

Autonomous farm machinery could offer solutions to future farming challenges and many of the developments shown at a recent event in France will move to on-farm trials or commercial availability this year. Jane Carley reports.

Robots march to market

The sixth annual FIRA robotics exhibition was run as a hybrid event at the end of 2021, with 36 robots presented both live at the venue in Toulouse in the south of France and online to more than 1,500 visitors.

The theme of the event was 'When farmers take over robots' and many of the workshops, roundtable discussions and pitches looked at how developments are advancing from the concept stage to a viable product which can be marketed to farmers or contractors.

Examples of how the industry is progressing are plain to see in host country France, with trade association Robagri boasting 71 member bodies, including research organisations, manufacturers and farmers. One of its objectives is knowledge transfer and Robagri presented a scientific workshop in which Athens University's Dr Spyros Fountas outlined developments in agricultural robotics for field operations following a study carried out by the university in collaboration with Wageningen



The FIRA event combined a live exhibition and conference with virtual presentations from around the world, all focused on agricultural robotics.

University in the Netherlands and the Fraunhofer Institute for Manufacturing, Engineering and Automation in Germany.

Research

The study found that most developments are currently focused on high value crops, such as strawberries and grapes, with wheat and maize close behind. Research is mainly targeting harvesting, weeding,

crop scouting and multi-purpose autonomous systems.

Dr Fountas said: "Weeding robots address future needs such as reducing manual labour requirement by up to 40%, along with the high environmental impact of herbicides and potential yield losses of up to 60% from failing to control weeds."

However, future needs include increased working area and speed for robots, early weed

detection, the ability to target more weeds in more crops and compatibility with new and more sustainable cropping systems.

Harvesting robots offer the greatest potential for fruit crops where timing is key and labour requirement is high, said Dr Fountas.

"Future needs include improved fruit localisation and increasing picking speeds to ▶

Robot awards

▶ FIRA and Future Farm Technology awarded their Best Multipurpose Field Robot Concept title to a familiar name, which has begun to stake its claims in the robotic arena.

The Horsch Roboter is designed as a tracked carrier which can be used for a number of tasks including seeding. It currently works in a 'partially autonomous' format using a

remote control and is authorised for a range of 500m. Horsch says that the next step will be a sensor system so that the machine can be monitored, for example, for coulter blockages.

Awards were also made to Canadian manufacturer Vermeer for its Bale Hawk autonomous bale collector and to Ripe Robotics, for the Eve fruit picking robot.



compare with human pickers. Crop cultivation systems and tree training may also have to be adapted."

Multi-purpose robots, to carry out a range of tasks which may in themselves only be carried out once- or twice-a-year, are starting to emerge, he added.

"There are platforms with various integrated or demountable tools and modular robots in development, which use different sensors for each task. They need to offer good performance for all tasks and a high level of modularity, while being adaptable for different tasks.

"Precision seeding using robots is also gaining ground, with accurate plant density contributing to high yields. Most prototypes are focused on cereals."

Automating spraying offers the opportunity for selective or spot spraying and reducing operator exposure, but low working speeds and adoption of real-time detection are limiting factors.

Detection

"Faster detection speeds, more spraying coverage and capacity and greater autonomy will be needed," said Dr Fountas.

Areas still in their infancy

Driverless tractor

»The multinationals have dabbled in automating established tractor systems, and specialist manufacturer Sabi Agri has also taken this approach with its Zilus Box for its electric tractor range.

The Robotic Operating System, currently at the proof of concept stage, can assist

the driver or work autonomously for repetitive work such as mechanical weeding.

Using LIDAR and GPS to steer in the row and make headland turns, trials are being carried out with research organisation INRAE for work in crops from vines to cereals and maize.

include disease and insect detection, which involves complex tasks and vision-based detection; crop scouting, with

challenges in big data computing and automation of data processing; and plant management, an area with particular

Range of multi-purpose robots on show

»Korechi Innovations, based in Ontario, Canada, presented two versions of its RoamIO autonomous machine, designed for tasks from cultivation to soil sampling and data logging.

The RoamIO mini automates standard implements such as a spreader and with its tracked chassis has minimal impact on wet fields. Power is supplied by batteries with eight hours runtime and navigation is via RTK with sub-inch precision. LIDAR and camera vision add collision avoidance and tracking. It can also be hooked up to an auxiliary computer for data logging from sensors.

The higher capacity RoamIO HCT offers nine hours runtime from its battery which can be supplemented with a generator. With an output of 17hp and top speed of 8.5kph, it can work with a wider range of attachments.

Both are operated via an Android app, either locally or remotely and the developers are also working on a voice command function.

»Agrointelli unveiled a new version of the Robotti system trialled on UK farms last year.



The latest version of Agrointelli's Robotti has a 300-litre fuel tank said to offer up to 60 hours runtime.

The Robotti LR 'long range' has its three-point linkage lift capacity increased to 1,250kg and a new GPS tower at the centre of its frame. Navigation is via RTK GPS with 3D LIDAR scanners offering obstacle detection.

Power is now supplied by a single 72hp Kubota diesel engine as this version is designed for use with hydraulic attachments, eliminating the need for a second engine to drive a pto.

The 300-litre fuel tank gives runtime of up to 60 hours, a significant increase on its predecessor. The Robotti LR is said to be capable of working on slopes up to 10%.

Future developments include

deploying vision cameras to add monitoring facilities and extending functions to spot spraying, for example.

According to Agrointelli, the use of a familiar power unit gives peace of mind on reliability, but it is also developing service backup with its local distributors.

»Swarm Farm operates 20 robots on 38,000 hectares in Australia, supplying a platform for third-party attachments, such as sprayers and mowers.

The diesel-powered Swarm Farm robots have four-wheel drive and a Category 2 three-point linkage and are supplied on a three-year operating lease. With customers spread

over 4,000km, the company carries out its own servicing, so remote monitoring via the Swarm View app is an important part of the package.

Capable of running for 24 hours unsupervised, the firm's robots use 'paddock data' to switch off at the end of a job and run along private farm roads to the next task.

Gathering weather data allows the robot to switch to Sleep mode if wind speeds exceed parameters for an operation, such as spraying. The company plans to scale production up to a machine a week by summer this year.

»Naio Technologies, based in the Haut-Garonne region of France, has 200 robots in operation around the world and recently launched a contract service in the USA.

New to its range is the Orio, designed for operations from seeding to hoeing in industrial or seed crops. The battery-powered robot has a runtime of eight to 12 hours and is fitted with central and rear hitches and the option for a pto. Expected to be priced at about €130,000 (£108,500), it will be available later this year.



potential for tasks such as pruning in vineyard and protected crops.

Developers

Taking robotic systems from the laboratory to the market is the challenge now facing many developers and Darcy Cook, general manager of JCA Technologies, a US-based company supplying customised tech solutions to original equipment manufacturers,

addressed this issue in a session on 'development of agricultural robots for scaled production'.

He explained that as developments cross from a customer base of early adopters to the majority, there is a 'chasm' where the offering not only needs to have a strong value proposition but also to be an effective and robust solution.

He said: "Success in the early phases does not necessarily translate to scaled production ▶"



Traxx emerges

»Spraying giant Exel Group launched the first product from its new robotics division Exact Robotics.

Designed for the company's important vineyard market, the Traxx is a narrow straddle tractor aimed specifically at steep land areas such as the Champagne region and Burgundy. It is used in an

autonomous mode to offer operators protection from slope, noise and chemical hazards, with LIDAR and GPS navigating along the rows and GPS providing the turn function. The company has chosen a diesel engine over batteries to reduce weight and the spray pack comes from sister company Tecnomat.

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systems. It requires robustness – which is not just reliability. It is a combination of reliability, usability, diverse use and support.”

Mr Cook defined ‘usability’ as the ability to be used by a wide set of users of different skill levels and ‘diverse use’ as the ability to operate across many conditions and in applications additional to the primary intended workflow.

Support will also be key, he added: “This is the ability for system issues to be resolved quickly and efficiently as well as to support upgrades and improvements over the life of the system.”

This last point is clearly hitting home with many of the manufac-

Lightweight scout

» Meropy has developed the SentiV scouting robot, designed to move in a random pattern within the field and scan vegetation.

Weighing around 20kg and 1m tall, its spoked wheels allow it to travel over crops without damaging them. Cameras are mounted on the body to film above the canopy and at the

rear to view below the crop. A field boundary or plot is uploaded to SentiV and it then works fully autonomously.

The 12MP camera offers high speed capture of plant biomass, allowing viability maps to be created. It is available for lease with service included for €5,000 per year (£4,166/year).



turers and start-ups that presented their innovations at FIRA. Some of the systems that we report on below are to be offered either on a lease basis or

as an operated service in the initial phase of their commercial availability and beyond. While this may be in part due to a reluctance – revealed in previous

research – for farmers to invest heavily in new technology – it also offers the opportunity to build guaranteed specialist support into the package.

Developments in weeding tools

» Weedbot’s Lumina system uses lasers to kill weeds and is being launched as a tractor-mounted implement for 2022, in addition to its autonomous format.

A pto-driven generator charges lasers mounted in a hooded frame, with images from a computer vision system used to control them. A modular design allows implements to be configured for different row widths and output is around 500 metres per hour. The main market is currently carrot growers but the artificial intelligence is also being applied to beetroot, spinach and baby leaf. The company claims sub-cm precision and 90% recognition of the green parts of the carrot.

Initial trials have shown that treatment of weeds up to 1cm diameter



Nexus claims its weeding robot can replace five workers, using gripper tools to pull weeds out by the roots.

weeding. When the value of the crop data gathered is factored in, the company predicts savings of €989/ha per year (£826/ha/year) compared with a hoe.

» Nexus Robotics estimates that its Le Chevre mechanical weeding robot could replace five manual pickers, equivalent to its 2022 commercial rental fee of €50,000 (£41,750) per season.

Using a camera system to guide three robotic arms which host grippers to pull the weed out by its roots, it is aimed at growers of field-scale vegetables, such as onions and carrots, with 90% weed removal claimed.

Le Chevre maps weeds as it works to improve performance via learning and can deposit larger weeds at specific positions to avoid crop damage. Scouting functions are also in the pipeline.

Gripper tools are tailored to the crop, with machines working in Florida in cabbages in 2021. A hybrid drive system offers 24-hour running with outputs of 1.2-2ha per day.

is successful and two passes will kill weeds up to 2cm.

Weedbot will initially be available for rental at €1,000 per hectare (£835/ha) and is being trialled in the UK by partners in Agri-Tech East.

» UK-based Earth Rover introduced its Concentrated Light Autonomous Weeding

and Scouting (CLAWS) system (below left), which uses a light beam in place of a laser to destroy weeds, while gathering scouting data.

Collecting data at plant level allows earlier detection of disease and the production of crop maps. The Lightweeder unit uses cameras and deep learning to detect weeds, before halting forward motion to apply a concentrated beam of light to each weed. Earth Rover suggests the technique is safer for operators, cheaper and more reliable than using lasers, while avoiding the potential crop damage and regrowth risks of mechanical

