



EMERGING TECH RESEARCH

Agtech Overview

Industry and taxonomy update with latest VC activity

2022

Published March 17, 2023



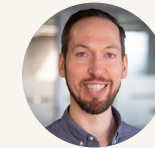


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Institutional Research Group

Analysis



Alex Frederick Senior Analyst, Emerging Technology
alex.frederick@pitchbook.com
pbinstitutionalresearch@pitchbook.com

Data

TJ Mei Data Analyst

Publishing

Report designed by **Jenna O'Malley, Joey Schaffer,** and **Julia Midkiff**

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This report is an annual overview of the agtech industry. For a more granular perspective on the agtech industry, please see our [latest quarterly edition](#).



Vertical overview

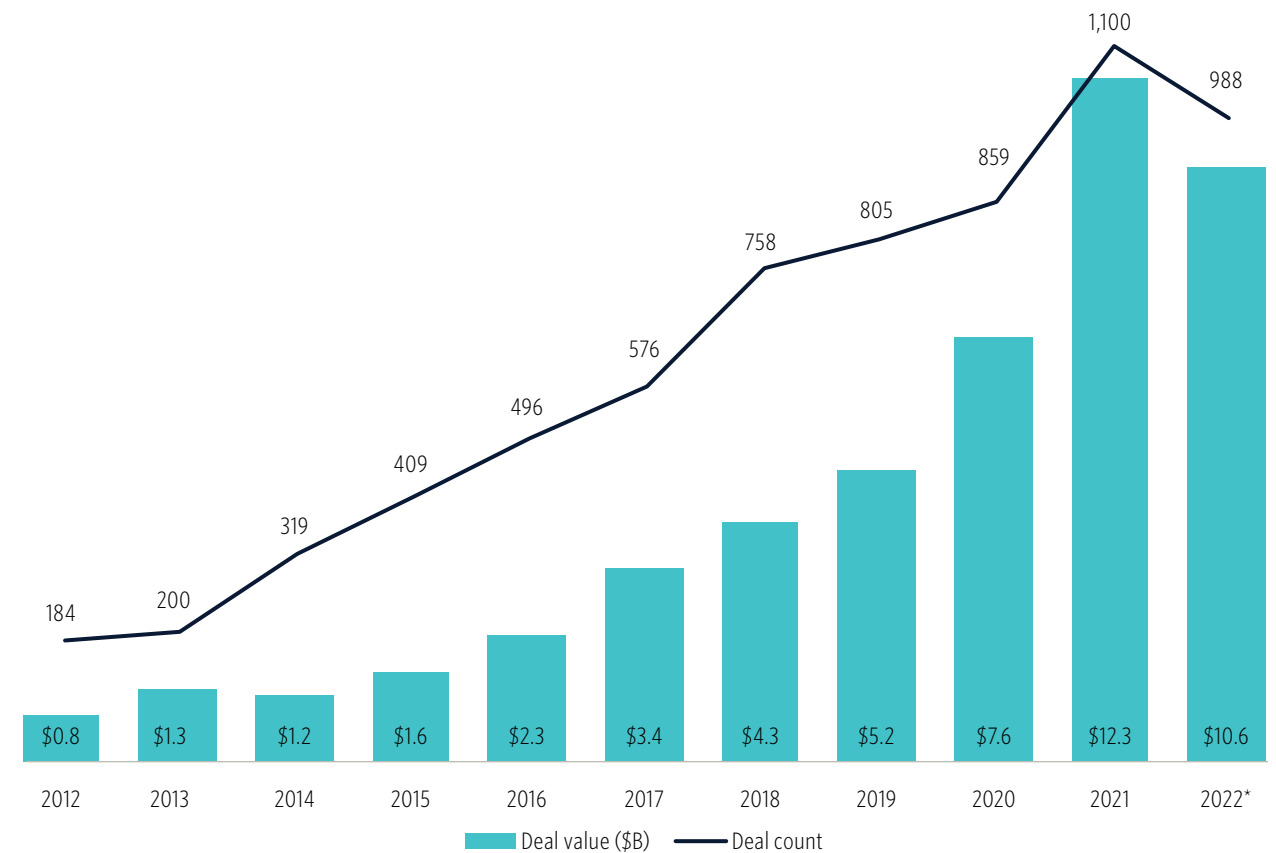
The agricultural industry has been transforming rapidly in recent years due to technological advancements in various fields. Emerging agricultural technologies have the potential to significantly impact the industry by improving productivity, sustainability, and profitability. As we move into 2023, it is important to take stock of the trends and developments that occurred over the past year that will shape the agtech landscape in the year ahead.

The 2022 Annual Agtech Industry Overview Report provides an overview of the industry's current state and examines key trends and technologies to watch. The report covers a broad range of agtech applications, including precision agriculture, plant genetics and breeding, robotics and automation, digital tools and platforms, and indoor farming.

The report provides a detailed segment analysis, including industry drivers, market sizing, key business models and investment activity. It also explores challenges and opportunities for key technology segments and stakeholders in the agtech ecosystem, from farmers and food producers to technology developers and investors.

As we navigate a changing global landscape, the role of emerging agricultural technology in addressing food security, sustainability, and economic growth becomes more critical than ever. This report provides a comprehensive perspective on the state of agtech in 2022 and beyond, offering insights and recommendations for businesses, policymakers, and investors looking to seize opportunities in this rapidly evolving space.

Agtech VC deal activity



Source: PitchBook | Geography: Global | *As of December 31, 2022



Agtech landscape

- 1** Ag biotech
- 2** Agrifinance & e-commerce
- 3** Indoor farming
- 4** Animal ag
- 5** Precision ag

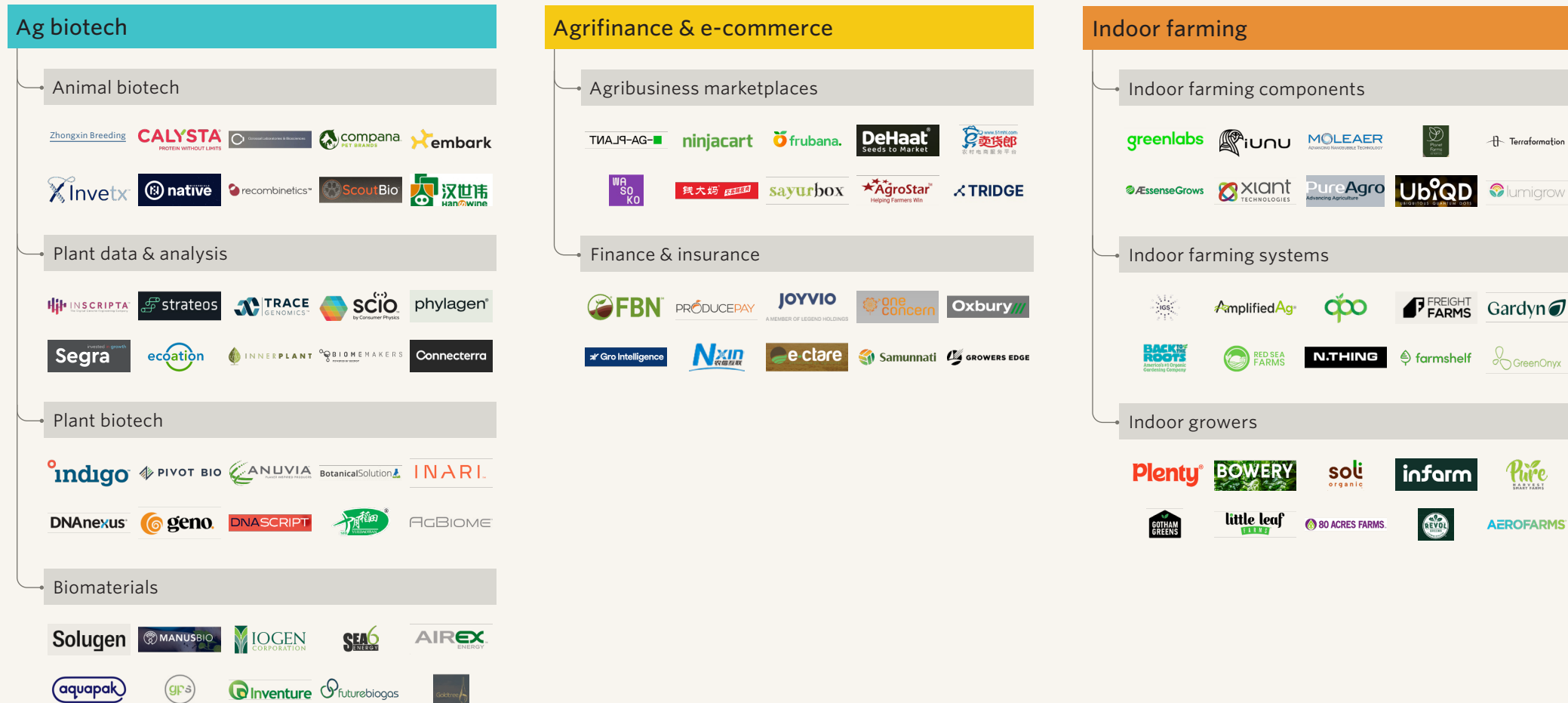




Agtech VC ecosystem market map

Click to view the interactive market map on the PitchBook Platform.

Market map is a representative overview of venture-backed or growth-stage providers in each segment. Companies listed have received venture capital or other notable private investments.





Agtech VC ecosystem market map

Click to view the interactive market map on the PitchBook Platform.

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Animal ag

Aquaculture



Livestock & land animal technology



Pollination tech



Insect farming



Precision ag

Farm management software



Robotics & smart field equipment



Field IoT



Drones & imagery analytics





VC activity

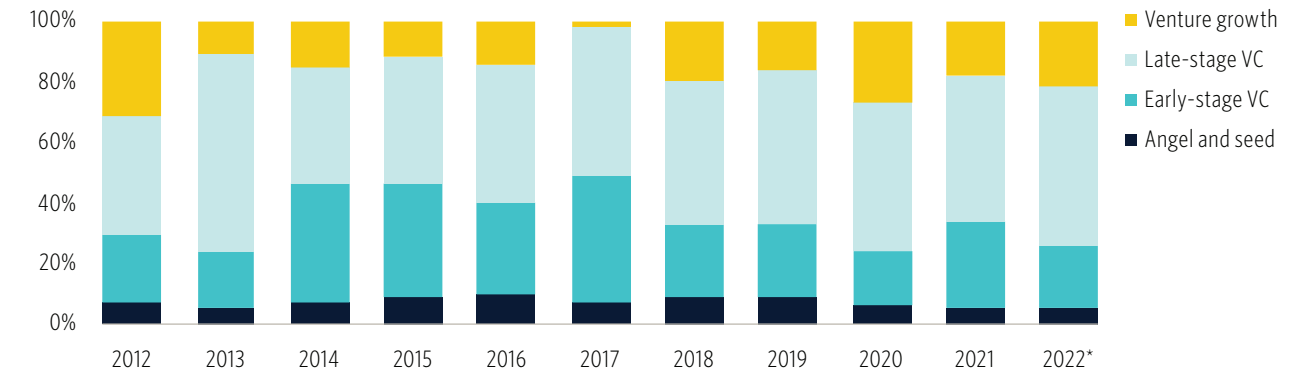
Despite the challenges posed by market volatility, rising interest rates in the US, conflicts abroad, and the continued ripple effects of the COVID-19 pandemic, agtech venture activity remained strong in 2022. Global agtech VC funding reached \$10.6 billion, down 13.2% from 2021, but the second strongest year on record. We logged 988 deals in 2022, falling 10.2% short of record activity in 2021. This surge in investment reflects the increasing interest in and recognition of the importance of agtech in addressing global challenges such as food security and sustainability.

The report found that the majority of agtech funding was directed toward late-stage and venture-growth-stage companies, with these deal types accounting for 74.2% of total funding. This indicates that investors are willing to make larger bets on more established companies with proven track records and market traction. Additionally, deal volume was concentrated at the late and growth VC stages in 2022. Historically, most deal activity by count has occurred at the angel and seed stages. However, late- and growth-stage VC companies received 42.4% of deals by count in 2022. This contrasts with the narrative that took hold in the second half of 2022 during which investors shied away from late-stage deals due to their proximity to public market volatility.

Ag biotech was the top recipient of funding by sector, accounting for 30.7% of total funding, followed by indoor farming at 22.1%. Ag biotech attracted 29.2% of deals by count, followed closely by precision ag at 27.9%. Increased food security, crop resilience, and sustainability were major drivers for investment in each of these sectors.

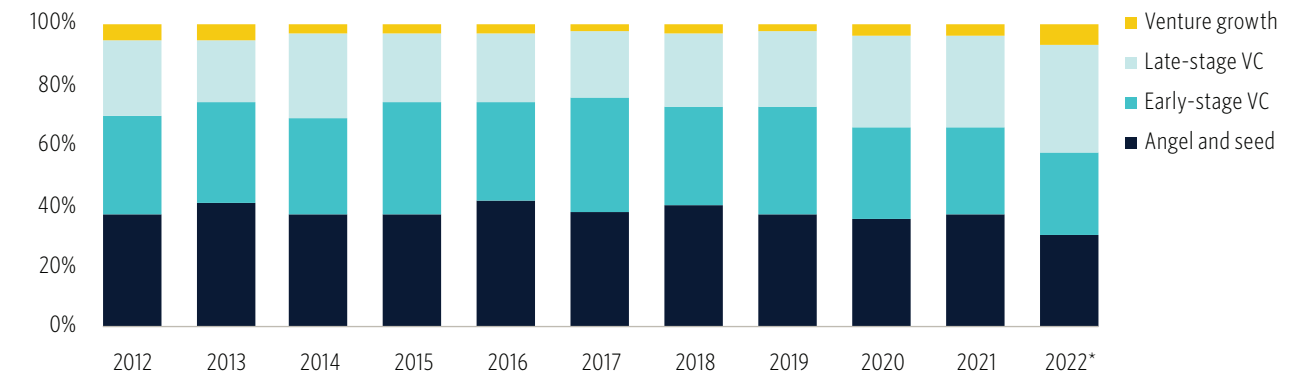
North America was the largest market for agtech investment, accounting for 47.4% of total funding by deal value. However, Asia also saw significant growth in agtech investment, with the share of total funding increasing from 13.1% in 2021 to 22.5% in 2022.

Share of agtech VC deal value by stage



Source: PitchBook | Geography: Global | *As of December 31, 2022

Share of agtech VC deal count by stage



Source: PitchBook | Geography: Global | *As of December 31, 2022



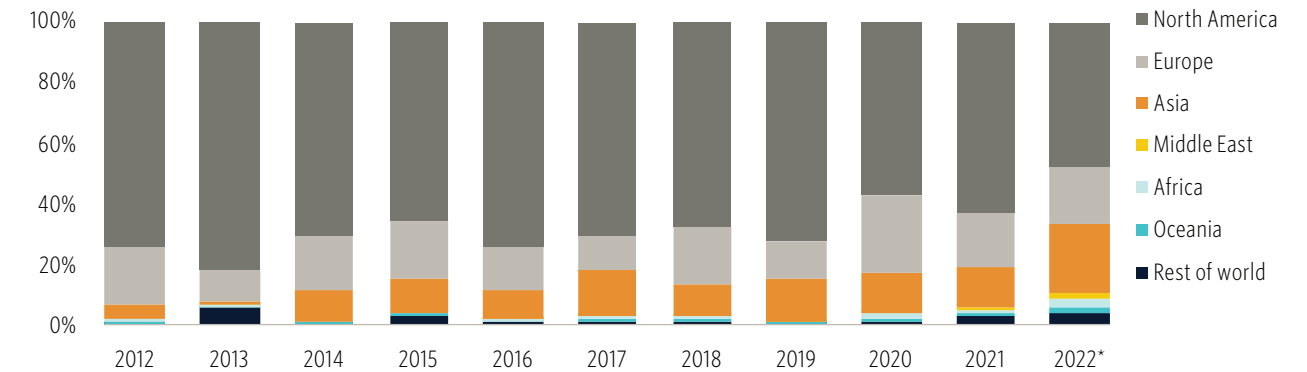
VC ACTIVITY

Notable agtech funding rounds in 2022 included California-based vertical farming company [Plenty's](#) \$400.0 million Series E round, French insect farm operator [InnovaFeed's](#) \$260.0 million Series D, and soil amendment/agribusiness marketplace platform [Indigo Agriculture's](#) \$150.0 million Series H.

VC-backed agtech exit activity in 2022 was weak—as expected—with a total of 38 exits and \$2.2 billion exited. This represents a significant decrease from 2021's record-breaking year but is still a robust performance given the challenges of market volatility and rising interest rates in the US. Deal counts were down 37.7% YoY, but up 18.8% from 2020. Most exits were through M&As, with a few notable public listings such as [GreenLight Biosciences](#) and [Satellogic](#). Notable acquisitions included the \$200.0 million purchase of biological provider [BioPhero](#) by [FMC](#) and the acquisition of robotic harvesting startup [Traptic](#) by [Bowery](#). Overall, the agtech industry appears to be maturing and attracting significant interest from investors and acquirers alike despite the immediate headwinds.

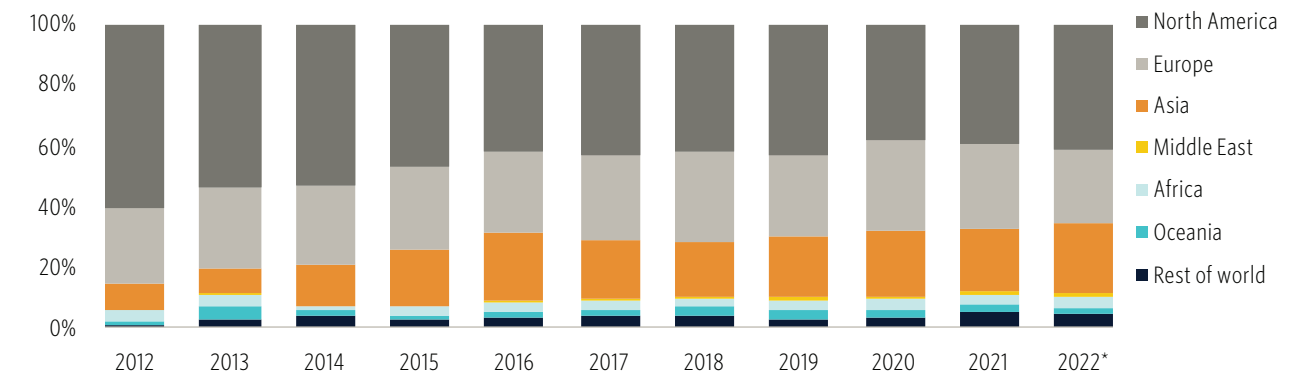
The strong agtech investment activity in 2022 indicates a growing recognition of the potential for technology to drive innovation and address critical challenges in the agricultural industry. As we move into 2023 and beyond, we can expect continued growth and evolution in the agtech landscape, with an increasing focus on sustainability, digitization, and innovation.

Share of agtech VC deal value (\$B) by region



Source: PitchBook | Geography: Global | *As of December 31, 2022

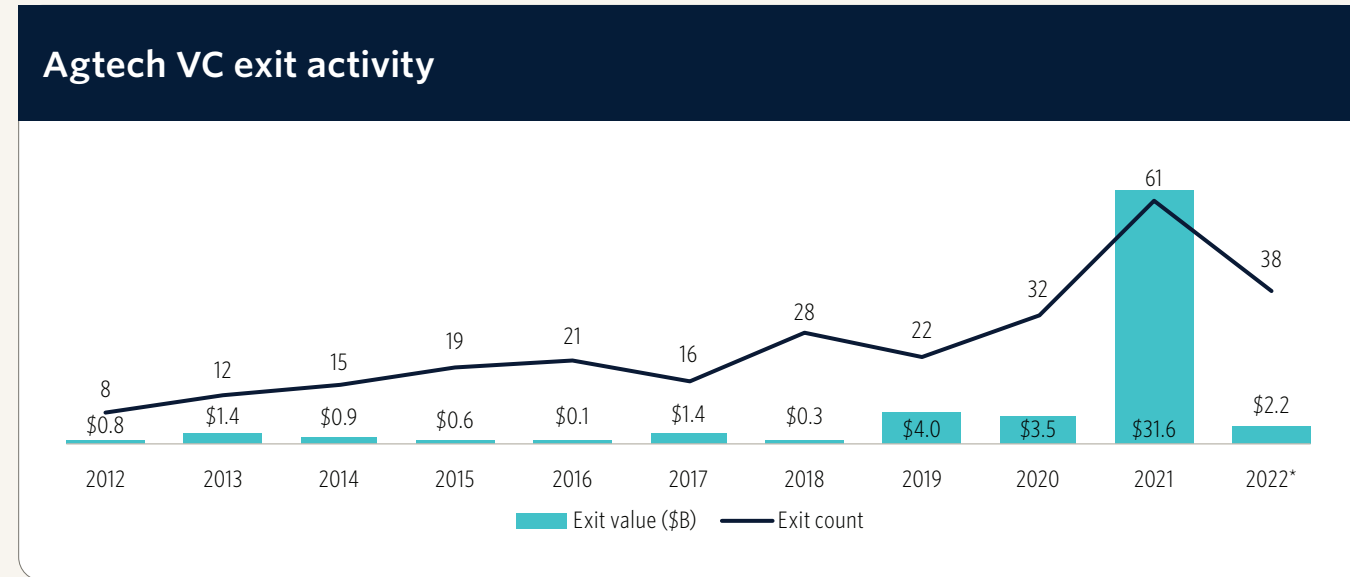
Share of agtech VC deal count by region



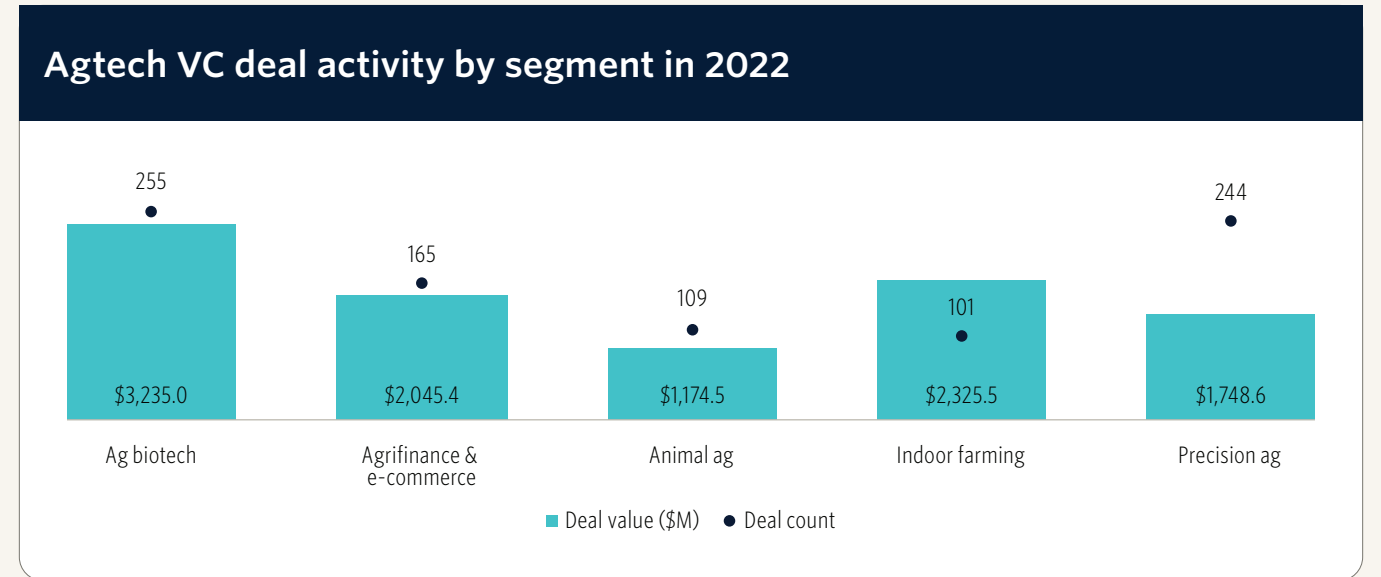
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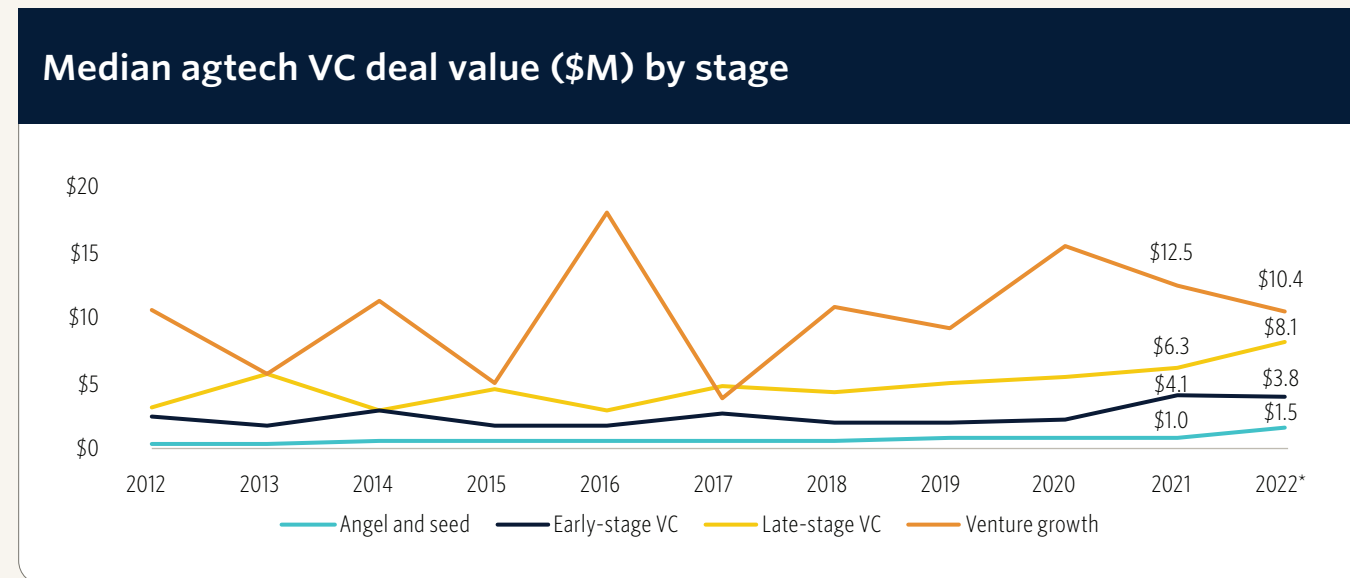
VC ACTIVITY



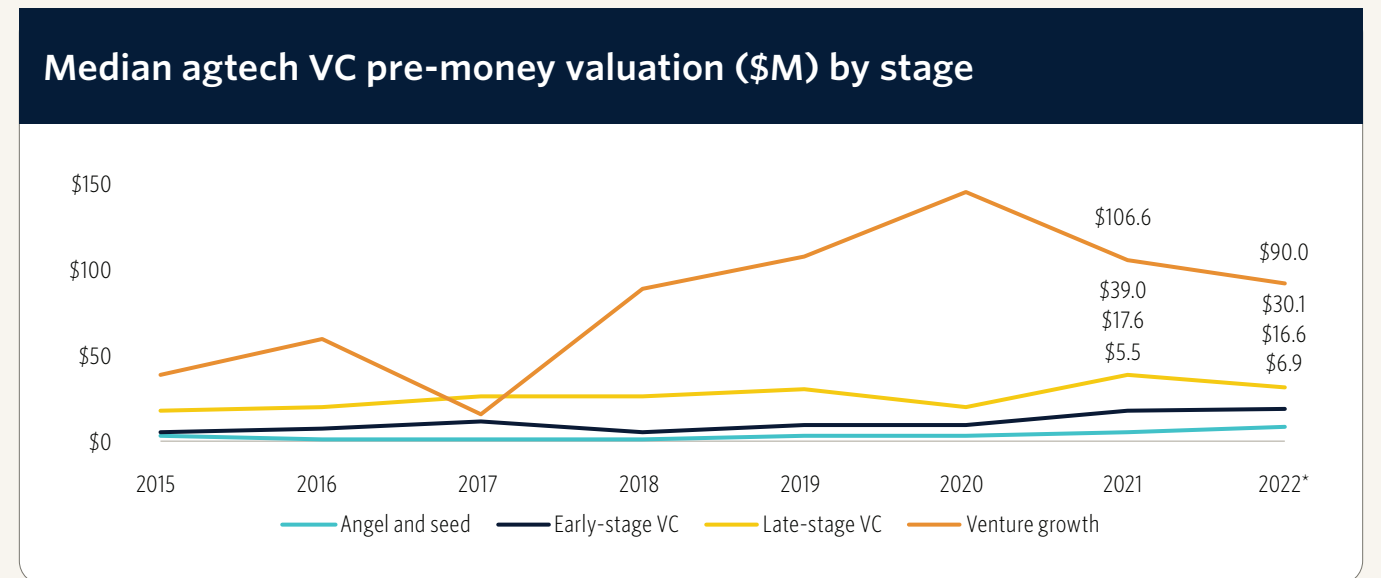
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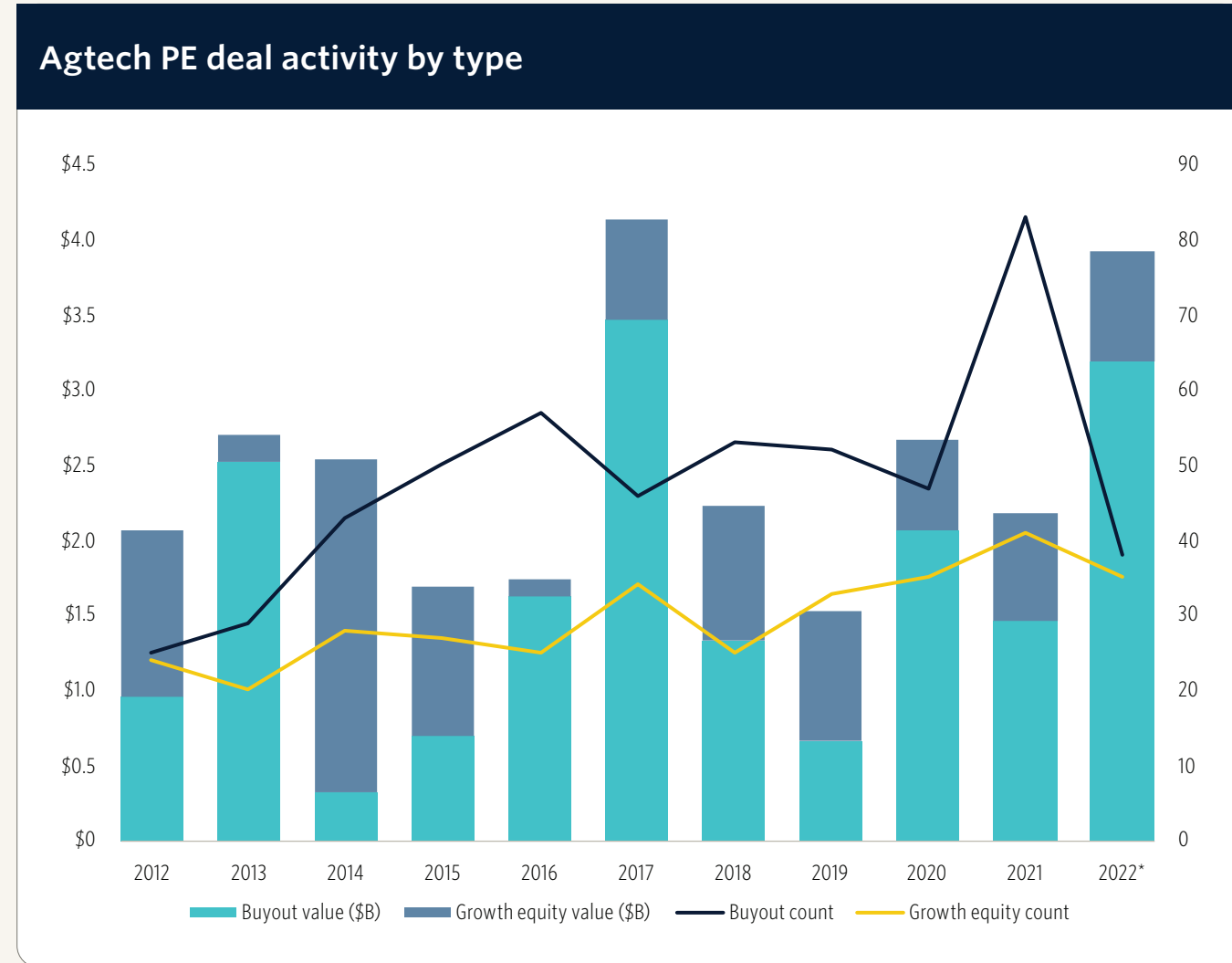
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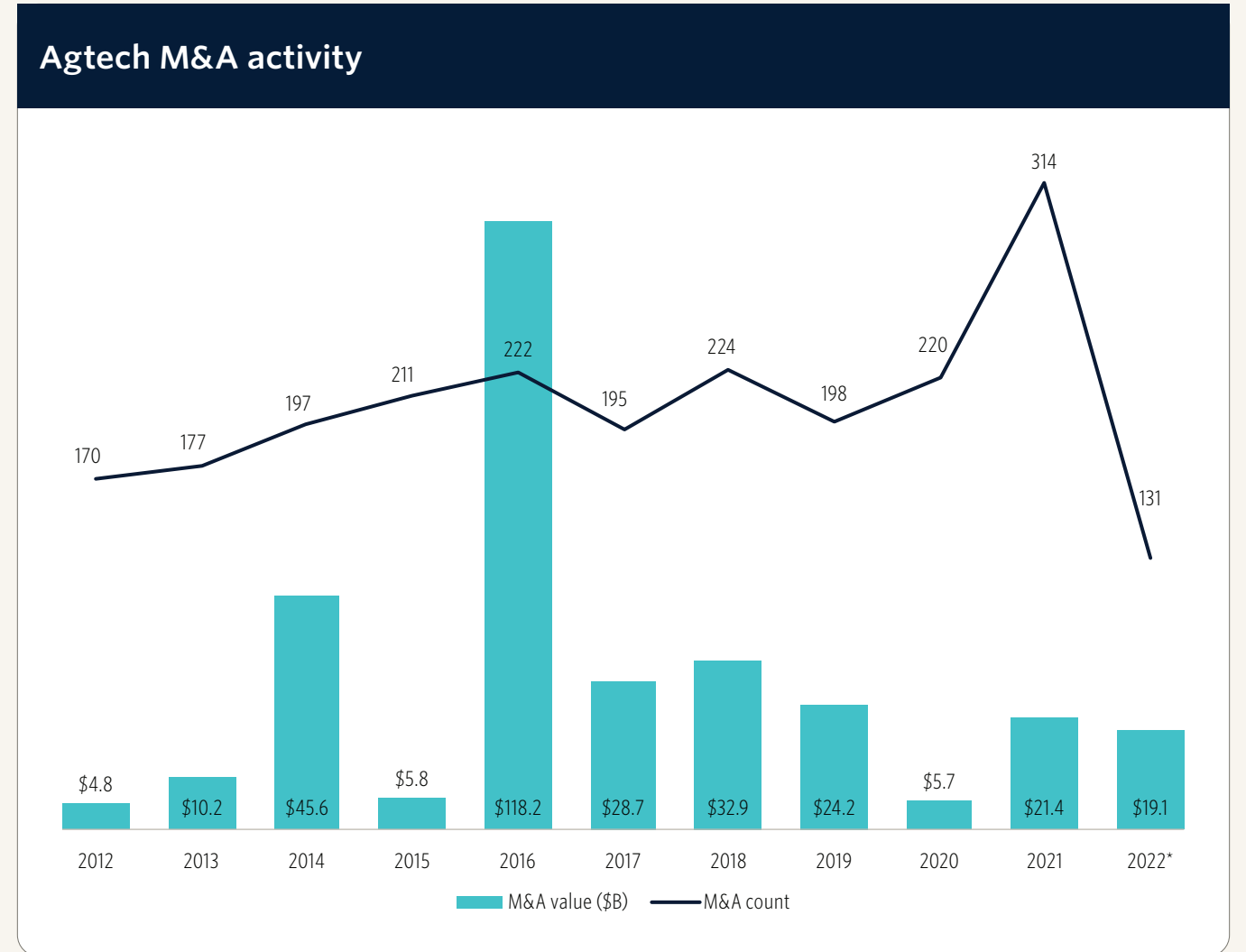
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VC ACTIVITY



Source: PitchBook | Geography: Global | *As of December 31, 2022



Source: PitchBook | Geography: Global | *As of December 31, 2022



Segment overview

Ag biotech

Synthetic fertilizer export blockages create unforeseen opportunities for biologicals.

Indoor farming

Supply chain challenges and food security concerns drive interest in indoor farming.

Agrifinance & e-commerce

Ag marketplaces empower smallholder farmers in emerging markets.

Precision ag

Interest in weeding robots takes root.

Animal ag

Funding for pollination tech triples as pollinator decline worsens.



Ag biotech

Overview

Ag biotech refers to agricultural inputs and services that use biological or chemical processes to improve crop or animal production yields. This segment encompasses a broad range of technologies, including genetics and microbiomics, fertilizers, genetic engineering, breeding technologies, and animal health feed additives. Synthetic biology (SynBio), which involves constructing or modifying biological components, is gaining momentum as a tool for agtech innovation. Gene-editing tools such as CRISPR have gained traction over GMOs due to their precision and reduced need for genetic modification, resulting in regulatory and public relations advantages.

Historically, the ag biotech industry has been dominated by the “big six” companies: [Dow](#), DuPont, [Monsanto](#), [Bayer](#), [Syngenta](#), and [BASF](#). However, recent consolidation and the emergence of VC-backed startups have led to changes in the industry. The new “big five” companies, namely ChemChina, [Bayer](#), [BASF](#), DuPont, and [Dow](#), still maintain significant market share, but startups are carving out a niche by focusing on emerging trends and consumer preferences, such as sustainable, organic, and GMO-free agriculture, as well as improving soil health.

Subsegments include:

Animal biotech: Biotech solutions optimizing animal health and production including genetics, breeding, feed, and animal health.

Biomaterials:¹ Companies selling biomaterials such as biogas and fertilizer produced from lower-value biomass such as manure and food waste, or companies developing the technologies to produce these biomaterials.

Plant biotech: Companies developing new crops, microorganisms, fertilizers, and other treatments to maintain and improve crop yields.

Plant data & analysis: Tools and software analyzing plant traits, DNA, and microbiomes.

Industry drivers

Crop production is subject to a range of pressures that are impacting the agricultural industry.

These include:

Climate change, severe weather, and infestation events: The effects of climate change, such as temperature change, drought, flooding, and insect swarms, make crop production more challenging. To adapt to these conditions, it is necessary to develop crop varieties that are hardier and more resilient.

¹: New in 2022.



AG BIOTECH

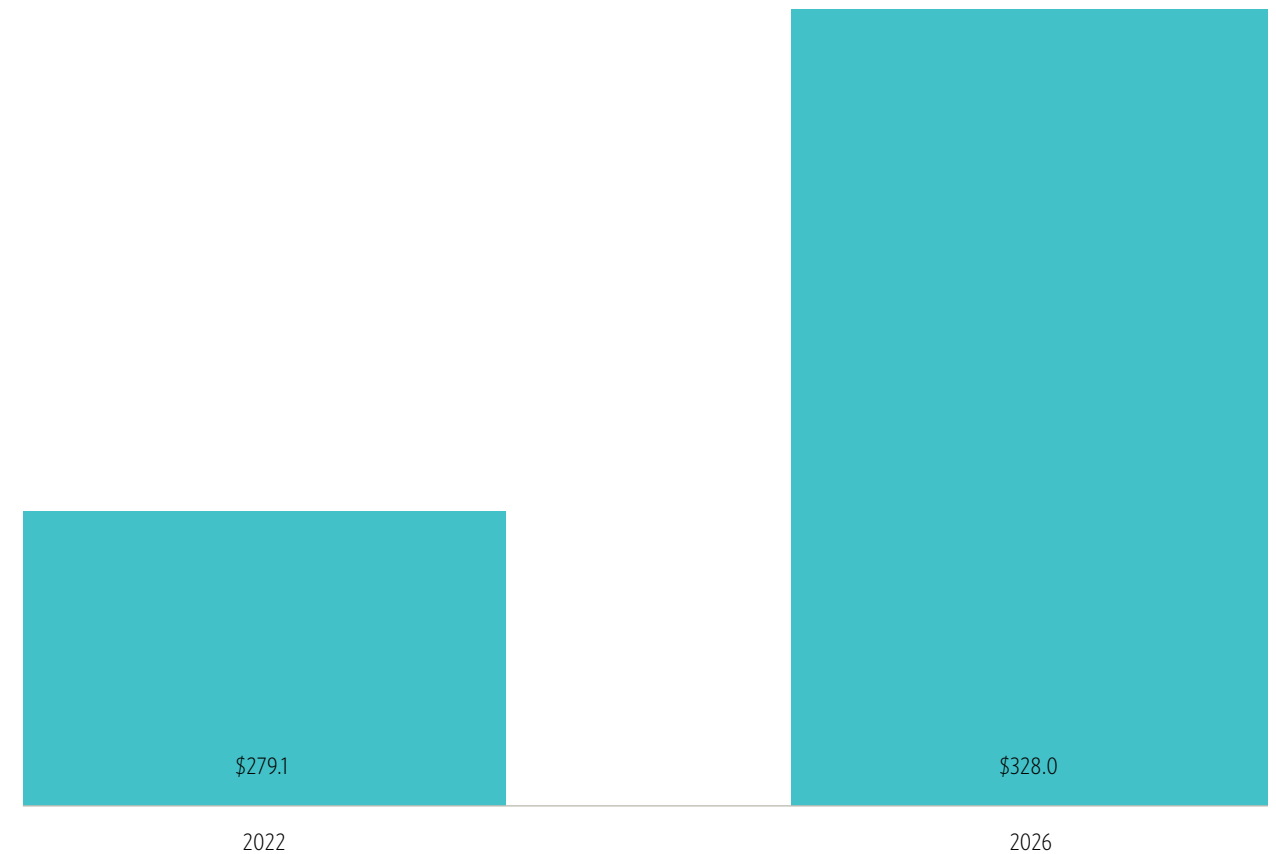
Changing consumer preferences: Consumers are increasingly interested in agricultural practices, including sustainability, the use of herbicides, and the nutritional content of agricultural products. This has led to greater demand for premium products, such as organic or non-GMO foods, and for traceability assurances, such as local or sustainably sourced products.

Changing demographics: As populations rise and resources such as water and arable land become more limited, growers must find ways to increase yields. Moreover, the increasing global demand for animal proteins is pressuring farmers to increase crop production for animal feed, such as corn.

Market size

The global agrochemical market is expected to generate revenue of \$237.4 billion in 2022, growing to \$328.0 billion by 2026, representing a 4.1% CAGR, excluding any structural market disruptions. Environmental concerns and mounting interest in biological alternatives to synthetic agrochemicals enable this growth. SynBio innovations such as microbial fermentation and cell-free systems speed up development timelines and lead to new products and use cases. Sustainable chemical company [Solugen](#) raised a \$200.0 million Series D in late 2022, demonstrating strong investor interest despite market volatility.

Agrochemical market size estimate (\$B)



Source: PitchBook Emerging Tech Research | Geography: Global | *As of December 31, 2022



AG BIOTECH

Business model

Companies in the ag biotech space monetize principally by developing and selling proprietary agricultural inputs to growers and agronomists directly or through agricultural co-ops. Other revenue sources include consulting and analysis services.

Common ag biotech key performance indicators:

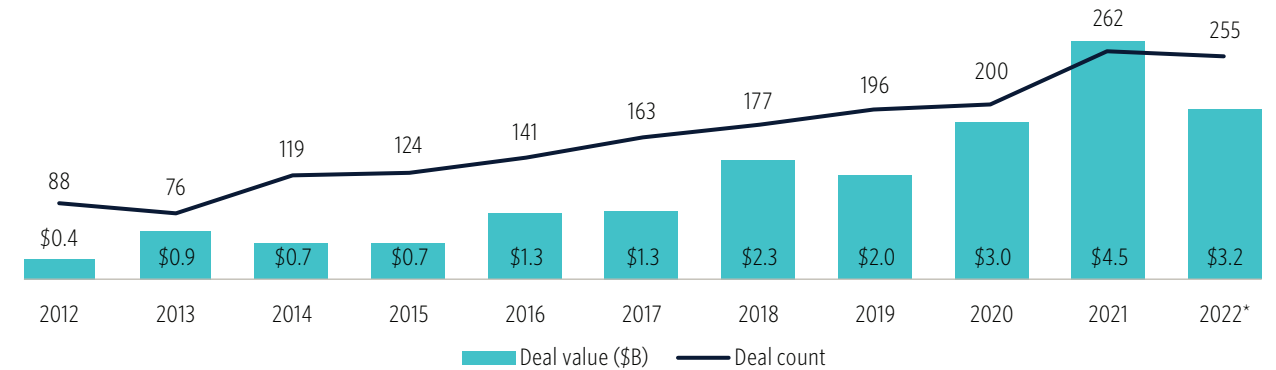
- [Increase](#) in production.
- Yield per plant/acre.
- Treatment (fertilizer, pesticide, or herbicide) use.

VC activity

Ag biotech is, once again, the top sector for agtech venture activity. In Q4 we logged \$723.3 million invested across 42 deals, more than double the deal value of any other agtech sector. The quarter's largest deal was a \$200.0 million Series D in sustainable chemical company [Solugen](#) to produce solutions including ag nutrition products and water treatment solutions.

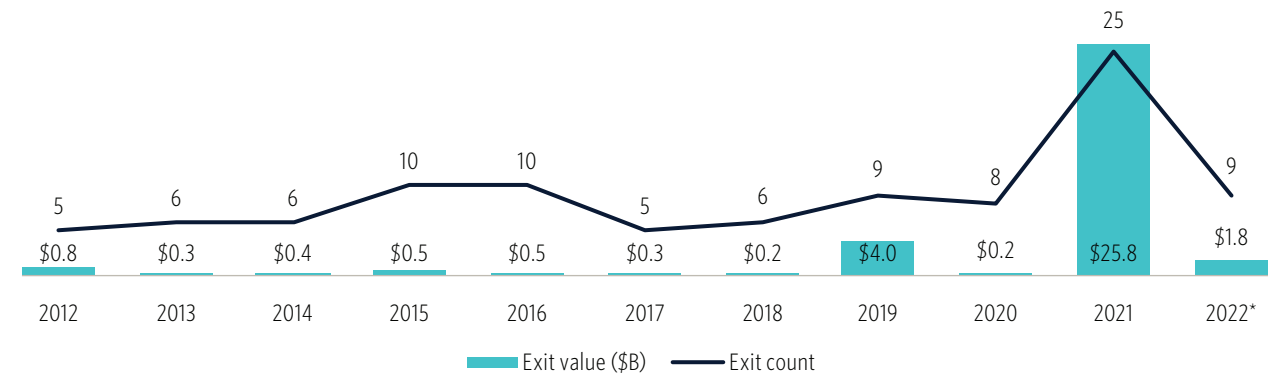
Annually, VC deal activity reached \$3.2 billion across 255 deals, down 28.8% and 2.7% YoY, respectively. The year's largest deal was a \$333.0 million early-stage investment in [Zhongxin Breeding](#), a company that uses genetic engineering to develop breeding pigs and semen products. Long-term, we anticipate substantial investment in ag biotech companies to fill the void of synthetic fertilizers and to develop inputs and crops that are more climate-friendly and resilient to climate change and extreme weather. However, near-term funding will likely be muted due to market volatility.

Ag biotech VC deal activity



Source: PitchBook | Geography: Global | *As of December 31, 2022

Ag biotech VC exit activity



Source: PitchBook | Geography: Global | *As of December 31, 2022



AG BIOTECH

Key ag biotech VC-backed companies*

Company name	Category	VC raised to date	Post-money valuation (\$M)	Most recent VC deal type
Indigo Agriculture	Plant biotech & agribusiness marketplaces	\$1,701.6	\$3,950.0	Series H
Solugen	Biomaterials	\$637.8	\$2,180.0	Series D
Pivot Bio	Plant biotech	\$616.7	\$1,700.0	Series D
Inari	Plant biotech	\$476.0	\$1,500.0	Series E
Inscripta	Plant data & analysis	\$459.5	\$1,300.0	Late-stage VC
DNAexus	Plant biotech	\$436.7	\$620.0	Series I
Geno	Plant biotech	\$401.5	\$436.0	Series C
Zhongxin Breeding	Animal biotech	\$332.9	N/A	Early-stage VC
DNA Script	Plant biotech	\$294.0	\$659.7	Series C
Brightseed	Plant biotech	\$119.9	\$300.0	Series B

Source: PitchBook | Geography: Global | *As of December 31, 2022



AG BIOTECH

Key ag biotech VC deals 2022*

Company name	Close date (2022)	Category	Deal size (\$M)	Post-money valuation (\$M)	Deal type	Lead investor(s)	Valuation step-up (post to pre)
Zhongxin Breeding	September 30	Animal biotech	\$332.9	N/A	Early-stage VC	N/A	N/A
Solugen	October 28	Biomaterials	\$200.0	\$2,175.0	Series D	Kinnevik, Lowercarbon Capital, Refactor Capital	1.1x
DNAexus	March 8	Plant biotech	\$200.0	\$620.0	Series I	Blackstone	2.2x
DNA Script	January 4	Plant biotech	\$191.7	\$659.7	Series C	Catalio Capital Management, Coatue Management	3.4x
Indigo Agriculture	July 28	Plant biotech & agribusiness marketplaces	\$150.0	\$3,950.0	Series H	N/A	1.0x
Inari	October 4	Plant biotech	\$124.0	\$1,500.0	Series E	N/A	1.1x
Vestaron	August 15	Plant biotech	\$92.0	\$362.0	Series C	Cavallo Ventures, Ordway Selections	2.4x
Enko	December 5	Plant biotech	\$80.0	\$330.0	Series C	Nufarm	2.0x
Sound	December 7	Plant biotech	\$75.0	\$375.0	Series D	BMO Capital Markets, Chan Zuckerberg Initiative	1.6x
Brightseed	April 6	Plant biotech	\$68.0	\$300.0	Series B	Temasek Holding	1.8x

Source: PitchBook | Geography: Global | *As of December 31, 2022



AG BIOTECH

Key ag biotech VC exits 2022*

Company name	Close date (2022)	Category	Exit size (\$M)	Exit type	Acquirer(s)/index	Valuation step-up (post to exit valuation)
GreenLight Biosciences	February 4	Plant biotech	\$899.0	Public listing	Environmental Impact Acquisition	3.0x
Vanguard Renewables	July 20	Biomaterials	\$700.0	Buyout	BlackRock	N/A
BioPhero	July 19	Plant biotech	\$190.7	Acquisition	FMC	N/A
BioEnTech	October 10	Biomaterials	N/A	Buyout	CNP Assurances, Caisse des Dépôts Group, Global Infrastructure Partners, Meridiam Infrastructure, Suez Environment	N/A
Microread Genetics	June 27	Animal biotech	\$4.8	Public listing	National Equities Exchange and Quotations	N/A
Jinyuan Seed	July 18	Plant data & analysis	N/A	Public listing	National Equities Exchange and Quotations	N/A
Plant Response	February 24	Plant biotech	N/A	Acquisition	The Mosaic	N/A
CoverCress	August 1	Plant biotech	N/A	Acquisition	Bayer	N/A
Rapid Genomics	April 1	Plant data & analysis	N/A	Buyout	Abu Dhabi Investment Authority, Astorg (Paris), Cinven, LGC, Omnes Capital	N/A

Source: PitchBook | Geography: Global | *As of December 31, 2022



AG BIOTECH

Key ag biotech incumbents*

Company name	Category	Key products	EV/NTM revenue	EV/NTM EBITDA
Zoetis	Animal biotech	Vaccines, parasite control products, antibiotics	10.1x	23.4x
Benson Hill	Plant biotech	Phenotyping, predictive breeding and environmental modeling	2.0x	N/A
Bayer	Plant biotech	Ag chemicals, seeds & biotech products	2.1x	8.0x
BASF	Plant biotech	Crop protection, seeds, pest control	0.8x	6.1x
Corteva Agriscience	Plant biotech	Seeds & traits, crop protection, biologicals, digital tools	2.7x	15.6x
Nutrien	Plant biotech	Fertilizer, feed	1.6x	4.3x
The Mosaic	Plant biotech	Fertilizer	1.2x	3.3x
Yara International	Plant biotech	Fertilizer, digital tools	0.7x	3.9x
Elanco Animal Health	Animal biotech	Antibiotics, vaccines, insecticides, nutritional health	3.6x	15.1x
K+S Chemicals	Plant biotech	Fertilizer	0.8x	1.7x

Source: PitchBook | Geography: Global | *As of December 31, 2022



AG BIOTECH

Opportunities

Biomaterials: Biomaterials companies offer products such as biogas and fertilizer that are produced from lower-value biomass such as manure and food waste. Additionally, companies in this space sell technology directly to agricultural operators to enable them to produce these biomaterials. Anaerobic digestion involves using bacteria or microbes to break down organic matter into useful new materials. Companies offer anaerobic digestion reactors to agricultural operators to convert manure and other agricultural waste into valuable outputs. For instance, [Future Biogas](#) processes crops and manures into biomethane and “digestate” soil additives that enhance soil health. Another emerging biomaterial solution is biochar, a type of charcoal created from agricultural waste used as a farm input to improve soil quality. The benefits of biomaterials include new revenue streams, reduced agricultural waste, decreased greenhouse gas (GHG) emissions, improved soil health, and reduced input costs. Companies such as [Pacific Biochar](#) and [Rainbow Bee Eater](#) are creating and selling carbon credits based on the carbon sequestration potential of biochar. [Airex Energy](#), on the other hand, converts agricultural waste into biocarbon products such as biochar. Other key VC-backed providers in this space include [Glanris](#), [Made of Air](#), and [Capricorn Power](#).

Plant data & analysis: Companies in this category are developing tools and software to analyze plant traits, DNA, and the soil microbiome. These tools and insights are invaluable in accelerating research and development in agriculture. [Strateos](#), for example, provides remote access laboratories and lab control software for life science discovery, including agricultural applications. The company offers a range of discovery biology services, including emerging synthetic biology capabilities such as gene assembly, cell-based protein expression, and cell-free protein expression. Similarly, [Biome Makers](#) provides soil microbiome analysis tools for agronomists and farmers to

understand soil health, assess risks of crop disease and soil deficiency, and receive actionable insights on how to improve soil health and crop yields. These tools help farmers and other agricultural professionals make informed decisions about crop management and soil health, which can ultimately lead to more sustainable and productive farming practices.

Plant biotech: Companies operating in plant biotechnology develop biological or chemical products, including custom plants, organisms, fertilizers, and other transgenic inputs. Plant biotechnology solutions aim to improve crops’ resiliency, yield, and nutrition qualities. Benefits include increased productivity per acre, enhanced environmental practices—for example, a reduction in synthetic agrochemical usage—improved nutrition, and a reduction in crop losses from extreme weather, pests, and disease. Drivers of plant biotech innovation include population growth and demand for organic and sustainable produce, which motivates growers to produce commercially viable crops without using toxic herbicides or pesticides. While some providers focus on single solutions, others use multi-input solutions by combining gene-edited seeds and herbicides or taking a platform approach. In an example of the platform approach, [Boost Biomes](#) uses a proprietary discovery platform to research and develop microbial products for ag applications. [Pivot Bio](#) is developing self-fertilizing cereal crops to reduce or eliminate the need for synthetic nitrogen fertilizer and the accompanying environmental impacts. [AgBiome](#) has developed a microbial screening platform that can search for microbes that provide pest control and crop protection. It has commercialized one fungicide and has a product pipeline of 11 fungicides, insecticides, and herbicides with a targeted market launch by 2025. [AgBiome](#) claims its products have the same efficacy as synthetic chemicals. Key VC-backed providers in plant biotech include [Indigo Agriculture](#), [Botanical Solution](#), and [Vestaron](#).



AG BIOTECH

Animal biotech: Animal biotech companies share the same primary objectives as their plant biotech counterparts—optimizing animal health, production, and nutrition. Companies in this category offer solutions such as animal health products, genetics (genetic engineering, genetic modification, and cloning), breeding, and feed additives. One emerging technology for which providers are developing animal ag solutions is CRISPR-Cas9. Some animal biotech companies aim to reduce undesirable inputs and activities in modern industrial agriculture, such as the overuse of antibiotics. [Phage Lab](#) is developing animal ag treatments that combat bacteria in intensive animal-rearing processes, reducing the need for antibiotics in most cases. [Zhongxin Breeding](#) uses genetic engineering to develop breeding pigs and semen products. Key VC-backed providers in animal biotech include Colossal, [Embark](#), and [Invetx](#).

Risks & considerations

Effectiveness limitations: “Biologicals” are agricultural inputs containing living microorganisms. As such, biologicals have unique characteristics and require different handling practices than synthetic inputs. Bio-based nitrogen fertilizers are designed to supply soil and plants with nitrogen using microbes. As living things, they may not be as precise or effective as synthetics. [Once](#) applied, microbe inputs compete with native microbes for food and will likely die or become inert in as little as a day. In most cases, bio-based fertilizers will be used as part of a larger input recipe that supplants as much as 50% of synthetic inputs. However, continued innovation in the field is increasing the effectiveness and duration of biological inputs, allowing a greater reduction in synthetic usage. Elevated nitrogen fertilizer prices due to the Russia-Ukraine war drove increased demand for biologicals in 2022, which may accelerate innovation.

Environmental concerns: Critics of ag biotech take issue with its potential negative impacts. Improper use of fertilizers or potent insecticides and herbicides could cause them to leak into bodies of water, killing plants and animals. New technologies bring rational fears of unknown consequences, such as the creation of super viruses or genetically modified animals that are more susceptible to disease. Another concern is that foreign microbes could proliferate and outcompete native microbes, disrupting the existing microbiome.

Food safety concerns: In market-oriented economic systems such as the one in the US, consumers are the ultimate arbiters of the food supply. Many consumers have become concerned with the health impacts of consuming GMO produce, GMO-fed animals, and other GMO food products. Concerns primarily include possible allergenicity and toxicity. As such, many countries have passed laws regulating where GMOs can be sold and for what purposes. Microbially-based inputs pose biosafety concerns regarding the safety of ag workers handling pathogenic microorganisms and how the organisms may potentially contaminate crops. Ag biotech in animals is a concern for critics as well. Antibiotic resistance in humans has been attributed to the use of antibiotics in animal production. Providers need to factor in consumer perceptions when considering biotech inputs with food product use cases. Gene-editing technologies such as CRISPR significantly improve GMO technology, providing greater precision. These tools edit targeted sections of an organism’s genetic sequence, while GMO processes insert transgenic material into an organism. The upshot is that gene editing may see less regulatory and consumer scrutiny, leading to faster approval and a greater market opportunity.



Agrifinance & e-commerce

Overview

Agricultural finance (agrifinance) and e-commerce startups provide financial services specifically designed for agricultural companies and growers. These services include business loans, insurance, and risk assessment tools for agrifinance purposes. Ag marketplaces serve as platforms that connect industry stakeholders, such as growers, input vendors, distributors, agronomists, and financing providers, facilitating the trade of goods and services. Some marketplaces such as [DeHaat](#) offer additional services, such as connecting couriers and delivery agents to transfer goods after they have been sold. Providers in this space typically focus on local opportunities and offer products specialized to specific local needs.

The financial needs of rural growers in developing countries often differ vastly from those in developed countries, for example, in terms of specific crop types and growing cycles. Providers in developing countries offer comprehensive services to address the unique challenges faced by smallholder farmers who operate in fragmented markets or with underdeveloped infrastructure. Smallholder farmers are typically family-owned farming operations found in the developing world with 24 or fewer farmed acres.

Examples of VC-backed agrifinance companies focused on smallholder farmers include [DeHaat](#), [AgroStar](#), and [E-ctare](#). These companies provide financial solutions tailored to the needs of smallholder farmers, such as microloans, crop insurance, and access to agricultural inputs such as seeds and fertilizers. By providing these services, they help to promote sustainable agriculture and improve the livelihoods of smallholder farmers.

Subsegments include:

Agribusiness marketplaces: Online platforms to buy, sell, lease, and trade ag equipment or inputs. Providers may also offer auxiliary services and tools, including input and commodity price monitoring, logistics tools, weather forecasting, and more.

Finance & insurance: Financial products to help growers manage risk and access capital for operations.

Industry drivers

Increasing risk of climate change and shifting weather patterns: Climate change is having a profoundly negative impact on farmers. Extreme weather such as drought, flooding, and severe heat, as well as shifting climate trends all increase production risks and can reduce crop yield. Climate-smart finance can help farmers mitigate risk, adapt to change, and provide a safety net for crop disasters.

Emerging underwriting technology: The proliferation of farm data-collection sources, including IoT sensors, mobile devices, drones, and satellite imagery, enables insurers to price risk more accurately.

Evolution of e-commerce: The growth of e-commerce has freed many farmers from the constraints of traditional distributors and buyers. Farmers can now access supplies and machinery from a variety of digital channels, including directly from other farmers. Startups are seizing on the sizeable market opportunity to connect fragmented emerging markets and optimize underdeveloped infrastructure.



AGRIFINANCE & E-COMMERCE

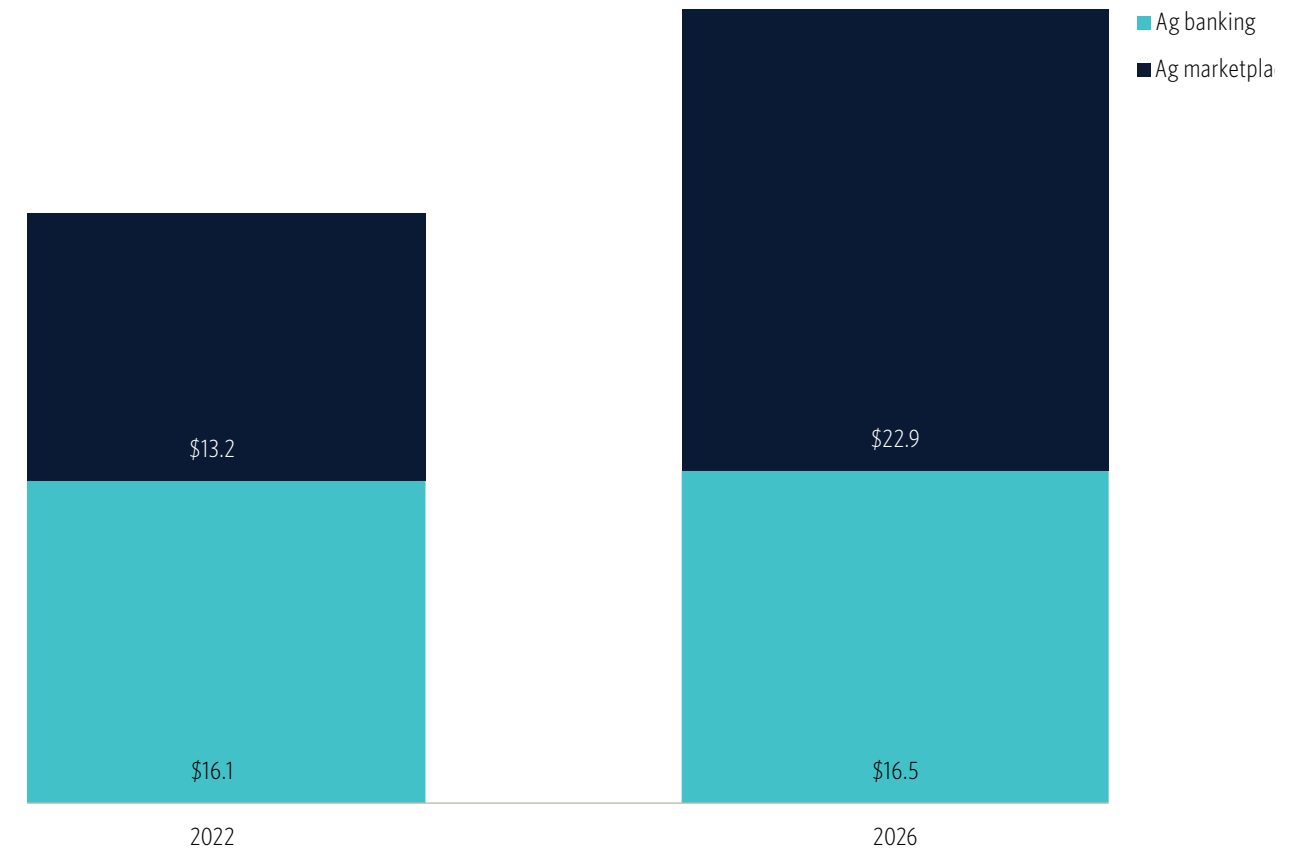
Market size

We estimate the agrifinance & e-commerce market grew to \$29.2 billion in 2022 and forecast the market to grow at a 7.8% CAGR to reach \$39.4 billion by 2026. Ag banking, a proxy for agrifinance, currently presents a larger market opportunity due to its long-standing role as a lifeline to growers and a key stakeholder in the agricultural industry. However, ag marketplaces are growing faster, as growers and input providers turn to digital platforms to interact directly with merchants and customers and commoditize goods.

Business model

Agrifinance companies monetize software through software-as-a-service (SaaS) models or by originating loans and charging lending fees. Agricultural marketplace companies monetize primarily through commissions on transactions and may draw additional revenue streams from associated services.

Agrifinance & e-commerce market size estimate (\$B)



Source: Ibis World, Research & Markets | Geography: Global | *As of December 31, 2022



AGRIFINANCE & E-COMMERCE

Common agrifinance performance indicators:

Agrifinance

- New originations (in both volume and dollar amount).
- Origination margin.
- Cost of capital.
- Pricing (APR).
- Credit risk (average credit score of new applications and approved applications).
- Default rates.
- Approval rates.
- Unpaid principal balance.
- Customer acquisition cost (sales and marketing cost as a percentage of originations)

Marketplaces

- Gross merchandise value.
- Average order value.
- Monthly cohort retention percentage.
- Customer acquisition cost (CAC).
- Customer lifetime value (LTV).
- LTV/CAC.

VC activity

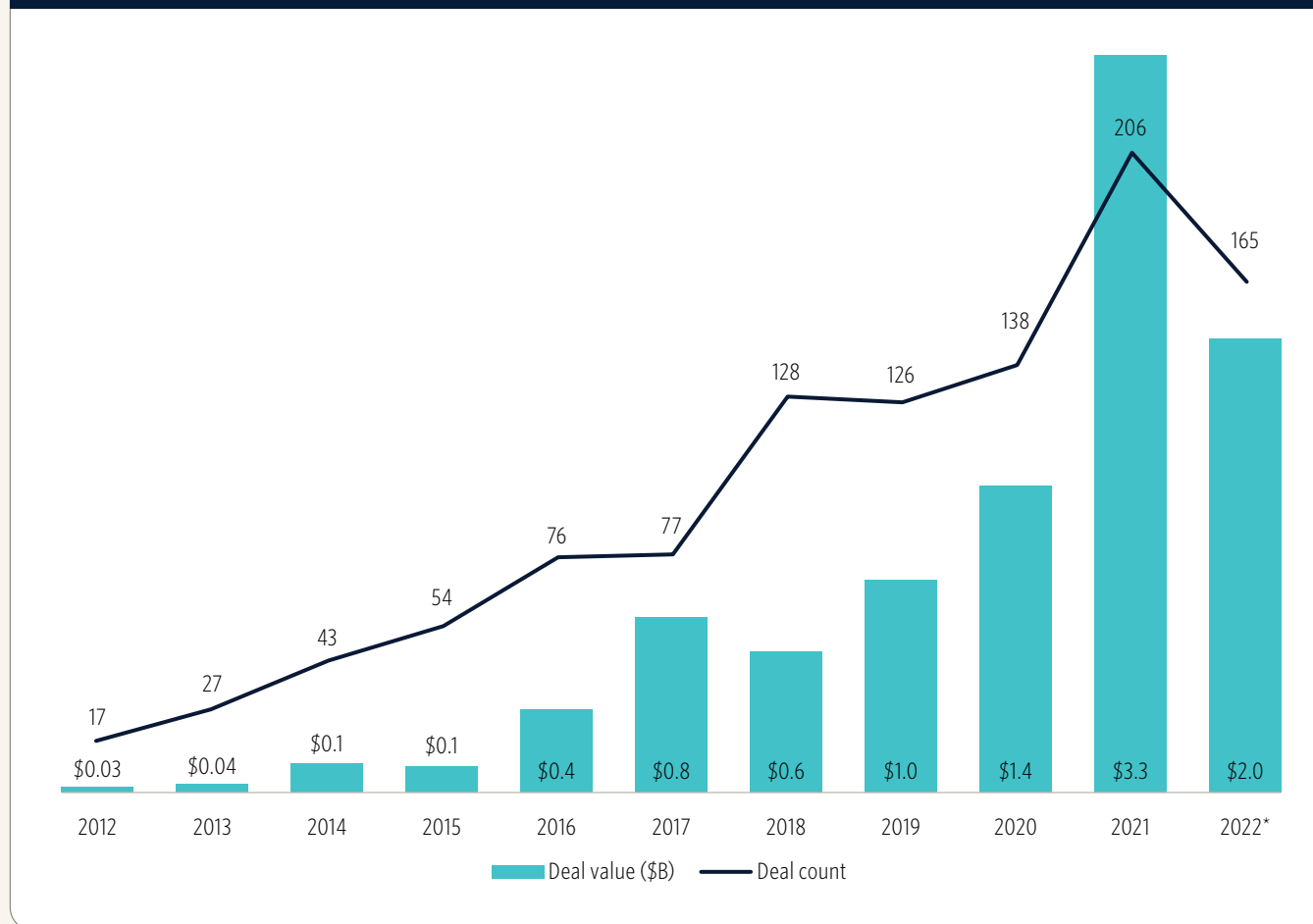
The agrifinance & e-commerce sector logged a precipitous decline in funding in Q4, with \$239.9 million invested across 19 deals. Following four quarters of sustained elevated investment activity, this was a 62.3% decline in deal value QoQ. The quarter's largest deal was a \$60.0 million Series E in [DeHaat](#), led by Sofina and Temasek Holdings. [DeHaat](#) is an agriculture platform that includes a suite of digital tools for farmers; a marketplace that connects farmers with stakeholders including input vendors, distributors, agronomists; and financing providers.

Annually, deal activity totaled \$2.0 billion across 165 deals. Deal values declined 38.5% YoY, but 2022 was still the second-strongest year regarding deal count and deal values. Aside from the [DeHaat](#) deal, notable deals included a \$150.0 million Series H in grain marketplace [Indigo Agriculture](#) and a \$60.8 million Series B in farmland investment marketplace [AcreTrader](#).



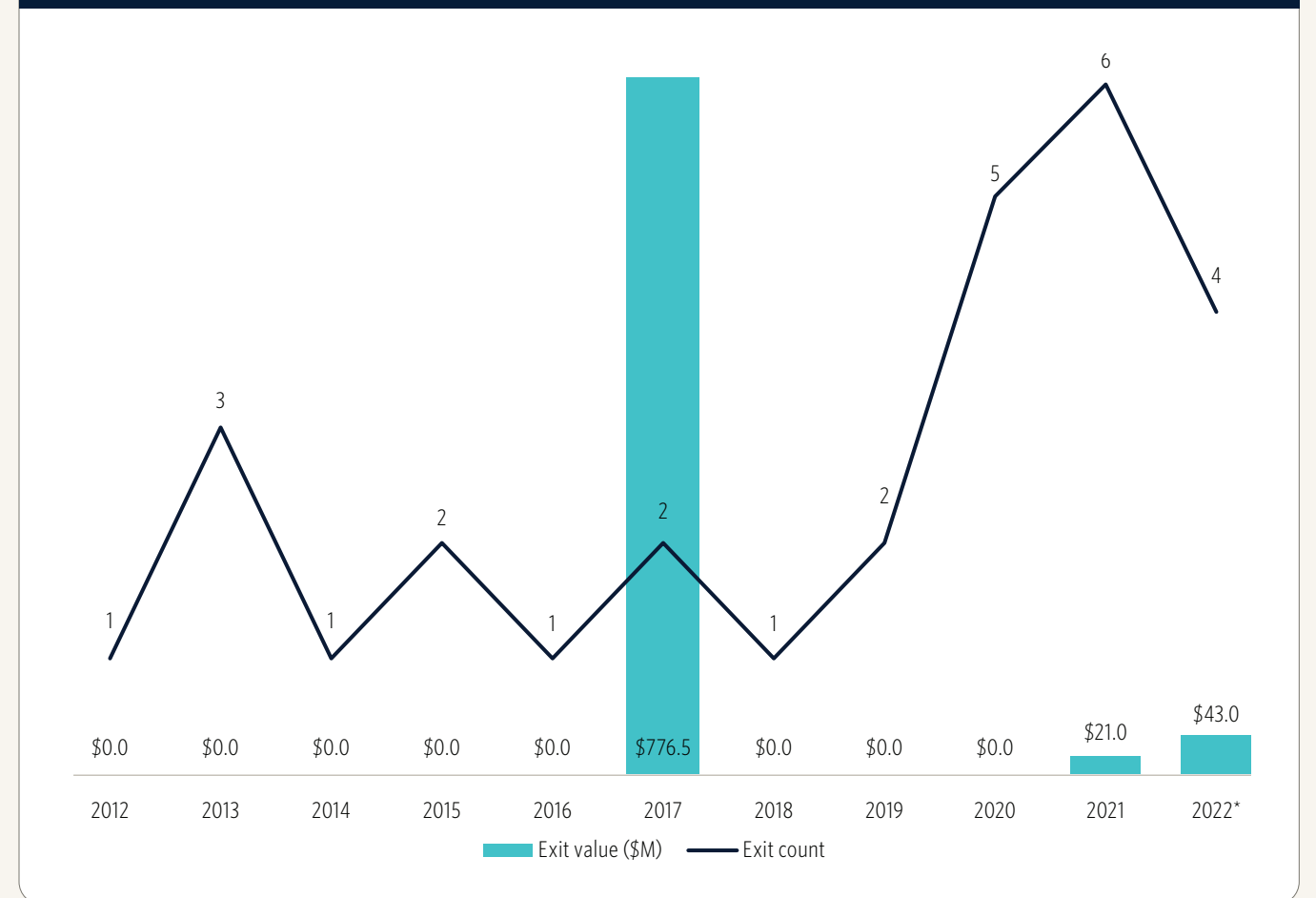
AGRIFINANCE & E-COMMERCE

Agrifinance & e-commerce VC deal activity



Source: PitchBook | Geography: Global | *As of December 31, 2022

Agrifinance & e-commerce VC exit activity



Source: PitchBook | Geography: Global | *As of December 31, 2022



AGRIFINANCE & E-COMMERCE

Key agrifinance & e-commerce VC-backed companies*

Company name	Category	VC raised to date (\$M)	Post-money valuation (\$M)	Most recent VC deal type
Farmer's Business Network	Finance & insurance, farm management software, agribusiness marketplaces	\$919.3	\$3,800.0	Series G
DeHaat	Agribusiness marketplaces	\$221.8	\$154.3	Series E
One Concern	Finance & insurance	\$152.3	\$57.5	Late-stage VC
Maihuolang Information Technology	Agribusiness marketplaces	\$150.0	N/A	Series A
Qiandama	Agribusiness marketplaces	\$142.3	\$1,320.0	Series D1
Oxbury	Finance & insurance	\$142.0	\$166.6	Series 2
Sayurbox	Agribusiness marketplaces	\$135.3	\$159.6	Series C
AgroStar	Agribusiness marketplaces	\$134.1	\$228.6	Series E
Tridge	Agribusiness marketplaces	\$123.3	\$2,700.0	Series D
Gro Intelligence	Finance & insurance	\$120.4	\$575.0	Series B

Source: PitchBook | Geography: Global | *As of December 31, 2022



AGRIFINANCE & E-COMMERCE

Key agrifinance & e-commerce VC deals 2022*

Company name	Close date	Category	Deal size (\$M)	Post-money valuation (\$M)	Deal type	Lead investor(s)	Valuation step-up (post to pre)
Frubana	July 6	Agribusiness marketplaces	\$157.3	N/A	Series C	N/A	N/A
Ninjacart	May 18	Agribusiness marketplaces	\$149.6	\$756.8	Series D	Flipkart, Walmart	1.3x
Wasoko	April 22	Agribusiness marketplaces	\$125.0	\$625.0	Series B	Avenir Growth Capital, Tiger Global Management	N/A
Sayurbox	March 21	Agribusiness marketplaces	\$120.0	\$159.6	Series C	Alpha JWC Ventures, Northstar (Singapore)	N/A
Oxbury	July 5	Finance & insurance	\$62.5	\$166.6	Series C	N/A	1.1x
AcreTrader	July 26	Finance & insurance	\$60.8	\$390.8	Series B	Anthemis Group	6.3x
DeHaat	December 1	Agribusiness marketplaces	\$60.0	N/A	Series E	Sofina, Temasek Holdings	N/A
Agriconomie	November 8	Agribusiness marketplaces	\$59.1	N/A	Series B	Aliment Capital, Temasek Holdings	N/A
Captain Fresh	May 1	Agribusiness marketplaces	\$56.2	\$449.8	Series C	Prosus Ventures, Tiger Global Management	2.0x
Jai Kisan	July 29	Finance & insurance	\$49.0	N/A	Series B	Grantham Mayo Van Otterloo, Yara Growth Ventures, Blume Ventures, and DG Daiwa Ventures	N/A

Source: PitchBook | Geography: Global | *As of December 31, 2022



AGRIFINANCE & E-COMMERCE

Key agrifinance & e-commerce VC exits 2022*

Company name	Close date (2022)	Category	Exit size (\$M)	Exit type	Acquirer(s)/index
Aiyangniu Technology	June 16	Agribusiness marketplaces	\$43.0	Acquisition	China Modern Dairy
Färm	March 1	Agribusiness marketplaces	N/A	Acquisition	Ekoplaza
NorQuin	May 19	Agribusiness marketplaces	N/A	Buyout	Above Food, Eat Beyond Global Holdings, Gravitas Securities
Krishi Safal	May 24	Agribusiness marketplaces	N/A	Acquisition	Krishi Network

Source: PitchBook | Geography: Global | *As of December 31, 2022



AGRIFINANCE & E-COMMERCE

Key agrifinance & e-commerce incumbents*

Company name	Category	Key products	EV/NTM revenue	EV/NTM EBITDA
Armac Locação	Agribusiness marketplaces	Farm equipment	5.9x	N/A
Banco Patagonia	Finance & insurance	Ag financing, ag insurance	N/A	N/A
AgroGalaxy Participações	Agribusiness marketplaces	Agro retail chain	0.3x	N/A
Prudential Investment Management	Finance & insurance	Ag financing	N/A	N/A
AgAmerica Lending	Finance & insurance	Ag financing	N/A	N/A

Source: PitchBook | Geography: Global | *As of December 31, 2022



AGRIFINANCE & E-COMMERCE

Opportunities

Ag fintech & insurance: Agrifinance tools and services provide growers with ways to manage and mitigate risk. This is becoming essential given increasingly frequent extreme weather occurrences and pressure to adopt new crop inputs and technologies to increase profitability. [Growers Edge](#) provides product warranties and other financial risk products that offer money-back guarantees to reduce the risk of adopting new crop inputs and ag technologies. [FarmTogether](#), [AcreTrader](#), and [Farmfundr](#) provide farmland trading platforms that enable investors to purchase farmland and growers to scale operations by increasing leased acreage.

Digital marketplaces: Marketplace startups develop online platforms for buying, selling, leasing, and trading ag equipment, inputs, and outputs—for example, crops or animal products. Online agtech marketplaces such as FBN act as modern co-ops, enabling growers to buy ag inputs at reduced costs. Alternatively, ag output marketplaces such as [Indigo Agriculture](#) help link growers with buyers looking for crops with specific characteristics, elevating crops from commodity status to premium products. [DeHaat](#) addresses the unique needs of smallholder farmers by providing complementary services such as crop advisories and delivery agents to complement its ag marketplace. Significant benefits for retailers include reduced marketing and sales costs and access to more buyers, while benefits for buyers include a more extensive selection of goods and access to inputs, technology, and equipment that may otherwise be out of reach. Notable startups include [AgroStar](#), [ProducePay](#), and [Aruna](#).



AGRIFINANCE & E-COMMERCE

Risks & considerations

Concentrated portfolio risks: Many agricultural risks tend to be systemic in that they will affect numerous farmers working in the same geography. Given that agriculture insurance providers have traditionally been local, an insurable event could affect many accounts, threatening the solvency of a local insurance provider. Global insurtech companies such as [TerraMagna](#) provide local-level insurance and credit services across many geographies by using satellites and remote sensing technology to offer insurance at the local level but across a wide range of geographies. Startups that are not able to distribute risk across a broader portfolio face more solvency risks.

Seasonality and cyclicity: Agricultural activities tend to be subject to seasonality and gestation periods, such as the time from seed to harvest, that can last several years—particularly in animal ag and tree crops. This affects the return on investment (ROI) of invested capital and the cash flows of growers. Financing substantial assets such as farm machinery requires significant capital outlays that may take several years to generate revenue. Extended loan maturity timelines and irregular payment schedules increase oversight costs and the risk for lenders, while presenting lower profitability potential compared with other sectors.

Farmers' long-term strategic decisions: While many farmers may want to make long-term investments in progressive farming practices such as regenerative farming, near-term profit goals and limited extra cash may prevent them from doing so. Many lending facilities are structured on a short-term basis, limiting farmers' ability to experiment with new farming models. Several progressive funds and agriculture financing organizations seek to help farmers address these financing needs. For example, Mad Capital and rePlant Capital provide agriculture loans such as transition loans, equipment loans, and infrastructure loans for sustainable farming practices, while the Black Farmer Fund provides funding for Black farmers and agricultural businesses. These organizations, which tend to use nonprofit or concessionary capital, may limit agrifinance companies' ability to take share in the market.



Animal ag

Overview

Animal agriculture companies are leveraging technology to monitor, analyze, and optimize animal health and production. Software platforms and hardware providers offer specialized solutions tailored to specific animal types and use cases. The animal agriculture industry is not limited to traditional livestock but also encompasses the rearing of insects, fish, and other animals using advanced technologies and techniques.

Within each animal category, companies focus on different objectives, including activity tracking via wearables, herd management, automation, and operations management. For example, companies such as [Afimilk](#) and DeLaval offer dairy farm-management solutions that include software for monitoring cow health and milk production. Similarly, firms such as [BinSentry](#) and [CattleEye](#) offer feed management solutions that use sensors to track feed levels and optimize animal nutrition. In the aquaculture industry, firms such as [eFishery](#) and [Sofar Ocean](#) provide software and hardware solutions for monitoring and optimizing fish health and growth.

Overall, animal ag companies are leveraging technology to improve animal welfare, increase efficiency, and reduce costs. By using advanced software platforms and hardware solutions, animal agriculture is becoming increasingly data-driven and sustainable.

Segments include:

Aquaculture: Companies optimizing aquatic production of fish, seaweed, algae, and other waterborne products.

Livestock & land animal technology: Companies optimizing the production of livestock, poultry, dairy, and other land animals.

Pollination tech: Companies producing tools to improve the effectiveness of natural pollinators or provide alternatives when natural pollination is not viable.

Insect farming: Operators of insect cultivation facilities and technologies used in the cultivation of insects.

Industry drivers

Regenerative farming: Mounting sustainability challenges and declining soil health affect long-term yields and exacerbate climate issues. Regenerative ag practices such as rotational grazing improve soil health, prevent erosion, reduce nutrient and sediment runoff, and improve the soil's ability to store atmospheric carbon—ultimately reducing negative environmental impacts and improving yields.

Declining wild fisheries stocks: Decades of overfishing, climate change, and pollution have decimated global marine fisheries. Aquaculture is one solution to address declining supply.

Labor challenges: Animal ag is a labor-intensive industry. Although some practices may be seasonal, animals need nonstop feeding and care. For this reason, the cost, availability, and dependability of labor all pose challenges that incentivize market participants to seek alternatives.



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Maximizing animal health and production value: Maximizing animal health and productivity is key to operating a profitable farm. Animal ag technologies, such as sensors and wearables, can monitor animal health, prevent disease, and identify sick animals earlier, helping keep animals healthy and productive longer.

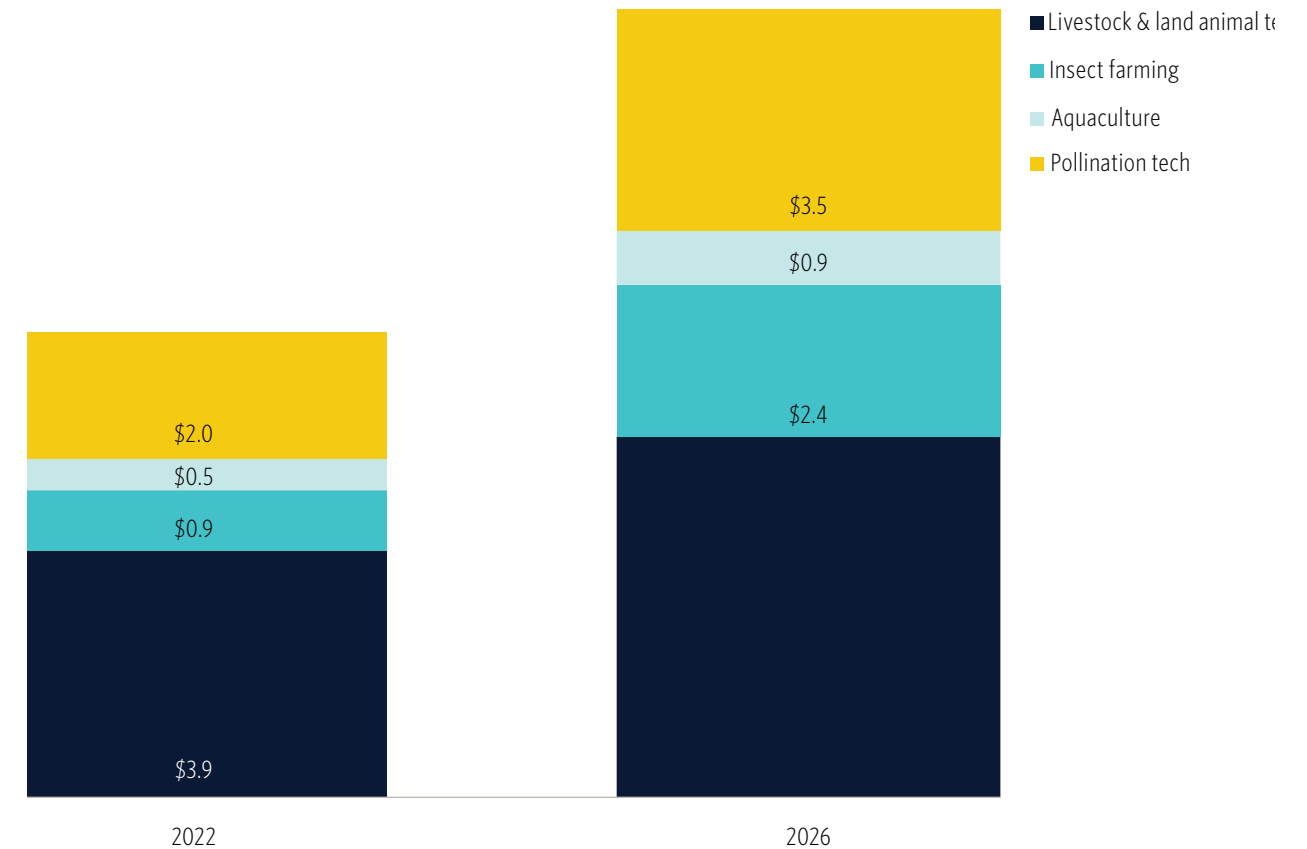
Consumer demand for food traceability: Consumers are increasingly demanding and paying a premium for visibility into the origin of animal products. That transparency helps build consumer trust, conveys product safety, and adds brand value by providing an opportunity to tell a story about the product.

Pollinator decline: Pollinator insects such as honeybees have faced population decline due to the use of harmful agricultural chemicals, loss of natural habitat, and the global spread of pests and diseases, among other factors. Under-pollinating can result in yield losses.

Market size

Based on global revenues of animal ag technology providers, we estimate that the market size of the animal ag space reached \$7.3 billion in 2022, and that it will grow at a CAGR of 14.2% to reach \$12.4 billion by 2026. Insect farming is expected to see the most rapid growth due to the rising demand for new protein sources. Pollination tech is also expected to see double-digit growth due to pollinator decline.

Animal ag market size estimate (\$B)



Source: PitchBook Emerging Tech Research | Geography: Global | *As of December 31, 2022



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Business model

Animal ag may use one of several business models depending on the product or service sold:

- Hardware, such as dairy parlor automation technology, is typically sold through traditional sales and service business models.
- Wearable and sensor technology, such as herd monitoring devices, may be sold through traditional sales models or a hardware-as-a-service (HaaS) model combined with a software element.
- Software, such as farm-management platforms, is typically sold through SaaS models.
- Operators, such as insect farms, raise animals that are then typically sold to farmers, food companies, and other end markets through distributors or directly to the customer.

Operational

- Number of animals monitored.
- [Increase](#) in production.
- Connectivity range.

Financial

- Gross margin.
- Unit sales.
- Revenue mix.

VC activity

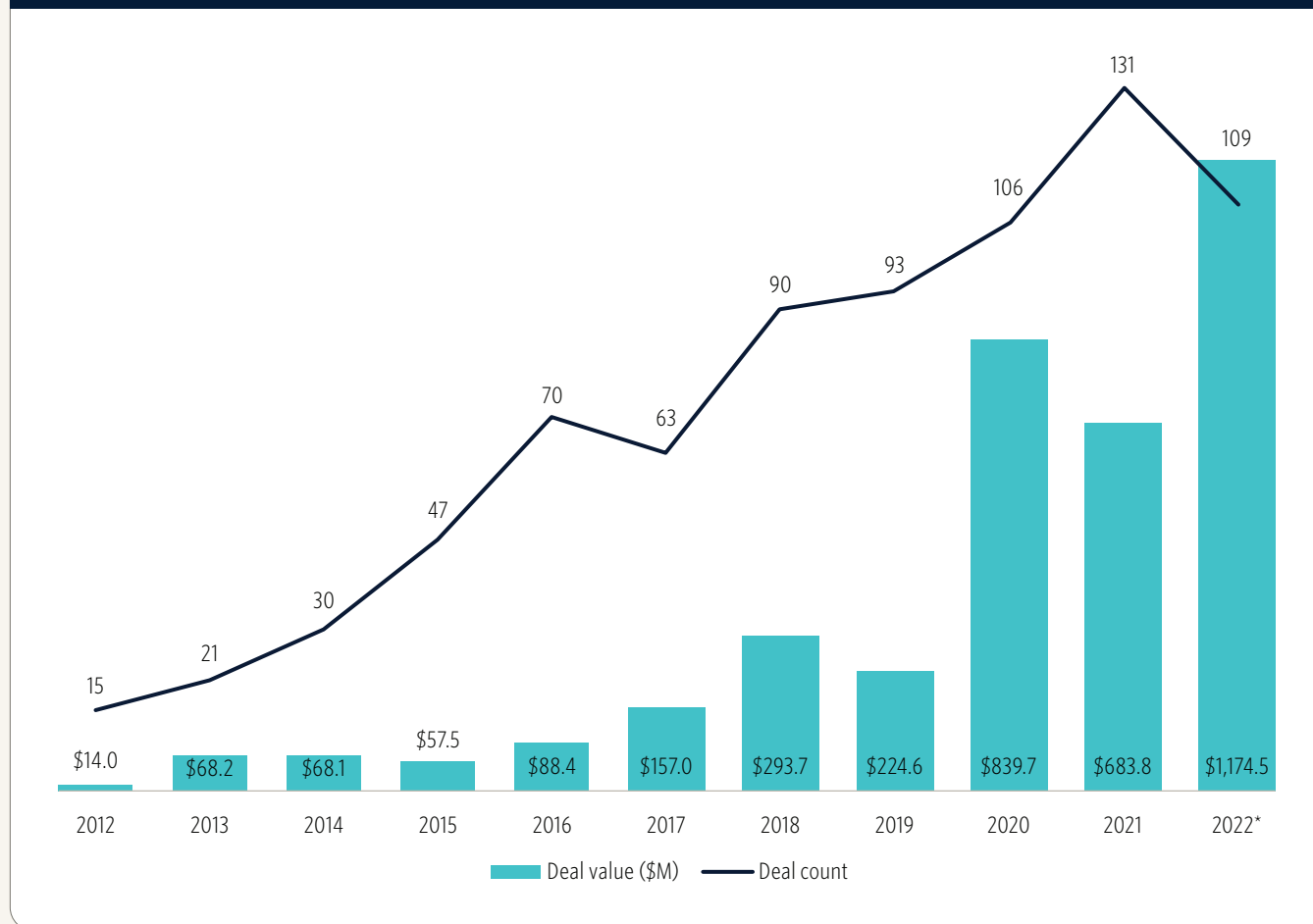
Animal ag is one of the more nascent sectors within agtech. As such, it receives less funding on average and experiences greater volatility than other sectors. However, strong growth in the animal ag ecosystem has resulted in steady funding growth over the past decade. In Q4 we logged \$219.6 million invested across 20 deals. The quarter's largest deal was an \$80.0 million late-stage VC round for aquaculture technology provider [eFishery](#). The company offers a suite of aquaculture products including a software platform, smart feeder, financial tools, fish feed, and a digital marketplace to sell fish.

On an annual basis, investment saw sizeable growth from 2021. We logged \$1.2 billion invested across 109 deals in 2022, with deal value up 71.2%. Animal ag saw significant growth in 2022, while other sectors were marked by notable funding pullback. Annual aquaculture funding reached \$474.2 million, up 123.4% YoY—likely a reaction to wild fish stocks crashing despite rising global demand. Pollination tech funding totaled \$163.6 million, increasing by a whopping 164.1% YoY. We attribute this to rising concern over pollinator population declines and an increase in the number of startups focusing on this issue. The year's largest deal was a \$260.0 million Series D investment in [InnovaFeed](#). The French company is among several European operators who have recently expanded operations into the US. [InnovaFeed](#) is currently building a new facility in Illinois that is adjacent to customer ADM, with plans to supply animal feed and oils derived from black soldier fly larvae. Animal ag investment is likely to continue growth, propelled by population growth and the macro trends constricting global protein supply, such as climate change and overfishing.



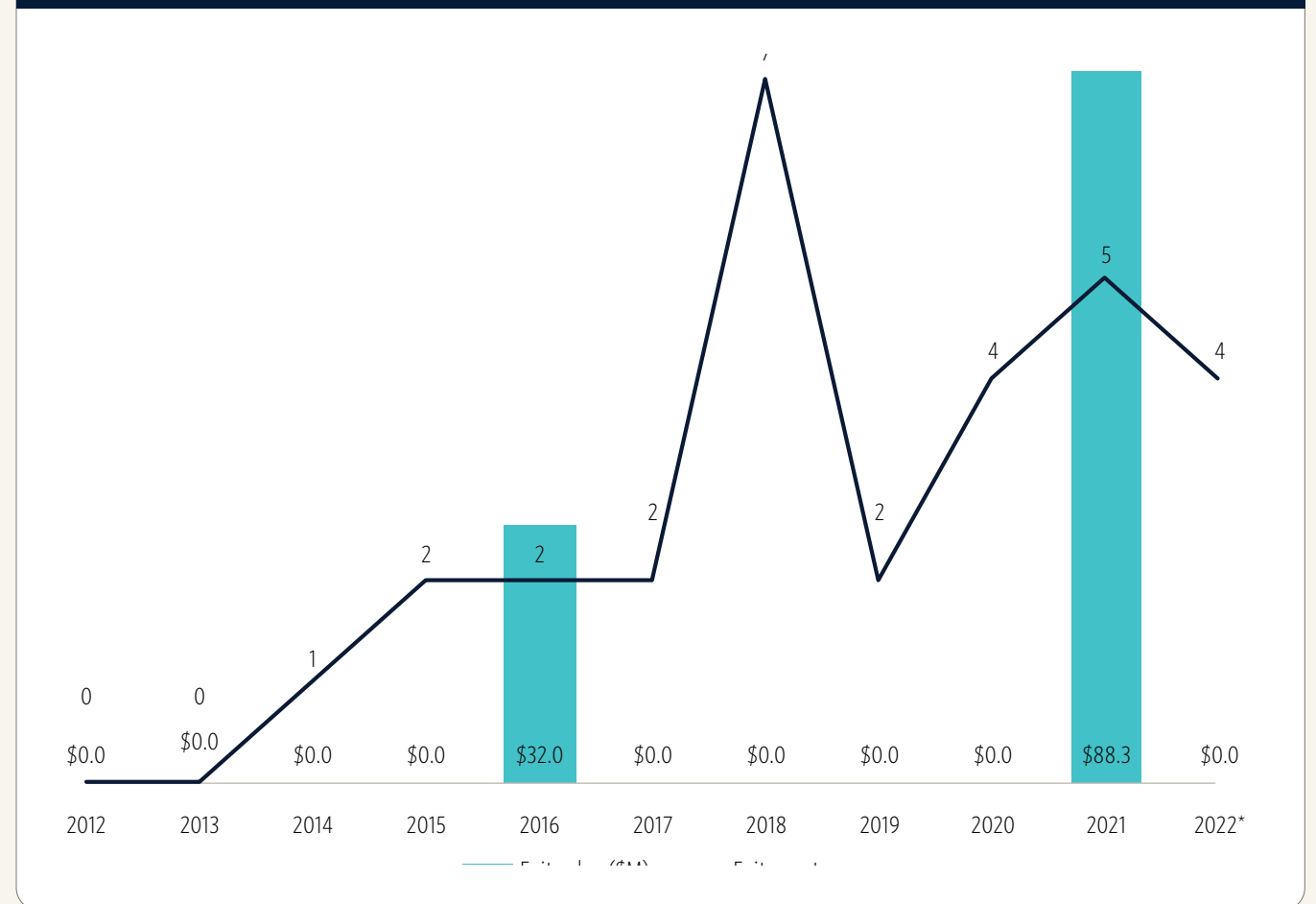
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Animal ag VC deal activity



Source: PitchBook | Geography: Global | *As of December 31, 2022

Animal ag VC exit activity



Source: PitchBook | Geography: Global | *As of December 31, 2022



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Key animal ag VC-backed companies*

Company name	Category	VC raised to date (\$M)	Post-money valuation (\$M)	Most recent VC deal type
InnovaFeed	Insect farming	\$489.3	N/A	Series D
Ynsect	Insect farming	\$408.4	\$747.5	Late-stage VC
eFishery	Aquaculture	\$221.8	\$407.5	Late-stage VC
Agronutris	Insect farming	\$117.8	N/A	Late-stage VC
Beewise	Pollination tech	\$114.8	\$277.0	Series C
Aspire	Insect farming	\$71.6	N/A	Late-stage VC
Open Blue Cobia	Aquaculture	\$66.0	\$73.3	Late-stage VC
Nutrition Technologies	Insect farming	\$63.5	\$53.6	Series A2
Lemnature AquaFarms	Aquaculture	\$62.7	N/A	Late-stage VC
BeeHero	Pollination tech	\$59.7	\$30.0	Series B

Source: PitchBook | Geography: Global | *As of December 31, 2022



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Key animal ag VC deals 2022*

Company name	Close date (2022)	Category	Deal size (\$M)	Post-money valuation (\$M)	Deal type	Lead investor(s)	Valuation step-up (post to pre)
InnovaFeed	September 20	Insect farming	\$250.0	N/A	Series D	Qatar Investment Authority	N/A
eFishery	January 10	Aquaculture	\$113.2	\$407.5	Series C	Sequoia Capital India, SoftBank Investment Advisers, Temasek Holdings	3.4x
eFishery	October 7	Aquaculture	\$80.0	N/A	Late-stage VC	N/A	N/A
Beewise	March 30	Pollination tech	\$80.0	\$277.0	Series C	Insight Partners	2.1x
Entosystem	April 26	Insect farming	\$52.4	N/A	Late-stage VC	N/A	N/A
BeeHero	December 1	Pollination tech	\$42.0	N/A	Series B	Convent Capital	N/A
Sofar Ocean	August 10	Aquaculture	\$39.3	\$149.3	Series B1	N/A	4.6x
Ava Ocean	January 17	Aquaculture	\$34.0	N/A	Late-stage VC	N/A	N/A
AlgaeCytes	January 14	Aquaculture	\$21.5	N/A	Late-stage VC	N/A	N/A
Nutrition Technologies	September 12	Insect farming	\$20.7	\$53.6	Series A2	PTT Public Company	N/A

Source: PitchBook | Geography: Global | *As of December 31, 2022



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Key animal ag exits 2022*

Company name	Close date (2022)	Category	Exit size (\$M)	Exit type	Acquirer(s)/index
Arctic Fish Holding	December 29	Aquaculture	\$18.2	Acquisition	Mowi (OSL: MOWI)
Pollenity	August 5	Pollination tech	\$0.5	Public listing	Bulgarian Stock Exchange
Cainthus	June 21	Livestock & land animal technology	N/A	Acquisition	Ever.ag
HiProMine	July 14	Insect farming	N/A	Public listing	Warsaw Stock Exchange
IceRobotics	May 16	Livestock & land animal technology	N/A	Acquisition	Peacock Technology
Jord Producers	March 29	Insect farming	N/A	Acquisition	Ynsect
Moonsyst	September 1	Livestock & land animal technology	N/A	Acquisition	Agri IoT
Naviaq	October 20	Aquaculture	N/A	Buyout	Bluefront Equity
Tibot Technologies	November 24	Livestock & land animal technology	N/A	Acquisition	Octopus Biosafety (PAR: MLOCT)
Vence	September 30	Livestock & land animal technology	N/A	Acquisition	Merck Animal Health

Source: PitchBook | Geography: Global | *As of December 31, 2022



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Key animal ag incumbents*

Company name	Category	Key products	EV/NTM revenue	EV/NTM EBITDA
Archer Daniels Midland	Livestock & land animal tech	Feed, feed additives, premix, macroingredients	0.7x	11.3x
New Hope Liuhe	Livestock & land animal tech	Animal feed products	1.0x	88.4x
Mowi	Aquaculture	Farmed salmon	2.9x	10.9x
SalMar	Aquaculture	Farmed salmon	4.8x	16.4x
Norway Royal Salmon	Aquaculture	Farmed salmon	N/A	N/A
Aker BioMarine Antarctic	Aquaculture	Krill-based products	2.4x	10.7x
Atlantic Sapphire	Aquaculture	Farmed salmon	5.5x	N/A
The Kingfish Company	Aquaculture	Farmed yellowtail kingfish	7.6x	N/A
Clean Seas Tuna	Aquaculture	Farmed yellowtail kingfish	1.1x	14.3x

Source: PitchBook | Geography: Global | *As of December 31, 2022



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Opportunities

Livestock and land animal tech: Companies in this category are focused on optimizing the health and productivity of livestock and other land animals. Companies such as [Stellapps](#) produce wearable devices to monitor livestock health, fertility, and location. [Stellapps'](#) MooOn device provides preventive cow health tracking devices to reduce health expenses and the time between breeding periods, as well as improve milk quality. It also monitors herd activity to improve management. Herd management is a mature category of the animal ag space, populated by well-established incumbents such as Amelikor, VAS, and DRMS; however, startups are disrupting the space with innovative tools and technologies focused on the management of livestock such as cattle, poultry, and pigs. [Connecterra's](#) Ida platform aids dairy farmers by capturing livestock data and using AI & ML to improve decision-making. Regenerative farming is an emerging trend drawing new attention to herd management tools. Some livestock collars can track and move livestock between fields, enabling rotational grazing—a practice that improves soil health, increases biodiversity, and prevents erosion and water runoff. Key providers include Halter, [Advanced Animal Diagnostics](#), and [Stellapps](#).

Aquaculture: Aquaculture is the practice of farming fish and other aquatic plants and creatures. Agtech companies in this category are focused on optimizing production through a wide range of practices, from biotech, to sensors, to building and operating aquaculture facilities. [InnovaSea Systems](#) is developing all-in-one fish farming systems for fish farmers to deploy in open-sea environments. These systems help fish farmers monitor fish health and water conditions,

automate tasks, minimize environmental impact, and improve efficiency. Aquaculture can be performed onshore in tanks or offshore in freshwater or saltwater. Developed by companies such as [InnovaSea](#), deep offshore systems may help fish grow faster, decrease mortality rates, and reduce environmental impact. Key providers include [eFishery](#), [Open Blue Cobia](#), and [Lemnature AquaFarms](#).

Insect farming: Relative to traditional livestock, insect farming costs less and has a lower environmental impact, making it attractive to environmentally conscious consumers or corporate food companies looking for innovative ways to reach sustainability goals. Insect farming has several benefits compared to plant and livestock farming. Insects reach maturity in a matter of days versus months or years for traditional plants and animals. Relative to livestock, insects are less expensive to produce and more resource-efficient, requiring less feed, land, and water. Insects may also be a viable food source to address growing food insecurity challenges, particularly in emerging regions where populations and food demand are rising fast. While Western cultures are generally averse to insect consumption, the practice is common in parts of Asia, Africa, and South America.

There are many sustainability benefits of insect farming. For example, startup [InnovaFeed](#) recently partnered with the food processing conglomerate ADM to build an insect production site next to one of its plants. In what can be described as “industrial symbiosis,” the deal allows [InnovaFeed](#) to harness waste heat and steam while feeding its insects with an “upcycled” corn-based byproduct



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from the ADM facility. Insect excrement can also be used as a crop fertilizer. While manure from industrially raised livestock often contains antibiotics that can lead to antibiotic resistance in soil, insect excrement is free from antibiotics. Key VC-backed providers in the space include [Better Origin](#), [Ynsect](#), and Agrinutris.

Pollination tech: Pollination is a critical aspect of plant growth for most crops and is essential to sustaining food production and the natural ecosystem. 90% of flowering plants require pollination, including corn, rice, and wheat. Although some crops self-pollinate or are wind-pollinated, most are pollinated by insects such as bees, which have faced population declines due to the use of harmful agricultural chemicals, loss of natural habitat, and the global spread of pests, among other factors. Under-pollinating can result in crop yield losses. The importance of pollination has led growers to seek out tools and services that ensure the desired levels of pollination. Pollination tech includes services that rent out bee colonies, augment and monitor pollinator activity, or provide new ways to pollinate, also known as “artificial pollination.” Some crops, such as almonds, require a higher amount of pollination activity than others and will suffer yield losses if it does not occur. A trend toward increasing crop or tree density is only exacerbating the pollination requirement. Almond growers have largely turned to pollination services, such as rental bee colonies (bees-for-hire), to supplement natural pollination activity, accounting for 82% of total US pollination service expenditures.² Bees-for-hire startup [BeeHero](#) is leveraging Big Data, ML, and IoT sensors to maximize crop yields by monitoring bee colony health and activity. Other key providers of artificial pollination emerging technologies include [Beewise](#), [PowerPollen](#), and [Ubees](#).

2: “Driven by Almonds, Pollination Services Now Exceed Honey as a Source of Beekeeper Revenue,” USDA, Amber Waves and Peyton Ferrier, July 2, 2018.

Risks & considerations

Large herds can lead to high wearable costs: Although animal wearables pose valuable benefits, pricing can be steep for large herds. While some “e-tags” cost as little as \$10 per tag, this can add up to a significant investment with herd sizes in the US as large as 14,000 cattle, pegging the cost at \$140,000 before including data-collection hardware and software. With a tag lifespan that can reach two years, the outlay may be challenging for farm owners in an industry characterized by low margins. [Stellapps](#) is working to make wearables more affordable for customers, primarily farmers in India, by commoditizing the hardware, using cloud services, and working with local banks to help farmers finance the technology.

Competition is large and established: Despite innovative technological offerings, animal ag startups face challenges from firmly established incumbents. Legacy providers GEA, [Lely](#), and DeLaval have an oligopoly on milking, feeding, hygiene automation, and robotics technologies. Due to the high capital requirements to replace a legacy system, new entrants may need to develop product offerings that retrofit existing technologies. As with animal robotics, incumbents dominate the herd management technology space. Switching costs from legacy providers, such as Amelcor, VAS, and DRMS are also high due to a lack of industry data standards, which complicates interoperability among providers.



Indoor farming

Overview

Indoor farming, also referred to as controlled environment agriculture (CEA), is a method of growing agricultural products such as produce, medicinals, and fungi indoors, using advanced technologies to regulate environmental factors. Vertical farming, hydroponics, and aeroponics are some of the techniques employed to maximize volumetric space and resource efficiency. Through control of environmental factors such as light, nutrients, and humidity, indoor farming manipulates plant biology to optimize desirable plant traits, resulting in, for instance, crunchier and greener lettuce. The technique also maximizes yields and reduces inputs beyond what would be possible outdoors. The indoor farming ecosystem encompasses software, hardware, infrastructure, and operators that are focused on commercial and consumer indoor agriculture.

Indoor ag provides a host of benefits, including:

- Creating a local produce supply to reduce reliance on imports.
- Increased control over growing conditions and inputs.
- Increased sustainability through reduced or eliminated reliance on water, fertilizer, herbicides, pesticides, and energy.
- Shorter growing cycles.

An ideal environment to implement robotics and automation, reducing labor requirements and human error.

Although many companies are developing pure-play technologies or services, the most well-funded startups develop much of the technology in-house, shielding it from public view as a trade secret and competitive advantage. We expect this trend to become less frequent as vertical farming technologies become ubiquitous.

Segments include:

Indoor farming components: Precision technologies designed to optimize the growing environment, such as lighting systems, monitoring sensors, irrigation, and environmental controls, as well as the software to manage grow operations.

Indoor farming systems: Complete growing environments spanning small consumer table-top solutions to massive commercial facilities. Most solutions are turnkey, allowing customers to step in and begin operations.

Indoor growers: Operators of indoor farming facilities. Many growers build out proprietary components and systems to reduce costs and increase yields.



INDOOR FARMING

Industry drivers

Food Safety: Ensuring produce is safe to eat by the time it reaches consumers is a top concern for conventional farmers, consumers, and regulators. Many potential contamination points riddle the food supply chain, including tainted irrigation water from nearby livestock facilities or handling from an agricultural worker with dirty hands. Long supply chains create additional opportunities for contamination and spoilage. Climate change is expected to increase food safety risks from foodborne and waterborne diseases.³ The Centers for Disease Control and Prevention (CDC) confirmed 470 multistate enteric disease outbreaks from 2017 to 2020 primarily attributed to foodborne illness. Of these outbreaks, 25 were attributed to listeria contamination, 186 for salmonella, and 39 for E. coli. The impact of these outbreaks included 14,312 illnesses, 3,517 hospitalizations, and 65 deaths.⁴ These recalls can impact food industry sales and reduce consumer confidence. CEA offers a potentially safer solution by providing a more controlled end-to-end production environment with shorter supply chains that can improve food freshness and safety.

Population growth and food insecurity: Food insecurity is already a significant issue in many countries, and it is only expected to worsen in the coming decades as populations grow. The United Nations projects that the global population will reach 9.7 billion by 2050.⁵ Limited arable land and water mean that new food sources need to be identified, and food production efficiency will need to increase. Indoor farming offers one potential solution to this global problem. CEA is highly resource-efficient—unrestricted by climate, daylight, or pests—and much more productive per square foot than conventional agriculture.

3: [“Climate Change 2022: Impacts, Adaptation and Vulnerability” The Intergovernmental Panel on Climate Change, H.-O. Pörtner, et al., October 2021.](#)

4: [“Summary of Possible Multistate Enteric \(Intestinal\) Disease Outbreaks in 2017-2020,” CDC, August 18, 2022.](#)

5: [“Growing at a Slower Pace, World Population Is Expected to Reach 9.7 billion in 2050 and Could Peak at Nearly 11 billion Around 2100,” United Nations, June 17, 2019.](#)

Consumers are prioritizing food traceability and local foods: Like organic produce, consumers are paying a premium for locally sourced foods. Indoor farming allows for local production of crops that would otherwise be inaccessible due to a lack of arable land, for example, in an urban environment, or due to a lack of appropriate climate, for example, for growing fresh tomatoes in winter.

Improving the quality and yield of high-profit plants: One of the most considerable benefits of indoor agriculture is the ability to control virtually every factor affecting growth, such as light, temperature, and nutrient availability. This allows growers to decrease production times and improve desirable plant traits. For example, cannabis can be manipulated in a controlled indoor environment to provide a highly profitable yield.

Climate change driving pursuit of sustainable farming practices: According to the World Economic Forum, food systems are responsible for 20% to 30% of greenhouse gas emissions, account for 70% of freshwater withdrawals, consume about 30% of the world’s available energy, and are the most significant drivers of deforestation.⁶ Climate change is diminishing crop yields and the availability of water and arable land. Indoor farming promises significant sustainability gains on water consumption, arable land requirements, and fossil fuel emissions.

6: [“New Nature Economy Report II: The Future of Nature and Business,” World Economic Forum, 2020.](#)



INDOOR FARMING

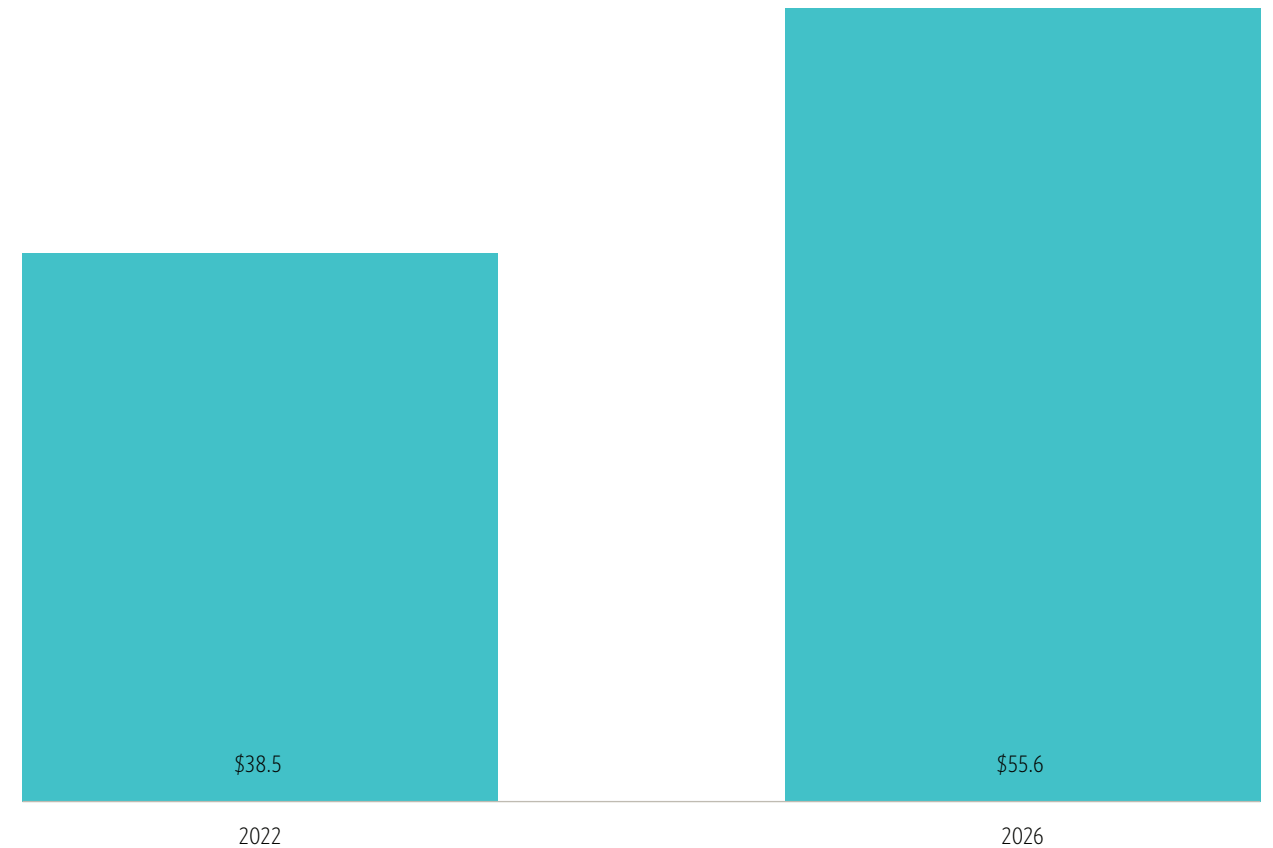
Market size

The indoor farming market is rapidly growing, with global revenue expected to reach \$38.5 billion in 2022. This growth is projected to continue with a 9.6% CAGR, reaching \$55.6 billion by 2026. The increasing need to overcome climate challenges such as aridification and flooding, geopolitical issues such as conflicts disrupting traditional farming practices, and concerns over food safety are driving the expansion of the indoor farming sector. Additionally, technological advancements in indoor farming are expected to help reduce production costs, and new indoor farming facilities are set to come online, increasing supply in 2023 and beyond.

Business model

Indoor farming components and systems are primarily sold through traditional hardware sales and service business models. However, there is a growing trend towards SaaS or HaaS models for software and certain systems. Indoor farm operators sell their crops and other yields through traditional models such as grocery distributors and retail chains. To reach consumers, indoor farm operators employ two primary operational strategies: expansive regional facilities or a network approach of smaller local facilities.

Indoor farming market size estimate (\$B)



Source: Future Market Insights | Geography: Global | *As of December 31, 2022



INDOOR FARMING

Regional facilities are typically located in rural locations where land and other costs are less expensive, but still within driving distance of urban populations. On the other hand, startups such as [Infarm](#) and [80 Acres Farms](#) have placed farms much closer to urban centers, even directly at the point of sale, to offer consumers the freshest possible produce. These companies operate networks of small facilities and provide fresh produce to local communities, food deserts, and even specialty buyers. While expansive indoor farming facilities aim to lower operational costs through scale efficiencies, localized facilities benefit from reduced logistics, lower transportation expenses, and maximal freshness.

Common indoor farming key performance indicators:

- Startup costs.
- Production volume measured in harvest weight.
- Crop prices.
- Transportation costs or savings.
- Energy consumption.

VC activity

The indoor farming sector saw quarterly VC activity surge to record highs in the first half of 2022 before falling by half for two successive quarters in the year's second half. Q4 ended with \$211.9 million invested across 15 deals, with deal values down 51.6% QoQ. The quarter's largest deal was a \$125.0 million Series D in indoor grower [Soli Organic](#). The company differentiates itself from other leading providers with its soil-based process. Most other leading providers use vertical and hydroponic grow strategies.

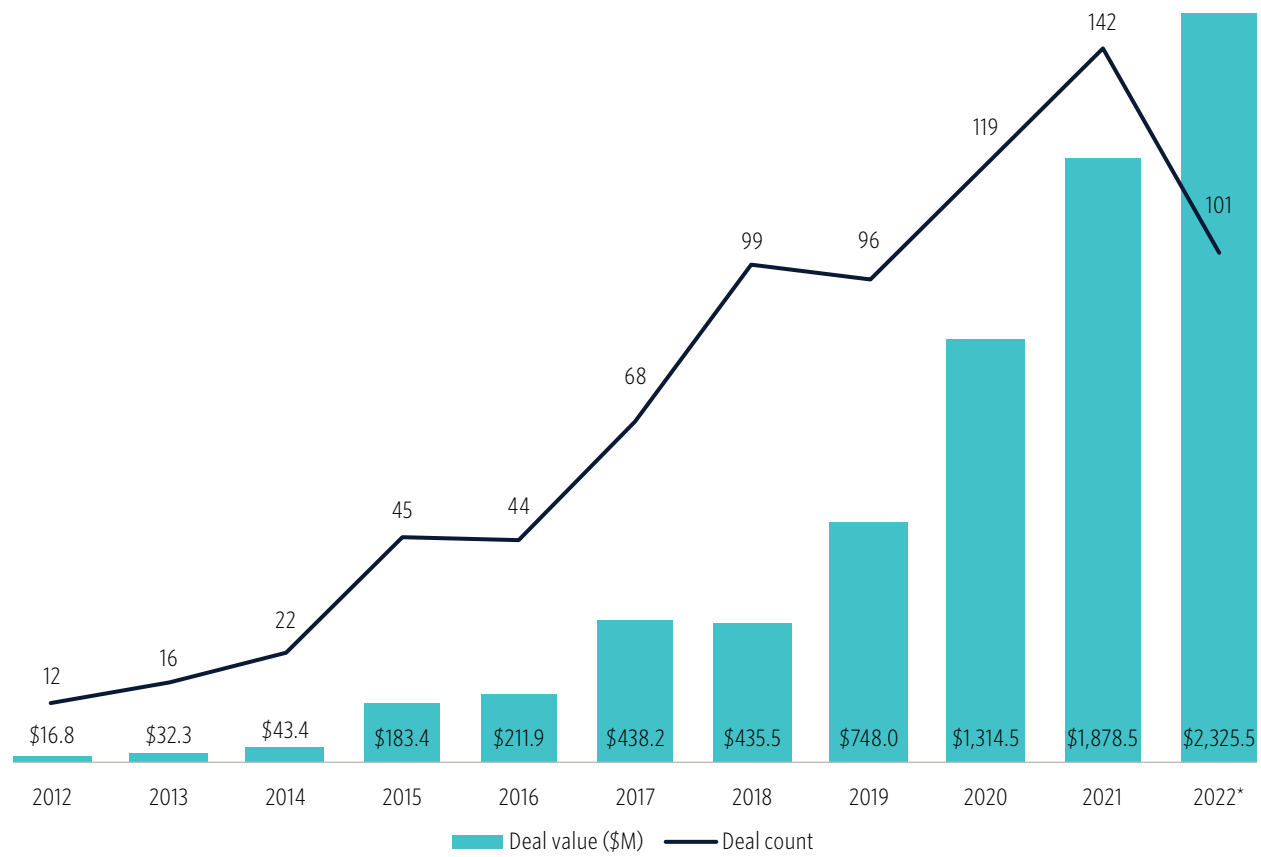
Annually, we logged \$2.3 billion invested across 101 deals. Funding values reached a record high in 2022 following three straight years of more than 40% growth. The year's largest deal—across every segment in agtech—was a \$400.0 million Series E into [Plenty](#) led by JS Capital Management and One Madison Group. The company recently announced plans to build a new \$300.0 million facility in Virginia and is already operating sites in California and Wyoming. [Plenty](#) uses hydroponics, vertical farming, automation, and robotics, enabling it to achieve 350x traditional farm yield according to claims.⁷ A small number of indoor growers went public over the past two years, including [AppHarvest](#), [Kalera](#), and [Local Bounti](#). These companies have displayed strong revenue growth, but long paths to profitability have negatively affected stock performance and could hinder VC investment in the medium term.

⁷: ["Plenty to Build 'World's Largest' Indoor Vertical Farming Complex," Bloomberg, Erin X. Wong, September 14, 2022.](#)



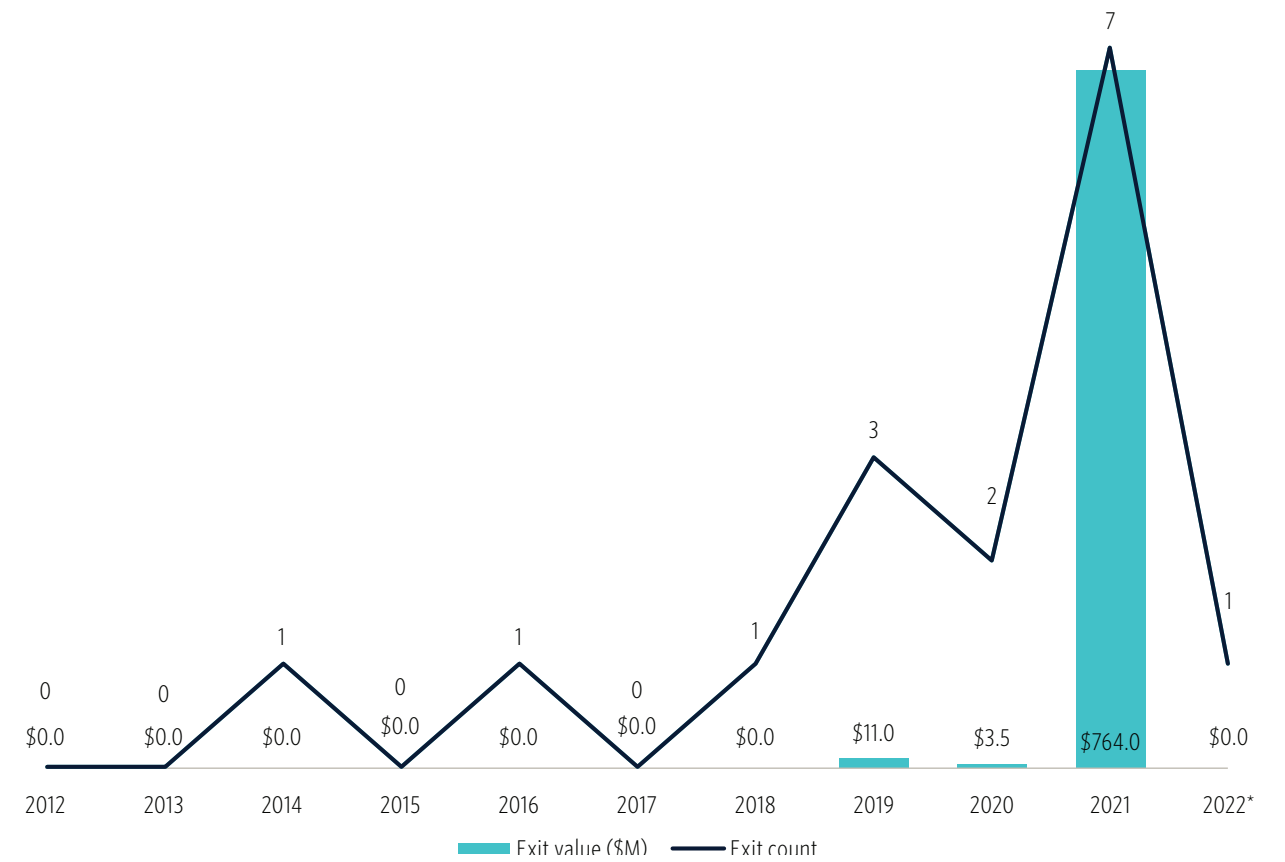
INDOOR FARMING

Indoor farming VC deal activity



Source: PitchBook | Geography: Global | *As of December 31, 2022

Indoor farming VC exit activity



Source: PitchBook | Geography: Global | *As of December 31, 2022



INDOOR FARMING

Key indoor farming VC-backed companies*

Company name	Category	VC raised to date (\$M)	Post-money valuation (\$M)	Most recent VC deal type
Plenty	Indoor growers	\$941.0	\$1,430.0	Series E
Infarm	Indoor growers	\$632.4	\$1,200.0	Series D
Bowery	Indoor growers	\$516.6	\$2,320.0	Late-stage VC
Soli Organic	Indoor growers	\$477.6	N/A	Series D
Gotham Greens	Indoor growers	\$439.9	\$880.6	Series E1
Little Leaf Farms	Indoor growers	\$410.0	N/A	Late-stage VC
Pure Harvest Smart Farms	Indoor growers	\$334.3	N/A	Late-stage VC
AeroFarms	Indoor growers	\$214.5	\$1,200.0	Series E
Green Labs	Indoor farming components	\$163.8	\$840.0	Series C
Upward Farms	Indoor growers	\$152.8	\$460.0	Series B

Source: PitchBook | Geography: Global | *As of December 31, 2022



INDOOR FARMING

Key indoor farming VC deals 2022*

Company name	Close date (2022)	Category	Deal size (\$M)	Post-money valuation (\$M)	Deal type	Lead investor(s)	Valuation step-up (post to pre)
Plenty	January 25	Indoor growers	\$400.0	\$1,425.0	Series E	JS Capital Management, One Madison Group	1.4x
Gotham Greens	September 12	Indoor growers	\$310.0	\$880.6	Series E1	Ares Management, BMO Capital Markets	2.6x
Little Leaf Farms	May 31	Indoor growers	\$300.0	N/A	Late-stage VC	Bank of America, TPG, The Rise Fund	N/A
Pure Harvest Smart Farms	June 30	Indoor growers	\$180.5	N/A	Late-stage VC	IMM Investment, Metric Capital Partners	N/A
Green Labs	January 20	Indoor farming components	\$140.0	\$840.0	Series C	BRV Capital Management	N/A
GrowUp	February 17	Indoor growers	\$135.2	N/A	Series A	Generate	N/A
Soli Organic	October 12	Indoor growers	\$125.0	N/A	Series D	Caisse de dépôt et placement du Québec	N/A
Absolute	May 5	Indoor growers	\$100.4	\$501.9	Series B	Surge (Accelerator)	N/A
Square Roots	April 7	Indoor growers	\$41.0	\$190.5	Series C	N/A	1.5x
Moleaer	June 6	Indoor farming components	\$40.0	\$196.0	Series C	Apollo Global Management, Husqvarna	2.2x

Source: PitchBook | Geography: Global | *As of December 31, 2022



INDOOR FARMING

Key indoor farming exits 2022*

Company name	Close date (2022)	Category	Exit type	Acquirer(s)/index
Pete's	April 4	Indoor growers	Acquisition	Local Bounti
Edible Garden	May 5	Indoor farming components	Public Listing	Nasdaq
ColdHubs	September 30	Indoor farming systems	Buyout	N/A
ECS Botanics	January 1	Indoor growers	Acquisition	Murray Meds
Emerald Metrics	February 1	Indoor farming components	Acquisition	N/A
Sundrop Farms	December 14	Indoor growers	Buyout	Centuria Capital

Source: PitchBook | Geography: Global | *As of December 31, 2022



INDOOR FARMING

Key indoor farming incumbents*

Company name	Category	Key products	EV/NTM revenue	EV/NTM EBITDA
Agrify	Indoor farming systems	Vertical farming systems, insights, grow lights, crop protection	0.4x	N/A
AppHarvest	Indoor growers	tomatoes, strawberries and salad greens	14.5x	N/A
Village Farms International	Indoor growers	Tomatoes, cucumbers, peppers, cannabis	1.1x	N/A
Local Bounti	Indoor growers	Leafy greens	20.6x	N/A
Hydrofarm	Indoor farming components	Nutrients, grow media, containers, lighting, atmospheric control etc.	1.0x	10.1x
Urban-gro	Indoor farming systems	Turn-key farm design and systems integration	0.3x	7.5x
AgriFORCE	Indoor farming systems	Facility and lighting design, automation, nutrients, genetics	2.2x	N/A
Indoor Harvest	Indoor growers	Hemp	N/A	N/A
Heliospectra	Indoor farming components	Lighting systems	3.9x	N/A
CubicFarm Systems	Indoor farming systems	Automated indoor farms	3.7x	N/A

Source: PitchBook | Geography: Global | *As of December 31, 2022



INDOOR FARMING

Opportunities

Components: Indoor farming startups are using precision technologies to optimize the growing environment, using lighting systems, monitoring sensors, irrigation, and software to manage grow operations. For instance, [Xiant Technologies](#) produces photon modulation lighting systems that offer artificial light in “sunless” environments. The lighting systems are designed to maximize plant yields and growing cycles by allowing for nonstop photosynthesis. [iUNU](#), another startup, provides a grow house management platform that connects plants, facilities, and people, using cameras on rail systems to monitor plant health and provide operators with actionable insights. As the operational activities required to run a profitable indoor agriculture operation are becoming more complex, comprehensive tools are needed to manage business processes and stakeholders. Other notable VC-backed providers include [Green Labs](#), IGS Horticulture, and AEssenceGrows.

Systems: Indoor farming systems are comprehensive growing environments spanning small consumer table-top solutions to massive commercial facilities. One of the most attractive benefits of indoor ag is the ability to grow plants in otherwise inhospitable environments. Some providers are converting shipping containers into ultraportable indoor farming facilities that can be dropped anywhere to introduce ag capabilities into a community with minimal construction time. [Freight Farms](#)—which develops climate-controlled, vertical, hydroponic farms—is a leader in the indoor ag containers space. The company’s container systems include IoT farm-management tools to automate processes and optimize growing variables.

Commercial indoor ag system providers develop large-scale greenhouses and grow facilities that allow operators to replace or enhance plant supplies. For example, [TruLeaf](#) develops turnkey vertical farm facilities specializing in leafy greens that enable operators to provide a year-round

food supply, reducing transportation costs and reliance on produce imports. Consumer indoor ag systems allow consumers to grow crops at home on a smaller scale, too. This concept is not new: One of the first widely available countertop “indoor gardens” was a hydroponic system called AeroGarden, launched by AeroGrow International in 2006. The competitive landscape has since expanded, with providers offering products with a wide range of complexities and capabilities. Food inflation may drive adoption of consumer farming equipment. [Farmshelf](#), [Click and Grow](#), and [Rise Gardens](#) are just a few of the companies developing consumer hydroponic equipment that enables consumers to grow herbs, leafy greens, and other vegetables at home without pesticides and with at least 90% less water.

Growers: Companies in this category operate indoor farming facilities. [Growers](#) that receive VC-backing often build out proprietary components and systems that can yield a higher ROI relative to turnkey systems. Indoor farming grow operations involve the management and operations of an indoor farming facility. However, the cost-effectiveness and efficiency of operations can be a competitive advantage in this field. Many operators use proprietary facility design, technology, and even exclusive crops. For instance, vertical farm grower Bloom performs plant breeding in addition to typical operations to develop crops that will thrive in the climate of the facility’s location. Grower [Iron Ox](#) achieves elevated levels of automation and efficiency using robots for many tasks. Other key VC-backed providers include [Plenty](#), [AeroFarms](#), and [Infarm](#). In the past five years, the indoor farming market has become saturated with well-funded growers. In the medium term, we expect funding to be concentrated among leading providers as they scale up and seek profitability.



INDOOR FARMING

Risks & considerations

High startup costs: Startup costs to establish a CEA facility are much higher than those required by conventional farming. These costs include designing, building, or retrofitting facilities; acquiring and installing technology such as IoT sensors, and automation hardware; and environmental control solutions such as lighting and irrigation. Falling technology costs are helping mitigate these expenses.

Urban real estate costs: One of the most significant benefits of indoor farming is the ability to grow food in urban environments near the highest demand. Aside from reducing transportation costs and increasing local produce, indoor farming facilities can address food deserts, a growing health and social justice issue. A significant barrier to urban indoor ag is the cost of real estate, which can be prohibitively expensive in many major cities. [Growers](#) of low-margin crops, row crops, and most other vegetables, may not be able to make the numbers work, although specialty crops such as ginseng, herbs, and cannabis may hold more promise.

High production costs: CEA production is characterized by higher operating expenses than those of conventional farms. Historically, energy costs to operate lighting and control systems, IoT sensors, and automation technology have been significant barriers to CEA profitability, making it difficult to compete against traditional farms on price. Recent strides in precision agriculture and energy efficiency are helping reduce energy and input costs. Startups such as [GrowFlux](#) are working to develop smart lighting controls to reduce the energy needs and costs of indoor ag lighting systems. Sensors and software solutions increase the precision with which inputs are applied, thereby reducing waste, and high-energy-consumption devices such as lighting are being improved to reduce energy needs. In the near term, global energy crises due to the Russia-Ukraine war may present significant cost barriers that offset gains in efficiency. US operator [Kalera](#) recently sold its international operations—surging European electricity costs may have been a leading factor. Some operators are building massive facilities to maximize scale efficiencies. Over time, investing in automation and robotics will likely offer cost savings by reducing labor requirements.



INDOOR FARMING

Limited crop varieties: High operational costs mean indoor farmers tend to focus on high-revenue-generating crops. According to a 2017 survey of CEA farmers worldwide conducted by CEA software provider Artemis, the five most predominant CEA crops are leafy greens, microgreens, herbs, flowers, and tomatoes. All providers in our list of the most well-funded, VC-backed, US-based CEA operators produce leafy greens as their primary—if not sole—crop. These CEA farms are drawn toward leafy greens because hydroponically grown greens have the highest profitability among CEA-grown crops, at a 46% average profit margin. Row crops, such as corn and soybeans, are commodity crops that command very low pricing. Specialty crops, such as leafy greens and tomatoes, generate higher revenues because they have quicker growth cycles and are more space-efficient, thus allowing for vertical stacking. They are also highly perishable and benefit from growing near consumers.

Limited arable “land”: Production volumes in indoor ag facilities are limited compared to traditional farms due to the square footage constraints of growing facilities. The largest traditional farm in the US is 190,000 acres. Contrast that with the world’s largest indoor farm: AeroFarm’s 70,000-square-foot, or 1.6-acre, vertical farming facility in Newark, NJ. Although arable “land”

is increased through vertical stacking, it is unlikely that indoor facilities will be able to match the potential output of traditional farms. Despite some operational advantages, there are considerable financial and operational challenges when maintaining the technology required, such as lighting and irrigation, in an indoor ag facility.

Crop variety limitations: Growing crops in a controlled environment requires advanced knowledge of plant varieties that perform well in these environments. Most plant varieties are designed to grow in outdoor environments or greenhouses and may not be suitable for “sunless” environments. Although horticulturalists are rapidly researching and developing crops designed for indoor ag, many operators of indoor farms are limited to producing the same easy-to-grow crops such as strawberries, herbs, and leafy greens.



Precision ag

Overview

Precision ag involves farm equipment, robotics, and machinery that optimize or automate in-field operations such as seeding, fertilizing, irrigating, and harvesting. Emerging products include unmanned ground vehicles that replace tractors with autonomous machines, crop-picking robots, and drones. Providers differentiate through hardware and software features for individual crops or broader applications. Field IoT solutions use software and sensors to monitor, analyze, predict, and optimize crop condition, water, weather, and pest levels. Startups offer sensors to collect specific farm data; others develop software to interpret data and improve decision-making. While precision ag promises benefits, growers have lacked sufficient tools to interpret and act on data, leading to technology fatigue and resistance to new technologies. Advanced data-collection infrastructure, emerging AI & ML, and predictive analytics technologies are set to improve decision-making and offer meaningful recommendations.

Segments include:

Farm-management software: decision support software, ag data-collection devices, and farm-management platforms.

Robotics & smart field equipment: advanced field machinery automating or optimizing in-field operations.

Field IoT: IoT sensors and software that help to monitor and manage in-field variables.

Drones & imagery analytics: imaging tools, including software that relies on drones, satellites, or other aerial platforms used to gather crop health information, such as disease and pest detection, and use predictive analytics to optimize activities.

Industry drivers

Supply constraints: The Russia-Ukraine war and ensuing political clash among other European nations has severely constricted the supply of grains, fertilizer, and fuel. Climate change and extreme weather events, including flooding in Pakistan and drought in the western US, are further impacting yields. Precision ag may be essential to boosting global supply.

Labor shortages: Widespread agriculture labor shortages, as well as rising costs and declining dependability have challenged farm fieldwork for years. The COVID-19 pandemic and ongoing political issues have worsened the situation, especially for farms relying on migrant workers.

Expanded digital infrastructure: Communications providers have historically prioritized densely populated urban environments to deploy internet infrastructure. Communications providers are increasingly expanding internet access to rural locals, enabling autonomous technology and improving farm productivity.

Improving connectivity: The increasing availability of internet connectivity options, including wifi, high-speed cellular, fiberoptic, and satellite, in agricultural environments makes it possible to collect and transmit data from IoT sensors.



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Loose regulatory environment: Unlike autonomous passenger vehicles, autonomous farm machinery, such as autonomous tractors, face few regulations if they stay on farms and away from public roads. While California's Occupational Safety and Health Administration (OSHA) regulations require an operator to be onboard moving autonomous equipment, we believe the lax regulations are favorable for commercialization and innovation.

Advances in AI and IoT technology: AI is becoming easier to use, and IoT sensors are getting cheaper, smaller, and quicker.

Increasing global food demand: Population growth pressures growers to increase farm productivity. Limited arable land means that growers need to increase crop yields on existing acreage.

Agriculture profit margin squeeze: Farming profit margins have become increasingly tighter as crop prices have decreased while costs have grown or maintained.⁸ Extreme weather events and shifting climate patterns increase risk and challenge yield targets.

Market size

Based on the global revenues of agricultural equipment manufacturers, we estimate the precision agriculture market reached \$7.0 billion in 2022 and predict it will grow at a CAGR of 11.8% to reach \$10.9 billion by 2026. Advances in computer vision, AI, automation, and predictive analytics are driving the adoption of precision ag technology, which increases productivity, decision-making, and yields for growers.

⁸: ["Understanding the Margin Squeeze," Purdue University, Brent Gloy, January 5, 2015.](#)

Precision ag market size estimate (\$B)



Source: The Insight Partners | Geography: Global | *As of December 31, 2022



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Business model

Precision ag companies typically sell a combination of hardware and software or software alone. Business models often involve traditional sales and service, as well as subscription services. For example, [Arable](#) sells a data-collection device and accompanying software platform. Customers purchase the devices outright and subscribe to the software through a SaaS model.

Device manufacturers are increasingly using HaaS models, providing customers with lower upfront costs and manufacturers with stable revenue streams and improved inventory forecasting. However, traditional sales and service models are still common for farm machinery. This is beginning to shift as manufacturers use robotics-as-a-service (RaaS) models for autonomous farm machinery that require significant human oversight and refinement.

As technology becomes more complex, the “right to repair” has emerged as an important issue. Manufacturers often place strict constraints on equipment maintenance and repair, causing lengthy repair wait times that can lead to missed farming windows and ruined crops. In January of 2023, the American Farm Bureau Federation announced a memorandum of understanding with John [Deere](#) to enable farmers and independent mechanics to buy John [Deere](#) software and manuals for equipment servicing. Critics argue this action was taken to prevent legislation. We expect continued legal battles in the medium term as providers fight to maintain trade secrets and a valuable service revenue stream. If the right to repair is enforced, we may see equipment costs decline as competitors gain access to new technologies, and a third-party service and modification industry will likely grow.

Common precision ag performance indicators:

Operational

- Number of pieces of machinery or systems deployed.
- Patents.
- Acres serviced per hour (harvested, weeded, or planted).
- Horsepower.

Financial

- Addressable markets.
- Gross margin.
- Unit sales.
- Revenue mix.

Hardware

- Power budget (active battery time).
- Form factor (size).
- Memory (RAM).
- Connectivity range.



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Software

- Number of application programming interfaces (APIs).
- Financial.
- Gross margins.
- CAC.
- Customer lifetime value.

VC activity

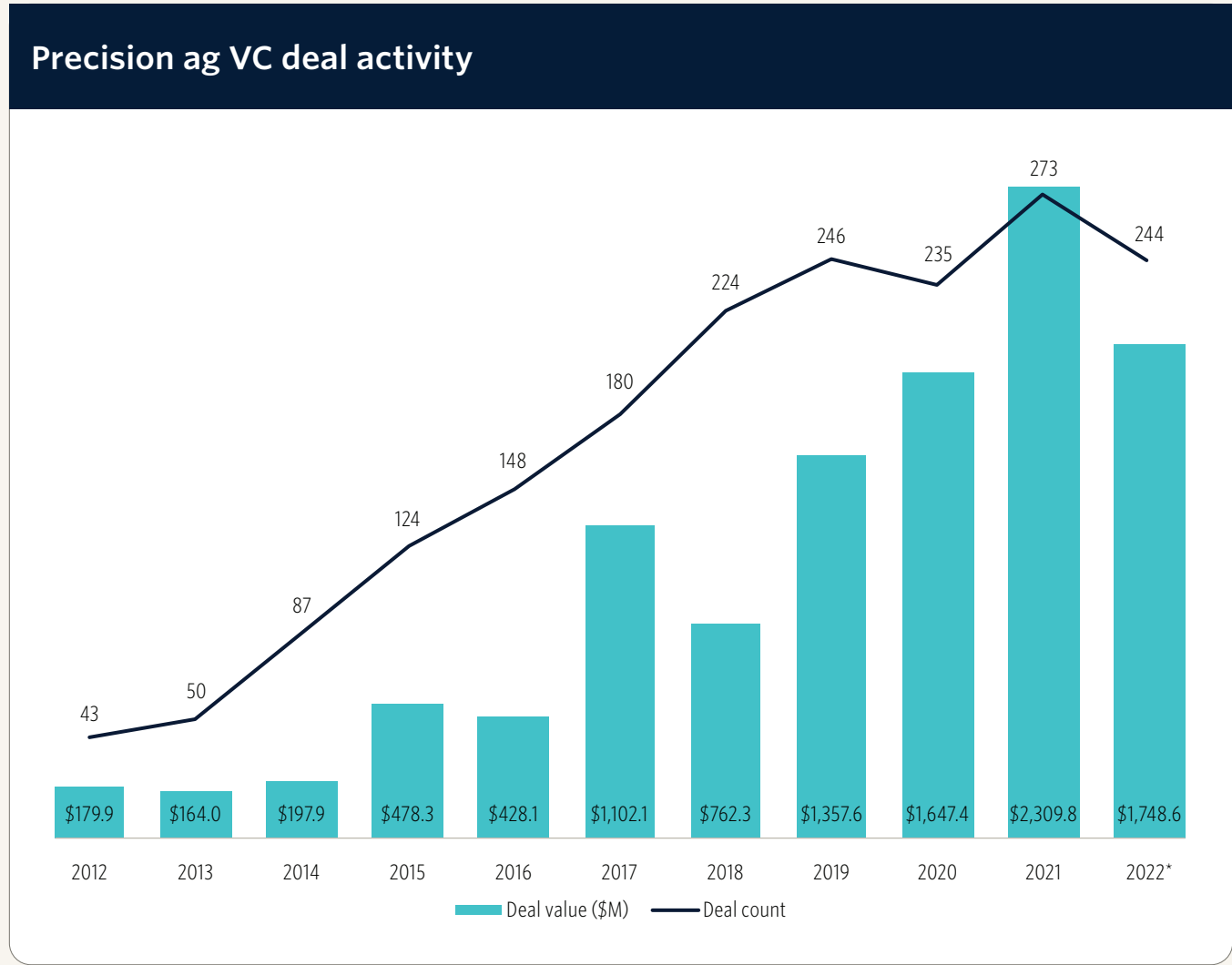
Precision ag startups logged \$323.6 million in VC across 40 deals in Q4 2022. VC funding activity has declined for the third straight quarter, yet deal values remain historically elevated. The quarter's largest deal was a \$46.5 million Series A in startup [Verdant Robotics](#). The company is developing a smart spraying implement that uses computer vision and articulated nozzles to identify and spray weeds with precision, reducing chemical usage by up to 95%. Smart weeding implements gained popularity in 2022 due to the increased resource efficiency of these machines and the increased awareness of soil health importance.

Annually, deal values totaled \$1.7 billion across 244 deals, the second-highest year in terms of deal count and deal value. However, both measures declined by double-digits from record funding activity in 2021. Three of the four precision ag categories logged 30% or more declines in deal values YoY. The robotics & smart field equipment category saw growth in the low single digits in 2022—remarkably bucking the decline among other categories. Notable deals include a \$60.0 million late-stage VC round in smart “spot-spray” implement provider [Solinftec](#), and mechanical weeding robot provider FarmWise.

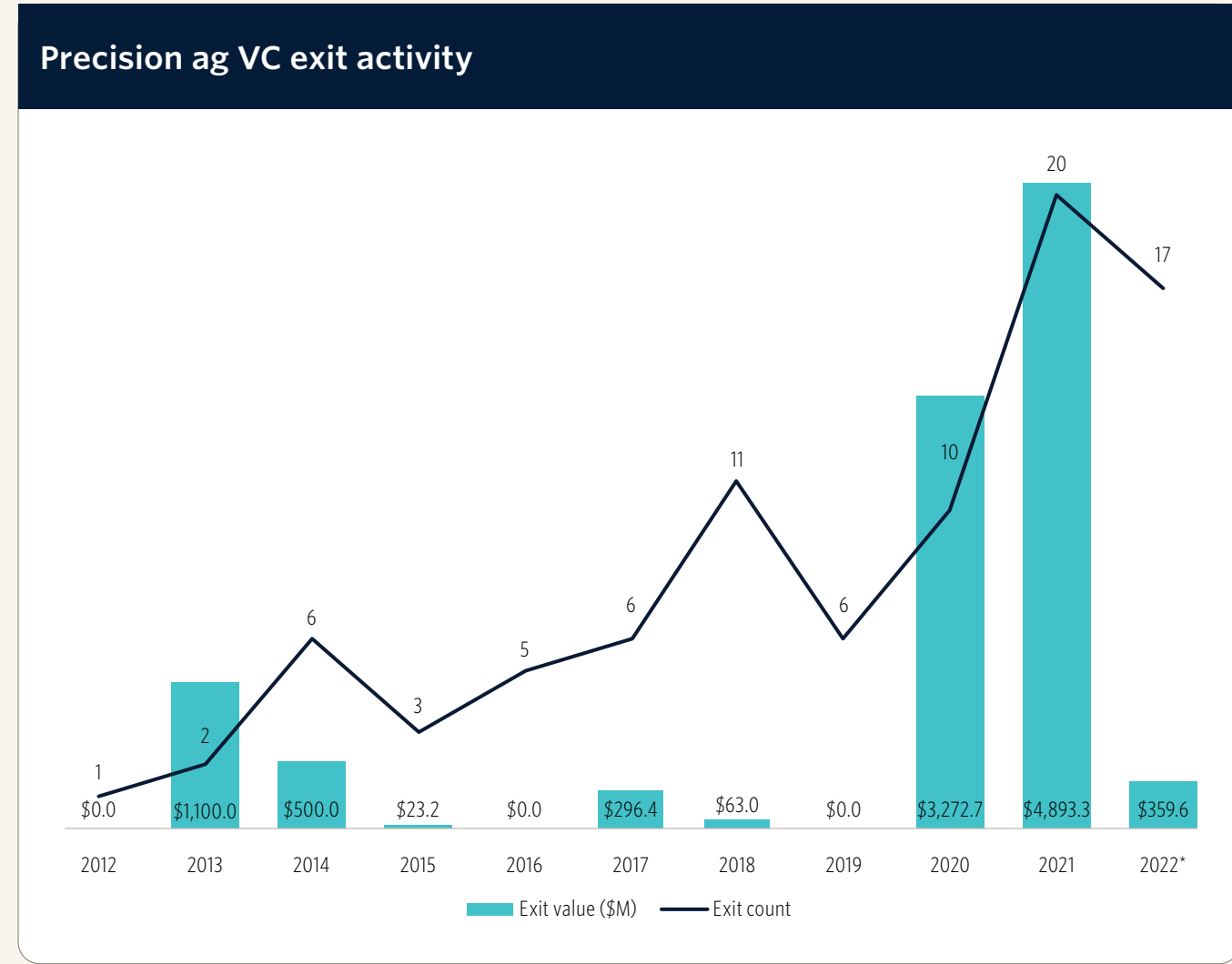
Exit counts have remained strong in 2022. We recorded 17 exits in 2022—down from 20 in 2021—despite a shut IPO window and elevated interest rates. Notable exits include the SPAC of [Satellogic](#) on the NASDAQ exchange and [Matterport](#)'s acquisition of [Enview](#). Exit activity is expected to be muted in 2023, although there might be attractive opportunities for corporate acquirers with healthy balance sheets.



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Source: PitchBook | Geography: Global | *As of December 31, 2022



Source: PitchBook | Geography: Global | *As of December 31, 2022



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Key precision ag VC-backed companies*

Company name	Category	VC raised to date (\$M)	Post-money valuation (\$M)	Most recent VC deal type
Orbital Insight	Drones & imagery analytics	\$203.7	\$323.2	Late-stage VC
Xaircraft	Robotics & smart field equipment, drones & imagery analytics	\$201.8	\$560.7	Series C3
Capella Space	Drones & imagery analytics	\$194.0	\$320.0	Series C
Semios	Field IoT	\$180.5	\$789.6	Late-stage VC
Tomorrow.io	Farm management software	\$163.2	\$1,200.0	Late-stage VC
VisionNav Robotics	Robotics & smart field equipment	\$156.9	\$550.0	Late-stage VC
DroneDeploy	Drones & imagery analytics	\$150.0	\$495.0	Series E
PrecisionHawk	Drones & imagery analytics	\$138.9	\$232.6	Series D2
FJ Dynamics	Robotics & smart field equipment	\$130.9	N/A	Series B
Solinftec	Robotics & smart field equipment	\$120.0	N/A	Late-stage VC

Source: PitchBook | Geography: Global | *As of December 31, 2022



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Key precision ag VC deals 2022*

Company name	Close date	Category	Deal size (\$M)	Post-money valuation (\$M)	Deal type	Lead investor(s)	Valuation step-up (post to pre)
Capella Space	May 12	Drones & imagery analytics	\$97.0	\$217.0	Series C	NightDragon	0.7x
VisionNav Robotics	April 29	Robotics & smart field equipment	\$76.0	\$500.0	Series C1	5Y Capital, Meituan	N/A
Solinftec	April 12	Robotics & smart field equipment	\$60.0	N/A	Late-stage VC	Lightsmith Group	N/A
Blue Ocean Robotics	January 4	Robotics & smart field equipment	\$50.9	N/A	Late-stage VC	N/A	N/A
Verdant Robotics	November 29	Robotics & smart field equipment	\$46.5	N/A	Series A	Cleveland Avenue	N/A
FarmWise	April 21	Robotics & smart field equipment	\$45.4	N/A	Series B	Fall Line Capital, Middleland Capital	N/A
Scythe Robotics	December 16	Robotics & smart field equipment	\$42.0	\$102.0	Series B	N/A	1.4x
Taranis	September 7	Drones & imagery analytics	\$40.0	N/A	Series D	Inven Capital	N/A
Alleaves	July 19	Farm management software	\$40.0	\$240.0	Series A	The Eleven Fund	N/A
Apollo Agriculture	February 9	Farm management software	\$40.0	N/A	Series A	SoftBank Investment Advisers	N/A

Source: PitchBook | Geography: Global | *As of December 31, 2022



PRECISION AG

Key precision ag VC exits 2022*

Company name	Close date	Category	Exit size (\$M)	Exit type	Acquirer(s)/index	Valuation step-up (post to exit valuation)
Satellogic	January 24	Drones & imagery analytics	\$278.0	Public listing	CF Acquisition Corp V	N/A
Enview	January 5	Drones & imagery analytics	\$71.0	Acquisition	Matterport	1.4x
Lyckegård	February 21	Robotics & smart field equipment	\$6.4	Public listing	Nasdaq OMX Nordic Exchange - Stockholm	N/A
Vultus	May 20	Field IoT	\$4.1	Public listing	Nasdaq OMX Nordic Exchange - AktieTorget	N/A
Agroptima	December 13	Farm management software	N/A	Acquisition	Groupe ISAGRI	N/A
Descartes Labs	August 4	Drones & imagery analytics	N/A	Buyout	Antarctica Capital	N/A
Tibot Technologies	November 24	Robotics & smart field equipment	N/A	Acquisition	Octopus Biosafety	N/A
Prakshep	June 2	Drones & imagery analytics	N/A	Acquisition	Arya.ag	N/A
Headwall Photonics	January 18	Drones & imagery analytics	N/A	Buyout	Arsenal Capital Partners	N/A
Bloom Automation	November 3	Robotics & smart field equipment	N/A	Acquisition	Eteros Technologies	N/A

Source: PitchBook | Geography: Global | *As of December 31, 2022



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Key precision ag incumbents*

Company name	Category	Key products	EV/NTM revenue	EV/NTM EBITDA
Kubota	Robotics & smart field equipment	Tractors, balers, rakes, tedders	1.6x	11.2x
Deere	Robotics & smart field equipment	Tractors, sprayers, planters	3.3x	14.8x
Lindsay	Field IoT	Irrigation systems, management, scheduling	1.9x	14.7x
CNH Industrial	Robotics & smart field equipment	Tractors	1.8x	15.9x
AGCO	Robotics & smart field equipment	Tractors, combine harvesters, forage harvesters, balers, implements	0.9x	7.5x
Planet Labs	Drones & imagery analytics	Satellite analytic feeds, monitoring	6.3x	N/A
Satellogic	Drones & imagery analytics	Satellite analytic feeds, monitoring	14.9x	N/A
Spire	Drones & imagery analytics	Satellite analytic feeds, monitoring	2.1x	N/A
AgEagle Aerial Systems	Drones & imagery analytics	Drones and sensors for imagery analytics	N/A	N/A
Deveron	Drones & imagery analytics	Agronomic insights	1.7x	62.6x

Source: PitchBook | Geography: Global | *As of December 31, 2022



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Opportunities

Robotics & smart field equipment: Field robotics providers develop farm machinery that automates or augments current technology or existing manual processes. Companies in the space develop tools that aid or automate harvest tasks by leveraging emerging technologies such as computer vision, 3D perception, and AI that can detect ripeness and pick crops with a high degree of precision and minimal force. These machines increase productivity and safety while compensating for labor shortages. Startup [Burro](#) manufactures autonomous robots that ferry crops from pickers to packers, increasing the productivity of field workers. Startup [Tortuga AgTech](#) develops robots that harvest strawberries in indoor facilities. The company uses a RaaS model, charging by the kilo of strawberries harvested. Other startups, such as [Small Robot Company](#), develop autonomous robots to replace tractors and other machinery to perform technical in-field activities such as planting, weeding, and treating arable crops. Startups are not the only providers getting in on the autonomous robot action. At CES 2023, incumbent John [Deere](#) showed off its fully autonomous tractor that leverages cameras, sensors, GPS, and AI to operate without human intervention. Even semi-autonomous machinery equipped with advanced technologies offers value to growers. Farm owner Fazenda Diamente has said machinery equipped with GPS and autopilot systems improves efficiency and has led to a 5% to 10% decrease in costs.⁹ However, old habits die hard. As Todd Main, director of market development at Illinois Soybean Association states: “Farmers like to ride around in tractors. That’s one of their things. It will be interesting to watch how this plays out.”¹⁰

Agriculture drones: Also known as unmanned aerial vehicles, agriculture drones are aircraft that are automated or operated by remote control. In agricultural settings, drones are equipped with imagery tools or farming hardware such as fertilizer spraying tools. Enthusiasm peaked in 2018 and 2019, although some farmers reported disillusionment with the challenge of reaping benefits from drone use. Some of the hurdles that cooled off farmer interest were onerous federal regulations, steep operational learning curves, and volumes of cryptic data. However, new capabilities and use cases are driving renewed interest in drones for agricultural applications. The most common agricultural applications for drones include imagery analytics and precision farming. Drones equipped with imaging tools can monitor and scout farms, track livestock activity and location or pinpoint crop health concerns. Imagery data is critical to data-focused farm managers seeking actionable insights to address crop issues and maximize productivity. Drones can also be equipped with tools to perform tasks traditionally reserved for conventional ground machinery. Top use cases include seeding fields and spraying crops with fertilizers and pesticides. [Pyka](#) develops autonomous electric airplanes that can safely, accurately, and autonomously spray crops on-demand. [Guardian Agriculture](#) provides a drone service that can both spray and seed commercial farms. Although a single drone may have limited carrying capacity, providers are moving toward deploying multiple drones, or swarms, to increase output. Other key VC-backed providers include [Tevel](#), [Nileworks](#), and [Farmfriend](#).

9: “Agtech helps sugarcane grower face COVID-19 crisis,” [Future Farming](#), Daniel Azevedo, July 17, 2020.

10: “Farmers are preparing for driverless tractors, and companies are already investing in the technology,” [WCBU](#), Tim Alexander, January 17, 2023.



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Imagery analytics: Imagery analytics companies develop software and imaging sensors affixed to drones, planes, and satellites that can gather crop health information, such as disease and pest detection. These products use predictive analytics to improve decision-making. Imagery analytics companies use aerial imagery and data analytics to improve farm management. Startup [Ceres Imaging](#) incorporates high-resolution multispectral imagery and fixed-wing aircraft to gather data readings on plant nitrogen content, canopy density, cumulative stress, and water stress. These data points help identify irrigation issues, plant health issues, and projected yields. Startup [Sentera](#) develops software and sensors that affix to drones and help farmers monitor crop health data. Although drones are more easily deployable, critics argue they are less efficient and cannot carry the same quantity of robust sensors that can be attached to a larger aircraft. Other key VC-backed providers include [Orbital Insight](#), [Capella Space](#), and ClimaVision.

Field IoT: Companies operating in this category are land-based cousins to imagery analytics. Providers are developing in-field sensors that enable growers to monitor, analyze, predict, and optimize field operations in real time. [Semios](#) develops sensors and software for vine and tree crops. Solutions monitor climate and plant stress and aid growers in managing pests, disease, frost, and water. [Arable](#) sells an in-field device featuring a variety of sensors to monitor crop health, as well as weather and soil conditions. The device is affixed to a pole and sits stationary in a field capturing “ground-truth data.” Other key VC-backed providers include [Pattern Ag](#), [Hortau](#), and [N-Drip](#).

Farm-management software: Farms today are nearly unrecognizable from 20 to 30 years ago—many have evolved from small-scale to large-scale operations with millions of dollars in assets. Farm-management software provides modern farmers with visibility and control over field activities, operations, labor, finances, and crop performance. The ability to unite production activity with financial data helps farmers make more finance-driven decisions and provides a key incentive for adopting management software. [FieldIn](#) provides a comprehensive farm-management software platform that tracks field activities, communicates work orders, manages inventories, and provides cost and yield analysis tools. Cropin offers a robust software platform that includes a comprehensive suite of operational and analytical tools and a host of other features, such as traceability and compliance data, satellite imagery, reports, and crop loss management tools, to manage a farm and maximize profits. Other key VC-backed providers include [Apollo Agriculture](#), [Regrow](#), and [Cervest](#).



Risks & considerations

Regulations may hinder benefits and deployment: Autonomous farm equipment technology has seen minimal federal regulation in the US. However, California's OSHA agency has published regulations requiring "self-propelled equipment" to have an operator "stationed at the vehicular controls" during operation,¹¹ negating the central benefit of autonomous operation. The regulation intends to maintain the safety of field workers when working with near-autonomous vehicles. California is the largest producer of food in the US, and these regulations will likely affect the entire industry, limiting the growth of this emerging technology. We expect to see other states or possibly federal agencies follow California's lead as autonomous farm equipment technologies become widespread.

Technology fatigue: For decades, farmers have been promised tools to improve yields, reduce costs, and increase profits, yet most early in-field sensor technology did not provide software sophisticated enough to give meaningful insights or automate processes based on data. For this reason, field monitoring & analysis products frequently failed to live up to expectations. Although

analytics software has improved significantly in recent years, providers still struggle to overcome resistance from growers. Increased consolidation is helping to centralize datasets and reduce the number of apps for growers to manage, which may aid in adoption.

Data ownership concerns: Field monitoring & analysis companies are generating massive amounts of data to improve decision-making, enhance outcomes, and gain competitive advantages. As the agriculture industry becomes increasingly data-centric, farmers are becoming more concerned about data privacy, security, and ownership.

¹¹: ["§ 3441. Operation of Agricultural Equipment." State of California, July 14, 2021.](#)



Appendix



APPENDIX

Top angel and seed VC-backed agtech companies by total VC raised to date*

Company name	Category	VC raised to date (\$M)	Post-money valuation (\$M)	Most recent VC deal type
Stacked Farm	Indoor growers	\$39.4	N/A	Seed round
SPREAD	Indoor growers	\$29.3	\$101.9	Seed round
PredaSAR	Drones & imagery analytics	\$25.0	\$90.0	Seed round
Pursell Fertilizer	Plant biotech	\$23.5	\$27.5	Seed round
Agtonomy	Robotics & smart field equipment	\$22.5	N/A	Seed round
Precision AI	Drones & imagery analytics	\$20.0	N/A	Seed round
Guardian Agriculture	Drones & imagery analytics	\$16.5	\$29.5	Seed round
MushroomSupplies	Indoor farming systems	\$12.1	\$30.0	Seed round
Faarms	Agribusiness marketplaces	\$12.0	N/A	Angel (individual)
Aqgromalin	Farm management software	\$11.5	\$21.5	Seed round

Source: PitchBook | Geography: Global | *As of December 31, 2022



APPENDIX

Top early-stage VC-backed agtech companies by total VC raised to date*

Company name	Category	VC raised to date (\$M)	Post-money valuation (\$M)	Most recent VC deal type
Plant-Ag	Agribusiness marketplaces	\$900.0	N/A	Early-stage VC
Zhongxin Breeding	Animal biotech	\$332.9	N/A	Early-stage VC
Colossal	Animal biotech	\$155.0	\$245.0	Early-stage VC
Maihuolang Information Technology	Agribusiness marketplaces	\$150.0	N/A	Series A
FJ Dynamics	Robotics & smart field equipment	\$130.9	N/A	Series B
E-ctare	Finance & insurance	\$114.6	N/A	Early-stage VC
Chari	Agribusiness marketplaces	\$106.3	\$75.0	Early-stage VC
Climavision	Drones & imagery analytics	\$100.0	N/A	Series A
Revol Greens	Indoor growers	\$215.0	N/A	N/A
AcreTrader	Finance & insurance	\$77.8	N/A	N/A

Source: PitchBook | Geography: Global | *As of December 31, 2022



APPENDIX

Top late-stage VC-backed agtech companies by total VC raised to date*

Company name	Category	VC raised to date (\$M)	Post-money valuation (\$M)	Most recent VC deal type
Pivot Bio	Plant biotech	\$616.7	\$1,700.0	Series D
Botanical Solution	Plant biotech	\$561.4	\$20.1	Series A2
InnovaFeed	Insect farming	\$489.3	N/A	Series D
Little Leaf Farms	Indoor growers	\$410.0	N/A	Late-stage VC
Pure Harvest Smart Farms	Indoor growers	\$334.3	N/A	Late-stage VC
Shiyue Daotian	Plant biotech	\$268.3	N/A	Series B
AgBiome	Plant biotech	\$236.2	N/A	Series D
DeHaat	Agribusiness marketplaces	\$221.8	\$154.3	Series E
eFishery	Aquaculture	\$221.8	\$407.5	Late-stage VC
Orbital Insight	Drones & imagery analytics	\$203.7	\$323.2	Late-stage VC

Source: PitchBook | Geography: Global | *As of December 31, 2022



APPENDIX

Top venture growth VC-backed agtech companies by total VC raised to date*

Company name	Category	VC raised to date (\$M)	Post-money valuation (\$M)	Most recent VC deal type
Indigo Agriculture	Plant Biotech, agribusiness marketplaces	\$1,701.6	\$4,000.0	Series H
Plenty	Indoor growers	\$941.0	\$1,400.0	Series E
Farmer's Business Network	Finance & insurance, farm management software, agribusiness marketplaces	\$919.3	\$3,800.0	Series G
Infarm	Indoor growers	\$632.4	\$1,200.0	Series D
Bowery	Indoor growers	\$516.6	\$2,300.0	Late-stage VC
Soli Organic	Indoor growers	\$477.6	N/A	Series D
Inari	Plant biotech	\$476.0	\$1,500.0	Series E
Inscripta	Plant data & analysis	\$459.5	\$1,300.0	Late-stage VC
Gotham Greens	Indoor growers	\$439.9	\$880.6	Series E1
DNAnexus	Plant biotech	\$436.7	\$620.0	Series I

Source: PitchBook | Geography: Global | *As of December 31, 2022



APPENDIX

Most active investors in agtech accelerator deals in 2022

Investor name	Deal Count
SVG Ventures-THRIVE	18
Techstars	16
i.d.e.a. Fund	11
Google for Startups Accelerator	7
EIT Food	7
Katapult Group	6
National Science Foundation	4
Catalyst Fund	3
Big Idea Ventures	3
Tech Incubator Program for Startups	3

Source: PitchBook | Geography: Global

Top VC investors in agtech companies in 2022

Investor name	Deal count	Angel and seed	Early-stage VC	Late-stage VC	Venture growth	Investor type
Cavallo Ventures	13	2	5	3	3	CVC
S2G Ventures	10	1	1	5	3	VC
AgFunder	9	1	5	3	0	VC
Innova Memphis	9	2	4	3	0	VC
Ag Ventures Alliance	9	4	2	3	0	VC
SOSV	8	6	2	0	0	VC
iSelect Fund	7	0	3	1	3	VC
Toyota Ventures	6	3	1	2	0	CVC
GV	6	2	2	1	1	CVC
Elevate Ventures	6	6	0	0	0	VC

Source: PitchBook | Geography: Global



APPENDIX

Top strategic acquirers of agtech companies 2020-2022*

Investor name	Deal count	Investor type
GrowGeneration	4	Corporation
Hub International	4	PE-backed company
Deere	2	Corporation
High Street Insurance Partners	2	PE-backed company
Country Visions Co-Op	1	Corporation
Form-A-Feed	1	Corporation
Titan Machinery	1	Corporation
Auxly Cannabis Group	1	Corporation
GrubMarket	1	VC-backed company
Marsh & McLennan Agency	1	Corporation

Source: PitchBook | Geography: Global | *As of December 31, 2022

Top PE investors 2020-2022*

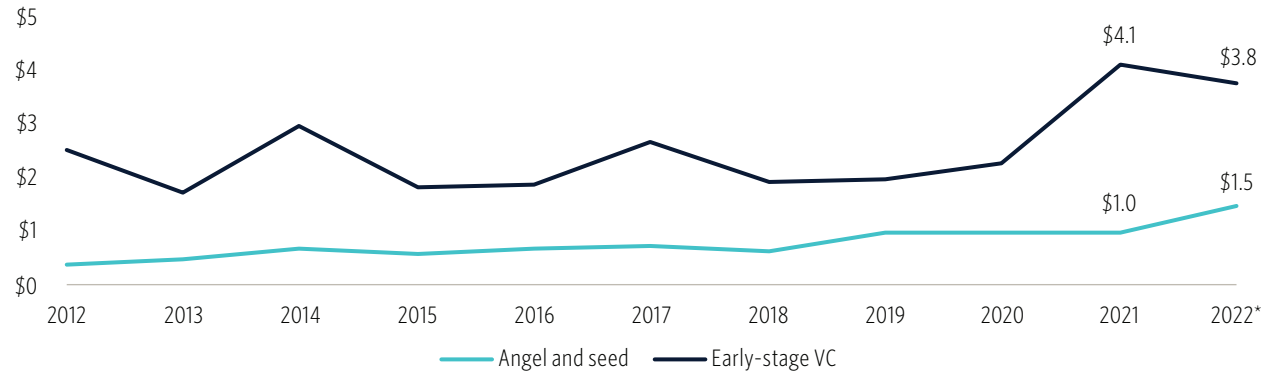
Investor name	Deal count	Investor type
HarbourVest Partners	8	PE/buyout
AlpInvest Partners	5	PE/buyout
Hellman & Friedman	5	PE/buyout
The Carlyle Group	5	PE/buyout
Altas Partners	5	PE/buyout
Rabo Investments	4	PE/buyout
EQT	4	PE/buyout
Farol Asset Management	3	PE/buyout
APES Partners	3	PE/buyout
L Capital	3	PE/buyout

Source: PitchBook | Geography: Global | *As of December 31, 2022



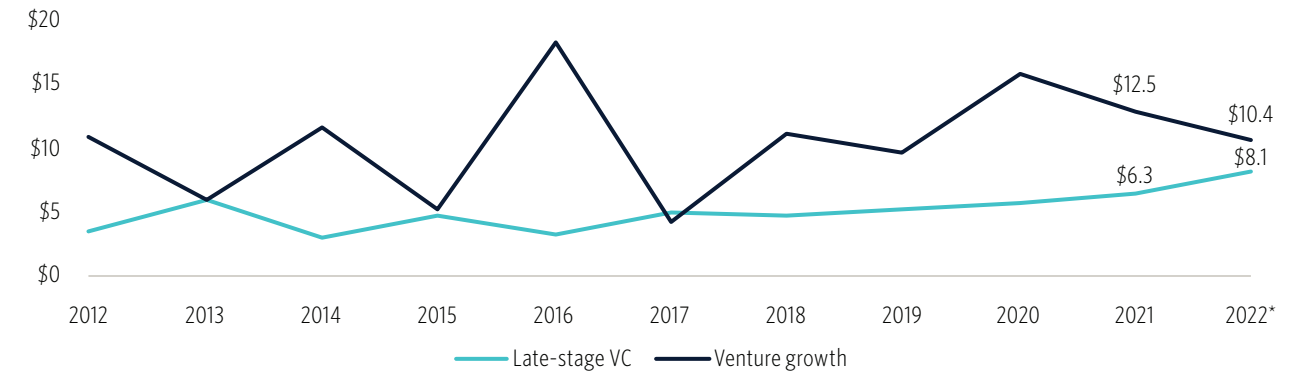
APPENDIX

Median agtech angel and seed and early-stage VC deal sizes (\$M)



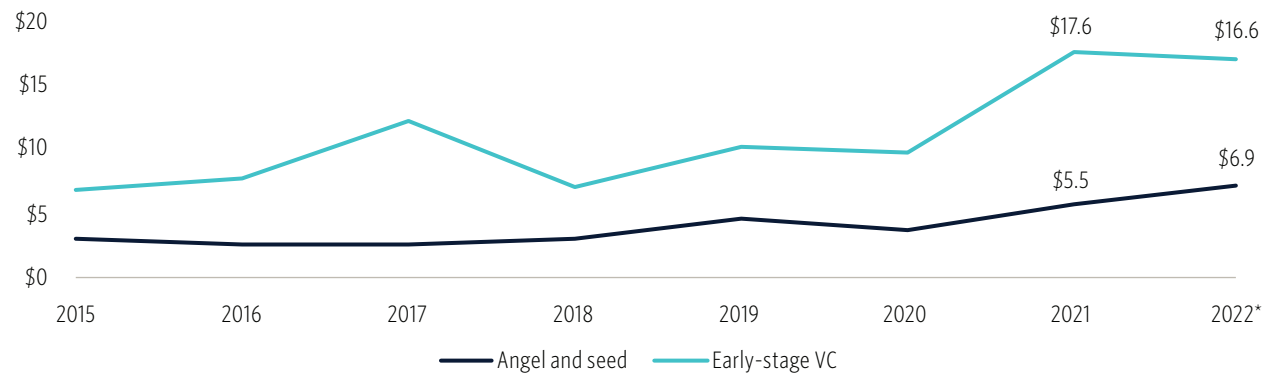
Source: PitchBook | Geography: Global | *As of December 31, 2022

Median late-stage VC and venture growth deal sizes (\$M)



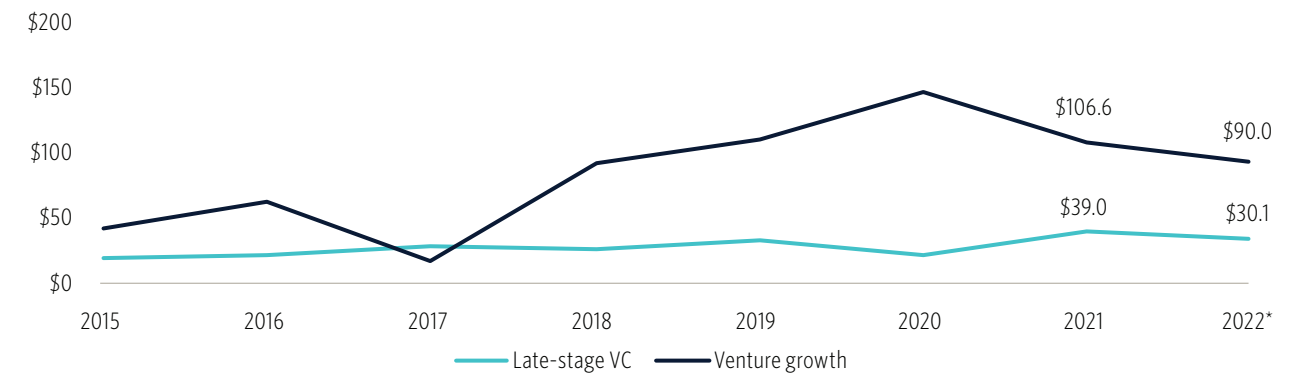
Source: PitchBook | Geography: Global | *As of December 31, 2022

Median agtech angel and seed and early-stage pre-money valuations (\$M)



Source: PitchBook | Geography: Global | *As of December 31, 2022

Median agtech late-stage VC and venture growth pre-money valuations (\$M)

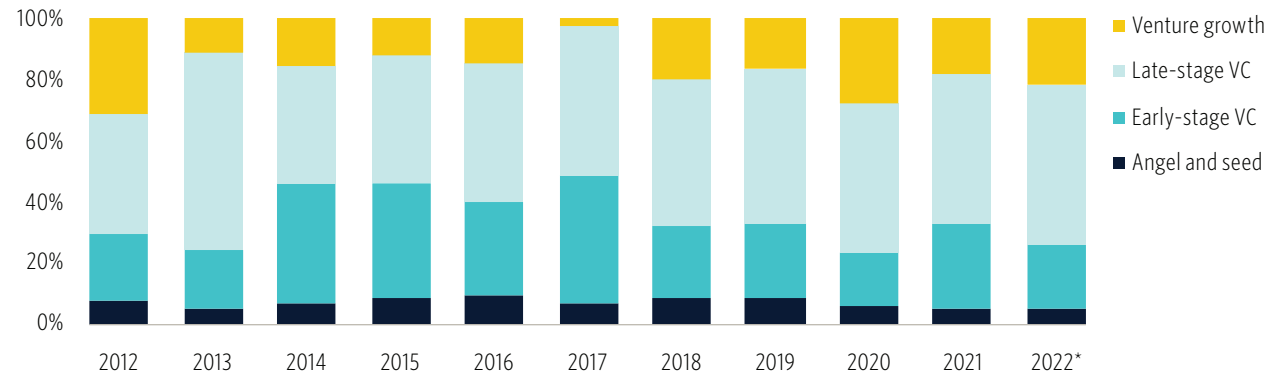


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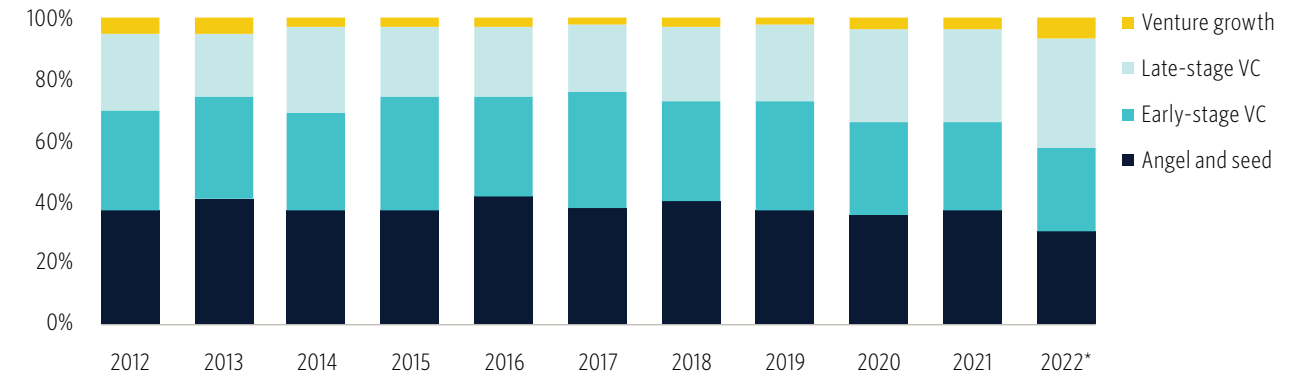
APPENDIX

Share of agtech VC deal value by stage



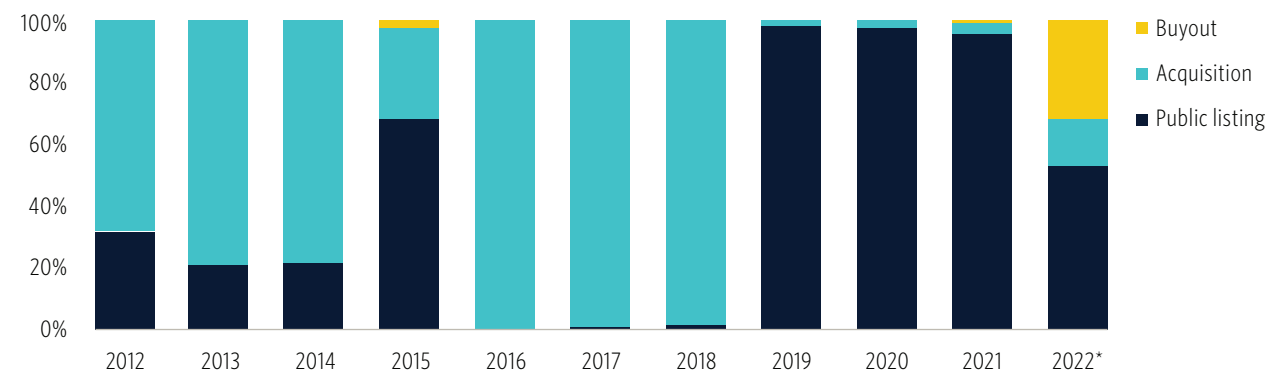
Source: PitchBook | Geography: Global | *As of December 31, 2022

Share of agtech VC deal count by stage



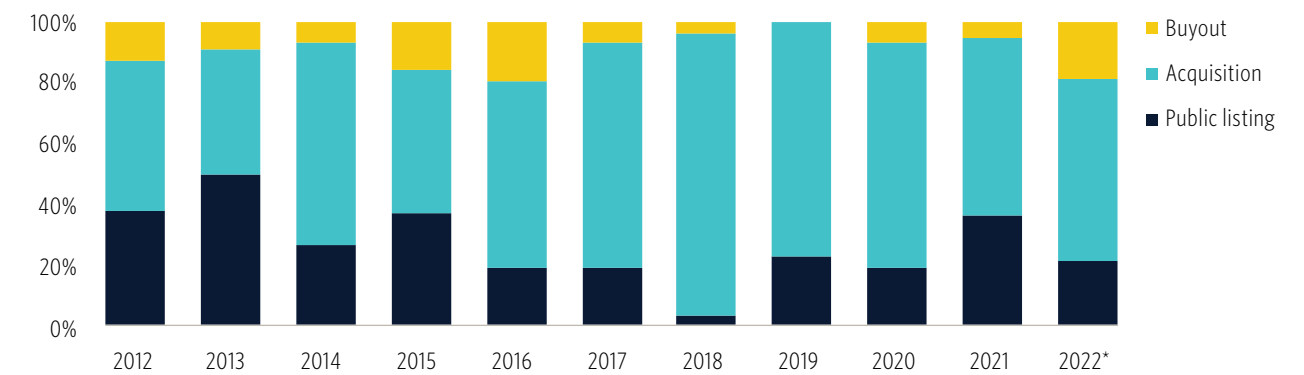
Source: PitchBook | Geography: Global | *As of December 31, 2022

Share of agtech VC exit value by type



Source: PitchBook | Geography: Global | *As of December 31, 2022

Share of agtech VC exit count by type



Source: PitchBook | Geography: Global | *As of December 31, 2022

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PitchBook Data, Inc.

John Gabbert Founder, CEO

Nizar Tarhuni Vice President, Institutional Research and Editorial

Paul Condra Head of Emerging Technology Research

Additional research

Eric Bellomo
eric.bellomo@pitchbook.com
Gaming
E-Commerce

Brendan Burke
brendan.burke@pitchbook.com
Internet of Things
Information Security
Artificial Intelligence & Machine Learning

Aaron DeGagne
aaron.degagne@pitchbook.com
Medtech
Digital Health

Alex Frederick
alex.frederick@pitchbook.com
Agtech
Foodtech

Jonathan Geurkink
jonathan.geurkink@pitchbook.com
Supply Chain Tech
Mobility Tech

Derek Hernandez
derek.hernandez@pitchbook.com
SaaS

Ali Javaheri
ali.javaheri@pitchbook.com
Emerging Spaces

Robert Le
robert.le@pitchbook.com
Web3/DeFi
Insurtech
Crypto

John MacDonagh
john.macdonagh@pitchbook.com
Carbon & Emissions Tech
Clean Energy Tech

Rebecca Springer
rebecca.springer@pitchbook.com
Healthcare Services
Healthcare IT

Rudy Yang
rudy.yang@pitchbook.com
Fintech

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