AGRICULTURAL EQUIPMENT

# AUTOMATION is on a roll

*GPS-assisted steering is increasingly accurate and facilitates mechanical hoeing.*

**Automated equipment is on the increase on farms, from autosteering to spraying and mechanical weeding. Arvalis reviews the level of development reached by the different technologies.**

The most common form of automation is currently GPS-assisted steering. It appeared in the 2000s and optimises tractor work in fields by limiting gaps and overlaps. The latter account for 12% of soil cultivation, 5% of cereal harvest work and 2% of sowing and spreading operations. The driver no longer touches the steering wheel, instead he or she monitors the tool's work. Besides ensuring consistent quality regardless of visibility (gully, fog, etc.), it provides essential comfort.

## Omnipresent and high precision steering

The accuracy of an autosteered system depends on the type of servo-control used (hydraulic or electric motor), and the decimetric or centimetric RTK GPS correction. GPS-based journey optimisation can even make automatic U-turns possible. This technology has been available for several years, but it is definitely not mainstream in France. It will ultimately lead to autonomous tractors. Although they are already demonstrated at events such as the SIMA show, those prototypes will definitely not be in our fields for another decade.

GPS use also optimises spraying. Autosteering limits overlap between passes, and switching off certain boom sections limits overlap over already sprayed areas. Already installed on most sprayers, boom section closure devices reduce overlaps by around 3%. This figure depends on the section's width and the parcel size, and not its shape.

For a given section width, the resulting overlap will be the same whether the switching off is operated manually or automatically by the GPS. The GPS device's only advantage is that its reaction time

is faster than the driver's. Those devices are currently evolving towards individual nozzle closure systems. This has been launched on the market, but is not yet widely used.

## Innovation is the name of the game in spraying

Four years ago, we saw the introduction of automatic selection nozzle bodies. In 2016, it was the turn of pulse nozzles, or PWM. They have a similar purpose, which is to ensure consistent quality of spraying, regardless of forward speed, and to vary the volume of spray mixture according to a spraying recommendation map. The automatic selection nozzle body, with 2 or 4 nozzles, makes it possible to go from one nozzle to a combination of nozzles, or vice-versa, depending on the expected output. The idea is to use each nozzle within its optimum pressure range. Tests carried out by Arvalis between 2014 and 2016 on different equipment (Tecnoma and Amazone) show that they work: the rate applied matches the requested rate (between 50 l and 200 l/ha). The PWM is a nozzle body equipped with an electric solenoid that regulates the nozzle opening and closing at given intervals. The system varies the output by altering the length of the nozzle's opening cycle. Tests carried out by Arvalis in 2016 with the manufacturer Raven Industries indicate that the rate applied matches the requested rate. Direct injection is an older technology and consists of carrying clean water in one tank and various "neat" products in others. It has been tested with Raven Industries and Spray Concept equipment, combined with a GPS. It reacts to a recommendation map, but the time necessary for the correct rate to come through varies from 30 to 60 seconds. This year, new equipment (by Diimotion) should reduce this delay to within a second; this will need to be verified by tests.

Each of those innovations could potentially affect all the different functions of a sprayer (fungicide application, weed control, etc.). However, we do not yet have at our disposal all the agronomic criteria necessary to create recommendation maps.

*Three teams battle it out at the Culturales field event in 2017: 3 students from UniLaSalle (1st prize with their H3VR weed control robot), Vesoul Agro Campus (2nd with Small Weeders) and Université de St Quentin (3rd with BatBot).*

## Increasingly precise weed control

Research work is currently focussing on precision weed control. This involves, first of all, locating weeds with a sensor linked to a data processor. The weed control operation is either immediate, with real time spraying, or deferred and carried out during a second pass. Deferred spraying requires extremely precise positioning. Detection and spraying vectors must have the same spatial reference, so that the nozzle or boom section open exactly at the right time.

Because of the size of weeds, and therefore the required image resolution, the detection sensor is located on a tractor, a drone or a robot. On board a tractor, Trimble's Weedseeker has been used for around ten years in the United States. It is a multispectral sensor (NDVI measurement) that measures the average reflectance over an area with a diameter of around 30 cm. If any vegetation is detected in that area, a wide inter-row for example, the sprayer nozzle opens up. The trigger is fast, as the measurement analysis is simple: anything green is considered as a weed and will therefore be sprayed; this means that Weedseeker can only be used on stubble or bare soil.

Companies such as Bilberry mount cameras (imaging sensors) on the sprayer boom. In that case, the image (weed, crop or bare ground) must be analysed instantly. The main constraint is therefore the analysis time lapse, which currently limits their use in real time. Similar developments are afoot for drones, both with multispectral sensors and cameras.

*Ecorobotix's weed control robot identifies a weed by comparing the image taken by its camera to its image library, then sprays the weed using one of its two arms.*

## Robotic weed control is on the up

At the moment, robotic prototypes are giving us a glimpse of real time detection and spraying in arable crops, but the throughput is very slow and varies depending on weed diversity. Ecorobotix is one of the first arable crop robots. The others are positioning themselves on the vegetable market (Garford's Robocrop Spot-on Sprayer).

For mechanical weed control, the hoe can be steered via a camera, or by the tractor's autosteering system. The latter is mainly used by seed producers and organic farmers. Tests carried out by Arvalis at Boigneville, near Paris, show that it is possible to hoe cereals 15 cm apart, provided the RTK autosteering parameters are perfectly set and the tools are properly centred. This technique can also be used on a slope with a gradient of up to 10% according to tests carried out in Montans, southern France, in 2016. If the slope is steeper, the tool must be actively steered. A

GPS aerial then controls its progression independently from that of the tractor. Recordings are being made on farms.

The first robots capable of mechanically controlling weeds were designed for vegetable producers, whose crops have a high added value. Naïo's Oz robot must hoe between the rows of vegetables; given its width and speed, its throughput is low (slightly below 0.1 ha/h for a crop sown with an 80 cm inter-row). Tests carried out at Arvalis's St-Hilaire and Montardon stations on maize show that several passes are necessary to reduce weed density. Naïo is currently developing Dino, a larger prototype with a throughput 2 or 3 times greater than current products. As for Carré, its Anatis robot can hoe several rows simultaneously. Initially designed for vegetable production, those robots could eventually evolve towards arable crop applications. Many other crop operations are also benefiting from technological progress. One example is the detection of insects, like tomato fruitworms, with microphones placed in traps (CAP2020's CapTrac system). The possibility of pre-symptomatic detection of diseases using thermal infrared is also being investigated; it is achievable in lab conditions, but more difficult in a field. Although initial developments focus on crops with a high added value, those innovations will eventually reach field crops. The question is which technology and sensor-vector combination will farmers be interested in?

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**"Rob'Olympiades", or agricultural robot Olympics**

The Culturales show hosted the very first Rob'Olympiades on 14th and 15th June 2017. This robotic competition is designed to promote digital farming and innovative environmentally friendly systems. The robots had to move in a straight line between two rows of beetroot, do a U-turn and move into the adjacent inter-row. They then had to turn the soil over down to a given depth, to simulate mechanical weeding. Each robot also had to detect a green target representing a weed on bare soil, spray it with a coloured product proving that it was able to spray a plant protection product accurately.

*Editor's note : The Rob'Olympiades were repeated on 6th and 7th June 2018 in l'Isle-Jourdain (southern France) during the Culturales Sud event, and 5th and 6th June 2019 close to Poitiers*