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Autonomous ambitions

Innovation
Automation & robots

Autonomous crop production has the potential to be game-changing for the future of farming – but does it stack up financially? *CPM* finds out more.

By Charlotte Cunningham

The benefits of automation and robotics in crop production have been circling for some time, but it seems there are a few key hurdles which are often attributed to standing in the way of wide-scale adoption on arable farms.

Namely these include cost and the actual capabilities of the technology, however, a new research paper has highlighted that arable crop production using autonomous equipment is both technically and economically feasible — and could help boost medium-sized farms.

The paper — published in Precision Agriculture, an international journal on advances in precision agriculture — is the work of four Harper Adams University academics, and uses experience from the university's Hands Free Farm project to demonstrate that medium-sized farms can produce arable crops at close to minimum per unit production cost levels.

These changes mean that the use of autonomous equipment could see greater independence for farmers, a chance for smaller farms to become cost competitive, and less requirement for farmers to 'get big or get out' in arable production, according to the report.

The study was headed up by Professor James Lowenberg-DeBoer, Professor Richard Godwin, Professor Karl Behrendt and senior lecturer Kit Franklin — and is claimed to be the first of its kind to be published.

"This paper is the first scientifically reviewed paper on either the Hands Free Hectare or the Hands Free Farm and published in a peer reviewed journal," says James.

Economic feasibility

"It focuses on the Hands Free Farm experience — and looks at the economic feasibility of robotics of the type which were used on the Hands Free Hectare.

"The Hands Free Farm is a great place to study the economics of crop robotics, which is presently a very sparsely researched area.

"As far as I can tell, this is the one place on earth — certainly within the public sector — where you can get information about a whole cycle for comparing results of the kind we did, particularly with autonomous equipment."

Because of the nature of the Hands Free Farm and Hectare projects, the academics were able to use data gained from them in the paper to show how crop robotics could be applied to arable agriculture — drawing upon actual field experience and real-life data which is unavailable to many other studies of crop robotics.

"Because the Hands Free Hectare used retrofitted conventional equipment, we know the costs of each piece of that equipment — you can work that out using the cost of the conventional equipment," adds James.

"It's a much better place to set out this kind of analysis from. The idea was to produce an economic study to help engineers and investors establish what would be the best use of this equipment.

"Much of this technology is becoming readily available and is almost there — and the Hands Free Farm showed it was possible."

The study noted that the costs of farming using the autonomous equipment used on the Hands Free Farm is substantially lower than on conventional farms, as the equipment involved is smaller and used far more intensively.

Digging deeper into costings, baseline models were used to assess the financial differences — divided into four different farm sizes and four equipment sets.

Farm sizes included:

- A 66ha farm (average farm size in the West Midlands)
- A 156ha – (the average size of a cereals farm in England)
- A 284ha farm (the average size of a cereals farm over 100ha in England)
- A 500ha farm (an arbitrary larger farm size)

The equipment sets included:

- HFH sized equipment (28kW tractor)
- HFH autonomous equipment (28 kW tractor).
- Smaller conventional equipment (112 kW tractor).
- Large conventional equipment (221 kW tractor).

The report concludes: "The ability to achieve near minimum production costs at relatively smaller farm sizes, and with a

A new research paper has highlighted that arable crop production using autonomous equipment is both technically and economically feasible.

modest equipment investment, means that the pressure for farming businesses to continually seek economies of scale — i.e. to "get big or get out" — is diminished.

"This provides the opportunity for modest size grain enterprises to become profitable instead of being a lifestyle choice. By reducing the need for labour and equipment investment, these enterprises could be combined with livestock, on-farm value added activities or off-farm employment to provide enough income for family needs."

James adds: "People who talk about autonomy sometimes say 'but what about all those people who will lose their jobs?' — but in arable agriculture, those jobs have already gone.

"What autonomy can do is help create new opportunities. With autonomous equipment, for instance, it will be possible for many more farms to become organic.

"With autonomous equipment, and a little bit of AI, you can create machinery which enables farmers to do things at much more competitive prices.

"So if the policy framework around autonomous equipment is well-aligned, it can help to create new opportunities for farming — and new opportunities for young people."

While specific robotics companies and novel start-ups have been working on bringing viable solutions to market for some time now, mainstream manufacturers are now following suit.

Among those is Horsch, which is also working on developments from task automation to autonomous driving systems — with the Horsch Roboter working as a development platform for the company to explore autonomous technologies.

Michael and Philipp Horsch have been focusing on automation and autonomous driving systems since the early 2000s, when they bought the first AutoFarm GPS steering system.

First RTK system

It was the first RTK system which allowed for driving within the range of a centimetre. "We immediately thought if something like this works, we should also be able to drive completely autonomously," says Michael. "When we bought our test farm AgroVation in the Czech Republic, we had the chance to focus on controlled traffic farming and track planning. We originally started with an agronomic point of view, but we soon realised that CTF first and foremost is about planning. This was another step towards autonomous driving systems."

There are many things associated with the term autonomous that Philipp says he would rather call automation. "Take the example of a tractor that drives with GPS and can reverse on its own. This only is an automation step, there is still somebody sitting on the machine who controls it.

"Autonomous means there is no driver and we are talking about different vehicles, vehicles without a cabin. What

The Hands Free Farm is a great place to study the economics of crop robotics, which is presently a very sparsely researched area, believes James Lowenberg-DeBoer.

is extremely important is that automation comes before autonomous driving.

"It's definitely the first step. Automation has been an important topic for years and we have been making good progress. However, there still are quite a few hurdles to clear until we reach complete autonomy," he explains.

To be able to work in a partially autonomous way today, there are three requirements: the track planning system, geofencing (a digital fence) and the safety issue, says Philipp. "Today, we solve it by placing a 'driver' with a remote control in the field to monitor everything and to intervene in case of emergency. The remote control is effective for a 500m range. These aspects ensure that we can work in the field in a partially autonomous way and be safe."

The next step will be a sensor system so that the machine can be monitored, for ▸

A summary of solutions for representative farm sizes with temporary labour available.

Scenario	Arable area (ha)	Labour hired (days)	Operator time (days)	Whole farm gross margin (£/year)	Return to operator labour, management and risk taking (£/year)	Wheat cost of production with operator labour costallocated (£/t)
Conv 28 kw	59.4	0	79	47.048	15.846	168
Conv 28 kw_2	143.1	72	118	107.759	36.344	150
Conv 28 kw_3	255.6	195	144	187.237	64.923	140
Conv 28 kw_4	450	411	186	302.920	99.321	137
Autonomous	59.4	0	26	47.048	12.301 1	40
Autonomous	143.1	8	54	112.691	46.891	125
Autonomous	255.65	0	62	198.587	78.340	122
Autonomous	450	121	76	347.015	141.936	118
Conv. 112 kw	59.4	0	28	47.048	-26.001	212
Conv. 112 kw	143.1	0	68	112.243	8142	157
Conv. 112 kw	255.6	31	89	200.017	54.178	136
Conv. 112 kw	450	108	104	331.989	63.017	140
Conv. 221 kw	59.4	0	16	47.048	-70.973	288
Conv. 221 kw	143.1	0	39	113.343	-35.731	182
Conv. 221 kw	255.6	1	69	202.371	11.560	152
Conv. 221 kw	450	35	87	353.677	90.743	131

[Source: Economics of autonomous equipment for arable farms report, Precision Agriculture 2021. Superscript under scenario indicates the number of autonomous equipment sets]

Dutch innovation looks promising for UK growers.

Last month's issue took a brief look at AgXeed's AgBot following its launch at the Cereals Event.

But for those who are interested in the viability of how it could be useful on farm, here's a more in-depth insight…

In summary, the AgBot Ecosystem — from Dutch firm, AgXeed — is a digital path planning, autonomous task performing and automatic data collection robot, which can be controlled with just a couple of clicks.

Using existing and standard tools on your farm, AgXeed says the AgBot Ecosystem is ready to use right out of the box.

As part of the offering, users are provided with an autonomy system with scalable and customisable hardware, virtual planning tools and valuable data models.

Looking at the technical specifications, the AgBot features a 4.1-litre, Stage V engine, with a pony count of 156hp and maximum torque of 610Nm.

As well as the automation benefits, the optional crawler tracks — with belt widths from 300 to 910mm, combined with a low maximum weight of 6t (without ballast) — make it a soil-friendly option too. The vehicle also features an adjustable track width, load-sensing hydraulics and a linkage with a lift capacity of up to 8t. Crop clearance comes in at 42cm.

An electric PTO, independent of the engine speed, and external high-voltage connections are also optionally available. The electric equipment includes all the technology required for hazard and obstacle detection, in addition to an RTK steering system.

The AgBot Ecosystem is a digital path planning, autonomous task performing and automatic data collection robot, controlled with just a couple of clicks.

Visually, it looks like something out of sci-fi film and with its quiet, stealth like movements and approach to tasks it almost creates an eery feel on farm — but could this be the future?

The Horsch Roboter is working as a development platform for the company to explore autonomous technologies.

▸ example, clogging detection, he adds. "From a technical point of view, we are working on different concepts. We know we have to take different concepts into the field, exercise respectively, learn and develop further."

Michael adds that putting autonomous driving systems into practice requires not only technical innovations but changes in the law. "At the moment, the law treats the road and field as equal."

He says there are significant differences regarding different speeds on road and in the field and the issue of opposing traffic. "The need for a re-definition and the public pressure to finally create appropriate framework conditions is enormous. If we separated road and field, we could get started in the field much faster."

Another point he considers to be essential is the possibility of the accreditation of the safety concepts, such as camera systems, radar and lidar systems. "We hope that in the next few years the safety systems will have developed in such a way that they can be homologised, from a technical point of view we are ready. All this is perfectly sufficient for a test farm, for this is where we want to gather experiences, test machines and integrate them into the farm processes."

In the future, Michael reckons the realisation of the technology will mainly be borne by the next generations who grow up with today's digital conditions. "The time of the generation that is into fully air-conditioned cabs and a showy bonnet is coming to an end. The next generation is already waiting in the wings — the 14 to 18 years old and digitally native. The ability to deal withtouchscreens, smartphones and tablets is almost innate. These young people control everything that moves completely intuitively and without ever having read a user manual. The users are already there. We have to meet their requirements." ■

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