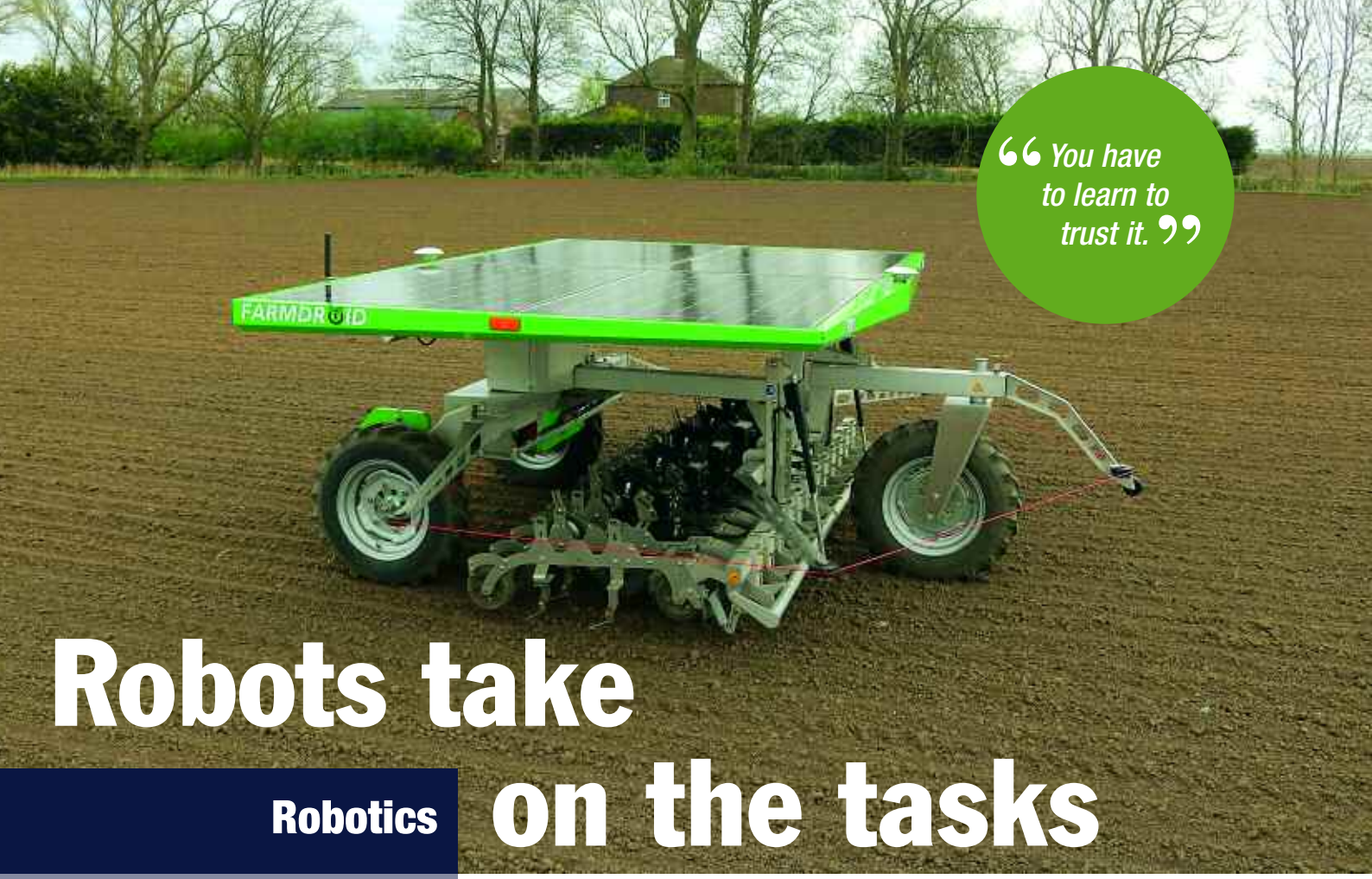

> “You have to learn to trust it.”

Robots take on the tasks

Robotics

It’s time to put your feet up and leave the tedium of fieldwork to autonomous machines. *CPM* travels to Lincolnshire to see the UK’s first seed-and-weed robot at work and to Hampshire to hear about pilot trials of a per-plant scanning service.

By Tom Allen-Stevens

The FarmDroid FD20 lines up on the headland of the 16ha field near Stamford, Lincolnshire, and the electric actuator lowers the 12 rows of coulters into the silty loam soil. Then, curiously, it shuffles a couple of cm from side to side.

“We call it the FarmDroid shimmy,” explains Angus Steven of Opico, who is demonstrating the autonomous, solar-powered machine. “It does a bit of a hip swing at the start of every bout to ensure the coulters and weeding wires are embedded just below the surface.”

Then it starts, slowly at first, and after a few seconds reaches its full working speed of 950m per hour.

Launched at Agritechnica in 2019, The FD20 is now sold in 18 countries, with six units currently running in the UK and more than 250 worldwide. Here it’s distributed by Opico, at a purchase price of £59,500. It’s claimed to be the first autonomous seed-and-weed robot, mainly for vegetable and sugar beet growers, although also suitable for oilseed rape.

Precision planting

Designed to run on a 20ha field, it takes about four days to precision plant the seed, using its own dedicated RTK guidance signal (costing an extra £4243). Then it turns straight round and starts weeding, remembering where each seed has been placed.

It’s powered entirely by the solar panels on its roof. These kick out 1.3kW in bright sunlight — more than enough to power the machine that uses no more than 0.8kW when seeding — with the rest charging up the 28V on-board battery. It’ll carry on through the night and simply stops when it runs out of juice, then starts up again once the sun rises, although it’s claimed it will operate fine even on a dull day.

According to FarmDroid head of sales and marketing Eddie Pedersen, once you’ve set it up in the field, you just leave the FD20 to do its thing. A smartphone-based app keeps you in touch and will inform you if there’s a problem. “You have to learn to trust it,” he says. Compliant with regulations for unsupervised robots, a wire around the machine triggers a shutdown if it comes across an unexpected obstacle.

So what about theft? “If it’s moved unexpectedly an alarm goes to the app, and it’s pretty useless if it’s disconnected. The individual components have a relatively low resale value,” says Eddie.

FarmDroid is the brainchild of Danish brothers Jens and Kristian Warming. “When Jens finished his education in ▸

Once you’ve set it up in the field, a smartphone-based app keeps you in touch with the FD20 which can be left alone to do its job, says Eddie Pedersen.

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It's a low-maintenance machine, but most in-field issues can be sorted out remotely, with the minimum downtime, says Angus Steven.

The metering disc (left) is 3D-printed and can be made to order. Seed drops down to the shoe (right) where a gate opens to let it into the soil at precisely the right moment.

▸ engineering, he was unemployed and started working on his parent's organic farm. But he soon got fed up of manual-weeding the sugar beet, so he went to a scrapyard and found the components he built into a machine that would do it for him," says Eddie.

Joined by his brother, the two then spent many long days in the field refining their prototype. "Eventually their wives issued an ultimatum to them that they must either turn it into a business or stop devoting so much time to it. In 2018, FarmDroid was founded and gained financial backing from robot pioneer Esben Hallundbæk Østergaard."

In 2020, FD20 version 2.0 was launched and is pretty much the same as the model introduced into the UK by Opico last month. It has a 3m working width and can be fitted with 4-12 crop rows at a minimum row distance of 22.5cm. On the toolbars, active and passive trailers are mounted in pairs. The active trailer has the moving parts — the seeding unit and intra-row weeder.

The seeding unit comprises a six-litre hopper, metering unit and double-disc coulter, designed to plant to up to 6cm depth into a fine tilth, with a usual working dept in most soil types of around 3cm. the seed disc inside the cone receptor under the hopper is 3D-printed and can be made to order, if the right one isn't already available — you can set it to seed different crops, seed sizes and populations.

There's no vacuum — the electric-powered unit drops the seed into the shoe and a gate opens to let it into the soil at precisely the right moment, as pre-determined through the app. "The FD20 works out the correct spacing for the desired plant population and knows where every seed is placed," notes Eddie. A light sensor in the unit will tell if there's a blockage and sends a notification to the app.

Downwards pressure

The trailer itself has a leading clod pusher and front and rear press wheels. There's a spring to apply downwards pressure, but with the FD20 weighing a total of 800kg, a fine tilth must be prepared if you're looking for good seed-to-soil contact. Either that or follow up with a set of rolls.

With the seeding done (which takes about four days for a 20ha field), you'll need a 10mm and 13mm spanner and less than an hour to adjust the FD20 for weeding. The whole toolbar is shifted along to offset it, then each seeder unit is tilted out the way and the intra-row weeder is brought into play.

This has a knife mounted on an actuator that passes just below the soil surface along the row. "It knows the location of every crop plant, so moves to one side at precisely the right moment, working to an exclusion zone that you set through the app," explains Eddie. It can work within 5mm of each seedling between rows and 20mm within the row.

In between each active trailer there's a passive trailer on which is mounted a simple weeding wire. This passes just below the surface carrying out the inter-row weeding. "The first weeding pass is a 'blind run' taking place before the crop has emerged, but the FD20 doesn't need a camera to see the plant to know where it is," says Eddie. "It will then carry on continually weeding for as many runs as required. You can shut off the intra-row actuator once it's no longer needed."

There are two powered wheels that also steer and will keep the robot on track even on slopes, he says. The front wheel swivels, allowing the FD20 to turn on its own axis. Although it doesn't need a camera for scanning, targeting or identifying weeds, there's one mounted below the panels trained on the toolbar that you can access via the app to keep an eye on progress. Although it applies a light footprint, it's not so lightweight it will be blown off course — the FD20 will stay safely in the field in winds up to 50mph.

Organic growers will get the biggest benefits from the FD20, says Eddie, although conventional growers will also make savings, especially for crops with limited herbicide availability. "It cuts down weeding time by 80-94% and reduces the ▸

The seeding unit on the active trailer (left), is tilted out of the way when weeding (centre). A knife mounted on an electric actuator (right) carries out the intra-row weeding.

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▸ workforce you need by as much as 15 to one. Farmers have found yields have improved by up to 40% compared with tractor-hoed crops. Depending on the crop, you can get a return on investment in less than a year."

There are eight Opico dealers ready to service UK farmers, says Angus. "After half a day's set up and instruction, during which we ensure you're completely happy with the FD20, there's not a lot more to it. The parts don't really wear out and there are no fuel or running costs."

The FD20 downloads its own software updates and there's a central monitoring station in Denmark — a bank of screens keeping tabs on every FarmDroid in the world (although it doesn't harvest your data, assures the company). "If there's a problem with a machine, it'll probably be sorted out before you know it," notes Angus.

"Opico also provides a remote-assist service if something goes wrong, which includes a remote-guide service, so we can instruct a non-technical person to make an adjustment and save downtime."

Grant funding for robot purchases may be available through Defra's Farming Transformation Fund. ■

Promise of "huge" savings from per-plant scanning service

Pilot trials undertaken by Small Robot Company (SRC) have revealed herbicide applications can be reduced to as little as 3% of amounts currently applied and fertiliser use can be reduced by at least 15%.

Its Per Plant Farming service will be rolled out this autumn, and SRC is currently actively looking to bring farmers into "Service Pods". This is where up to six local farmers commit at least 120ha to the weed mapping and plant count service. Around 1000ha have already been signed up, says SRC.

Each pod shares a Tom autonomous monitoring robot. This will scan the wheat fields four times in a season: soon after crop emergence, as it shuts down for the winter, post-vernalisation in February and in around April as spring growth kicks off before the canopy closes.

The pod will also have the option of a pre-crop green-spotting service that will detect green areas of a field for spraying with glyphosate, rather than treating the whole field.

In a pilot trial of the service in Suffolk, a sprayer with individual nozzle control was used to treat broadleaf weeds in a wheat field using a map generated by robot Tom in early spring. Just 3% of the field was treated.

The SRC team are also taking the plant density information and augmenting this with other metrics such as growth stage, physiology and weather, etc, to be able to support decisions on when and how much fertiliser to apply and exactly where it's needed.

Farmers within pods will be the first to benefit in terms of fertiliser savings which trials suggest will be around 15%, says SRC co-founder Ben Scott-Robinson, "But we believe that's just the tip of the iceberg in terms of the potential for what per-plant farming can deliver, both in input-cost savings and yield enhancement," he adds.

"It opens up a window on a new level of knowledge about wheat plants — the potential gains are huge."

During autumn 2021, robot Tom worked trial fields on three farms, scanning the crop to a level of detail that identified individual plants. It can successfully identify all the wheat plants, determining precise plant counts, as well as broadleaf weeds. This information can be used to inform variable rate fertiliser applications and to spot-apply herbicides.

Robot Tom v3 is the latest iteration of the autonomous scanning bot that has been trained to work with wheat in the UK. Its six on-board cameras, mounted on a boom, deliver a ground sample distance of 0.39mm per pixel — among the highest resolution of any crop-scanning technology, claims SRC. With a survey speed of 2.2ha/hr, robot Tom gathers 15,000 images from its cameras, or 40Gb of per-plant intelligence, for every ha.

"We can literally see individual water droplets on leaves," says SRC head of intelligence Tom Walters. The information on the crop is transferred to Wilma which processes the data and makes it available to the farmer through a web interface, he explains.

Two surveys were carried out in a farmer's field in Hampshire as part of the pilot trial in late October and December. "The previous crop was beans, and Wilma picked out the individual bean volunteers," he notes.

The 10ha field, that contains 22,099,559 wheat plants, was split into six tramline plots, with one tramline left untreated with an autumn pre-emergence herbicide. This gave accurate information on the efficacy of the pre-em, but it's the detail that Tom believes is more significant.

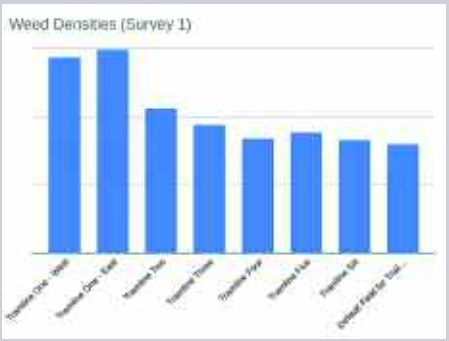
Another survey on a different farm showed up an area of slug damage, for instance, giving the patterns of how this developed. The weed survey revealed "surprisingly few" areas of the field where the density triggered the threshold of up to five weeds/m^2.

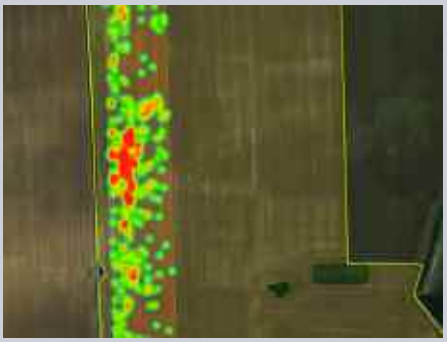
"There were weeds, but without this information, you'd blanket treat the whole field, rather than just where they'd be likely to cause a problem. A heat map of weeds in the field showed they were beginning to take over where the slug damage was," says Tom.

Every survey is training for Wilma, he adds. "One area that showed up as high weed density at the edge of a field was actually leaves from a tree. Wilma hadn't distinguished these from dicotyledonous weeds, and a green shotgun cartridge case was also picked up. The more data we have, the more Wilma learns and improves the model."

There are more details on the Service Pod and how to register your interest at *https://www.smallrobotcompany.com/servicepods.*

Farmers at a recent meeting in Hampshire hear about what robot Tom spotted in wheat fields this season.





Weed density data from the tramline plots (left) indicated the overall efficacy of the pre-em herbicide, but it was the detail from the weed heat maps (right) that offered more insight.