



# Innovation in Agricultural Technology: Strategic Considerations

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For:  
Contra Costa County Bar Association  
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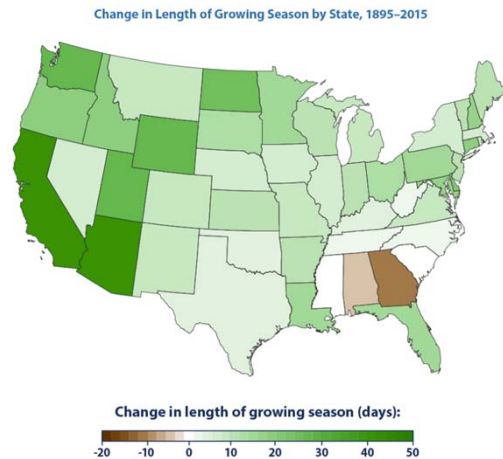
## Agriculture

- 10,000-year-old industry
- Feeding 10B people by 2050 (affects each of us ~3x a day)
- Climate change and its effect on growing
- Agriculture's role in climate change



## Changing Growing Season

- Shifting industry – changing arable land
- Traditional land in the Midwest experiencing changes in temperature that affect ability to grow wheat, corn, soy – moving north in Canada
- Rising temperatures in Southeast disrupt crop growing – reliance on indoor farming
- Warmer climates promote infiltration of pathogens once limited to South America



Data source: Kunkel, K.E. 2016 expanded analysis of data originally published in: Kunkel, K.E., D.R. Easterling, K. Hubbard, and K. Redmond. 2004. Temporal variations in frost-free season in the United States: 1895–2000. *Geophys. Res. Lett.* 31L03201.  
For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at [www.epa.gov/climate-indicators](http://www.epa.gov/climate-indicators).

## AgTech v. Human Health

AgTech evolving following footsteps of Pharma

### Similarities

- Consolidation
- Acquisition-based pipeline/External innovation
- Product development timeline/cost

### Differences

- Less investment funds
- Diverse/larger syndicates
- Higher investor education barrier
- Investment amounts (~10x less)
- ROI (5-10x less)

## AgTech: Select Sectors



Crop  
Protection



Plant fitness/  
improvement



Novel  
Farming  
Systems



Animal  
Health



Innovative  
Food



Agribusiness



Digital Ag

## Definitions

**GMO:** Genetically modified organism; introduction of new DNA into organism; results in an organism with a new characteristic (in plants, called a "trait")

**Gene Editing:** Altering the normal DNA of an organism using biotechnology to result in a new characteristic/trait

**Breeding:** Cultivating plants or breeding animals to develop a desired characteristic/trait

**Biologics:** active compositions typically made using biotechnology methods – proteins, natural or engineered microorganisms, fermented products (e.g., metabolites); contrast to chemically synthesized small molecules.

**Nucleic Acids:** RNAs and DNAs; genetic material that encodes proteins or has other functions (e.g., cDNA, mRNA, RNAi, dsRNA)

**Vertical Farming:** growing plants in a controlled-environment in vertically stacked layers; a sector of indoor farming

**Aquaculture:** rearing of aquatic animals or cultivation of aquatic plants for food



## Crop Protection

Pesticides: Herbicides, Insecticides, Fungicides

### Issue

- Loss of 50% in wheat and 80% in cotton without pesticide use<sup>1</sup>
- Lack of innovation – majority of treatments were developed near WWII

### Approaches

- Small molecules, nucleic acids, biologics, traits



<sup>1</sup>Popp, J. *et al.*, Pesticide productivity and food security. A review. *Agronomy for Sustainable Development* 33::243–255 (2013)



## Plant Fitness/Improvement

Drought/saline resistance, yield maximization, nitrogen/phosphorous efficiency

### Issues

- Adaptations to environmental pressures/climate change
- Regulatory pathway faster (or not needed)

### Approaches

- Microbial discovery/editing, small molecules, biologics, gene editing, breeding, epigenetics





## Novel Farming Systems

Vertical/Indoor Farming, Aquaculture

### Issues

- Seeds – adapted for outdoor cultivation
- Infrastructure – lighting, harvesting, software
- Contamination – ability de-contaminate
- Optimizing Conditions – growth, yield, media, nutrients

### Approaches

- New materials for growth, software, breeding, AI (machine learning), hydration systems, automation

### Vertical farming worldwide

Total market value in billions of US dollars



Source: BBC research



Photo Source: <https://www.inc.com/jenna-broughton/bowery-snags-20m-to-fund-the-future-of-farming.html>

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## Animal Health

Livestock, companion, equine

### Issues

- Regulatory considerations
- Interplay with human health market
- Antibiotic resistance/use restrictions

### Approaches

- Small molecules, biologics, gene editing
- Vaccine development/deployment
- Health sensors – biometrics, mobility



Photo source: <https://www.planning.org/knowledgebase/urbanlivestock/>

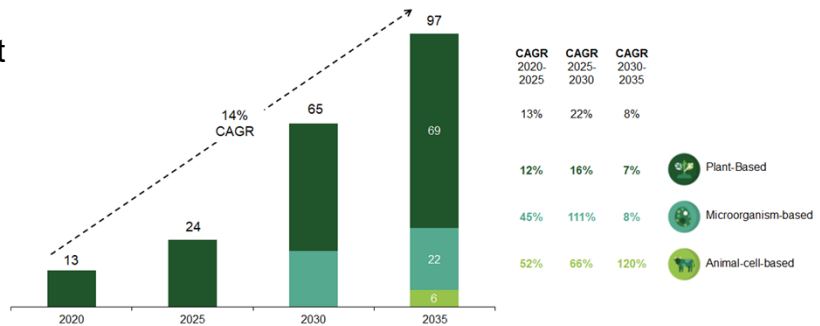
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## Innovative Food

Cultured meat, Novel ingredients, Plant/Insect-based protein

- Multisegmented market
- Consumer driven
- Perception v. Reality
  - Sustainability
  - Cost parity
  - Health



Consumption of alternative proteins by source (million metric tons, base-case scenario)



## Innovative Food

Cultured meat, Novel ingredients, Plant/Insect-based protein

### Issues

- Complex regulatory approvals/labelling
- Consumer Preferences: heme-producing plants, texture, taste, physical properties

### Approaches

- Specialized manufacturing, gene editing, breeding systems





## Agribusiness

Seed selection, production, food safety, traceability, farm management, processing technology, leasing, insurance

### Issues

- Servitization
- Adoption, data privacy
- Carbon credit management

### Approaches

- Software/hardware, automation



## Digital Agriculture

Drones, sensors, grow equipment, harvesting equipment

### Issues

- Integration
- Meaningful/useful display of data
- Automation
- Data privacy

### Approaches

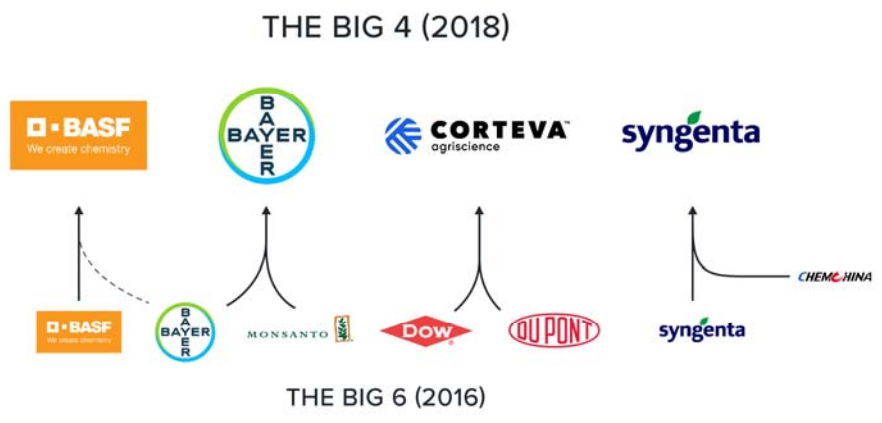
- Software/hardware, robots
- Geo-referenced maps based on public records (weather, soil, topography), satellite images
- Crowd sourcing farmers



# Three Forces are Disrupting the Agriculture Business Model

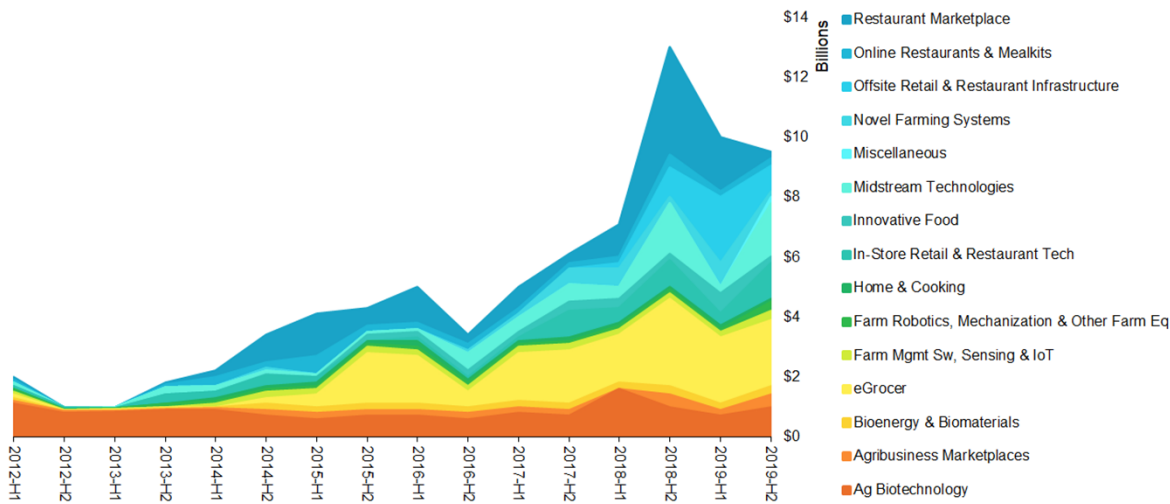
 <p><b>The new agriculture paradigm</b></p> <ul style="list-style-type: none"> <li>• Increased yield</li> <li>• Pressure to improve resource efficiency and sustainability</li> <li>• Changing consumer needs and expectations</li> </ul> <p>Source: BCG analysis.</p>	 <p><b>The ongoing digitization of agriculture</b></p> <ul style="list-style-type: none"> <li>• Increasing customer proximity</li> <li>• Greater transparency into input value</li> <li>• An enhanced customer experience</li> </ul>	 <p><b>Industry consolidation and value chain shifts</b></p> <ul style="list-style-type: none"> <li>• Increasing price pressure and competitiveness</li> <li>• A stronger set of integrated competitors</li> <li>• A blurring of boundaries between agricultural-supply sectors</li> </ul>
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# Consolidation of Ag





## Deal Making in AgTech



<https://news.crunchbase.com/news/19-4b-invested-in-agri-foodtech-in-2019-according-to-agfunder/>

## Value of Intangible Assets – Intellectual Property

**Intangible Assets have risen from 17% to 90% of value in the S&P 500 from 1975-2020**

### Tangible Assets

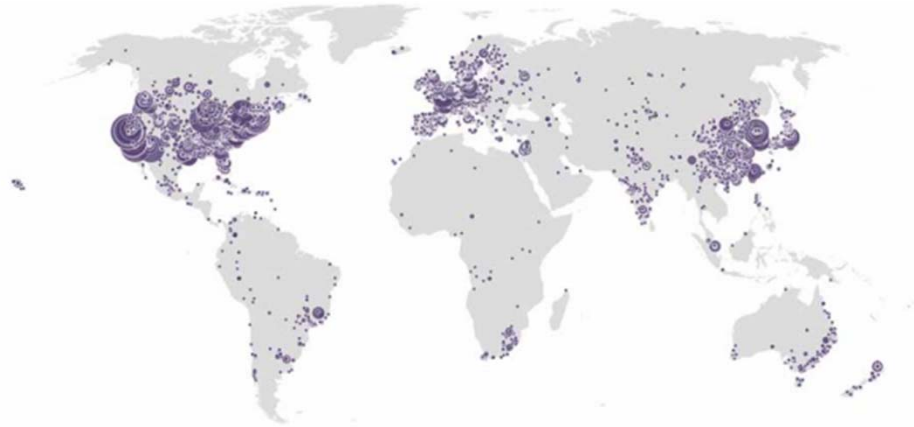
- Buildings & equipment
- Cash and bonds
- Inventory

### Intangible Assets

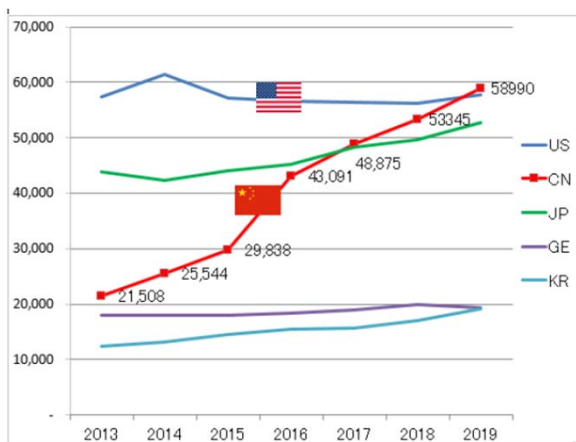
- Patents
- Trademarks
- Copyrights
- Trade Secrets
- Licenses
- Consumer data



The distribution of agriculture biotech patent filings has been relatively wide since the 2000s



## WIPO: China becomes top filer of PCT applications



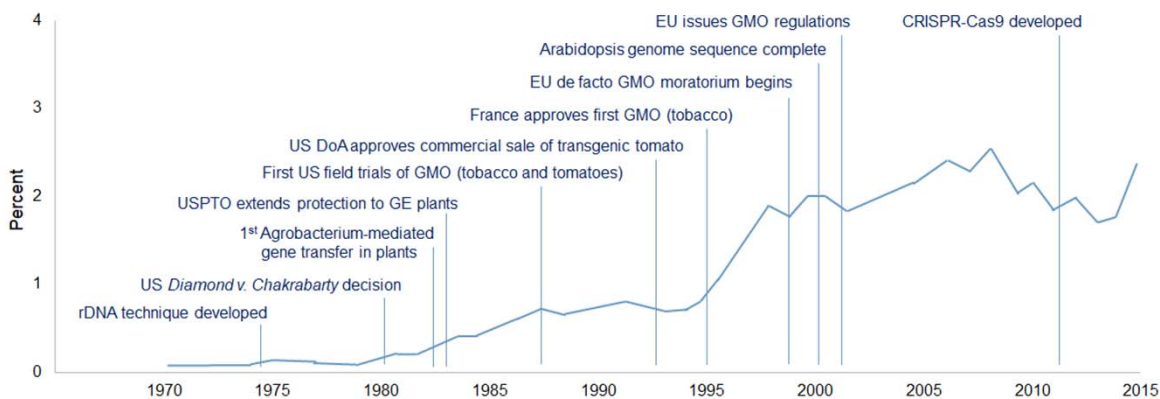
GraphCite: <https://www.lexology.com/library/detail.aspx?g=eed36553-8ef0-4009-ae04-4d9cd9305e0c>

- 1.4B people: Agriculture is a national security interest
- China overall: has been the top patent filer for the last 2 years
- China's National Intellectual Property Agency has been issuing dispositions in favor of international IP rights (e.g., Bayer)<sup>1</sup>
- Trend in filing patent applications only in China (97% in last 5 year)<sup>2</sup>
- Incentives for filing
- 612K patents applied for between 2015-2019<sup>2</sup>

<sup>1</sup>: <https://www.natlawreview.com/article/china-s-national-intellectual-property-administration-releases-top-ten-cases>  
<sup>2</sup>: <https://www.chinadaily.com.cn/a/202011/21/WS5fb84c57a31024ad0ba95877.html#:~:text=Chinese%20nstitutes%20and%20enterprises%20applied,by%20the%20Chinese%20Academy%20of>

## Crop biotechnology growth

Share of Plant Biotechnology filing over total patent by origin (%)



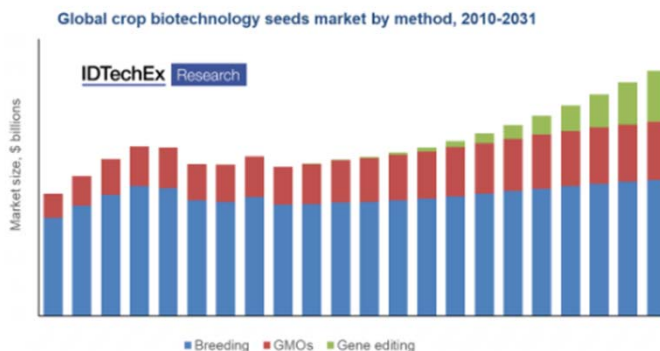
[https://www.wipo.int/edocs/pubdocs/en/wipo\\_pub\\_944\\_2019-chapter4.pdf](https://www.wipo.int/edocs/pubdocs/en/wipo_pub_944_2019-chapter4.pdf) (modified 21 From Fig. 4.6)



## Strategic Considerations - Breeding/Editing

Crop Protection, Novel Farming Systems, Plant Fitness/Improvement

- GMO: \$135M & ~10-20 years
- Gene Edited: \$20M & ~2 years (may not be regulated)
- Breeding: \$5-100M & 2-20 years
- 2020 SECURE Rule: regulation of edited crops – not regulated if *could* be found in nature OR have only one edit
- Directed epigenetic modification *not* regulated
- CRISPR: ownership rights in question, multiple licenses may be required
- EU: current ban on GMO & edited plants



<https://www.idtechex.com/en/research-report/genetic-engineering-in-agriculture-2021-2031/750>

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## Strategic Considerations - Breeding/Editing

Crop Protection, Novel Farming Systems, Plant Fitness/Improvement

In addition to utility patents gene edited/GMO plants, other plants protections are:

### PVP: Plant Variety Protection – 25-year protection

- New, distinct, uniform, stable, sexually reproduced or tuber propagated plant varieties
- Exemptions: farmers may bulk seed for own use, if deemed necessary by USDA, for research purposes

### Breeder's Rights – 20/25 year protection\*

- Under TRIPS (members of WTO) new, distinct, uniform, stable variety of any plant species
- Owner has rights to production or reproduction, conditioning, exporting, importing, stocking
- \*woody plants: 25 years

### Plant Patents – 20-year protection

- Asexually reproduced (other than tuber or non-cultivated), algae and macro-fungi (not bacteria) included
- Deposits required, not available in many jurisdictions



## Strategic Considerations - Crop Protection

**Pesticide:** “Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.”

	Synthetic Chem	Biologics	Nucleic Acids
Cost/Time	\$130M & 10 years	\$20M & 5 years	\$20M & 5 years
IP	Thickets where no COM	101	101
Lifecycle management	✓	✓	✓
Regulatory EPA	✓	✓	✓
Int'l crop market selection	✓	✓	✓
Manufacturing	Int'l	Domestic	Domestic
EU ban considerations	✓	-	-
Patentability issues	-	✓	✓



## Strategic Considerations - Animal Health

- Costs for a new active ingredient<sup>1</sup>:
  - Companion Animals: \$22.5M and 6 years
  - Livestock: \$30.5M and 8 years
- Regulatory:
  - Different agencies for different products:
    - Pharmaceuticals: FDA Center for Veterinary Medicine (CVM)
    - Biologics (e.g., vaccines): USDA
    - Pesticides (e.g., flea, tick): EPA
    - Gene modified animals: FDA and USDA
  - Generic Animal Drug and Patent Term Restoration Act: all approved animal drug products are listed in the Green Book; 5 years exclusivity of an approved human therapeutic for animal use
- Licensing from human health, IP freedom to operate, royalties, and clearance
- IP Lifecycle management – follow-on filings for delivery, formulations, dosing



## Strategic Considerations – Innovative Food

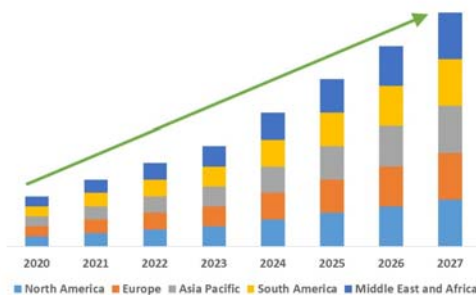
- Patent claim strategy: Consumer-experience focused
  - Food science approach
  - Functional claiming – may not be as strong
- Cell-based meats: regulated by FDA and USDA Food Safety & Inspection Service (FSIS)
  - FDA oversees cell collection, coordinated oversight with FSIS for livestock and poultry, food products with cultured fish and seafood
  - FSIS & FDA: share oversight at harvest, principles for labeling, food safety
  - FSIS: inspect manufacturing establishments and require all meet requirements, preapproval and verification of labels, enforcement actions, coordinate with FDA
- Plant-based: regulated by FDA
- Labeling - FDCA (Federal Food, Drug, and Cosmetic Act): only animal derived foods can use words like “meat”, “sausage” and “burger”



## Strategic Considerations – Agribusiness/Digital Ag

- Growing market, relatively slow adoption
  - Farmer reluctance
- Evolution in software patent eligibility: questionable older IP but AI/machine learning inventions protectable
- Protection of code (*Google LLC v. Oracle America Inc.*, S. Ct. Apr. 5, 2021)<sup>1</sup>
  - Using "small lines of code" is not infringement
- Blended approach to IP coverage
  - copyright, patent, trade secret, and trademark (brand)

Global Smart Farming Market is Expected to Account for USD 25.02 Million by 2028



Graph: <https://www.databridgemarketresearch.com/reports/global-smart-farming-market>  
1: [https://www.supremecourt.gov/opinions/20pdf/18-956\\_d18f.pdf](https://www.supremecourt.gov/opinions/20pdf/18-956_d18f.pdf) 27

## Summary

- AgTech is a growing and diverse field
- Different sectors within AgTech have different issues
- As in any other market, robust IP portfolios are critical in AgTech
- Regulatory strategy can also be a critical factor in product development



*Questions?*



<https://zinfandel.org/legendary-zinfandel-vineyards-of-the-contracosta-county-ava/>

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