Agriculture Robotics:

Technologies Enabling the Fourth Agricultural Revolution



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Executive Summary

The agricultural robotics sector stands at a pivotal moment of investment opportunity despite broader macroeconomic headwinds. This comprehensive analysis examines trends across seventy-one companies identified within the space, representing more than $2.6 billion in total funding. The sector has sustained a healthy growth relative to other ag-tech sectors, due to the growing global challenges the agricultural sector faces, and the proliferation of affordable technologies. The challenges to reach commercial traction, namely overcoming technical complexities while ensuring operational robustness and affordability to gain farmers' trust, present a high barrier to entry. M&A and strategic partnerships between players and other stakeholders within the farming ecosystem consolidate this fragmented market and signal a long-term confidence in this sector's value creation. Companies with flexible business models, easier deployment to the end user, and earlier collaboration with the farming community are better poised for success. A promising array of technologies needs a more diverse set of financing capital mechanisms to scale pilots, in-field testing, and manufacturing. Today presents a narrow window for strategic investors to provide financial and operational support to startups facing capital challenges.

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A Role for Robotics as Agricultural Producers Adjust to Pressures

The agriculture sector is in crisis. Over the last few decades, the agriculture industry around the world has grappled with surges in labor and input costs, abrupt climate pattern shifts, pesticide resistance, and a growing, urbanizing population.[1,2] **With agriculture responsible for roughly one third of global greenhouse gas emissions, solving this crisis is a climate imperative.**[3] Given the repetitive and labor-intensive nature of many farming tasks, this sector has vast potential to adapt automated and data-driven solutions to address these growing pressures and develop more sustainable food production systems. An agricultural revolution is in sight.

Automation sub-sectors such as in-field robotics and drone solutions have sustained healthy growth, both in technological maturity and commercial deployment. This has been boosted by the rapid decreases in sensor, component, and computational costs. The ability to gather farm-level data at an unprecedented precision equips farmers with better decision-making and enhanced efficiency. Agriculture robotics companies also benefit from the machine-learning flywheel of gathering additional training and testing data. **Farms that leverage robotics can unlock the potential of Precision Agriculture**, including the ability to gather and analyze data at the plant-level. This enables farmers to tackle age-old agricultural challenges of yield prediction and disease detection at transformative precision and scale. In addition to scaling operational farm productivity, agriculture robotics can also reduce agriculture's environmental impact and enable more socially responsible and equitable farming practices. These tools can alter the course of traditional in-field farming to yield better quality and more reliable output of produce; less waste; and a reduction of pesticides, herbicides, and water use. It is also an opportunity to redefine farm labor.

Rising labor costs and availability shortages are driving the case for automation. Retaining a competitive agricultural workforce is vital for sustaining agricultural production levels. Farmers struggle with increasing labor costs due to a shrinking supply in skilled workers. In the US, the labor shortage is at 20% and is on a trajectory to grow by 7% each year.[4] There are four times the number of producers older than 65 than younger than 35.[5] In Europe, the statistics are similar: the agricultural workforce is projected to decline at 2% annually, exacerbated by the decline of family farms, increases in input processes, increased reliance on migrant workers, and a demographic crisis.[6,7,8] Younger generations of rural economies are rapidly urbanizing to seek more stable, comfortable alternatives. Developing countries are also seeing an aging agricultural labor force as gender and social inequality amongst farm laborers compared to other sources of employment further drives outmigration.[9,10] Further, against the backdrop of macroeconomic and political headwinds where opinions on immigration are changing globally, the agricultural labor shortage will only worsen.[11]

Agriculture robotics companies will have to demonstrate an attractive enough return on investment to turn farmers' speculative consideration into purchases. Despite promising advances in technology maturities and attractive value propositions, agriculture robotics have struggled to make a substantial dent in widespread commercial adoption. **The high costs of existing robotics solutions are a blocker for an industry characterized by razor-thin margins.** The appetite for risk is low, given farmers are already struggling with climatic shocks and increased input costs.[12] Dispelling the perceived risk of adopting novel technology is a major challenge that the agriculture robotics players have yet to overcome.

Business models must adapt to the variability of farm structures and needs. Companies within this sector must develop strategic business models and partnerships to gradually unlock adoption and gain trust within the farmer base. The automation of agriculture lies at the heart of a complex nexus of stakeholder relationships among technology providers, purchasers, operators, policymakers, and the farmworkers themselves.

Notwithstanding current macroeconomic conditions, **key investment opportunities exist to strengthen the market.** This report serves to first illustrate the current state of the agriculture robotics sector, then dissect constraints and opportunities for investors to consider**.** A presentation and evaluation on key players and business model case studies will help distill the industry's needs to reach sustainable and environmentally positive deployment at scale.

1 1 Market Overview

1.1 Scope and definition

Within the scope of this analysis are companies that are directly developing technology applied to *in-field crop* agriculture. In-field robotic applications range from mechanizations of farm tasks such as weeding, harvesting, seeding, pruning, irrigating, spot spraying, and load carrying; to software-enabled tasks including analyzing data on a crop and farm field level on plant and soil health, yield estimates, and growth analytics; and land use analytics.

Leaps in technological innovation of the last couple of decades have enabled a new wave of technologies to emerge within the field of robotics and artificial intelligence. In particular, the research community's progress in **Embodied AI** in recent years has enabled the interconnection between the fields of hardware-centric mechatronics and software engineering, giving rise to sophisticated robotics stacks. Embodied AI refers to an artificial intelligence system that interacts with the physical world by incorporating inputs from multiple sensors, motors, computer vision and machine learning algorithms.[13] This differs from traditional digital AI systems that process digital streams of data, or generative AI, which generates new data from digital data input. The software, sensor, and IoT developers enabling this input-processing play a key role in operationalizing end-to-end farm automation technology. The software-hardware spectrum of companies helps shape their specialization within the value chain and define characteristics of successful business models.

The analysis excludes livestock-supporting technologies or technologies applied to controlled environment agriculture and greenhouses. These technologies present distinct markets and technology stacks.

1.2 The Three-Body Challenge of Agriculture Robotics

Robotics is naturally well adapted to automate dull, dirty, and dangerous jobs for which humans are not best suited. This particularly applies to the more labor-intensive organic and regenerative farming practices, where manual weeding labor alone often represents the greatest expense for farmers.[14] However, operating and maintaining mechanical technologies in outdoor agricultural environments is not without its challenges. In contrast to other industries that employ similar robotics and drone solutions, such as healthcare, surveillance, warehouse automation, defense, and industrial site maintenance, agriculture has lagged in innovation.[15] This is partly due to the difficulty of operating in inherently variable and complex outdoor environments, and of overcoming the industry's inertial resistance to change and risk.

Agriculture robotics companies face a three-pronged set of challenges to reach commercial traction. Until companies overcome these challenges to become a mainstream technology across food production industries with proven commercial robustness and attractive return on investment, the bulk of the farming community will not have the risk appetite or the capital to invest.

1.2.1 The Technical Challenge

Robotics is still a relatively nascent field of technology. Most mature commercial-scale robotics products exist within controlled environments in other industries, such as warehouses or hospitals. Operating outdoors in biologically dynamic land is significantly harder. The technology stacks must adapt to a wide variability in farmland: differences in crop row widths, crop densities, soil types, topology, biodiversity and weather. Some players have attempted to overcome this by focusing on a stable, flexible module optimized for land movability across field types, while others have specialized in a particular kind of crop and field. Specialty crops are, by definition, more variable than row crops and require a higher degree of customization. But specialization is a trade-off to market diversification. Too much specialization in a specific use case or farm type hinders the company's ability to scale to new crops or geographies if the product-market fit is not properly defined.

Algorithmically speaking, embedding software stacks within mechanical hardware has additional challenges within agriculture. First, most agricultural plots are remote and do not have good GPS signal, which is used by traditional navigation systems in other commercially deployed robotics applications, e.g., warehousing. A proliferation of IoT products and navigation algorithms has emerged in the last five years to specifically address GPS-denied autonomous navigation challenges. These include the multi-sensor fusion algorithms incorporating a variety of specialized sensors adapted for agricultural land, such as thermal and multispectral cameras.[16] LiDAR-based navigation systems have also increased in popularity, due to their rapidly decreased cost curves and higher precision compared to other vision systems.[17,18]

Second, an autonomous system must also allow for powerful enough computational capacity on board to allow for these algorithms to process live sensor data and situate itself while moving, an algorithmic process called SLAM (simultaneous location & mapping).[19] Deploying and optimizing SLAM algorithms for such real-world dynamic environments as agriculture is still an active area of research amidst roboticists.[20,21]

Third, automation of in-field robotics has required safety mechanisms to ensure farmworkers feel comfortable deploying an autonomous system navigating through their fields. Established regulatory bodies have enforced more stringent regulations on robotics applied to open fields, especially around autonomous navigation systems, as is the case in California.[22] More redundancies are thus being built into the robot, with additional cameras, sensors, more robust algorithms, physical bumpers, and safety trainings to mitigate the risk of an accident. This often increases the Bill of Materials (BOM) and servicing costs, making the robot more expensive for the purchaser.

1.2.2 The Cost Scaling Challenge

Despite the benefits of efficiency, reliability, and scale potential, the high up-front cost hinders deployment rates. Often cash-stripped and operating with razor-thin margins emblematic to the agricultural sector, investments of thousands, sometimes millions of dollars required up-front for heavy equipment or expensive technology are a challenge.[23]

These CAPEX-heavy "hard" technology companies building hardware must appropriately bring down their costs, even at early stages, while they undergo pilots to find their product-market fit. Given farm viability, particularly notable within the specialty crop market, each robotic solution must be tailored for the end-user farm requirements. With small initial custom units deployed for each customer, many players may struggle to achieve the benefits of scale from bulk manufacturing or partnering with external contract manufacturers, instead building the robot in-house at higher costs. Supply chain and macro political uncertainties faced today may further slow the pace of cross-border manufacturing.

Further, real-world testing cycles between prototypes struggle to align with short crop seasons. Companies must either have long, underutilized periods between growing seasons where they cannot test in-field or find other crops or geographies. Return on investment periods must be stretched accordingly, which does not match the traditionally shorter venture-capital funding horizons.

Finally, earlier-stage companies also often design their hardware and software from scratch in-house and miss out on cost-saving opportunities to partner with more mature, specialized players across the value chain. The efforts to maintain and protect IP by developing in-house could hinder opportunities to lower cost, share knowledge, and scale.

1.2.3 The Social Stakeholder Challenge

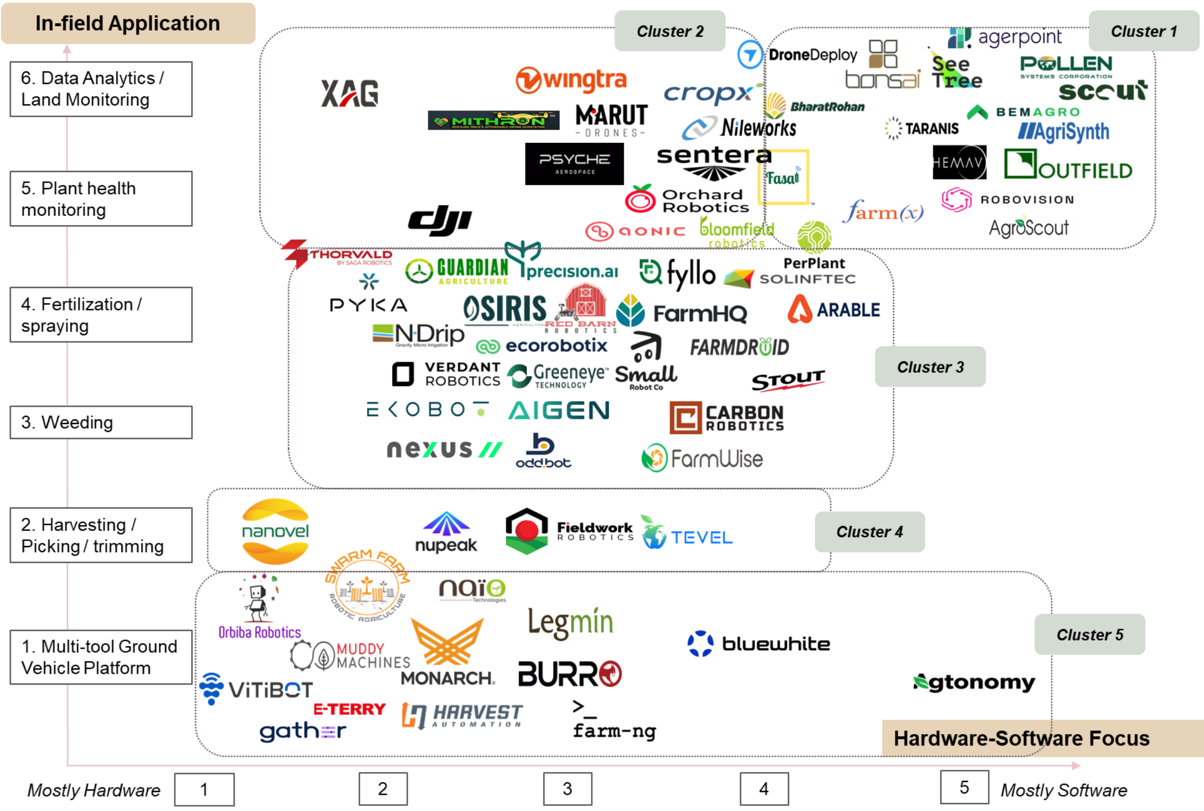
Training, support, and ensuring robustness is a crucial consideration for establishing longer lasting and trusting relationships with the farmers. The primary concern farmers have is whether the technology will even *work* on their land, let alone save money or time. Many early deployers of ag-tech have over-promised and under-delivered, further eroding the trust with the early-adoption farmers.

Researchers at the R&D and university level tend to focus on the cutting-edge technology to achieve maximal efficiency but neglect the concern for *robustness* within a longer-term operational use case. Moreover, farmers on the ground holding key local context and expertise are not sufficiently included in the decision-making and design process. **Often, the purchaser of the robot is not the end user.** The end user must overcome the communication and training gap needed to make the technologies relevant for the in-field farmworkers that will be utilizing or working alongside them.[24] If proper stakeholder considerations are not incorporated early enough in the design process, companies will continue to face issues in piloting and selling to a risk-averse and skeptical user base.

1.3 Market Map

CREO identified seventy-one companies as active and relevant for in-field agriculture robotics. The analysis elucidates five clusters within the space, grouped by the companies' main crop field applications and how hardware or software-heavy the company's primary IP is. The underlying value proposition and business model of the company allows investors to glean drivers for success within the ecosystem.

Figure 1: Market map grouped by application and degree of software versus hardware focus



1.3.1 Clusters naturally arise around specific applications and business models.

Cluster 1 contains Software companies focused on data analytics and crop intelligence, such as SeeTree, AgriSynth, and AgroScout. These mostly develop data ingestion and processing models and often fuse drone, satellite, and imagery data inputs to generate actionable information for farm operators. While they are not strictly developing robotic products in the traditional sense, they are a key player in the ecosystem due to their ability to be implemented on robotic and embodied AI systems. Several are designed to be hardware-independent, meaning that their software can be applied to varying hardware and sensor systems. They are thus important industry consolidation players.

Cluster 2 contains the drone and IoT device manufacturers, which tend to focus applications on land monitoring, yield estimation, and some applications of precision spraying and harvesting. Most of the companies are focused on the hardware optimization of the drone build, thus further along the hardware end of the x-axis spectrum. However, they will nearly all leverage some component of software to enable their drone features.

Cluster 3 contains solutions focus on precision spraying or mechanical weeding. Most of the players within this cohort are robotic ground vehicles with machine-learning capabilities for detection of the weeds, hence combining hardware and software IP and spreading around the middle range of the x-axis.

Cluster 4 contains a sparser set, representing robotics companies focused on harvesting. Harvesting is notoriously one of the most challenging robotics tasks to master, given the high degree of dexterity and sensitivity to the crop needing to be harvested, particularly berries or fruits from orchids. Given the sparsity of solutions, many have partnered with other players across the value chain to focus on the specific technical challenge of harvesting. For example, Fieldwork Robotics, the world's first autonomous raspberry harvester based in the UK, recently partnered with Burro to leverage Burro's autonomous ground vehicle expertise.[25] Also, Tevel presents a unique solution of utilizing drones to harvest orchard fruits. They are the one of the only operational drone companies focused on harvesting.[26]

The last cluster, **Cluster 5, contains companies specializing in multi-application ground robots**. These platforms are designed to have customizable tools and purposes, from carrying and ground logistics to weeding, pruning, trimming, and harvesting add-ons. But at the core, these companies have developed Autonomous Ground Vehicles (AGV), capable of operating across multiple agricultural tasks. Their competencies lie in the design and deployment of hardware-heavy systems designed for robust navigation on farmland, but many may still hold software components key to the operation of the robot. These may be designed in-house or leverage existing sensor fusing and data processing algorithms from other players; for example, those from Cluster 1.

1.3.2 The level of fragmentation in the market is correlated with the technological maturity and uptime of the application.

Far more weeding and analytics companies exist than those for harvesting, for example, due to the relative complexity of developing a fully autonomous harvesting robot. Given weeding is one of the costliest inputs for producers and simplest applications to automate relative to other agricultural tasks, and with a global weed control market valued to $34bn,[27] it makes sense that this cluster is the densest and most competitive on the map. Further, the uptime of weeding robots must be far greater than that of harvesting robots, given the higher frequencies of weeding required throughout the growing cycle, compared to pruning, thinning, seeding or harvesting. Weeding robots must undergo greater differentiation measures to stay afloat amidst a more competitive, diffuse market. Understanding how the players are protecting their IP across different applications is key to mapping the evolution of the space and identifying key players.

1.4 Business models diverge

As a result of the combination of technical, financial, and social challenges to deploy agriculture robotics successfully, varying business models for such companies have emerged. Understanding this differentiation allows investors to understand key pathways to profitability.

The business models range from **direct unit purchasing**, equipment **leasing**, **selling Data-as-a-Service**, **Robotics-as-a-Service**, **credit lines,** or **loan** models, to **partnerships** with key industrial players to help manufacture, market, transact, or service. In general, farmers demand low-risk trial periods before making a substantial equipment purchase, especially for newer robotics applications. This has resulted in the emergence of leasing and servicing models that allow robotics companies to improve on their products, adapt to the customer's needs, and gradually gain trust from farmers. Yet many farmers prefer to own the technology in the longer term as the cheaper solution, providing them with the most independence and control. Several companies have responded to these preferences by creating a customizable robotic "platform" base that can be adapted for the end user, with variable sale, installment, and servicing costs. Others have taken the streamlined approach to focus on a higher willingness-to-pay customer set, developing a single robot model and scaling manufacturing to achieve profitability.

Three case studies of companies are highlighted, each employing a unique approach to solidifying its position in the value chain: Aigen, Soliftec, and Burro.

1.4.1 Aigen

Aigen's solar-powered, autonomous mechanical weeding robot fleet of over 50 operational robots is currently deployed across several farms in the US. Aigen sells groups of units directly to the farms, supporting them with training and servicing. This represents a sizeable, but manageable cost to a mid- to large-acre U.S. farm—whether growing specialty crops or broadacre crops like soybeans, cotton, or sugar beets. Aigen's technology supports farmers who want to eliminate the use of pesticides and herbicides altogether. At the core of Aigen's value proposition is to use robotics to scale organic, regenerative farming practices, those requiring the most intensive human labor. Aigen announced that its latest Series A investment of $12 million in November 2023 would allow it to expand its manufacturing capacity by building a 7,500 sq. ft. manufacturing and R&D facility.[28] By focusing its technology on the specific mechanical weeding use case for specific crops within the organic and regenerative space, Aigen has positioned itself to dominate a market of higher willingness-to-pay customers that employ more labor and energy-intensive tasks.

1.4.2 Solinftec

Since launching its precision spraying solar-paneled robot across Brazil, Columbia, and parts of the US in 2022 for a wide range of crops, Solinftec's solutions have been applied to over 22 million hectares.[29] In addition to boasting high efficiency and yield gains of 30%, Solinftec is a pioneer in promoting sustainable farm practices with major herbicide and water savings.[30] They sell units directly to farmers and ag retailers, declaring in a recent interview that a farmer gets a return on the investment in up to two growing seasons.[31] Solinftec's primary selling point is its AI platform, which covers end-to-end tracking of activities involved in crop farming, including management, agronomic analysis, logistics, etc. A major component of its value add is its growing database of farmland data feeding its models. Solinftec provides sugarcane harvesting and transporting services for 96% of the domestic market in Brazil, making them one of the most penetrated agriculture robotics players in Latin America. With a manufacturing capacity of 150 machines per year, they plan to scale up to reach 1,000 by 2026. They opened a manufacturing plant in March 2024 in Indiana, thanks to a partnership with the Wabash Heartland Innovation Network.[32]

1.4.3 Burro

With a low-cost, modular robotic base design that can be customized for various applications, Burro has been innovative on several fronts, particularly through its focus on deployment support and partnerships. First, its emphasis on customer relationship and adaptability to end users has allowed it to be applied to many different types of fields: nurseries, orchards, vegetable fields, and depot yards. One of its key IPs is in its patented plug-and-play "Pop Up Autonomy," which empowers farmers to deploy the robot with minimal training needed. The robot's primary use case is as a harvest assist, working alongside the people harvesting. Given mobility's key importance in nearly all agricultural environments, Burro is adapted to serve a wide range of markets. By partnering with other companies with different core capabilities, such as Fieldwork Robotics for harvesting, and Weed It for precision spraying, Burro has developed expansion features for brush cutting and spot spraying.[33] Its partnership with large provider of agricultural equipment rentals Pacific Ag Rentals, Burro has facilitated the deployment of its platforms to farmers by allowing for more flexible rental options.[34] Burro currently has over 300 harvest assisting robots operational in fields. Having raised a series B in January 2024, Burro is scaling up its deployment of the newest model, Burro Grande, boasting a greater carrying and towing capacity and expanding its product line to reach other areas struggling with labor shortages.[35]

These three companies have demonstrated creative partnerships and business models that have enabled market penetration. Aigen and Solinftec's decision to scale up in-house manufacturing is a trend observed across many of the early-stage players in the ecosystem, as it facilitates incremental and shorter-cycle design updates while companies establish product-market fit.

2 Funding Flows

2.1 Funding remains slow and steady

Despite the macroeconomic headwinds facing the climate tech sector, alongside Venture Capital's 60% funding decline since 2021, agriculture robotics fared relatively better than other ag-tech sectors. Investment in the Farm Automation sector as defined by AgFunder grew year-over-year in 2024 compared to 2023 and has seen steady growth in the last 5 years.[36] The space is projected to grow at a healthy CAGR of 25.7% between 2024 and 2032.[37] The mapped companies have cumulatively raised 2.6 billion USD, with a median of 20 million USD.

Further, the investor base has significantly diversified within ag-tech investments in recent years, from the couple large agriculturally focused incumbents CNH and AgFunder to less specialized venture investors with broader investment scopes going beyond agriculture, such as OurCrowd, Innovate UK, Cultivator, Alumni Ventures, and S2G. This is attributed in part to the steady growth in venture funding toward ag-tech in the last decade, where the period between 2012 and 2021 saw a 20x capital investment jump, compared to the broader VC jump of only 11x.[38] This indicates a more diversified and sustained interest in applying the latest software and hardware innovations to the agricultural sector.

However, market conditions will inevitably lead to further consolidation and shake-out of some key players.

2.2 Key Investors remain active

Aligned with the broader macroeconomic venture slowdown, there has been little investment activity in this sector in the recent few months. The last notable raises have come from **Bonsai Robotics**, raising $15 million in Series A in late January 2025, led by **Bison Ventures.**[39] The drone and crop intelligence space saw several active deals in 2024, including **Psyche Aerospace**, **Aonic,** and **HEMAV**. A particularly large, later-stage deal came through for **Carbon Robotics** in late October 2024, raising a $70-million Series D led by **Bond.**[40]

The most active investors are **Agfunder**, **CNH, Innovate UK**, **OurCrowd**, **Cultivator**, **Alumni Ventures, and S2G Ventures**. They have each invested in agriculture robotics companies in the last 5 years. **Farmhand Ventures** has emerged in recent years as one of the few venture capital firms focused on early-stage agri-food tech startups, with a focus on automation and social equity amongst farming stakeholders.

The **CREO membership** has also been active in this space. The hardware-centric robotic base solutions within the CREO portfolio include **Burro**, **Muddy Machines**, **Harvest Automation**, **Aigen**, **Pyka**, and **Monarch Tractor**. Meanwhile, they have actively invested in several software-centric solutions: **Sentera**, **Agerpoint**, **N-Drip**, **CropX**, **FarmHQ**, and **Arable**.

Geographically speaking, most of the companies are based in the **US and Europe**, with some notable land imaging companies emerging from **South America**, and drone manufacturing in **China** and **India**. Developed nations are naturally further ahead of the automation curve, where labor pressures are the most acute, and farms and incumbent agricultural players have more generous balance sheets. Interestingly, developing countries with growing agricultural labor bases see growing deployment, such as **Brazil** and **India**. While the Global South may not face the same acute labor shortages, more extreme climate pressures of flooding, drought, and a lower technology penetration have contributed to invite interest in deploying novel technologies. Within the US, **California** houses most of the startups, thanks to the state's dominant agriculture and technology hubs. In Europe and the Middle East, **Israel** presents a focal point of ag-tech startups, due to its long tradition of innovating to overcome challenges in a harsh agricultural climate and arid land.

2.3 Funding flows toward more mature companies

Funding flows indicate a skew toward later-stage companies ready to scale. **Cluster 2 has received the highest average total funding** of $52.4 million USD per company, or a median of $21.5 million USD[1]. The larger funding and delta between median and average could be explained by the cross-over of applications to other industries. This group's funding is skewed by the larger drone manufacturers, such as **DJI**, included in the analysis for its strong focus on agriculture but spanning into such other industries as construction, industry, recreational, and land monitoring at large. Alone, DJI has raise a cumulative $108 million. Commercial drone operations in particular have benefitted from the maturing of regulatory and commercial frameworks that have greatly facilitated their deployment. By the end of 2024, 400,000 DJI Agriculture drones were used globally, a 90% increase since 2020, across 500 million hectares from more than 100 countries.[41] Drones for commercial agriculture have become widespread.

The space at large is relatively nascent: sixty percent of all the companies in this market map were founded in the last 8 years. Compared to the other clusters, Cluster 2 also has a higher percentage of older, later-stage companies, which generally result in larger funding sizes. This indicates a natural progression in funding toward later-stage rounds. It also indicates a relative maturity of these data analytics solutions over more technically difficult mechanical tasks. A McKinsey analysis confirms this, showing that farm software is the most penetrated agriculture technology, followed by remote sensing and automation.[42]

Cluster 3 has the second highest average total funding of $45 million. These spraying and weeding robots naturally require more capital to scale than SaaS or software-dominant products. Cluster 5 naturally follows, then 1 and 4.

The fact that Cluster 4 has received the lowest average total funding underlines the technological immaturity of harvesting robotics relative to other in-field robotic applications, and the earlier stage of the small set of companies included. In terms of overall total funding, due to the greater number of companies within the weeding and spraying applications, Cluster 3 leads, with $947 million.

Some companies have managed to raise significant amounts, such as **Carbon Robotics**' $70 million Series D, or Swiss-based **Ecorobotix**'s $52 million series B, in 2024 and 2023, respectively. In fact, roughly a quarter of the companies in the market map have raise $30 million or more in their latest rounds, nearly all in the form of equity, ranging from Series A to D. These relatively large raises indicate the scale of funding needed for the 75% of the earlier-stage companies remaining, particularly those with a hardware focus. **Appetite for these technologies is starting to materialize in larger ticket sizes.**

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[1] Funding flow data was sourced from Crunchbase.

3 Market Forces

Proving the technology requires earlier-stage players to demonstrate their products before farmers can commit; this build vs. sell catch-22 often deters investors who seek a guaranteed product-market fit even in earlier stages. Further, venture funding is not well equipped to support CAPEX-intensive startups with longer windows to profitability. Partnerships and M&A activity will thus continue to play an active role in developing the space, allowing more testing and de-risking for robotics start-ups to better signal commercial readiness to a broader investor base.

3.1 Consolidation and M&A are on the rise

The agriculture robotics sector has seen a lot of M&A activity in the last few years, driven by large acquisitions by the incumbent agricultural players, suggesting there is a healthy flow of funds steered toward robotics and automation.

- **John Deere and CNH lead the way** and have been investing in automation for decades. Both have made acquisitions of technologies to automate their tractor fleets: Deere's acquisition of Bear Flag Robotics for $250 million in 2021, and New Holland (a subsidiary of CNH)'s 3-year partnership with BlueWhite robotics in 2024, with both technologies boasting to automate their massive tractor fleets and boosting operational efficiencies.[43,44]
- More recently, in April 2025, in response to the current investment climate and funding windfall, **CNH acquired the assets and IP of Advanced Farm Technologies**, a leader in autonomous farming equipment.[45] This could be the first of a series of acquisitions while start-ups struggle to sustain funding flows. CNH also partnered with weeding robot Stout in 2022.[46]
- **Yamaha Motors acquired Robotics Plus** in February 2025, forming a new US-based arm, **Yamaha Agriculture**. The new entity focuses on delivering autonomous equipment to the specialty crop market.[47] Leveraging Yamaha's strong track record of manufacturing excellence could bolster cross-industry robotic technologies and advance the agriculture robotics space.
- **Muddy Machines acquired key assets and intellectual property from Fox Robotics** in November 2024, diversifying Muddy Machines' product line and positioning as leaders of in-field robotics with multiple applications: harvesting, weeding, planting, spraying and load transporting.[48]
- **Kubota North America acquired Bloomfield Robotics**, a SaaS image processing AI company that predicts crop harvest timing and yield analysis, in September 2024.[49] This acquisition helps Kubota lead digital solutions to the specialty crop market, which lags in terms of digitization and mechanization as compared to row crops.
- In April 2024, **AGCO Corporation and Trimble formed a joint venture worth nearly $2bn**, **one of the largest transactions in ag-tech history.**[50] The joint venture provided AGCO, a global leader in the design, manufacture, and distribution of agricultural machinery, with an 85% interest in Trimble's agricultural assets and technologies. Focused on the mixed fleet market, the JV is focused on retrofitting fleets across the AGCO portfolio with Trimble's autonomous and precision agriculture technologies.

- **Rockwell Automation**, a global leader in industrial automation, **acquired robotics equipment startup Clearpath Robotics** for $615 million in September 2023.[51] While the industry sectors apply beyond agriculture to aerospace, military, and academia, the size of this acquisition points to robotics reaching a new stage of commercial maturity.

This rise in M&A activity elucidates two encouraging considerations for investors. The first is a sustained and growing confidence in this technology segment, where making acquisitions allow these incumbents to stay ahead of the latest innovation trends and bringing in-house some specialized, high barrier-to-entry technologies. It also signifies an exploitation of a short-term buying opportunity, where valuations may be low and the cost of capital too high. Given current market conditions, M&A can be the best viable exit opportunity. These acquirers with larger, more flexible balance sheets, have signaled longitudinal support in the direction of agriculture automation, effectively derisking this sector for a wider investor base.

3.2 Partnerships begin to form

There is positive momentum in consolidation of the industry through partnerships and data sharing. This would help strengthen the ecosystem and bridge the deployment scaling challenge and trust concerns between technology developers and producers.

The **Western Growers Association (WGA)**, a major trade association of a wide network of farmers across the Western US, is bullish on ag-technology and has promoted the industry to its members in several innovative ways. Its **Innovation & Technology department** released two case studies, with Carbon Robotics and Stout exploring the potential of field automation, showing clear cost savings, to providing farmers with real grower data and trusted testimonials.[52] They have actively supported the development of **The Reservoir**, an incubator that houses in-field robotics testing and data sharing, to encourage a more symbiotic relationship between technology entrepreneur and farmer for early-stage development.[53] They have also supported the build of **The Vine**, a Californian network drive innovation in agriculture and biotechnology run by Farmhand Ventures.[54]

AgLaunch is another incubator that directly supports early-stage ag-tech companies in testing their products with AgLaunch's large network of farmers. The central thesis here is to **make farmers integral owners and co-developers of the products**: affiliated farmers form a cooperative to own a portion and invest in the portfolio companies.[55] This sort of real-world data sharing and partnership between farmers and entrepreneurs is unprecedented in the industry and will hopefully pave the way for higher adoption rates, faster testing, and deployment.

Partnerships between research organizations and commercial applications are continuing to grow as a recognition for the need for more communication between researchers and end users. Purdue University and Bayer's 2024 **Coalition for Sustainable and Regenerative Agriculture** is an example of a public-private partnership marrying industry commitment to improving soil health and food production sustainability. This initiative links regenerative agriculture practices to emerging farm technology and could invite a wider pool of investors and partners. The **IoT4Ag consortium** brings together several major universities with strong agriculture technology research capabilities across the US, including the University of Pennsylvania, Purdue, and University of California MERCED, to collaborate within the field of precision agriculture.[56] **FIRA**, the world's leading conference on agricultural automation, brings together researchers, entrepreneurs, and the farming community to explore the latest opportunities and constraints in commercializing the space.[57] They also facilitate partnerships for increasing in-field testing and data-sharing initiatives.

Some players are starting to form partnerships together, such as **Burro** and **Geodnet** to expand advanced RTK GPS autonomous navigation,[58] or **Sentera** partnering with **Flir**, one of the leading thermal camera manufacturers to advance their precision agriculture UAS offerings.[59] This shows a growing degree of collaboration, suggesting a willingness to share data and learnings to help scale the technology and bring down costs faster.

3.3 Notable bankruptcies

Despite the positive momentum, this industry has not been immune to the swathe of bankruptcies that have affected the VC world in the last couple of years. **Abundant Robotics**, one of the promising incoming harvesting robot companies, shut down in response to COVID disruptions in July 2021.[60] **PrecisionHawk**, a leading US agricultural drone manufacturer, filed for bankruptcy in December 2023.[61] And, more recently, **Farmwise** closed operations in April 2025, acquired at a distressed value by salad giant **Taylor Farms.**[62] The market may see continued distress amidst the general capital drought of recent years if companies do not overcome their challenges to unlock commercial deployment.

4 Key Insights for Investors

4.1 Today presents an investment window.

A 2024 McKinsey study on the ag-tech sector indicates that **30% of ag-tech startups will likely need funding to remain operational and are at high risk of liquidating**, particularly in the next-gen foods and alternative proteins, digital and precision agriculture, and CEA industries.[63] The rise in M&A activity is likely to continue. These corporate acquirers have signaled a long-term confidence in agriculture robotics and have capitalized on market conditions to consolidate their leadership.

Today presents a unique window for investors to strategically provide operational support to startups facing these capital challenges, while capital value remains high, and talent and IP can be retained. Startups will likely be focusing efforts to reduce burn rates and race for profitability – by specializing, reducing R&D lines, or developing partnerships or licensing agreements to expand into new markets. This niche technical field has a high barrier to entry. Investors who can get involved now will benefit from a more strategic leverage to position themselves into an inevitably growing market that will transform the agriculture industry in the longer term.

Where traditional venture capital may provide too short of an investment horizon and too much equity dilution for these more capital-intensive, hardware, and R&D-heavy robotics start-ups to take off, **a more diversified set of collaborative financing models gives rise to a more mature and consolidated market of agriculture robotics players**. With more than half the companies on the market map sampled above being early-stage ventures (pre-series B), much of the funding is used for derisking the technology: to iterate based on initial in-field testing and scale up manufacturing from singles or dozens to the hundreds of units necessary to reach profitability. With slow and seasonal testing and iteration cycles, investors should look more longitudinally and support companies through the initial deployment and manufacturing hump to a healthy deployment rate.

The growth of incubators and venture hubs such as The Vine suggests a need to promote more pre-seed company formation with earlier access to in-field testing. **Patient, early-stage capital is needed to finance these novel solutions and unlock adoption**. Parallel investment in plant genetics and breeding can further enhance the ability to specialize in higher-margin specialty crops with traits suited to pair with robotics.

4.2 Opportunities to specialize within the value chain.

The agriculture robotics sector is still a relatively nascent market with much capacity for consolidation within the value chain. While this analysis has clustered the space by use case and where their IP and primary innovative focus lies across the software-hardware continuum, many integrate solutions that span across the value chain. For example, most robotics companies develop their in-house hardware, software, and embedded systems stacks.

Companies with stronger hardware development capabilities could leverage existing machine-learning and sensor-development companies instead of trying to develop their own models.

They could explore contracting manufacturer partnerships instead of manufacturing in-house. Companies helping to bridge the software-hardware integration for data analytics, autonomous navigation, and sensor embeddings are well positioned to help consolidate the industry. A few examples of these key integration players applying software automation technology to a wide range of robotic or regular vehicle fleets are **Agtonomy**, **Robovision**, and **NeuPeak Robotics**.

The space could also be strengthened by the robotics community sharing a more uniform robotic programming language. **ROS2**, the most widely shared language amidst roboticists, helped foster a more collaborative ecosystem and driven innovation within specific algorithmic areas: navigation, sensing, and collaborating.[64] Many open-source algorithms for SLAM and multi-sensor fusion already exist. Companies that demonstrate unique IP and strategically decide to build in-house versus outsourcing will be better positioned to remain competitive, especially within the more fragmented clusters of weeding and crop intelligence. Specializing within the value chain and partnering with other services will enable more rapid deployment.

4.3 Business models need to diversify.

As companies mature and technology deployment will become more interlinked with day-to-day operations, **Robots-as-a-Service** business models are likely to grow in popularity to help de-risk technologies and increase penetration rates. Leveraging from Software-as-a-Service's scalability, this model also allows the company to shift the burden of maintenance, operations, set-up, and troubleshooting to themselves, reducing friction for the end users.

The variability of software-hardware focuses within this sector leads to a breadth of business model options. As companies specialize and develop solutions applied to other players in the space, one can expect to see a **shift toward more B2B** business models. Data analysis and IoT solutions providers can sell Software-as-a-Service to robotics and existing farming hardware products, or sell directly to OEMs, as Bonsai Robotics is exploring.[65] Hardware companies can explore leasing and servicing options to use existing farm equipment distributors with which farmers are already familiar, such as Burro's partnership with Pacific Ag Rentals.[66] Customizing cost structures for farmers' needs will facilitate showing a faster and more certain return on investment for the product.

4.4 Focus on the lower-hanging fruit: Collaboration with the farmers is key.

Labor should be enhanced, not replaced. Automation is not always best placed to entirely replace humans in such technical and hyper-local contexts as agriculture. The fact that so many high-tech companies within the autonomous harvesting and pruning industries have struggled to penetrate the market demonstrates a need for companies to simplify the technology stack and work *alongside* an existing labor base. Flipping the narrative from human replacement to augmentation, or supplementing versus supplanting, could facilitate dialogue between entrepreneurs and the farming workforce and speed up market penetration. This would also ensure that the farmers' needs are incorporated earlier on in the design process, fostering more trust and facilitating access to in-field testing.[2] Burro's emphasis on collaboration with the workforce exemplifies this idea. Further, **incorporating *collaborative* technology into the field serves to strengthen and retain a key agricultural labor base necessary to drive healthy growth within the sector**. Initiatives such as those led by the WGA and AgLaunch serve as an example for the power of bringing real-world case studies to the field, while involving the farming community earlier in the process. Investors should look for companies prioritizing robustness as opposed to speed or technical sophistication. The less-technically complicated applications that support and augment an existing labor force, such as ground vehicle load hauling, drone imaging, or weeding, may yield faster penetration and better serve to de-risk the space at large.

4.5 Pressures will grow; automation will follow: The Fourth Agricultural Revolution has arrived.

Investors seeking to address rising global food security concerns must recognize automation and robotics' key role in revolutionizing agriculture. The pressures on the agricultural sector will only continue to rise: labor and input costs, climate shocks creating more hostile farm labor environments, and growing urbanization will inevitably force the largest industry in the world to catch up with the rest of the industries' pace of innovation. Policy and innovations in farm financing mechanisms will also shape the pace of agricultural technology adoption.

The industry needs more diverse capital structures. A dearth of market penetration implies a need for more patient early-stage funding. While agriculture robotics is no silver bullet, nor a trivial solution set to get right, this analysis presents strong evidence of its essential role in addressing these crises. Fundamentally an adaptation and resilience solution set, agricultural robotics can strengthen food production systems by enhancing farm practices, placing more decision-making power in the hands of the knowledge-holding farmers, and building a more sustainable future of agricultural labor.

The data for this report was generated by combining sources, including interviews with industry leaders, Preqin, Crunchbase, and CREO's Research and Data Platform databases. If you would like to learn more about this report or the underlying data, please reach out to Sophie Thorel at sthorel@creosyndicate.org.

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