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ROBOTICS IN FARMING REPORT

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Smart Agro's highly experienced management team has an extensive business network that supports the development of ideas and start-ups from early stage through mature companies to exit.

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Robotics and autonomous vehicles in agriculture

Agriculture, one of the least disrupted sectors of the economy, is undergoing a deep transformation as it implements technology to address a variety of problems and ushers the industry into the digital era. The demand for food is outpacing available farmland and it is up to farmers and innovator companies to close this gap. Agricultural robots are aiding in this transformation and solutions are scaling at a fast pace, with promising technologies. To date, applications range from **addressing shortfalls in the workforce, labor costs, pollination, sustainability concerns, climate change, and waste reduction among others.**

The lack of an available workforce threatens the sustainability and preservation of the agricultural industry in developed countries. The rise in salaries adds a negative impact on the viability of this industry, and many farms might risk severe financial ramifications if no solution is found to counter the shortage of affordable and skilled operating resources.

Robots can work autonomously or alongside humans, facilitating and enhancing the daily work. Data is collected and filtered, with considerable input added to make it actionable data, thus building a more “data-driven” business.

Traditionally, farming requires hard labor and numerous repetitive tasks; at present, agriculture robots are capable of performing tasks such as seeding, pollinating, spraying, weed control, chemical applications, picking, harvesting, and tilling of soil.

Depending on the role in the field, companies are classified broadly into the areas of crop-picking, harvesting, pollinating, weed control, and general tasks.

The companies are active in diverse sub-fields, although we acknowledge that the field is still evolving, and some companies are still in demo/pilot mode. In the following tables, we selected the most relevant in each area, and at the end, we have highlighted the companies specific to berry plantations.

The market is getting bigger and is expected to grow from US\$ 4.9 billion to US\$ 11.9 billion by 2026, with a CAGR of 19.3%. This growth is expected mainly in Europe, South America, and the United States, where the need is more critical and adoption is moving faster, also with a higher willingness to pay from hi-tech greenhouses up to regular small farmers.

Picking, harvesting, and pollinating

Company	Country	Commercial	Description	Autonomous
Burro AI	USA	YES	A smarter farming system with user-friendly, autonomous robots that work alongside farm workers.	YES
Arugga AI	Israel	YES	Developing autonomous robots for pollination, and monitoring and treating greenhouse crops; replacing humans and replicating bee pollination.	YES
Tortuga AgTech	USA	NO	Robots that perform a variety of labor-intensive tasks on the farm, with an emphasis on harvesting.	YES
Advanced Farm	USA	YES	Strawberry picking.	YES
FFRobotics	Israel	NO	A reliable, robust harvesting platform emulating the human hand-picking process for efficient, cost-effective, and bruise-free fruit harvesting.	YES
Automato	Israel	PILOT	Their platform autonomously operates autonomously in any greenhouse and can mount and operate a wide range of robotic applications.	YES
Ripe Robotics	Australia	NO	Autonomous fruit picking, distribution into a bin, and then dropping the bins off at the end of the row.	YES
Digital Workbench	Germany	NO	Autonomous robotic platform, built in a modular way to adapt to different tasks inside the farm	YES
Four Growers	USA	NO	Working closely with various greenhouse growers to develop a tomato harvesting robot.	-
Muddy Machines	UK	NO	Asparagus harvesting robot.	YES
Octiva	Netherlands/ Belgium	NO	Partnership between Priva and Octinion to develop robotic	YES

			solutions for horticulture, berry picking, and yield prediction.	
Farm Droid	Denmark	YES	FarmDroid is the world's first fully automatic robot that can take care of both sowing and weed control. With the FarmDroid robot we help farmers and plant breeders reduce their costs of sowing and weeding and we even do it in a CO2 neutral and ecological way.	YES
HarvestCorp Technologies	Canada	NO	Canada's first automated asparagus harvester	YES
Nanovel	Israel	NO	Robotic solution for autonomous harvesting for a variety of tree fruit.	YES

Weed Control

The losses caused by weeds are greater than the losses caused by any other agricultural pest. Weeds account for 45% of the total annual loss in agricultural production, insects 30%, disease 20%, and other pests 5%.

Many weed control robots have been developed covering a wide variety of approaches, from smart spraying, and reducing the input of agrochemicals, through to UV properties and the electric burning of weeds.

Company	Country	Commercial	Description	Autonomous
Greeneye	Israel	YES	Artificial intelligence and deep learning technology to revolutionize the pest control process in agriculture.	NO
Swarm Farm	Australia	YES	Autonomous spraying robot	YES
Ecorobotix	Switzerland	YES	Targeted application of herbicides, fungicides, insecticides, or fertilizers.	NO
Verdant Robotics	USA	YES	A multi-crop platform that enhances the yield and profit	NO

			through transformative applications across targeted thinning, protectant and nutrient delivery, and laser application at millimeter level.	
DeepAgro	Argentina	YES	Intelligent weed detection system for performing a selective application of herbicides at any stage of the soybean crop growth. It saves up to 90% in agrochemicals.	NO
Thorvald	Norway	YES	Thorvald safely protects plants from powdery mildew through the application of high-intensity UV-C light.	YES
Small Robot Company	UK	YES	Precision application of herbicides.	YES
FarmWise	USA	YES	Weeding machine that supports a variety of crops including leafy greens, cauliflower, and broccoli.	YES
Trabotyx	Netherlands	NO	Precise weed control for organic farmers.	YES
Nexus	Canada	NO	Capable of removing weeds from many different crops while operating 24 hours a day.	YES
Guss	USA	YES	Autonomous spraying.	YES
Carbon Robotics	USA	YES	This system enables the robot to instantly identify, target, and eliminate weeds using thermal energy while self-driving.	NO
Robotic Perception	Israel	YES	Autonomous electric vehicles, sprayers, and mowers with simplified crop detection, irrigation requirement analyses, virus stress detection, and single plant detection.	YES

General tasks

On the farm, there are many non-specific tasks involving tractors or other vehicles, for example clearing a field full of rocks, assisting a worker, or towing a cart back and forth.

Companies such as Blue White Robotics and Bear Flag Robotics, among others, are able to adapt their technology and automate the farmer's current equipment, saving a heavy upfront investment.

Company	Country	Commercial	Description	Autonomous
Blue White Robotics	Israel	YES	Easy operation and management of a fleet of autonomous vehicles with control of any type of tractor, robot, or drone.	YES
Sky Grow	Australia	NO	Autonomous tree planting.	YES
TerraClear	USA	YES	Highly efficient precision rock removal with minimal soil disruption. Capable of operating in a wide range of field conditions.	NO
Bear Flag Robotics (John Deere)	USA	YES	Autonomous tractors.	YES
Monarch	USA	NO	Autonomous electric tractor.	YES
VitiBot	France	YES	Robot for weeding, trimming, and other tasks in the vineyard.	YES
Fieldin	Israel	YES	Autonomous tractor kit; smart spraying and data collection robots.	YES
AgXeed	Netherlands	-	Design, building, and delivery of ready-to-use autonomous units.	YES
Naio Technologies	France	NO	Addresses the shortage of farm workers, reduces the strenuous physical workload, and limits the use of chemical weedkillers.	YES
Agrointelli	Denmark	YES	Weeding, seeding, spraying. Easy to integrate into present-day farm practices. Robotti is already commercially proven	YES

			and is currently being used in 6 countries.	
Korechi	Canada	YES	Cultivating, seeding, weeding, mowing, soil sampling, data-logging, among other tasks.	YES
Robotics Plus	New Zealand	NO	Unmanned ground vehicle (UGV) is a highly adaptable and configurable autonomous agriculture platform designed for a variety of tree crop tasks.	YES

Task-specific work in the berry field

Identifying a berry that is ripe enough to pick, grasping it firmly but without damaging the fruit, and pulling hard enough to separate it from the plant without harming the plant, is the highest challenge faced by robots today. This problem applies to every delicate crop, but especially berries.

Crushing or bruising berries is still a common problem, and accidentally harming one strawberry while attempting to pick another is a problem that is often overlooked and rarely mentioned.

This field attracts a lot of interest for companies to develop solutions, with consideration of the higher prices of the products, too. So far, one of the most advanced solutions is Traptic (acquired by Bowery Farming Inc.), which purportedly can harvest 100,000 strawberries a day.

Company	Country	Commercial	Description	Autonomous
Fieldwork Robotics	UK	YES	An autonomous mobile platform developed to navigate multiple farming environments, and designed to be deployed through rows of crops for picking without human supervision.	YES
Agrobot	Spain	NO	Agrobot has successfully developed the first robot for gently harvesting strawberries, no matter where and how they are grown.	YES

Traptic (Acquired by Bowery)	USA	NO	Strawberry picking robots.	YES
Octinion	Belgium	YES	Autonomous strawberry-picking robot, Rubion, finds its way through the crop, picking berries without bruising the strawberries.	YES
Harvest Croo Robotics	USA	YES	Provides a harvesting service that automates the crop management, harvesting, and packing of specialty crops. They have started with strawberries.	YES
Organifarms	Germany	NO	Strawberry harvesting robot.	YES
Advanced Farm	USA	YES	Strawberry picking.	YES
AgPro Robotics	USA	YES	A fully electric platform that semi-autonomously follows harvesters in a row to collect the produce they pick.	

Challenges ahead for berry robots

As stated above, there are still many challenges to be solved in farming robotics. We have identified three:

- Cost: Development, training in, and implementation of these new technologies is still costly and exclusive for high tech farms.
- Force: Fruits bruise easily when harvesting, and it remains a challenge to regulate the force required to release the berries from the plant.
- Selectivity: Trials in controlled environments differ from the outside reality, where risks and conditions vary. Also, the AI needs to be really well trained so as not to leave fruits behind in the harvesting process.

Drones used in harvesting and spraying

The idea of unmanned aerial vehicles (UAV) has been very promising in the agtech field for many years, but the technology has been difficult to adapt, regulate, and scale to deliver acceptable costs.

Today, we are closer to resolving these issues, and many companies are working to deliver solutions for agriculture using drones for spraying, harvesting, and monitoring (not included in the chart).

Company	Country	Commercial	Description	Autonomous
Tevel	Israel	NO	Fruit harvesting with drones.	YES
Lahakx (formerly Skyx Solutions)	Israel	-	Autonomous agricultural spraying.	NO
Dropcopter	USA	YES	Aerial pollination.	NO
XAG	China	YES	Autonomous unmanned spraying.	YES
Rantizo	USA	YES	Aerial spraying.	NO
Eavision	China	Yes	Aerial spraying devices.	NO
Precision AI	USA	NO	Aerial spraying device with AI detection.	YES

Final remarks

The integration of robotics into daily farm operations has been occurring over the past 20 years, but now we are seeing faster progress than before. The technology is more refined, farmers are willing to accept it, and external conditions, as mentioned at the beginning of this report, are forcing the business to adapt and implement solutions. We expect to see an even higher rate of adoption as autonomous vehicles are also easier and less risky to test in open fields and agronomical operations, than in civil uses like ecommerce shipping in cities.

Artificial intelligence is creating an immense impact and is being integrated with mechanical robots to perform farm tasks accurately, with ongoing enhancements so that they continue to improve.

There is still a long road ahead as most robots still can't do a better job than humans, as they are slower or less delicate. Despite this, many companies have accomplished large milestones and delivered quality products that set expectations high for the coming years.

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