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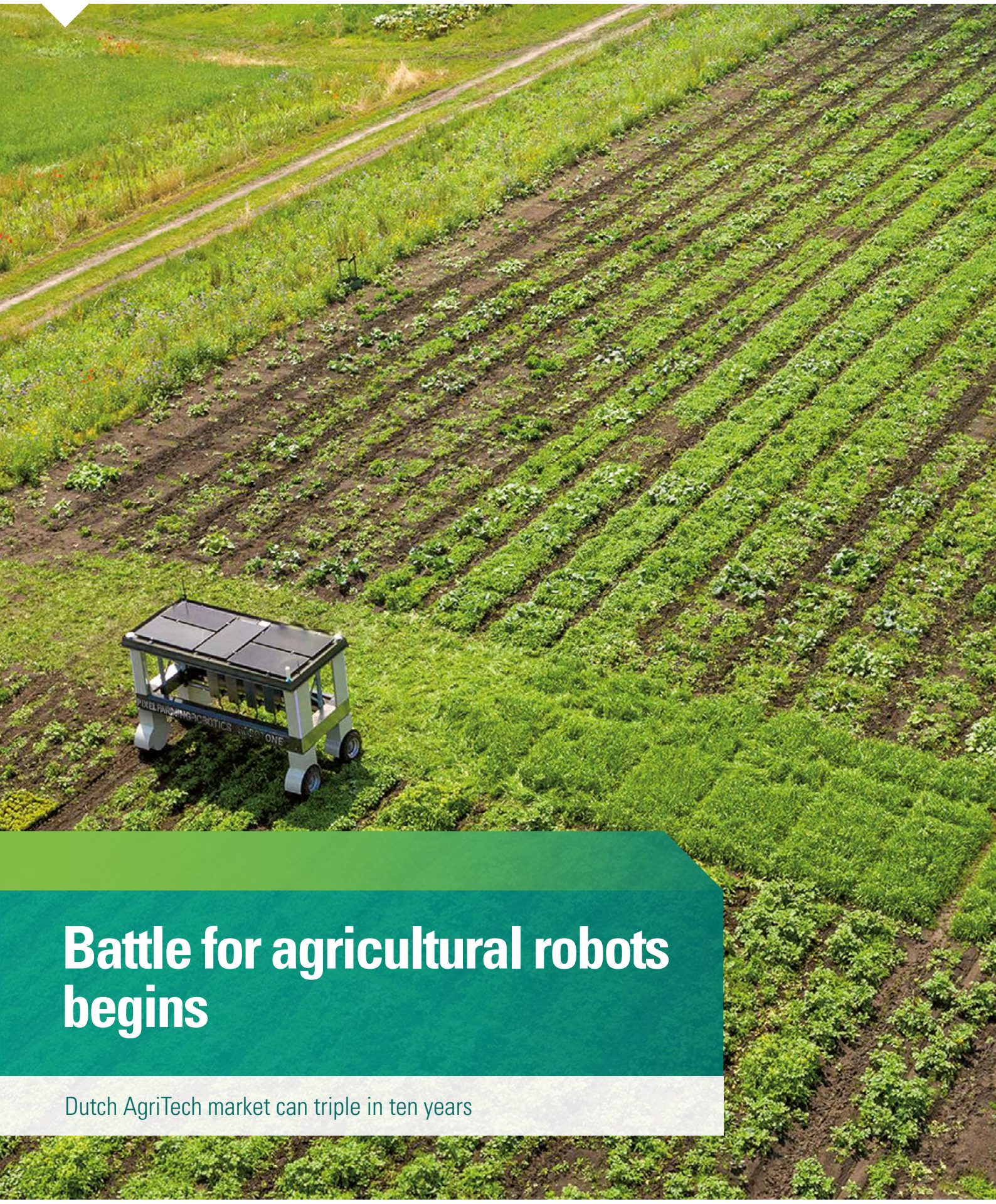

Battle for agricultural robots begins

Dutch AgriTech market can triple in ten years

August 2020

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Global population growth, labour shortages, scarcity of agricultural land and the need for sustainable food production will give a tremendous impulse to agricultural robotisation. ABN AMRO estimates current worldwide revenue in the 'AgriTech market' at more than EUR 6 billion. The Dutch market holds a share of 11.5% in that market, mainly thanks to milking and feeding robots. If the existing bottlenecks are addressed, the Dutch AgriTech market has the potential to triple in ten years from EUR 715 million to EUR 2.5 billion in 2030; that is an average growth of 13% per year.

The outbreak of the COVID-19 crisis has increased the need for changes in the food chain. Labour shortages, for instance, arose because migrant workers returned to their home countries due to the crisis. This affected the harvest of various products. Lack of labour is a structural problem in the agricultural sector, incidentally. Both agriculture and horticulture have long struggled to find sufficient skilled and motivated workers to get the work done in time.

In addition, the number of people facing acute food shortages since the COVID-19 crisis can double this year to 265 million due to growing poverty and logistical problems in the food supply.[1] This increases the urgency of the existing global food challenge; global population growth means that more mouths need to be fed, while ongoing urbanisation is leaving less land for agriculture.

Moreover, climate change threatens to make part of that already limited land unsuitable for agriculture. Optimal yields, after all, can only be achieved on fertile land with sufficient nutrition, water and sun hours. The shortage of resources such as fresh water, organic matter and fertilisers presents an extra challenge.

'Our current method of food production has reached its limits', says Jakob de Vlieg, Professor in Applied Data Science and Head of AgriFoodTech at Eindhoven University of Technology and Jheronimus Academy of Data Science (JADS).

Sustainability and the biobased economy

The enormous task resting on agriculture is made even more complicated by the need to protect the long-term viability of our planet. Sustainably produced food can make a big contribution to this goal and is high on the agenda of consumers, businesses and governments.

As a consequence, any intensification of agriculture can only take place under strict conditions. Accordingly, the European Commission's ambitious Farm to Fork plan requires the livestock farming sector to reduce its current use of chemical pesticides and antibiotics by 50% by 2030. And the use of fertilisers must decrease by 20%. Towards that time, 25% of the EU's agricultural land must also be organically farmed. With the current state of technology, more sustainable agriculture often requires more labour, which makes the task even more complicated. Furthermore, the trend towards sustainability means that the limited agricultural land is not just used for food production, but also for the biobased economy. Some crops, for instance, serve to make 'biomaterials'; fibres that are used in composites, paper, textiles and construction materials. Others, such as sugar cane and maize, are used as 'energy crops' to manufacture fuel. Finally, agricultural land is also being used for solar farms.

1 The United Nations

Robotisation receives growth spurt

Clearly, pressure on the shrinking agricultural area is mounting. And the enormous productivity increases in recent decades thanks to advancing technology and better plant varieties have not solved the problem. The reason is that agricultural intensification has led to a severe deterioration of the quality of the soil across the globe. One cause is the use of heavy equipment. The wheel load of tractors, harvesters and other machinery has doubled between 1980 and 2010[2]; that is a major cause of soil compaction.

> "Harvesting robots also help against soil compaction."

About half of the Dutch agricultural soil is excessively compacted.[3] This makes it more difficult for water and oxygen to enter the soil, leading to productivity and revenue loss. Maize yields, for instance, are 10% to 20% lower due to soil compaction. In addition, compaction negatively affects soil life and biodiversity and undermines the soil's function as a water storage reservoir.

In this light, further innovation is vital to produce sufficient food in a sustainable manner. One answer is the larger-scale use of robots. Small harvesting robots, for instance, can be deployed to prevent soil damage. Wageningen Research is currently carrying out experiments with such robots in two projects (Nationale Proeftuin Precisielandbouw and Strokenteelt). Small-scale agricultural and horticultural robots are already being marketed by importers such as Abemec and via the Ducksize platform.

But robot applications go much further. The dairy sector, for instance, can use robots to milk and feed cows and remove manure. Drones and ground sensors can provide accurate measurements of soil quality and air humidity. And advanced monitoring systems can keep track of the health condition of animals and plants. In short: the AgriTech market is poised for an international growth spurt in the coming years.

Dutch parties can benefit

Dutch suppliers are well-placed to benefit from the robot revolution, not least thanks to their strong position in the market for agricultural equipment. But the market is highly competitive. Companies in countries like the US, Australia and China are rapidly developing know-how and technologies and are competing on the world market with their innovations.

In this publication, ABN AMRO sketches the current state of the AgriTech market based on market research, interviews and research analysis. First, we will deal with two key drivers of the anticipated growth: labour shortages and the sustainability trend. Next, we look at the global and Dutch markets and identify existing bottlenecks.

2 Wageningen UR Alterra and Plant Research International
3 Council for the Environment and Infrastructure, 'De bodem bereikt?'

1. Growth driver: labour market

One prominent growth driver in the AgriTech market is the extreme dependence on agricultural workers. Seasonal workers in particular are often in short supply. The COVID-19 crisis has made this all too clear: the harvest of various products stalled when the virus caused migrant workers to return home.

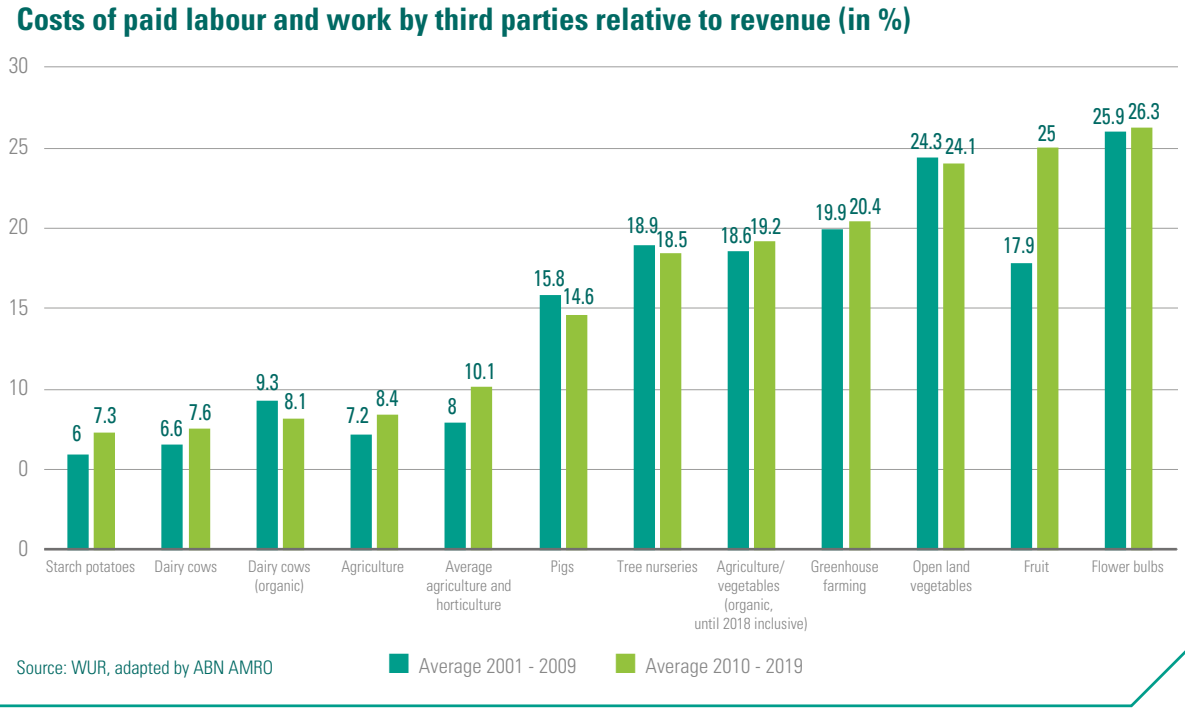
But, as the situation in our own country shows, the problem is more structural. Early in 2020, 18% of Dutch agricultural firms saw a shortage of labour as an obstacle to their work. The number has now fallen slightly to just under 14%, but that is still a lot higher than the percentage of just over 3% four years ago. The labour market indicator of ABN AMRO, which takes account of the willingness of job seekers to travel and their professional interest, shows that seasonal agricultural workers and employees for dairy farms and tree nurseries are hard to find. The same applies to operators of agricultural machinery such as tractors, seeding equipment, harvesters and sprayers.

The shortage of labour is expected to become even more pressing in the coming years. Erik Pekkeriet, Programme Leader of Agro Food Robotics Erik Pekkeriet at Wageningen University & Research, sees this as a global problem. He mentions China as an example. 'Young people there are migrating to the cities where they can get better paid jobs in far more pleasant living conditions. They are no longer prepared to labour on the land in the heat.'

Similar problems apply elsewhere. Japan's agricultural population is ageing and the United Kingdom faces a shortage of migrant workers for the next harvest period due to COVID-19 (and possibly also Brexit). 'Harvesting, sorting and packaging require a huge amount of manual workers and the problem is becoming untenable around the world', says Pekkeriet.

One important consequence is the rising cost of labour. In the period from 2010 to 2019 the cost of paid labour in Dutch agriculture and horticulture averaged 10% of the revenue versus about 8% in the previous decade. Conventional dairy farming, greenhouse farming and agriculture are among the sectors that have seen an increase in costs (see Figure 1). The causes are partly specific to certain segments of the market. Tomato growers, for instance, are increasingly cultivating varieties with smaller fruits, which require more labour.

Figure 1: Rising cost of labour in Dutch agricultural sector



Labour shortages: an opportunity for robot manufacturers

In view of the rising cost of labour, the general scarcity of labour and the decreasing availability and quality of seasonal workers, investing in automation and robotisation is becoming a better financial option.

> "Various asparagus growers face a 30% shortage of manual pickers."

Cerescon, a manufacturer of asparagus harvesting robots ('Sparter'), immediately points to the labour shortages in the agricultural sector. 'Various growers are currently facing a 30% shortage of manual pickers. Requests from growers for the Sparter have doubled since the COVID-19 crisis', said the Heeze-based company in May of this year. An asparagus harvesting robot, which uses underground detection to harvest asparagus before it rises above the ground, can replace up to 25 asparagus pickers. In the meantime, 400 growers have expressed an interest in the robot.

Robotisation will receive a further impulse when manufacturers are able to offer their products at an acceptable price. Cerescon worked closely with tech firm MTA to enhance its asparagus harvesting robot and make it suitable for serial production. As a result, the robot now works twice faster and its cost has been cut by no less than 40%. 'The grower's revenue model is essential in the development of agricultural robots. Everything must be right', says Commercial Director Patrick Geerts of MTA.

2. Growth driver: sustainability trend

The other prominent growth driver for the AgriTech market is sustainability. This subject is rising on the agenda of consumers, businesses and governments.

One consequence is that the limited agricultural land is no longer exclusively used for the cultivation of food. Some crops serve to produce 'biomaterials'; fibres that can be used in composites, paper, textiles and construction materials as an alternative for less sustainable materials. Other crops are cultivated for the production of organic fuels. Sugar cane, for instance, can be turned into bioethanol.

Table 1: Relatively little agricultural land per inhabitant in the Netherlands

(ha)	Area	Land area	Agricultural land	% agricultural land	Population (2020)	m² per inhabitant
World	51,000,000,000	14,900,000,000	5,100,000,000	34.2%	7,793,923,000	6,544
EU-28	447,600,000	399,676,457	172,967,400	43.3%	513,000,000	3,372
Netherlands	4,154,300	3,388,300	1,796,260	53.0%	17,800,000	1,009

Source: FAO 2015

At the same time, more and more mouths need to be fed. The global population is now 7.8 billion inhabitants and, according to the United Nations, is set to grow to 9.6 billion in 2050. Agricultural production levels must clearly be stepped up, particularly as the available agricultural land will shrink further due to urbanisation and nature development. The PBL Netherlands Environmental Assessment Agency estimates that almost 6,000 square metres of agricultural land is necessary to sustain current Dutch consumption levels, including clothing, wood and papers. That is six times more than the land available in the Netherlands itself (see Table 1).

But the efforts to improve efficiency must be subject to restrictions. The EU is aiming for a 50% reduction in chemical pesticides and antibiotics by 2030, and a 20% reduction in fertilisers.

And the EU also wants 25% of the agricultural land to be organically farmed towards that time. These objectives make it much more difficult to boost agricultural productivity. After all, if you use less pesticides, fertilisers and antibiotics, you need a lot more manual labour to work the fields and tend to the animals. And, as we saw in the previous chapter – even if sufficient workers can be found – their wages are likelier to rise than fall.

Robotisation essential to guarantee food security

Clearly, simply using even more traditional mechanisation is not enough to resolve the growing scarcity. This equipment is still labour intensive and also has a heavy impact on the soil. Fertiliser applicators, combine harvesters, beet harvesters and tipping trailers, for instance, place a heavy burden on the soil during the cultivation of maize, corn and root crops. This results in severe soil compaction.

According to the Council for the Environment and Infrastructure, half of the Dutch agricultural area is too compacted to let in sufficient oxygen and water. This leads to loss of productivity and revenue: maize yields, for instance, are 10% to 20% lower due to soil compaction. In addition, compaction is harmful to soil life and biodiversity and undermines the soil's function as a water storage reservoir.

Robotisation is therefore imperative. 'There are robots that can pull out weeds and fight pests and disease', says Corné Rispens, founder of the robot comparison platform Ducksize. He also asserts that field robots can replace heavier mechanisation to reduce soil compaction. HWodKa, an agricultural association, holds the same view. It started to advocate more robotisation as early as 2016.

Robots and AgriTech are also increasingly being used to keep crops weed-free. The German seed improvement company Strube has teamed up with a robot manufacturer (Naïo Technologies) and research centre (Fraunhofer EZRT). Its aim is to use weeding robots in order to cultivate sugar beets without pesticides.

Another German manufacturer, Lemken, sees similar opportunities. Five years ago it opened a factory for the production of field pesticide sprayers. This factory will be closed at the end of this year, partly due to growing regulatory and consumer opposition to chemical pesticides. Lemken, together with its Dutch subsidiary Steketee, will now focus on sustainable mechanical weeding and selective crop protection. The company's machines are equipped with smart cameras and automated control systems and, as such, belong to the AgriTech market.

3. Market size: substantial growth expected

AgriTech, as defined for this report, comprises diverse types of field robots, drones, milking and feeding robots. It also includes related hardware, such as field pesticide sprayers, weather stations and services (e.g. data analysis software).

Based on our own research, interviews with market parties and analysis of various research reports, we estimate the global revenue of this market at EUR 6.2 billion. Driven by the aforementioned labour shortages and sustainability requirements, this market will double in five years time, with annual global growth averaging 15%.

Major manufacturers and suppliers tend to be large multinationals, such as John Deere and AgLeader (both US), Bosch and GEA (both Germany), XAG and DJI (both Chinese drone manufacturers) and Lely (Dutch milking and feeding robot manufacturer). Numerous start-ups and scale-ups can also be found in countries with large home markets such as the US, Australia, France and Germany.

Competition is growing strongly in the AgriTech sector. Producers around the world are keen to tap into the vast growth potential of this market. The Chinese government has launched an ambitious plan: 'Made in China 2025'. The aim is to make China the world leader in agricultural technology. Other formidable competitors include tech giants with strong track records in software, hardware and data processing. 'Companies like DELL, Google, Intel, Microsoft and IBM are looking to serve the agrifood market', says Pekkeriet of WUR. IBM, for instance, owns The Weather Company, which delivers hyperlocal weather forecasts to help farmers plan their seeding, irrigation and harvesting.

Dutch market share over 11%

With a revenue of EUR 715 million, Dutch manufacturers hold a market share of no less than 11.5%, but that figure is deceptive. The high percentage rests mainly on the Netherlands' very strong position in milking and feeding robots; its market share in other segments is significantly lower. However, we see the strongest growth potential in less mature markets, where Dutch manufacturers still have a relatively weak presence. Table 2 shows the global revenue of Dutch manufacturers by type of activity. The rest of this chapter deals with this aspect in more detail.

Table 2: Dutch AgriTech revenue is growing fast

in millions of euros	2020	2030	Annual growth (CAGR)
Agridrones & services	8	30	14%
Precision agriculture (hardware)*	60	250	15%
Field robots	1	15	31%
Barn robots (e.g. milking, feeding and manure removal robots)	630	1050	5%
Software, sensors, data analysis, platforms & services	16	1155	53%
Total Dutch AgriTech market	**715**	**2500**	**13%**

Source: Estimate and forecasts ABN AMRO

*e.g. field pesticide sprayers, manure spreaders and irrigation systems

Data analysis, software and milking and feeding robots

The strongest-growing AgriTech segment comprises suppliers of data analysis, software and related services. In 2030, this segment alone will generate a revenue over EUR 1 billion, driven partly by advances in Artificial Intelligence technology. Start-ups operating under the umbrella or with the assistance of technical universities and European subsidies are benefiting from this trend. Together with these firms, Dutch livestock farmers are experimenting within the 'Connecting Agri & Food' platform with sensors that keep track of air humidity, temperature and CO_2 values.

The market for milking robots is dominated by about ten large machine builders that operate all over the world. Netherlands-based Lely is market leader and achieved 50% revenue growth in 2019, largely thanks to the success of the Astronaut A5 milking robot. DeLaval, GEA, SAC, Fullwood and Boumatic also jointly sell hundreds of milking robots worldwide.

Dutch manufacturers of milking and feeding robots already hold an extremely strong market position, so their potential for further annual growth is limited. This is understandable, as milking robots were the first robots to become commonplace on farms all over the world. The Dutch home market is leading this trend: one in three milking parlours have at least one milking robot, according to Stichting KOM. And this percentage will rise further as over three quarters of farmers invest in new milking robots when they build, renovate or expand their barns.

> The Netherlands is a very big player in the market for milking and feeding robots.

Some milking robot manufacturers sell feeding robots as a logical complementary activity. In addition, there are about ten specialised manufacturers of feeding robots. Examples are the Dutch companies Trioliet, Boreco, Peecon and Schuitemaker. Connecting the data of milking and feeding robots is an exciting option that can lead to new insights, higher milk yields and better animal welfare.

Field robots in the air: agricultural drones

Agricultural drones are the biggest sellers worldwide in terms of numbers. Large Chinese, Japanese and US manufacturers (DJI, XAG, Nileworks, AgEagle, Yamaha and SenseFly) sell thousands of drones every year. These agricultural drones start at five thousand euros each, excluding cameras, sensors and data analysis services. These services are provided by companies like DroneDeploy and PrecisionHawk. Agricultural firms with extensive areas of land (typically in the US, Canada, China and Australia) make daily use of drones to collect data and spray crops (if permitted) against weeds and disease.

Estimates for the global market for agricultural drones vary widely. The calculations often include the expected revenues from drone-related data analysis services. The MarketsandMarkets report 'Agriculture Drones, global forecast to 2025' expects the market to grow from USD 1.2 billion in 2020 to USD 5.7 billion in 2025. The expected annual growth is 36%.

Apart from several start-up drone builders (e.g. Drone4Agro, PATS, Atmos and Avular), most Dutch companies active in this area (e.g. DroneWerkers) specialise in services such as drone operation, scanning and data analysis. With this input, farmers can make field maps to plan their work in a more targeted manner. Current Dutch production is estimated at just under EUR 8 million. However, this is expected to grow strongly to about EUR 30 million in 2030. Dutch players are well-placed to experiment in their home market. Because up-to-date crop and soil data are becoming increasingly important in the Netherlands. One reason is the high population density and the abundance of water in the Dutch countryside. Another is the need to reduce nitrogen and other emissions.

Field robots on the ground

Field robots on the ground still play a minor role within AgriTech. The use of robots on fields is not yet common in the Netherlands. Legal restrictions pose a major obstacle. Most experts, however, see a big future for field robots. Major robot manufacturers such as DeLaval, which is also active in milking and feeding systems, foresee an adoption curve of five to ten years. Thereafter, the market will really undergo significant growth. So it is a promising market for the long term.

According to cautious estimates, over 400 ground robots (with a total value of about EUR 40 million) are currently active on agricultural fields around the world. This includes 115 autonomous tractors that are mainly found in Asia. Most robots are purchased. Some are leased, rented via a contractor or used via the manufacturer's 'as-a-service' proposition.

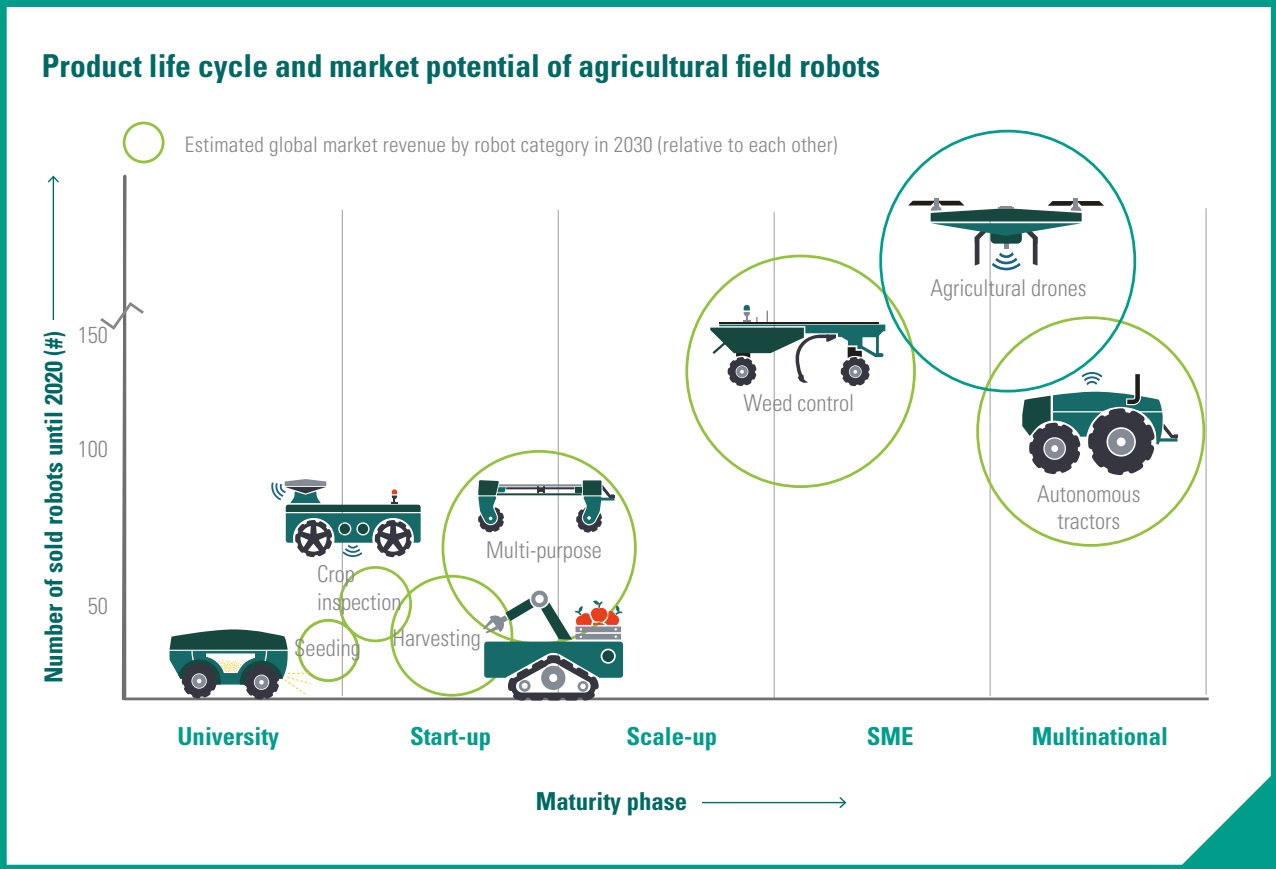
Based on our expectations, field robots in the Netherlands will still be far from reaching their full potential in 2030. But in 2030, sales will be worth no less than fifteen times more than today. The breakthrough of this type of robots is crucial for the enormous growth market of software and data analysis. One key selling point is their ability to solve the labour shortage problem in the agricultural sector. We distinguish between weed control robots, multi-purpose robots, crop inspection robots, autonomous tractors and seeding robots. Appendix A contains a more extensive list of international and Dutch players within the various product categories.

Growth market for field robots in close up

Growth market for field robots in close up

Figure 2 illustrates the various phases of maturity of the seven categories of field robots and drones. The green circle is the estimated relative worldwide market size by category in 2030. The estimates are based on global sales data, trade exhibition presentations, annual reports, professional literature and interviews. The text boxes contain a brief market description for each field robot category, including the largest players, estimated sales numbers, the Dutch position and the worldwide growth potential.

Figure 2: Product life cycle and market potential of agricultural field robots



Weed control robots

The biggest category concerns weed control robots, including mechanical weeders and chemical sprayers. The industry giant is French manufacturer Naïo Technologies, which has sold some 150 to 200 units of its three types of weeding robots (Oz, Ted and Dino) in France, Germany and California. Naïo expects about one thousand of its robots to be active on the fields by the end of 2021.

Danish manufacturers FarmDroid and AgroIntelli have, respectively, 60 and 20 active seeding and weeding robots. The biggest manufacturer of autonomous sprayers, costing about EUR 285,000 each, is US company GUSS. Swiss-based ecoRobotix is now poised to enter the market, backed by chemical giant BASF. In Australia SwarmFarm Robotics is putting its name on the map. It offers lease solutions for about ten autonomous sprayers. US-based FarmWise has so far delivered twelve as-a-service weeding robots: the farmers pay according to usage.

Dutch parties such as Odd.Bot and Steketee will also launch commercial robots in the coming years. Differences in growing systems and track and crop row widths still pose challenges. But the high costs of manual weeding and the large number of prospective customers give this market high growth potential.

Multi-purpose robots

The second-largest field robot category concerns the multi-purpose robot: an equipment carrier that acts as a platform to which multiple modules and sensors can be attached. As a result, one and the same robot can be used to seed, weed, harvest and inspect crops.

Industry heavyweights are Danish-based AgroIntelli and US-based DOT, which claims to have sold some twenty to twenty-five robots for USD 250 to 300 thousand each. The AgroIntelli robot - called Robotti - is available from EUR 100,000. Four are already active in the Netherlands. Looking to the future, the Dutch start-ups Pixelfarming Robotics and Ruvu also hope to bring a multi-purpose robot onto the market.

Autonomous tractors

The autonomous tractor category is dominated by large international manufacturers such as John Deere and AGCO (both US), CNH (American-Italian) and Kubota (Japan). They see the light self-driving vehicles as the next step in the evolution of their GPS-controlled tractors.

Asian parties are currently less restricted by regulations and can therefore grow faster than their US and European competitors. Kubota has already delivered at least sixty autonomous tractors in its own country. Yanmar (also Japan) has delivered fifty YT01 robot tractors for prices ranging from EUR 95,000 to EUR 120,000. Moreover, this Osaka-based company also offers a 'conversion set' for EUR 10,000 for making conventional tractors autonomous.

Outside of Asia, autonomous tractors are still a thing of the future, as the necessary legislation is not yet in place. However, prototypes showcased at trade exhibitions attract a lot of interest. Producers such as Farmertronics and AgXeed will present their 0-series soon.

Harvesting robots

Harvesting robots possibly hold the biggest promise. In the US, Australia and France they are used to pick strawberries, apples, tomatoes and wine grapes. Manufacturers include Root.ai and Octinion. These machines save labour costs and reduce labour-related complaints.

For these reasons, a lot of research is being carried out into this sub-segment. But the practical implementation remains difficult. Fruit and vegetables vary enormously in shape and ripening stages and visual inspection is impeded by foliage or underground growth. In addition, soft fruit is very delicate and therefore difficult to harvest at speed without damaging the fruit. The market potential for the coming years is therefore still expected to be relatively small.

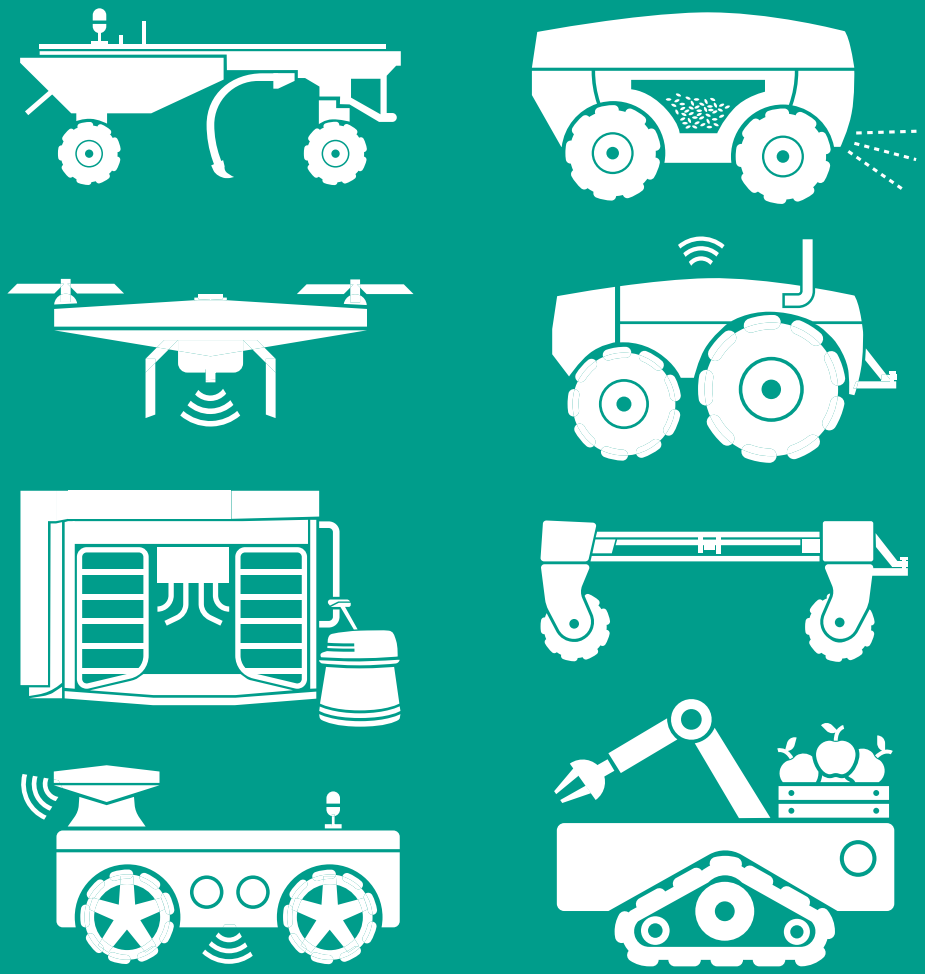
Dutch manufacturers are focusing on crops such as asparagus (Cerescon, AvL Motion) and cucumber, bell peppers, broccoli, chicory and sprouts (Tumoba, Sweeper, Rolan, Saia and Crux Agribotics).

Crop inspection robots and seeding robots

The final categories are crop inspection and seeding robots. Crop inspection robots are mainly being tried out in vineyards in France, Italy and Spain to help control disease and assess the ripeness of grapes. Examples are Vinescout, Vinbot, CEOL and VitoScanner.

Most crop inspection robots are prototypes based on joint university research financed with European subsidies. In the Netherlands, experiments are being carried out in greenhouses with the Plantalyzer of Berg Hortimotive and the IRIS scout of Metazet.

The supply of seeding robots remains limited as yet. Building universal robots for seeding different crops is a complex challenge. Fendt, part of multinational AGCO, has been experimenting for years with its Xaver and Mars robots. Possible solutions include the integration of a seeding robot into a multi-purpose robot or the attachment of a seeding module to an autonomous tractor.



4. Bottlenecks: how can the Netherlands benefit from the AgriTech revolution?

To help drive the global AgriTech revolution and benefit from the growth potential, businesses, governments and knowledge institutes must resolve several bottlenecks that are characteristic of such a young sector.

Bottleneck: legislation

The first bottleneck concerns Dutch and European regulations, which still restrict the use of robots in the home market. Field robots, in particular, run into regulatory obstacles. When active in open cultivation settings, they are usually required to be kept under continuous supervision. Such continuous supervision immediately eliminates the big advantage of a robot for crop growers and livestock farmers. It also puts them at a competitive disadvantage, as farmers in Australia, the US and Japan are allowed to use autonomous tractors without supervision.

The Dutch orchard sprayer manufacturer H.S.S. is one example of a company suffering from regulatory restrictions. It is exploring new and sustainable technologies, but is running up against restrictive dosage rules.

A review and adjustment of the regulations is vital in various areas of the AgriTech market. Business users of drones, for instance, need a licence where the maximum permitted distance and altitude depend on the weight of the drone. From the end of this year, Dutch drones will come under European rules.

Bottleneck: fragmentation of knowledge

AgriTech is still very young and much of the acquired knowledge fails to find its way to the practitioners in ‘the field’. Crop and bulb growers complain that many experiments and projects are carried out within their own narrow, demarcated strategy. Machine manufacturers recognise this problem. ‘It is important that the current fragmentation within experiments and research is replaced with a broader strategic approach’, says Director Marcel van Haren of GMV, the industry association for agrifood machinery suppliers.

Despite some interesting partnerships, there is still insufficient exchange of knowledge between researchers, businesses and users.

Connect knowledge clustering with training in working with robots and data.

'We need to connect more with the business community', says De Vlieg of TU Eindhoven, who sees opportunities for improvement. 'We're still working too much inside our own silos.' One important aspect, for instance, is to offer training to agricultural workers and new students so that they can put AgriTech into practice. Because using robots, sensors and data analysis calls for an entirely different way of working. And a smooth-functioning home market also helps manufacturers who want to export.

Van Haren (GMV) agrees. 'Businesses and knowledge institutes are insufficiently able to translate partnerships into good business models - particularly in a complex domain such as agricultural robots', he says.

Fragmentation of knowledge also means fragmentation of data. Due to the use of robots, sensors and software, we now collect far more data than before, but sharing this information with colleagues in the sector remains a sensitive matter. Nobody, after all, wants to reveal key company information to a competitor. This is a missed opportunity. 'Collecting and sharing data is essential to take innovation further', says De Vlieg.

That's why it is important to draw up protocols where farmers can share data in a manner that protects their ownership as well as the safety and privacy of the data. Initiatives in this direction are under way; various European parties have signed a 'Code of Conduct' for sharing agricultural data. Within the Netherlands, the province of Noord-Brabant, the municipality of Den Bosch and the universities of Tilburg and Eindhoven have set up a data science structure named JADS. Other Dutch examples are JoinData, an initiative of Agrifirm, FrieslandCampina, CRV, Rabo Frontier Ventures and LTO Netherlands, and Glas 4.0 within the greenhouse sector.

Bottleneck: Better access to subsidies and private capital

Another bottleneck for Dutch parties is the access to capital and subsidies that is vital for upscaling the development of robots. AgriTech companies feel insufficiently supported in their innovation programmes. Van Haren (GMV) confirms this. 'Many subsidies go to longer-term projects, but businesses must be able to innovate faster and in smaller steps', he says. 'This receives insufficient attention when subsidies are awarded.'

Fragmentation is also an issue that affects access to subsidies, says Pekkeriet of WUR. He is involved in the European Horizon 2020 project, which awards EU subsidies to innovative sectors, including AgriTech manufacturers. 'Project validation is usually limited because there are about sixty European precision agriculture projects that are all carried out separately from each other', he says.

Private money is also not widely available, says Pekkeriet. 'We at WUR have managed to secure support from innovation centres of large manufacturers such as Kubota, Lely and CLAAS, but it is still difficult to raise sufficient private capital to finance this.' An additional factor is that the Netherlands does not have a venture capital culture like other AgriTech regions such as California. As a consequence, Dutch start-ups lose a lot of time finding capital. 'You hardly get round to developing your actual business', says founder Martijn Lukaart of weeding robot manufacturer Odd.bot.

Such cultural differences are deep-rooted and will continue to exist. Even so, businesses can join forces with government agencies and knowledge institutes to improve their chances of raising capital. Cooperation between businesses, government agencies and knowledge institutes is crucial. Pekkeriet mentions RoboCrops in Naaldwijk as an example of a small-scale demonstration project that showcases the great potential of robots.

'Our Farm of the Future innovation project in Lelystad also falls in that category, but we still have to arrange the funding. In this case I think that tractor manufacturers should stand up and do more. All they're doing now is demonstrating the concept; they don't actually build it.' Other examples of similar projects can be found in e.g. the UK (HandsFreeHectare), France (Challenge Centénol) and Austria (Innovation Farm).

Revenue model

If parties in the AgriTech market jointly manage to resolve the above bottlenecks, robots will become cheaper to develop. And that will make it more attractive for agricultural businesses, which usually have low profit margins, to invest in these robots. In other words: the revenue model will become a lot stronger if the bottlenecks surrounding legislation, access to capital and knowledge fragmentation are removed.

> Short chains can reinforce business case.

A relatively simple step for overcoming most of the bottlenecks would be to organise 'short chains', so that the machine makers can involve farmers more closely in the development process. A short chain makes it easier for all parties to share information and invest together.

Moreover, Dutch manufacturers have an important competitive advantage here: the robot manufacturers have a large home market comprising livestock and dairy farming, meat processing, greenhouse farming, mushroom growing, fruit growing, potato growing and flower bulb cultivation. This makes it easier for parties to find each other and perform experiments with different types of robots in a short chain.

'Once an innovation proves successful in a short chain, the larger investments from farmers will follow automatically. This, in turn, will offer Dutch manufacturers a springboard for exporting their innovations', says De Vlieg. Finally, the barrier to investing can be lowered through the large-scale use of as-a-service models, where the user does not become the owner of the product but only pays for the usage.

Conclusion

The 'AgriTech market', the market for robots and related products and services in the agricultural sector, is poised for strong growth in the coming years. One key driver is the scarcity of agricultural workers, which is inflating the cost of labour.

Another major driver of robotisation in the sector is the accelerating trend towards sustainability. The challenge for the agricultural sector is to use less pesticides and fertilisers, which will require the use of more labour, and, at the same time, produce much more efficiently. The strong growth of the global population means that there are more and more mouths to feed, while agricultural land is limited and shrinking further due to urbanisation, climate change and the cultivation of fibres for textiles and biofuels.

ABN AMRO estimates the current worldwide revenue in the 'AgriTech market' at more than EUR 6 billion. Dutch manufacturers account for more than 11%, or EUR 715 million, of this. The expectation is that the Dutch contribution can triple to a revenue of EUR 2.5 billion in 2030, which represents 13% growth per year.

The growing importance of robots in the agricultural sector presents enormous growth opportunities to Dutch manufacturers. To achieve this growth in the AgriTech sector, it is vital to remove several bottlenecks, namely restrictive legislation, knowledge fragmentation and limited access to subsidies. The development of short chains, in which machine builders and farmers can innovate together, would significantly strengthen the revenue model.

Appendix A:
Appendix A: main international manufacturers by robot category

Milking and feeding robots

Company name	Parent company	Name of robot	Country
Blue Ocean Robotics		HG RoboFeeder	DK
Boreco		Shuttle	NL
BouMatic Robotics B.V.		Gemini	NL
DeLaval B.V.	Tetra Laval Group (CH)	VMS V300, OptiDuo, Optimat	CH
Fullwood Packo (Mewitec bv)	Fullwood Packo Group (GB)	M2erlin	GB
GEA Milking & Dairy Farming	GEA Group AG (DE)	DairyRobot R9500, Mixfeeder	DE
Hokofarm Group		Astrea	NL
Jeantil			FR
JOZ		Moov Pro, JT200 Evo	NL
Lely Industries N.V.		Astronaut A5, Vector, Juno	NL
Peecon	Peeters Landbouwmachines	MixMeister 3000	NL
Rovibec Agrisolutions		Crysta Mix DEC DP	CA
SAC Nederland bv	SAC Group (DK)	RDS Futureline Elite	DK
Schuitemaker Machines B. V.	SVgroup, Wadinko	Innovado	NL
TKS Agri AS	samenwerking met Kuhn	K2 1600	NO
Trioliet Mullos B.V.		Triomatic T40/T30	NL
Wasserbauer		Shuttle Eco, Butler	AU

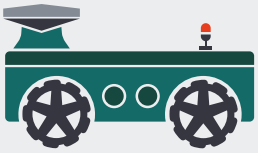
Multi-purpose robots

Company name	Parent company	Name of robot	Country
Agrointelli		Robotti	DK
Augean Robotics, Inc.		Burro	US
Clearpath Robotics			CN
Continental AG		Contadino	DE
DOT Farming reimagined	Raven Industries (VS)		CA
Harvest Automation		HV-100	US
Instar Robotics			FR
Korechi		RoamIO	CA
Maka Autonomous Robots		Maka-ARS	US
Octinion Technology Group		Rubion, Titanion	BE
Pixelfarming Robotics		Robot One	NL
Ruvu			NL
Saga Robotics		Thorvald	NO
VitiBot		Bakus	FR

Drones

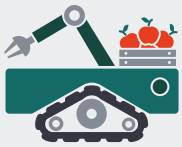
Company name	Parent company	Name of robot	Country
AgEagle Aerial Systems Inc	NYSE: UAVS	Agribotix	US
Avular bv			NL
Delair			US
DJI Agriculture	DJI (CN)	T16, Matrice, Phantom	CN
Drone4	OEM Group (NL)		NL
Kiwi Technologies			US
Lehmann Aviation Ltd			FR
Nileworks Inc.	o.a. Sumitomo Corp	Nile T19	JP
Panasonic Corp.			JP
PATS Indoor Drones Solutions			NL
Percepto	o.a. Hyundai		US
Pyka			US
senseFly (eBee AG)	Parrot Group (CH)		CH
Volocopter GmbH			DE
Wingtra AG			CH
XAG Co. Ltd.		Xplanet	CN
Yuneec	o.a Intel		CH

Crop inspection robots



Company name	Parent company	Name of robot	Country
A green culture		CEOL	FR
ACFR		RIPPA, VIPPA en Ladybird	AU
Berg Hortimotive	Royal Brinkman	Meto, Plantalyzer	NL
Cambridge Consultants	Altran (FR)	Mamut	GB
Deepfield Robotics	Bosch grow platform GmbH	Aquilla	DE
Dynium Robot		CropScout	GB
EarthSense, Inc		TerraSentia	US
ecoRobotix SA		AVO, ARA	CH
Grape			IT
GreenPatrol		GreenPatrol robot	NL/ES
HayBeeSee		Crophopper	GB
Meropy		SentiV	FR
Metazet Formflex		IRIS	NL
Polariks		VitoScanner, OUVA	FR
Small Robot Company (SRC)		Tom (scout), Dick (weed), Wilma	GB
Vinbot			ES
Vinescout			FR
Vision Robotics Corp.			US

Harvesting robots

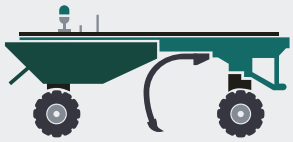


Company name	Parent company	Name of robot	Country
Abundant Robotics, Inc.			US
Advanced Farm Technologies, Inc	o.a. Yamaha, Kubota		US
Agerris		SwagBot	AU
Agrobot	Soluciones Roboticas Agricolas (ES)	E-series	ES
AvL Motion bv		Compact S1560	NL
Cerescon bv		Sparter	NL
Codian Robotics	Codian (US)	TD-4	NL
Crux Agribotics	One of A Kind Technologies		NL
Denso		Faro	JP
Dogtooth Technologies			US
Energid	Teradyne (US)		US
FFRobotics			IL
Harvest Croo Robotics		Berry 5	US
Iron Ox			US
Metomotion		GRoW	IL
Octinion Technology Group		Rubion, Titanion	BE
Pellenc S.A.S.		Optimum	FR
Raussendorf GmbH		Casar	DE
Robotics Plus			NZ
Rolan Robotics			NL
Root AI, Inc		Virgo	US
Saia Agrobotics			NL
Syha			FR
Tomoba			NL
Tortuga AgTech	Spero Ventures (US)		US
Traptic			US

Seeding robots

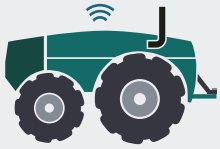
Company name	Parent company	Name of robot	Country
AutoSatum			AR
Dawn Equipment			US
FarmDroid ApS		FarmDroid FD20	DK
Fendt	AGCO International Ltd. (US)	Xaver, Mars	DE
RowBot Systems			US

Weed control robots



Company name	Parent company	Name of robot	Country
ACFR		RIPPA, VIPPA en Ladybird	AU
Adigo		Asterix	NW
AgTech Carbon-bee		SmartStriker	FR
Amazone		Bonirob	DE
Berthoud Agricole SAS			FR
BlueRiver Technologies	John Deere		US
Braun Maschinenbau			DE
Carré SAS		Anatis	FR
Deepfield Robotics	Bosch grow platform GmbH	Aquilla	DE
ecoRobotix SA		AVO, ARA	CH
Etarob			DE
F.Poulson Engineering ApS.		Robovator	DK
FarmBot		Genesis	US
FarmDroid ApS		FarmDroid FD20	DK
FarmWise			US
Franklin Robotics		Tertill	US
Garford Farm Machinery Ltd	Zürn Harvesting GmbH & Co. KG		VK
GUSS Automation LLC		GUSS	VS
HayBeeSee		Crophopper	GB
Hortibot			US
Ibex Automation Ltd			GB
IdaBot			VS
Naio Technologies		Dino, OZ, TED	FR
Odd.bot		Weed Whacker	NL
Rometron bv			NL
Small Robot Company (SRC)		Tom (scout), Dick (weed), Wilma	GB
Steketee	LEMKEN GmbH (DE)		NL
SwarmFarm Robotics			AU
TartanSense			IN
Trabotyx			NL
Vitirover			FR

Autonomous tractors



Company name	Parent company	Name of robot	Country
AGCO Netherlands B.V.	AGCO International Ltd. (US)		US
AgXeed			NL
Autonomous Tractor Corporation		Spirit (demo)	US
AutoSatum			AR
Avrora Robotics		AgroBot	RS
Bear Flag Robotics	John Deere (US)		US
Case IH	Case IH CNH Industrial, Exor Agnelli	Magnum	NL
Elatec		E-tract	FR
Escorts/Farmtrac			ID
Farmertronics Engineering bv		eTrac-20	NL
Hyliion			US
John Deere Nederland bv	John Deere (US)		NL
Kubota		Farm Pilot	JP
Mahindra			IN
Precision Makers	Alamo Group (US)	GreenBot	NL
Renu Robotics Corp.			US
Rhoban System		eTract	FR
Rostselmash			RS
Sabi Agri		Alpo	FR
Sitia		Trektor	FR
SwarmFarm Robotics			AU
Yanmar Agribusiness Co. Ltd.	Yanmar Holdings Co. (JP)	Concept YT01	JP

Sources

Sources used

- AgFunder, '2020 European Agri-FoodTech Investment Report', 2020
- CEMA, 'Full deployment of agricultural machinery data-sharing: technical challenges & solutions', 5 February 2020
- FoodSwitchNL, 'Extra verdienvermogen voor Nederland door wereldwijde duurzame voedselproductie', 2020
- Fountas, S., Mylonas, N., Malounas, I., Rodias, E.,Hellmann Santos, C. & Erik Pekkeriet, 'Agricultural Robotics for Field Operations', 7 May 2020
- Holland Robotics, 'Position paper; Kansen voor de Nederlandse robotica', January 2018
- Invest-NL, 'Agrifood sector als vliegwiel voor de energietransitie', 28 July 2020
- Macquarie Research, 'Service Robots, the force is awakening', January 2017
- MarketsandMarkets, 'Agriculture Drones, global forecast to 2024', August 2020
- McKinsey & Company, 'How OEMs can seize the high-tech future in agriculture and construction', 2018
- NRC, 'Veldboon, ui, tarwe, gerst, gras: de boer van de toekomst doet alles in stroken', 24 June 2020
- Oliver Wyman, 'Agriculture 4.0 – The future of farming technology', 2018
- Pekkeriet, E. en Gerben Splinter, 'Arbeid in de toekomst; Inzicht in arbeid en goed werkgeverschap in de tuinbouw', Wageningen University & Research, February 2020
- Council for the Environment and Infrastructure, 'De bodem bereikt', 29 June 2020

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