

MAPPING CORPORATE POWER IN BIG FOOD



FOOD BARONS 2022

Crisis Profiteering, Digitalization and Shifting Power



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ETC Group is a small, international, research and action collective committed to social and environmental justice, human rights and the defence of just and ecological agri-food systems and the web of life. We focus on understanding and challenging corporate-controlled techno-industrial systems and exposing the dangers of the technological manipulation of life, especially in relation to climate justice and food security. We uphold peasant and indigenous ways of life and knowledge systems; food sovereignty; people's control of technology; and just economies and governance.

Food Barons 2022:

Crisis Profiteering, Digitalization and Shifting Power

FULL REPORT

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EXECUTIVE SUMMARY

ETC Group's 2022 update of corporate concentration offers a snapshot of the world's Food Barons – the biggest players up and down the industrial food and agriculture chain. We examine the leading corporations that control each of 11 key industrial “agrifood” sectors: seeds, agrochemicals, livestock genetics, synthetic fertilizers, farm machinery, animal pharmaceuticals, commodity traders, food processors, Big Meat, grocery retail and food delivery. Rankings are based on 2020 sales figures.

Our findings show that many agrifood sectors are now so “top heavy” they are controlled by just four to six dominant firms, enabling these companies to wield enormous influence over markets, agricultural research and policy-development, which undermines food sovereignty.

The year 2020 was a horrific year for food security and health—but a bonanza for Big Food and Big Ag. In the midst of a global pandemic—combined with climate shocks, supply chain gridlock, price spikes, increasing hunger, food and energy shortages, civil strife, racial violence and wars—these Food Barons made the most of the converging crises in order to tighten their grip on every link in the Industrial Food Chain. In doing so, they undermine the rights of peasants, smallholders, fishers and pastoralists to produce food for their own communities and many others. The Food Barons exploit workers, poison soil and water, diminish biodiversity, prevent climate justice and perpetuate a food system structured upon racial and economic injustice.

We identify seven key aspects of the global Industrial Food Chain, which we have conceptualized in terms of power: The Food Barons aim to hold on to, naturalize and expand their power, despite their many failings—failings that became especially obvious during the global pandemic.

We also bring attention to three critical, multi-sectoral trends that increase the ability of the Food Barons—Big Ag, together with Big Tech and Big Finance—to maintain control over the Industrial Food Chain. The first of these is the digitalization of food and agriculture across the chain. The second is the rising power of Asian (especially Chinese) Food Barons. The third is horizontal integration, including the increasing involvement of asset management companies in food and agriculture sectors— which creates the semblance of competition, but diminishes actual competition.

In contrast to the increasing concentration and power of the Food Barons it is important to remind ourselves who feeds the majority of the world: peasants. The Peasant Food Web feeds the equivalent of 70% of the world's people¹ using less than 30% of the world's land, water and agricultural resources. Proposals from the grassroots—such as the International Planning Committee for Food Sovereignty's Nyéléni Process²—aim to put farmers, growers, fishers, hunters and consumers back at the heart of the food system and undo the power being usurped by industrial agriculture.

As we confront climate change and its alarming consequences, we must recognize the voices, actions, solutions, and leadership of all peoples. The analysis in this report is based on understanding the relationship between racial justice and climate change and how extractive agriculture disproportionately impacts people of colour and Indigenous communities.³

It's time to divest from the Industrial Food Chain. Institutions under pressure from civil society have already succeeded in partly directing funds away from tobacco, arms and fossil fuels on moral grounds. Grassroots climate movements have successfully named fossil fuel companies as the obstruction to meaningful climate action. Food movements should follow suit: it is a logical next step to demand the elimination of all financial support to the Industrial Food Chain, exposing its high degree of transnational corporate control and its multiple abuses.

The participatory assessment of technologies based on precaution, as well as the development and support for the implementation of socially and ecologically useful technologies, should also be a top priority. In addition, anti-competition regulators must develop new mechanisms to understand and restrict the cross-chain powers of data giants and horizontal shareholders and require much greater transparency among private equity and other corporate actors.

This is a moment to see the Food Barons for what they are, to find their structural weaknesses and to take strategic collaborative action to take them on. This report provides some useful intelligence for food sovereignty movements and their allies in the battles ahead.

*Full research reports for each sector can be found here:
<https://www.etcgroup.org/content/food-barons-2022>*

INTRODUCTION

Power Failure: Covid-19 exposes Industrial Food Chain’s inbuilt structural weaknesses

In 2020, as the Covid-19 pandemic unfolded, lockdowns, concentrated markets, logistics disruptions and the spreading health crisis combined to ramp up hunger and food insecurity, with nearly 12% of the global population – 928 million people – severely food insecure.⁴ Climate change grew more apocalyptic – wildfires in Australia; severe drought in the southern cone of Latin America; crippling floods and locust plagues in sub-Saharan Africa – and exacerbated acute hunger and misery.

Extreme volatility and staggering economic inequality have now become defining features of global food and agriculture markets, with asymmetrical impacts: even as global food insecurity, food prices and hunger soared, Big Food and Big Ag posted record breaking profits. At the same time, the Covid-19 pandemic brutally unmasked the extreme vulnerability of a highly centralized, industrialized food system that exploits workers and relies on “just-in-time” global supply chains that are non-transparent and susceptible to disruption and corruption. Corporate concentration is a fundamental driver of these and other failures – across every link of the Industrial Food Chain.

Power Surge: shoring up power and crisis profiteering

When a handful of giant companies are allowed to dominate in uncompetitive markets, with little regulatory oversight, they can and do use their market power to squeeze out competitors, raise prices, hijack the R&D agenda, monopolize technologies (even flawed and ineffective ones) and maximize profits.

Today, amid ever-increasing corporate concentration and anemic antitrust regulation, some of the world’s largest companies are using pandemic-induced supply chain gridlock and inflation as an excuse to jack up prices: a practice known as “crisis profiteering.”

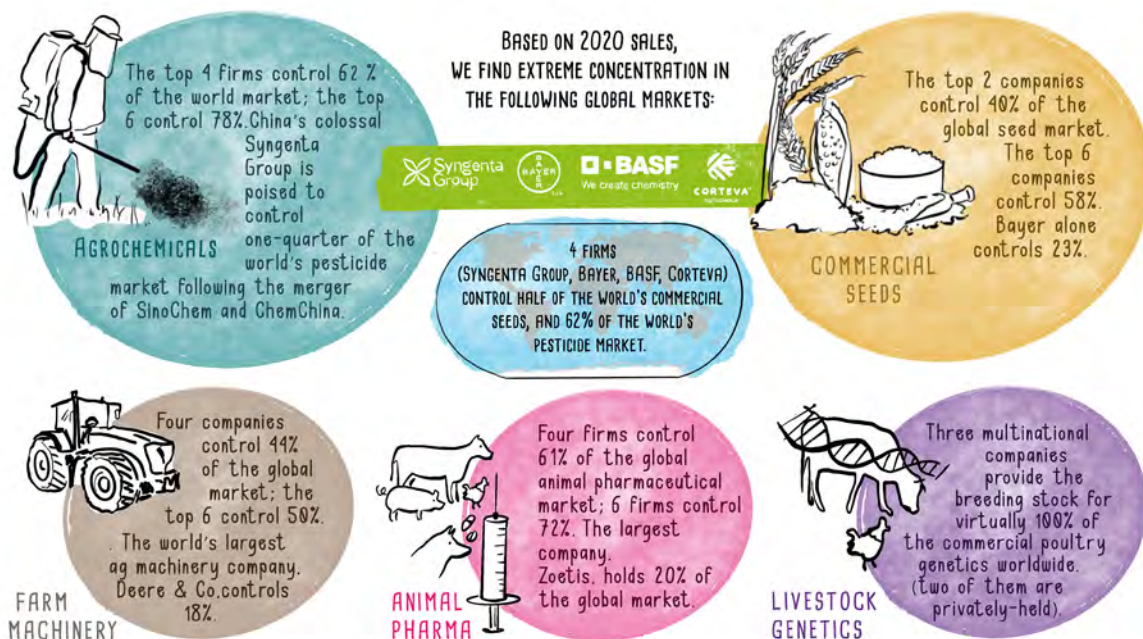
Merriam-Webster defines profiteering as “the act or activity of making an unreasonable profit on the sale of essential goods especially during times of emergency.”⁵

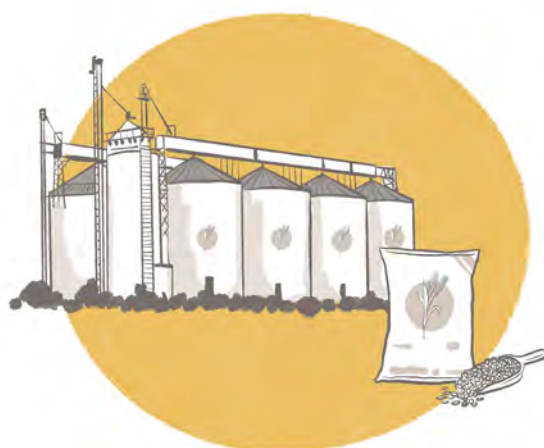
In 2020, most of the world’s largest food and agriculture giants saw sales and profits surge while almost a billion people went hungry and crops failed.⁶ In 2021, CNN reported that inflation was like a “gift” to the grocery sector, which “mark[s] up the full rate of inflation plus a little bit more.”⁷ But it’s not just the grocery sector: a wide range of sectors are taking advantage of the situation, benefiting from inflation, and sometimes even restricting supply to keep prices high, whilst blaming external circumstances such as the pandemic.⁸ A recent analysis of 100 U.S. corporations found a median increase in profits over the past two years of 49%.⁹ When it comes to food-price hikes in a crisis, it is difficult to discern what’s genuinely crisis-related and what’s rank profiteering. In other words, the problem isn’t just supply chain chaos or inflation; it’s corporate greed.¹⁰

“Even as demand and profits rose post-vaccine, [executives] passed on most or all inflationary costs to customers via price increases, and some took the opportunity to add more on top.”¹¹

From Top 10s to Top 4s

Our research reveals that, after decades of consolidation, many Industrial Food Chain sectors are so “top heavy” they are controlled by just four to six dominant firms. Economists typically consider a four-firm concentration ratio of 40% or higher reflective of a sector that operates as an oligopoly. Many of the sectors we monitor are already above that 40% threshold; others are on the verge of passing it.





25 YEARS AGO WE REPORTED THAT THE TOP 10 SEED COMPANIES CONTROLLED 40% OF THE GLOBAL COMMERCIAL SEED MARKET.



TODAY JUST TWO COMPANIES CONTROL 40% OF THE MARKET.



CHANGING CONCENTRATION IN THE SEED SECTOR

“When you go from 15 to 10 companies, not much changes... When you go from 10 to six, a lot changes. But when you go from six to four – it’s a fix.”¹²

“Those who have market power can raise prices above what’s considered fair market value... We’re at a point in our market concentrations that we haven’t seen ever before.”¹³

Power Play: Spinning false narratives

To sustain their market dominance, the Industrial Food Chain’s big players actively work to deflect attention from their power grabs by promoting a distorted picture of global food and agricultural systems. This was evident at the UN’s controversial 2021 Food Systems Summit, where Big Food executives and their trade groups wrung their hands over a food system ‘broken’ by climate change and pandemic; then they assured us they were the only ones who could fix it, with a ready-made agenda for “food system transformation”.¹⁴

Big Food consistently seeks to undermine the fact that the world’s three billion indigenous and peasant producers – rural and urban, fishers and pastoralists – not only feed a majority of the world’s people and most of the

world's malnourished, but that they also create and conserve most of the world's biodiversity making indigenous and peasant producers humanity's best defence against climate change.¹⁵

Power Up: Techno-fixes to lock-in corporate control

The Food Barons are introducing a suite of new technologies and “techno-fixes” that are conceived and designed to entrench corporate control over food and agriculture even further. They have already wrested control of the agricultural research and development (R&D) agenda to suit their own interests, whilst continuing to concentrate power and influence trade, aid and agricultural policies to fuel their growth and profit.¹⁶

“Techno-fix” refers to the development of a technology product or intervention to address a social or environmental problem – often a problem created by an earlier technological failure.

Up and down the industrial food chain, the digitalization of food and agriculture emerges as the new techno-fix of the day. Our ongoing research reveals that every sector of the Industrial Food Chain is in the process of transforming into a digital enterprise. At the same time, Big Tech is becoming tightly entangled with industrial food production. Data extracted via digital technologies is now itself a commodity: The Industrial Food Chain relies on Big Data to grow, process, trade, track, sell and transport its products.

Digitalizing food and agriculture from farm to front door

The vista of new digital initiatives in food and ag is dizzying. On the farm, it includes concerted attempts to impose digital agriculture, weaving in drone sprayers, Artificial Intelligence-driven robotic planters and automated animal-feeding operations tricked out with facial recognition for livestock. Big Ag giants such as Bayer, Deere & Company, Corteva, Syngenta and Nutrien are restructuring their entire businesses around Big Data platforms. Bayer's ‘Field View’ digital platform, for example, extracts 87.5 billion datapoints from 180 million acres (78.2 million hectares) of farmland in 23 countries and funnels it into the cloud servers of Microsoft and Amazon.¹⁷ Deere, the world's largest farm machinery company, now employs more software engineers than mechanical engineers.¹⁸ On the route to retail, the global grain trading system is getting a digital overhaul as it becomes increasingly automated and products are tracked via blockchain. At the same time online grocery platforms and food delivery apps (such as DoorDash, Zomato and Deliveroo) surged during pandemic lockdowns and are growing into a whole new ‘last mile’/ last link of the Industrial Food Chain.

Power Shifts: Big Food and Big Ag in China, Brazil, India and East Asia

In decades past, industrial agriculture was overwhelmingly dominated by corporations based in North America and Europe, and focused primarily on meeting market demand in those regions. Today, corporate players in the global South, especially China, Brazil and India are reordering the Industrial Food Chain, while adopting the same extractive model as their Northern counterparts.¹⁹ The pace and scale of China's hyper-industrializing agrifood system is without precedent. Chinese Food Barons are catering to colossal domestic as well as global markets: China's state-owned Syngenta Group is now the world's largest agrochemical input firm (seeds, pesticides, fertilizers); and China's newly consolidated COFCO is second only to Cargill as the world's largest agriculture commodity trader.

Power Trip: Asset managers and venture capitalists driving “financialization”

Recent decades have seen a massive increase in land grabbing and venture capital speculation in food and agriculture assets worldwide, with the latter trend exemplifying the “financialization” of the Industrial Food Chain. In this way the driving purpose of food systems moves ever further away from feeding people to feeding profits. More recently private equity and asset management firms are flocking to global food and agribusiness.²⁰ At the close of 2020, the private equity industry managed more than US\$7.5 trillion in capital,²¹ with increasing influence over the levers of corporate power in food and agriculture. For example, just three of the world's largest asset management firms collectively control more than one quarter of all institutional shares of some leading agribusiness corporations.

Selected holdings of “Big Three” asset management firms – State Street, Vanguard, Blackrock – in publicly-traded companies in the AgriFood Chain

Food & Ag Company / Sector	% of Shares held by State Street Corp	% of Shares held by The Vanguard Group	% of Shares held by Blackrock, Inc.	% of Shares held collectively by the Big Three	% of Shares held by Institutions	Rank of Big Three out of all institutional shareholders
Food & Bev Processors						
Pepsico	4.23	7.41	8.87	20.51	73.93	Top 3
Tyson	4.99	12.75	7.39	25.13	87.40	Top 3
ADM	5.62	10.87	7.43	23.92	83.63	Among Top 5
Farm Machinery						
Deere & Co.	3.70	7.09	5.97	16.76	80.00	Among Top 5
Agrochemical / Seed						
Corteva	5.10	11.16	8.46	24.72	83.02	Top 3
Fertilizer						
Mosaic	4.82	11.49	8.15	24.46	91.46	Among Top 4
Grocery Retail						
Walmart	2.21	4.58	3.37	10.16	33.14	Top 3
Kroger	5.28	11.33	10.19	26.80	82.85	Among Top 4

Source: Yahoo Finance, <https://finance.yahoo.com/>
Date holdings reported: 30 March 2022

ETC Group first reported on the largely invisible practice of horizontal shareholding by giant institutional investors in 2019. “Horizontal shareholding” is the practice of owning assets in multiple corporations that are supposed to be competing with each other, but are unlikely to compete if they have common owners. A small number of giant investor firms, often asset managers, hold significant “horizontal shareholdings” – in and across many sectors of the Industrial Food Chain, creating interlocking oligopolies.

There is mounting evidence that horizontal shareholding in concentrated markets is promoting anti-competitive practices that fly below the radar of antitrust regulators.²² In the global grocery sector, for instance, market concentration is relatively low, and competition may appear healthy, but competition is illusory because the influence of horizontal shareholders is largely invisible.

The bottom line is that policymakers and antitrust regulators haven’t developed the tools or the teeth to clamp down on 21st century oligopoly power – including the opaque power of financial actors such as private equity and asset management firms.

Hidden Power: Closing down information flows

Many of the Food Barons are relative unknowns, and that's because they are privately-held or state-owned companies. For example, the colossal firms that control agricultural commodity trading are among the most powerful and least-transparent companies. Three of the world's top-ranking ag commodity traders are privately held, and one is state-owned, and thus not obliged to publicly disclose information about their finances. The lack of transparency means that, in the absence of regulatory oversight, we can't fully track assets or determine corporate market share.

As corporate concentration increases, companies are becoming more guarded with their information. In a world where "market intelligence" is proprietary – accessible only to those who can pay for it – it is becoming much more difficult for civil society, social movements and even some governments to know the level of food-system control exercised by a handful of multinational enterprises. Access to such information is critical for democracy.

Even firms that are in the business of selling "corporate intelligence" are themselves consolidating and building steeper paywalls.²³

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Agrochemicals & commercial seeds



Agrochemicals/Pesticides: Companies in the agrochemical sector manufacture and sell pesticides used in agriculture. ETC Group uses the word “pesticide” as a synonym for “agrochemical.” The words “herbicide,” “insecticide” and “fungicide” refer to different types of agrochemical products (weed killers, insect killers and chemicals used to destroy fungus, respectively). In the wake of recent mega-mergers, at least five of the leading pesticide companies also dominate the world market for commercial seeds and traits. With the commercialization of molecular biotechnologies in the mid-1990s (e.g., herbicide-tolerant genetically modified plants), the pesticide and seed sectors became inextricably linked. Today they are being further linked by Big Data strategies.

Leading Companies by Agrochemical Sales, 2020

Ranking	Company /Headquarters	Agrochem Sales \$US millions	% Global Market Share
1.	ChemChina + SinoChem ¹ (China) <i>pro forma</i> (Syngenta Group)	15,336 11,208 (Syngenta Group) + 4,128 (ADAMA)	24.6
2.	Bayer ² (Germany)	9,976	16.0
3.	BASF ³ (Germany)	7,030	11.3
4.	Corteva ⁴ (USA)	6,461	10.4
TOTAL TOP 4		38,803	62.3
5.	UPL ⁵ (India)	4,900	7.9
6.	FMC ⁶ (USA)	4,642	7.4
TOTAL TOP 6		48,345	77.6
7.	Sumitomo Chemicals ⁷ (Japan)	4,010	6.4
8.	Nufarm ⁸ (Australia)	3,491	5.6
9.	Jiangsu Yangnon Chemical Co., Ltd. ⁹ (China)	1,413	2.3
10.	Shandong Weifang Rainbow Chemicals Co., Ltd. ¹⁰ (China)	1,048	1.7
TOTAL WORLD MARKET		62,400	100%

Source: ETC Group

The global market for agrochemical products was US\$62,400 million in 2020.¹¹

- ChemChina accounts for one-quarter of the global pesticide market – a share that is likely to expand rapidly following the 2021 merger of ChemChina + SinoChem (see below).
- Top 2 global pesticide market = 41%
- Top 4 global pesticide market = 62%
- Top 6 global pesticide market = 78%

Commercial Seeds & Traits: The seed sector refers to crop seeds (primarily proprietary field crop and vegetable seeds) sold via the commercial market and genetically modified crop traits. However, ETC Group's definition excludes farmer-saved seed and seed supplied by governments/public institutions. Despite the astonishing level of corporate concentration in the global commercial seed sector, the vast majority of the world's farmers are self-provisioning in seeds, and farmer-controlled seed networks still account for an estimated 80-90% of seeds and planting material globally.¹² Over the past 40 years, the world's largest agrochemical firms have used intellectual property laws, mergers and acquisitions (M&As) and new technologies to take control of the commercial seed sector. Today, pesticides and commercial seeds are no longer distinct links of the industrial food chain. However, ETC Group continues to provide corporate rankings and market share for seeds and agrochemicals as *separate* sectors. The 'pure-play' seed company (that is, a company that focuses primarily on seeds) is a rarity among the leading companies. Vilmorin (#5) and KWS (#6) are exceptions.

Leading Companies by Seeds & Trait Sales, 2020

Ranking	Company /Headquarters	Seeds & Trait Sales \$US millions	% Global Market Share
1.	Bayer ¹³ (Germany)	10,286	23
2.	Corteva Agriscience ¹⁴ (USA)	7,756	17
3.	ChemChina/ Syngenta ¹⁵ (China)	3,193	7
4.	BASF ¹⁶ (Germany)	1,705	4
5.	Groupe Limagrain/ Vilmorin & Cie ¹⁷ (France)	1,684	4
6.	KWS ¹⁸ (Germany)	1,494	3
TOTAL TOP 6		26,118	58
7.	DLF Seeds ¹⁹ (Denmark)	1,153	3
8.	Sakata Seeds ²⁰ (Japan)	648	1.0
9.	Kaneko Seeds ²¹ (Japan)	570	1.0
Total World Market		45,000	100

Source: ETC Group

According to Jonathan Shoham, Senior Analyst, IHS Markit, the global market for seeds and traits reached \$45,000 million in 2020.²²

- The top 2 companies control 40% of the global seed market.
- The top 6 companies control 58% of the global seed market.

Trends: chew on this

The global pesticide economy is undergoing tectonic shifts. The world's largest agrochemical/seed firms are racing to fortify their oligopoly power with ongoing consolidation, and feverish investments in high tech and digital platform technologies that are designed to extend their market share. Here ETC examines four, inter-related trends:

- **SuperSized Consolidation: ChemChina + SinoChem = Industrial Ag's Newest Input Empire**
- **Post-Patent & Generics Drive Pesticide Proliferation**
- **Big Ag's Digital Turf Grab**
- **New Techno-Fixes: 1) Gene Editing; 2) RNA Pesticide Sprays**

Supersized Consolidation: Chemchina + Sinochem = Industrial Ag's Newest Input Empire

The long-expected merger of **SinoChem** and **ChemChina** (both state-owned) was finalized in early 2021. The colossal Chinese merger creates not only the world's largest chemical conglomerate, but also the leading industrial farm input business (seeds, pesticides and fertilizer assets) — all under the umbrella of the newly formed Syngenta Group. As a result of the merger, annual sales of the new Syngenta Group (which consolidates all of ChemChina and SinoChem's ag input assets), will approach an estimated US\$27 billion.²³ The mega-merger is likely to spur even greater industry consolidation both within China and beyond.

In response to a surging demand for food (especially animal protein), a rapidly expanding middle class, and a diminishing pool of farm labour (80% of China's population will live in cities by 2050²⁴), China is revving up domestic food production with a full-throttle embrace of high-tech, industrial agriculture and chemical-intensive inputs.²⁵ With the acquisition of Swiss-based Syngenta in 2017, the Chinese state aims to ensure that a greater proportion of its industrial farm inputs, agribusiness technologies and intellectual property are China-owned and sourced, while simultaneously expanding export markets with a global reach.²⁶

Over the past 20 years, China has become the economic center for global pesticide production, use and export.²⁷ Since 2008, Chinese pesticide exports grew 14% per year. Today, China manufactures more pesticide active ingredients than the U.S. or the E.U..²⁸ Chinese companies have traditionally focused on cheaper ways to manufacture off-patent ag chemicals, rather than invest in costly R&D to develop new active ingredients. **But now, China is leading on all fronts. In addition to being the world's leading manufacturer of off-patent and generic pesticides, the Chinese state owns a multinational ag input powerhouse (Syngenta) with R&D muscle and a global presence.**

China’s Ag Input Empire: The union of **SinoChem** and **ChemChina** creates the world’s largest industrial chemicals group, with estimated revenues of about US\$153 billion per annum²⁹ and 200,000 employees.³⁰ The state-owned conglomerate operates oil and gas exploration and production, oil refining, trading and marketing, agricultural inputs, chemicals, real estate, and financial services business. Guided by its company motto, “in science we trust,”³¹ SinoChem’s agriculture division focuses on fertilizer (Sinofert Holdings Co.), and seeds (China National Seed Group Co.) and a rapidly expanding pesticide portfolio.³² SinoChem already owns two national level pesticide R&D centers, Shenyang Research Institute of Chemical Industry (SYRICI) and Zhejiang Institute.³³ In February 2021 Syngenta announced plans to build a US\$230 million R&D centre in the eastern Chinese city of Nanjing that will focus on digital agriculture, chemical pesticides and biologicals.³⁴ As a result of the merger, annual sales of the new Syngenta Group (which consolidates all of ChemChina and SinoChem’s ag input assets), will approach an estimated US\$27 billion.³⁵ Following a series of mergers and acquisitions, the newly-created Syngenta Group is straining under a heavy debt load.³⁶ To raise money, ChemChina announced plans to sell a 20% stake in Syngenta Group in an initial public offering (IPO) on Shanghai’s STAR Market in late 2021,³⁷ but the IPO was temporarily suspended.³⁸

Post-Patent & Generics Drive Pesticide Proliferation

Among the most significant trends in industrial farm inputs: the meteoric rise of off-patent and generic pesticides, especially in the global South.³⁹ The explosive growth of generic pesticides was fueled by the expiration of patents on best-selling pesticides (especially Monsanto’s glyphosate herbicide, in 2000).

During the same time period (2000-2020), multinational agrochem giants have been slower to develop new active ingredients for proprietary, high-value chemical products.⁴⁰ The lag in innovation by multinational agrochem/seed giants is, in large part, explained by the spiraling costs of bringing a new active ingredient to market.⁴¹ But economists also note that giant corporations operating in highly concentrated markets may have less incentive to innovate and invest in R&D.⁴² Moreover, with breakthroughs in ag biotech in the late 1980s and 1990s, the agrochem/seed giants pursued a *different* innovation pathway – opting to invest R&D in the genetic engineering of proprietary seeds that obliged farmers to buy more of the company’s agrochemicals.⁴³ Herbicide tolerance, the trait found in the vast majority of all genetically engineered crops worldwide – is a classic “technological lock-in” that is designed to entrench chemical dependence in agriculture and amplify market power.

With adoption of herbicide tolerant crops and massive use of chemical weed-killers (on both genetically engineered [GE] and non-GE crops), more than 250 weed species across 70 countries have evolved resistance to at least one herbicide formula,⁴⁴ leading farmers to spray more frequently or use multiple weed-killers. Taking just one example: in 1990, U.S. farmers applied an average of 1.8 herbicide sprays to each acre of corn. By 2018, farmers sprayed 3.4 herbicides, on average, per acre of corn.⁴⁵ In 2021 Bayer introduced XtendFlex soybeans that are engineered with triple chemical tolerance (to glufosinate, glyphosate, and dicamba herbicides).⁴⁶ And if that genetic arsenal doesn't pack a lethal punch, Bayer plans to develop six-way herbicide tolerant crops by 2030.⁴⁷

Over the past 25 years, as patents on blockbuster proprietary products began to expire, more nimble pesticide manufacturers – especially in China and India – have created huge markets by churning out cheaper formulations of post-patent products. Generic agrochemicals overtook proprietary and off-patent pesticides for the first time in 2002, and the cheaper off-patent and generic products have dominated the global market ever since.⁴⁸ By the end of 2013, off-patent products accounted for more than 77% of the total pesticide market, and that share has continued to grow an average 2% to 3% each year.⁴⁹ Today, China supplies almost half of all herbicide global exports, with glyphosate chief among them.⁵⁰ India's herbicide exports (largely glyphosate) grew 19% per year between 2003 and 2015.⁵¹ Notably, the world's fifth largest agrochemical firm, UPL Ltd. (India), derives 71% of its 2021 FY revenues from generic pesticides.⁵²

According to industry analysts, between 2017 and 2023, patents will expire on more than 100 agrochemical products – valued at US\$11 billion.⁵³ Although multinational pesticide giants have been slower to innovate with new active ingredients, they've managed to bolster their oligopoly market power, in part, by reformulating existing active ingredients into “profitable agrochemical cocktails.”⁵⁴ The multinational giants also rely on negotiating strategic licensing deals, including access to registration data, for their products that will soon go off-patent.⁵⁵

The bottom line: In recent years, hundreds of generic manufacturers, especially in China and India, have produced a global glut of pesticides that has helped to drive down the price of many agrochemicals.⁵⁶ Indiana University professor Annie Shattuck offers a profoundly disturbing but vital assessment of today's on-the-ground (and in-the-soil) reality: “The structure of global trade and underlying transformations in agrarian life have every bit as much to do with creating a toxic agriculture as any single corporation. The post-millennial global pesticide regime is one in which pesticide use is ubiquitous and its impacts are broadly illegible. As capitalist farming continues to expand around the globe, agrichemicals are traveling with it...Agriculture is becoming even more dependent on pesticides, not less, especially in the Global South.” – Annie Shattuck, 2021⁵⁷

Bayer’s Remorse Continues: Monsanto may be history, but its legacy of contaminating human health and the environment lives on.⁵⁸ Bayer acquired Monsanto for a whopping US\$63 billion in 2018, and continues to pay the price. Bayer has been forced to commit US\$11.6 billion – plus another US\$4.5 billion⁵⁹ toward future claims – to settle around 125,000 existing claims and lawsuits by users of Roundup (generic name: glyphosate) who allege that the Monsanto products caused their non-Hodgkin’s lymphoma.⁶⁰ The tragedy, of course, is that due to generic knock-offs, glyphosate exports and use have proliferated throughout the global South. However, numerous local jurisdictions and countries (e.g., Mexico, Vietnam, Germany) have initiated plans to restrict, phase out or ban glyphosate products.⁶¹

Big Ag’s Digital Turf Grab

The world’s largest agrochemical/seed firms have fortified their market control via consolidation and mega-mergers; now they are feverishly investing in high-tech and digital technologies that can further expand their already-solid oligopoly. They are not alone; other corporate titans, sitting atop their own sectors – fertilizer giants, ag equipment manufacturers, big tech – are muscling their way into the digital ag arena.

In the past half-decade, the biggest players in global agriculture consolidated to produce the Fat Four (Bayer, Corteva Agriscience, Syngenta Group/ChemChina, BASF) amid a dramatic onslaught of digital technologies that invite – almost require – cross-sectoral convergence. **“Data is the new soil”** – now a common metaphor to suggest digital information’s ubiquitous and foundational role – also points to the reality that Big Data is becoming the prerequisite, the milieu and the means of producing agricultural commodities. The world’s biggest data companies – Apple, Alibaba, Amazon, IBM, Google, Baidu, Microsoft, among others – are now tightly entangled with industrial food production.

The reach of digital food and ag is rapidly expanding to peasant and smallholder agriculture in the global South.⁶² Digital technologies offer new forms of control and value extraction that threaten to further usurp farmer autonomy and decision making while facilitating and expediting a new era of land grabbing.⁶³

Big Data down on the farm can include historical as well as real-time and predicted weather information and crop yields, commodity market information, units of seeds bought and planted, input prices, fertilizer dosage, plot measurements and mapping, soil nutrient levels, soil carbon levels, crop moisture levels, etc. The data is collected, stored, and analyzed with the help of algorithms to make automated on-farm decisions that are touted to improve efficiency and increase profitability. Driverless car technologies, face recognition technologies, robotics and artificial intelligence, machine learning, drone technologies, imaging and sensing technologies, cloud computing, blockchain technologies, mobile apps and more all play a role on the world's biggest industrial farms.

The justifications for using Big Data to advance and ultimately realize “precision agriculture” are already familiar and vary little from the arguments pushing for the acceptance of GMOs more than a generation ago: we are told that food production is inefficient, unpredictable and imprecise and so we must leverage newly-available technologies to produce more food more reliably (i.e., increase yields) for a growing global population – without increasing the need for land and while reducing negative environmental impacts from agriculture.⁶⁴ Data-driven decision-making, it is claimed, will allow farmers to increase yields even while reducing herbicide- and fertilizer-use because input-prescriptions will be meticulously accurate, down to the level of the field, the row, and even the individual plant. These automated prescriptions will, ostensibly, save farmers time, money and labour – and the environment wins, too.

Always More Room for Profit: Critics of Big Ag are rightfully dubious that the world's largest input producers are working hard to find ways to sell less product. We can be sure, in any case, the Fat Four won't sacrifice profitability and they will aim to offset reductions in traditional input sales – if, indeed, there are any reductions⁶⁵ – with increased sales of other products, which may include ‘tailored’ or site-specific inputs developed using collected, on-farm data. As Mao Feng, chief brand manager for Syngenta Group's MAP (digital agriculture platform in China, see Table below) explains: “Before, we sold pesticides, seeds and fertiliser. Now we're a farm services company – we sell service and technology...selling individual products, we had hit the ceiling, there was no more room.”⁶⁶ The new business model is vertical integration under the rubric of farm management services: instead of limiting sales to seed plus a linked-herbicide (Roundup Ready corn seed and Roundup, for example), seed/pesticide firms are now selling (the promise of) high-yielding, weed-free, bug-free fields.⁶⁷ To that end, the products for sale may include data-driven input recommendations by a company-linked consultant/agronomist (increasingly referred to as a “trusted advisor”),⁶⁸ modelling of potential profits based on pre-

dicted weather plus the application of additional proprietary products, soil sampling via in-field sensors and field-scouting via drone on a fee-per-pass basis,⁶⁹ etc. The aim is not to profit, necessarily, from the sale of digital tools or app subscriptions – BASF’s xarvio Field Manager app, for example, is free to download from the App Store; the aim is to sell data-driven farm management services – including traditional inputs – while collecting valuable on-farm data.

Every leading agrochemical company offers its own digital ag platform marketed to farmers as a way to transform on-farm data into savings that will ultimately increase farm profitability. The Holy Grail, they say, is a **“farm of one,”**⁷⁰ where a single farmer/data manager (equipped with many thumbs, perhaps?) can log on to a connected device, watch as the algorithms calculate input prescriptions – based on data collected from in-field sensors and hyperspectral imaging – and then send those prescriptions to a fleet of contracted drones that will dump herbicide, fungicide, fertilizer, growth regulator or other input in a just-right dosage for each plant growing in the field. Post harvest, the farmer can supposedly sit back and enjoy the profits from increased crop sales and reduced labour costs – as well as from payments for ‘carbon sequestration’ verified by traceability data collected and stored on a blockchain.

However, like varieties of breakfast cereals, there are already a dizzying number of digital ag platform names, tie-ins, co-branding, giveaways and corporate partnerships, blurring the lines between owners and partners.⁷¹ That lack of clarity has added to farmers’ already significant wariness about handing over their farm data via digital ag tools.⁷² In the context of industrial agriculture, farmers know that competing industrial ag peers, market speculators, commodity traders, landowners/buyers and input developers could all benefit from access to on-farm data related to soil quality, inputs, weeds, pests and yield.⁷³ If Big Ag companies can’t overcome these ‘trust challenges,’ they will try to sweeten the pot in other ways (see below). The following table presents the biggest seed/agrochemical companies with a sampling from their ever-expanding menu of digital ag services.

Digital Ag Bumper Crop or Data Boosting Product Cross-Fertilization?

Syngenta Group (ChemChina)	
Digital Ag Platform	AgriEdge ; Cropio (E. Europe); Cropwise (Brazil); Modern Agricultural Platform – MAP (China, developed by SinoChem Agriculture, has on- and off-line components).
Some Components	Ag Connections (Syngenta subsidiary, farm management software); Farm-Shots (Syngenta subsidiary, satellite imagery); Land.db (software for data collection, analysis – USA); Cropwise Protector (operations management, data analysis) and Cropwise Imagery (satellite remote sensing – both in Brazil); MAP Zhinong for field crops and MAP Huinong for cash crops (China); AD-AMA (part of Syngenta Group) Eagle Eye (drone analytics platform, Agremo technology).
Inter-Operability, Collaborations	FarmShots integrated with Sony’s Smart Agricultural Solutions ; AgriEdge integrated with Nutrien’s Echelon (fertilizer) precision ag tool; Land.db integrated with Simplot Grower Solutions and with Truterra Insights Engine (USA); Ram Trucks (USA; a new truck = one-year free subscription to AgriEdge); Syngenta MAP collaborating with Dole (and with Disney to market two Disney-branded tomato varieties).
Bayer	
Digital Ag Platform	Climate FieldView (Monsanto asset) in N. America, S. America, Europe (including Germany, France, Spain, Italy and Ukraine); Climate FarmRise (digital app in India).
Some Components	FieldView Drive , Precision Planting 20/20 , SeedSense and YieldSense (monitors for data-collection and -sharing); Digital Mapping of soil, cloud cover, seed population-to-yield; Seed Scripts (seed placement); Seed Advisor (corn seed selection and placement); Disease Risk Modelling , Fertility Scripting (input timing and rate recommendations).
Inter-Operability, Collaborations	Bayer’s Friends with FieldView web page lists 60+ collaborating companies , big and small, whose digital services are integrated with or connected to Climate FieldView : imaging, sensor, farm management, farm machinery, soil analytics, “profit mapping” (e.g., Ag-Analytics) and farm insurance companies; collaboration with TraceHarvest Network (BlockApps blockchain, China, Brazil and USA) and collaboration with Ant Financial (blockchain, China); collaboration with Biome Makers (AI virtual assistant in development – input recommendations and yield predictions using soil microbiome and environmental data); research partnership with XAG (ag drones) in South East Asia and Pakistan, Japan; part of AGROS , collaboration between Wageningen University & Research and 26 private partners , including BASF and Kubota (autonomous growing); strategic partnership with Rantizo (drone integration software using DJI drones).

BASF	
Digital Ag Platform	BASF Digital Farming; xarvio Digital Farming Solutions.
Some Components	xarvio Field Manager (mobile app, real-time field information, recommendations); xarvio SCOUTING (app to identify weeds/diseases); GrowSmart Advantage Tool (USA, uses farm data to estimate the monetary advantage of using BASF products).
Inter-Operability, Collaborations	Salient Predictions (long-range weather forecasting) integrated into xarvio; BASF Digital Farming joint venture with Bosch selling two products: Intelligent Planting Solution (IPS) (seed, fertilizer prescriptions) and Smart Spraying (camera sensor with xarvio); collaboration with Bosch (Curitiba, Brazil, targeted fertilizer application and seed placement); BASF Vegetable Seeds, part of AGROS, collaboration between Wageningen University & Research and 26 private partners, including Bayer and Kubota (autonomous growing); partnership with Hoogendoorn Growth Management (autonomous growing, software and hardware); collaboration with Zen-noh, farmer co-op in Japan (farmer alert system); agreement with AGvisorPRO (agronomic advisors for xarvio users, Canada); xarvio SCOUTING integrated with Nutrien Ag Solutions (fertilizer prescriptions); xarvio SCOUTING integrated with WinField United's ATLAS digital platform; xarvio Field Manager integrated with senseFly's eBee X fixed-wing drone platform.
Corteva Agriscience	
Digital Ag Platform	Granular
Some Components	Seed Prescriptions; Directed Scouting; Fertilizer Management; Nitrogen Monitoring; Pioneer seed App; Pioneer Yield Pyramid decision tool; Corteva Flight (stand assessments for corn, sunflower, lettuce; gap analysis, soybeans; Carbon and Ecosystem Services portfolio (agronomy support, carbon advisory services and access to carbon markets).
Inter-Operability, Collaborations	DroneDeploy (field monitoring software, used in Corteva's 600 drones and by the company's 1000+ drone pilots).
UPL	
Digital Ag Platform	nurture.farm (India, pilot projects in the U.S., South Africa, Brazil and Australia).
Some Components	Cultiv-e platform (Brazil, info sharing with UPL customers about soybean diseases, highlighting two UPL fungicides).
Inter-Operability, Collaborations	Collaboration with TeleSense (AI platform to monitor condition of stored grain – relevant for sale of UPL's fumigant pesticides); collaboration with Taranis UAS FlyUP (Brazil, aerial mapping of weeds, diseases in sugarcane fields and herd monitoring in pastures).
FMC	
Digital Ag Platform	Arc farm intelligence
Some Components	Mobile app action alerts; connection to FMC agronomists; uses open API (app interface) that allows Arc to work with other companies' digital ag tools; Pest Pressure Dashboard (predictive modelling and analytics).
Inter-Operability, Collaborations	Investment in Scanit Technologies; partnership with Scanit to use its Spore-Cam wireless sensor in Brazil to analyze Asian soybean rust; partnership with Nutrien Ag Solutions (sending data from Arc to Nutrien's pest control advisors (California); partnership with AI developer Shenzhen SenseAgro Technology Co., Ltd. (China, Fall Armyworm identification and control with FMC products).

Sources: ETC Group; Yating Jiang, "Rising to Transform Agricultural Production – How Agrochemical Titans Unlock the Potential of Digital Agriculture," 09 March 2021, AgroPages: <http://news.agropages.com/News/NewsDetail---38263.htm>.

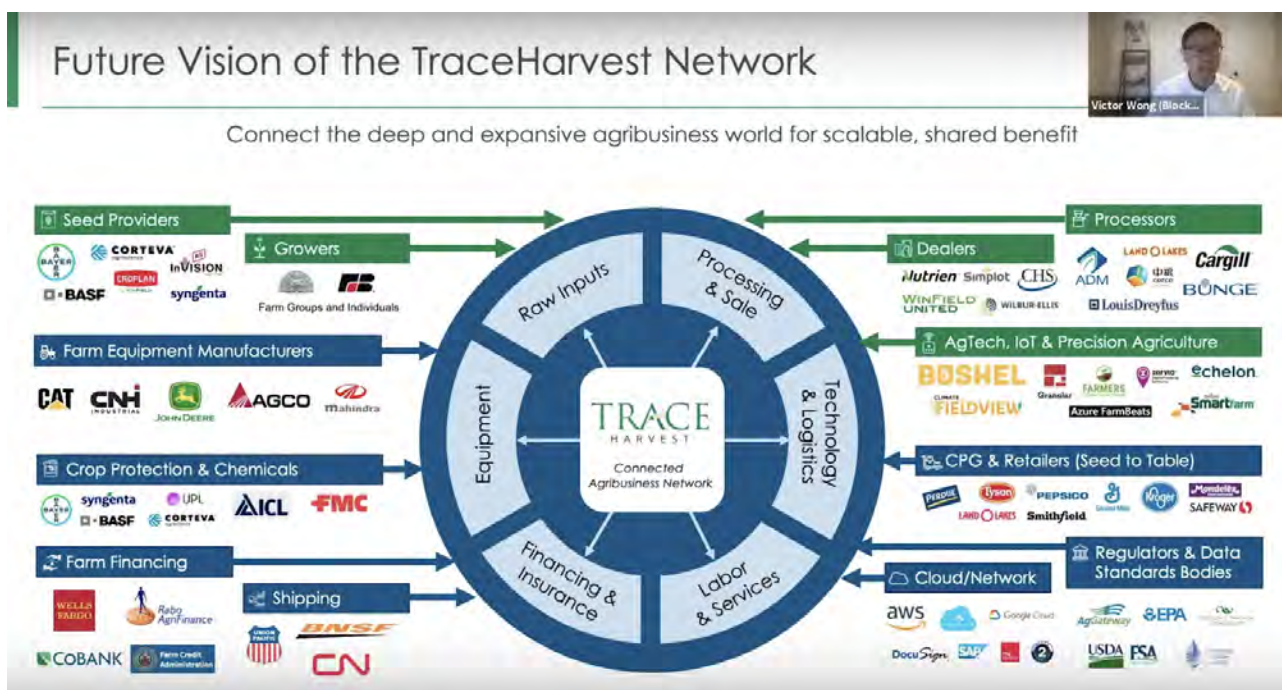
“[Block]Chain, Chain, Chain... You got me where you want me...”

When **Bayer** joined forces with blockchain platform company **BlockApps** to create a digital, global replacement for ‘high friction manual tracking’ in the ag sector, they came up with the “highly scalable”⁷⁴ **TraceHarvest Network**. The blockchain uses Amazon Web Services (AWS) cloud and computing infrastructure and will follow agricultural products all along the food chain from seed source to grocery shelf (or front door). The advantage of using blockchain’s electronic ledger technology, say its promoters, is that every transactional record (e.g., contract, input purchase, sale, transport, delivery) is secure, time-stamped and authenticated; and it’s impervious to tampering because the blocks are transparent – everyone on the blockchain platform sees each transaction as it happens, in real-time.⁷⁵

The vision for the TraceHarvest Network (see image, below) is to one day bring every big commercial player (and regulatory entity) active in the industrial food system on to one common digital platform – inputs, equipment, technology, processing, retailing, financing, logistics. Why? According to Stan Dotson, who joined BlockApps as a Senior Advisor in early 2021 after 30+ years at Monsanto (plus two years working for Bayer as VP of Digital Strategy and Transformation), Big Ag is under threat from “consumer backlash” due to a “trust crisis.”⁷⁶ High-profile food safety recalls have resulted in consumers favouring local and/or known producers. (In the same breath, Dotson also laments the “irrational preferences” of consumers who want their food “free-from-everything.”⁷⁷) He sees blockchain, and TraceHarvest Network in particular, as a way to counter the buy-local, know-your-farmer trends. If blockchains are perceived to be verifiable and tamper-proof – some refer to digital transactions stored as blockchained data the “Single Source of Truth” (SSoT)⁷⁸ – then TraceHarvest can help Big Ag overcome its “trust challenges” with consumers. In fact, some blockchains have been breached and are vulnerable to cybercrime.⁷⁹

Big Ag’s Recipe for CarbonEra? Tracing food back to its seed source is just one “use-case” for TraceHarvest, however, on its FAQ page, TraceHarvest claims its blockchain technology “promotes both sustainability and consumer well-being through solutions including carbon offset crediting, outcome-based pricing, and safer, faster food recalls.”⁸⁰ The focus on safer food recalls, rather than safer food, reveals a great deal about Big Ag’s thinking. Tracing carbon may turn out to be TraceHarvest’s most useful use-case for the agrochemical/seed company that helped design it. While Bayer piloted its own limited program in 2020 in Brazil and the U.S. – paying farmers to adopt so-called climate smart farming practices (e.g., no till or cover crop) – actually verifying increases in soil carbon wasn’t part of the program. The terms for participation in Bayer’s carbon program were a requirement to plant corn or soybeans, having an active “FieldView Plus” digital ag account and agreeing to share relevant farm data.⁸¹ It was assumed that following Bayer’s recipe would result in increased soil carbon; however, greenhouse gas emissions from energy-hungry blockchains or from data transport, storage and processing are not accounted for.

In tandem with, and under the umbrella of digital ag services, carbon credit schemes for farmers have proliferated in the last half-decade, particularly in Europe and the U.S..⁸² So far, carbon market schemes for agriculture are in early stages with both big and small players: startups Nori (U.S.) and Indigo Ag (U.S.), Soil Capital (U.K.) and Soil Heroes (Europe and U.K.) are competing with Bayer, Corteva and Nutrien. The U.S.-based Ecosystem Services Market Consortium (ESMC) will launch a nation-wide carbon market in 2022. Bayer, Syngenta and Corteva were early ESMC partners and have pledged financial support.⁸³ They are also helping to create the methods “to measure, verify and monetize increases in soil carbon,” reductions in greenhouse gas (GHG) emissions, and improved water quality in agriculture. Despite Big Ag’s shadow looming over ESMC, it claims to be an independent, non-profit, third-party provider of soil carbon verification. With data-sharing a sticking point for farmers but a crucial need for Big Ag to sustain its new business model, carbon payouts could be the way to bring farmers around and overcome its many “trust challenges.”



(Source: BlockApps webinar, 2020⁸⁴)

New Techno-Fixes: gene editing and RNA-based pesticide sprays

If the pesticide/seed industry giants can take dominant positions in digital farming platforms and a new generation of gene editing and/or RNA pesticide technologies, they are poised to capture new platforms that could provide new technological ‘lock-ins’ – obliging farmers and end-users to adopt a new and expanded menu of proprietary ag inputs and digital services.⁸⁵

Faced with expiring patents, herbicide-resistant weeds, the rise of generic pesticides, and efforts by some governments (especially the EU) to rein in

chemical toxins, agrochemical/seed giants are looking to fortify their oligopoly power with the rollout of novel, proprietary genetic technologies, most prominently :gene editing and RNA-based pesticide sprays. Although these technologies involve very different techniques, they both seek to concentrate corporate power and reinforce industrial agriculture. There are striking similarities in the way they are being introduced and promoted:

- The biotech industry touts them as tools that will bring faster, precise and highly predictable changes to the genomes of plants, animals and microbes.
- To win consumer acceptance and avoid any association with GMOs, industry insists that neither technology involves the use of genetic engineering (transgenic technology) and therefore must not be subject to GMO regulations.
- In their haste to attract investors and bring to market 21st century techno-fixes, corporate labs and start ups scarcely acknowledge huge knowledge gaps and associated risks.

We look at these in more detail below.

1. Gene editing: Biotech’s Silver Bullet for Food & Ag

What is gene editing?

Genome editing techniques are a form of genetic engineering (GE) used to alter the genetic material of an organism, plant or animal (including humans) by inserting, deleting or changing the DNA at a specific target site in the genome. A number of genome-editing technologies are currently being used in food and agriculture. The most well-known among these is the CRISPR-enzyme system (e.g., CRISPR-Cas9, CRISPR-CPF1, etc.) CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats, and DNA-cutting enzymes are generally called nucleases. Other gene-editing technologies include TALEN (Transcription activator-like effector nucleases) and ZFN (Zinc finger nucleases). CRISPR-Cas9 made headlines outside scientific circles in 2020 when the scientists who discovered it (Jennifer Doudna and Emmanuelle Charpentier) won the Nobel Prize in Chemistry.

In the food and agriculture arena, Big Ag multinationals and small tech start-ups tout gene editing as a fast, precise and predictable breeding technology that will rapidly deliver “innovative” traits – from non-browning mushrooms to waxy corn to fungus-resistant wheat with fatter grains.⁸⁶ Not surprisingly, the first gene-edited crop commercialized in North America was herbicide-tolerant – a canola variety developed by Cibus, which can withstand a dousing of an herbicide manufactured by the Canadian company Rotam. (The product was introduced as an alternative to Roundup Ready canola after Monsanto’s herbicide stopped working when weeds became resistant to it.) In an odd about-face the company later claimed their product was not gene-edited at all.⁸⁷

Beyond applications in plants, CRISPR is also being widely developed for gene-editing in livestock (e.g., pigs, cows, sheep, goats and chicken), insects and microbes (to boost productivity, soil fertility, disease resistance, and more).⁸⁸ If that extensive tinkering sounds worrisome, headlines like these are designed to demolish any obstacles to public acceptance:

“Crispr Can Help Solve Our Looming Food Crisis” – *Wired* (i.e., transform the food supply to one that can survive the ravages of climate change).⁸⁹

“Can Gene Editing Save the World’s Chocolate?” – *National Geographic* (i.e., climate tolerant and disease-resistant cacao)⁹⁰

“Why Gene Editing Is A Climate Change Solution” – *Seed World* (i.e., reduce greenhouse gas emissions, capture carbon, and make crops more resilient to the impacts of climate change)

“Gene Editing Could Protect Your Favorite Foods” – *Innovature* (i.e., will ensure the survival of chocolate, coffee, wine, bananas, oranges, etc., with plants that are higher yielding, climate- and disease-resistant, as well as water- and nutrient-efficient).^{91, 92}

Most gene-edited crops are still in the pipeline. A handful are being sold commercially and many more are soon-to-be-released. Calyxt’s high oleic, reduced saturated fat soybean oil was commercially launched in the U.S. in 2019.⁹³ Corteva’s waxy corn (used primarily for industrial corn starch and CRISPR-engineered for higher yields) was cleared for release by Canadian regulators in 2020 without a risk assessment, and has already been deemed a category of GMO outside the purview of regulatory oversight in Argentina, Brazil and Chile.⁹⁴ Sanatech’s CRISPR tomato (engineered to contain heightened levels of an amino acid that reportedly lowers blood pressure) received approval in Japan in early 2021, but its launch will be limited due to an intellectual property (IP) conflict (cultivation will be restricted to home gardeners who will be prohibited from selling or distributing the tomatoes).⁹⁵

Although the basic research on CRISPR and other gene editing tools like TALEN has been conducted primarily in public research institutions,⁹⁶ many of the first gene-edited products are coming from tech start-ups that were spawned by academic scientists.⁹⁷ Agrochemical and seed giants are conducting in-house R&D, as well as collaborating with and/or licencing technology from smaller companies.

Jennifer Doudna and Emmanuelle Charpentier, the scientists who won the Nobel Prize in Chemistry in 2020 for discovering CRISPR-Cas9, are closely associated with at least three of the start-ups actively commercialising the technology for food and agriculture. Doudna is the co-founder of Caribou Biosciences, which has funding support from food giant Mars, and she sits on the scientific advisory board of Inari Agriculture. Charpentier is the co-founder of

ERS Genomics (the company's sole focus is to maximize commercial licensing of a global patent portfolio related to gene editing owned by University of California Berkeley).⁹⁸ Dr. Feng Zhang and other members of the Broad Institute in Boston, U.S.A. also stake key patent claims to CRISPR techniques. They are among the founders of the start-up Pairwise.⁹⁹ Since 2016, The Broad Institute (MIT/Harvard) and UC Berkeley have waged a fierce and complicated patent dispute over key IP claims related to CRISPR.¹⁰⁰ Doudna and her colleagues at Caribou have exclusively licensed CRISPR to Corteva for use in corn and soybeans, while Zhang and his colleagues have licensed more liberally to Bayer-Monsanto, Syngenta, BASF, Simplot and Pairwise.

Common(s) Mistake: The Genome Editing Patent Landgrab There's an oft-repeated claim that CRISPR is “a democratizing tool” – suggesting that it is widely utilized and universally accessible.^{101,102, 103} In reality, the ag biotech industry is scrambling to win monopoly patents on gene-editing technologies, with high-stakes bidding over exclusive and non-exclusive licensing deals. *IPStudies* notes that around 200 patent families are published every month on CRISPR related nucleases, including a growing number of applications from China.¹⁰⁴

Corteva Agriscience, the world's 2nd largest seed company and 4th ranking pesticide firm, overwhelmingly dominates patent applications related to gene editing nucleases in the crop and seed sector, with more than 70 applications.¹⁰⁵ In 2018, Corteva, the Broad Institute (MIT/Harvard) and other discoverers of CRISPR-Cas9 created a patent pool comprising 48 patents that involve key CRISPR tools for the gene editing of plants.¹⁰⁶ The Munich-based Institute for Independent Impact Assessment in Biotechnology (Testbiotech.org) notes that any plant breeder interested in gaining access to comprehensive use of CRISPR-cas9 will have to obtain licenses from this pool, which is likely to make it costly or prohibitive for many breeders. Testbiotech likens Corteva's control of key patents related to genome editing to a “hidden patent cartel” (the licensing contracts are confidential).¹⁰⁷

Bayer, the world's top-ranking commercial seed company and 2nd largest pesticide firm, holds international patent applications on approximately 50 nucleases; KWS has around 30 applications, and Collectis/Calyxt around 20.¹⁰⁸ In the case of granted European patents on site-directed nucleases for application in crops, Corteva holds around 30, while Bayer, Collectis, BASF and Keygene each hold fewer than 10.

Industry's Quest to De-Regulate Gene Editing in the U.S. and E.U.: Proponents maintain that gene editing and GMOs are distinct because the CRISPR technique does not rely on the insertion of DNA from a different species (although it may include DNA from other species in some instances).¹⁰⁹ And they insist that gene editing techniques achieve the same results as conventional breeding, only much faster and far more efficiently.¹¹⁰

Sampling of Genome-Editing Companies Involved in Food and Agriculture

Company (Year founded, Headquarters)	Public / Private	Business Focus in Food and Agriculture	Annual Revenue or Equity Investment Raised US\$ million	Food & Ag R&D Collaborators
AgBiome (2012, USA)	Private	Biological and synthetic pesticides; crop traits	~15.68 ¹¹¹ Revenue	The Mosaic Company, Genective [JV: Limagrain and KWS], BASF ¹¹²
Inari (2016, USA)	Private	Crop traits (corn, soy, wheat)	352 ¹¹³ Investment	Beck's (US seed retailer, corn traits), Mertec (soybean germplasm), M.S. Technologies (trait provider) ¹¹⁴
Cibus (2001, USA)	Private	Crop traits (canola, rice, soybean, wheat, corn)	~131.3 ¹¹⁵ Investment	GDM (soybean genetics), Valley Oils Partners (vegetable oils) ¹¹⁶
Calyxt (2010, USA) (subsidiary of Cellectis, which owns TALEN)	Public	Crop traits (winter oats, soybeans, hemp, high fibre wheat, alfalfa)	23.9 ¹¹⁷ Revenue	NRGene (software), Perdue Agri-Business (soybean seed), S&W Seed Company (alfalfa)
Caribou Biosciences (2011, USA)	Public (IPO, July 2021)	Licenses its CRISPR/Cas9 technology	115 Investment in pre-IPO funding, 304 raised in IPO, July 2021 ¹¹⁸	Corteva AgriScience (Corteva has exclusive license to Caribou technology in corn, soybeans; joint research on off-target effects of gene editing) ¹¹⁹
ERS Genomics (2014, Ireland) ¹²⁰	Private	Licenses its CRISPR/Cas9 technology	N/A	Nippon Gene Co., G+FLAS Life Sciences, Axxam (all non-exclusive licensing)
Arcadia Biosciences (2002, USA)	Public	Hemp, wheat, safflower (oil products)	8,034 ¹²¹ Revenue	Ardent Mills; Corteva Agri-Science; Arista Cereal Seeds Pty Ltd; Bay State Milling Company (all wheat) ¹²²
Pairwise (2017, USA)		Crop traits (kale, mustard greens, corn, soybeans, wheat, canola, cotton, berries)	115 ¹²³ Investment ~9.19 ¹²⁴ Revenue	Bayer (trait development in corn, soybeans, wheat, canola and cotton); Plant Sciences, Inc. with USDA (gene-edited berries)
Tropic Biosciences (2016, UK)	Private	Crop traits (coffee, bananas, rice)	38.5 ¹²⁵ Investment	Genus Plc (porcine and bovine genetics); BASF (trait development)
Benson Hill Biosystems (2012, USA)	Public (IPO May 2021, after SPAC merger) ¹²⁶	Crop traits (soybean, yellow pea, corn)	282.3 Investment ¹²⁷ 71.5 Revenue in <i>first half</i> of 2021 ¹²⁸	Mars, Inc. (cacao traits); GDM (soybean breeding); Rose Acre Farms (soybean processing); Beck's (US seed retailer, corn traits)

Elo Life Systems (subsidiary of Precision Biosciences; Precision PlantSciences formed 2012; renamed Elo Life Systems 2018, USA and Australia) ¹²⁹	Private	Crop traits (canola, watermelon, vanilla, bananas, chickpeas) ¹³⁰	24.3 Total revenue of parent company, including Elo Life Systems	Cargill (reduced-fat canola oil); Dole (disease-resistant bananas); BASF, Bayer, Corteva, ¹³¹ Avoca (Clary Sage plants for extraction of sclareol, used in fragrances)
Sanatech Seed Co. Ltd. (2018, Japan), venture launched by University of Tsukuba	Private	High GABA tomato	N/A	Pioneer EcoScience (distributor of Pioneer brand products [Corteva AgriScience] in Japan, development of High GABA tomato) ¹³²
Yield10 Bioscience (founded as MetaboliX, 1992, USA)	Public	Crop traits in canola, soybean, corn, sorghum, rice and wheat. ¹³³	0.8 ¹³⁴	Bayer (soybean), Forage Genetics (sorghum), Simplot (potato), GDM (soybean) – all non-exclusive research licenses; ¹³⁵ Rothamsted Research, UK, omega-3 oils ¹³⁶

In a concerted campaign to win public acceptance and side-step regulations, the biotech industry is lobbying intensely to ensure that its proprietary, gene edited plants and animals will be excluded from existing GMO regulations and labelling requirements. In the U.S. regulatory arena, industry has exceeded its goals. In response to pressure from the Trump White House, in 2020 the US Department of Agriculture announced its decision to deregulate oversight of most genetically modified plants and seeds (including gene edited-plants and seeds) and proposed a similar de-regulation of gene-edited animals.¹³⁷ (The new rules are being challenged in court.¹³⁸) In contrast, the European Union (EU) has thus far upheld stricter regulatory oversight of gene editing. A 2018 ruling by the European Court of Justice requires genome-edited crops to be subject to the same regulations as GMOs. However, a 2021 study by Corporate Europe Observatory reveals that a powerful biotech lobby is campaigning aggressively to overturn the E.U.'s precautionary stance and ensure that new gene-editing techniques are excluded from existing GMO rules. If the industry lobby prevails, gene-edited plants, animals and microorganisms would not be subject to risk assessment, monitoring or consumer labelling in Europe.¹³⁹

Risks, Unexpected Consequences, Knowledge Gaps With hype and hoopla paving the way for the rapid deployment of gene editing in food and farming, biotech boosters have conveniently overlooked or ignored a growing body of scientific evidence that points to potential risks related to gene-editing technologies, including CRISPR-Cas9.¹⁴⁰

Recent studies indicate that, far from being precise and predictable, genome edits may often result in unwanted changes and unpredictable outcomes. A 2020 report by Testbiotech on new genetic engineering technologies explains

the “potential for unforeseen genomic interactions, genomic irregularities and unintended biochemical alterations” in two main categories:

- *Off-target effects* occur when genome editing introduces a change at an additional, unintended site of the genome in addition to the intended (target) location.
- Even if the edit is achieved at the targeted site, unintended *on-target effects* relate to possible deletions and rearrangements of DNA, or gene interactions that were not anticipated.¹⁴¹

Unexpected effects could involve changes in the chemistry, biochemical pathways or protein composition of an edited organism, with potential implications for food safety and biodiversity (such as altering toxicity or allergenicity). Despite widespread R&D and a rush to market gene-edited organisms, there are enormous gaps in the scientific literature on understanding of how new traits could impact the environment, particularly if they introduce novel compounds. A 2020 report written by Janet Cotter and Dana Perls, published by Logos Environmental, Canadian Biotechnology Action Group and Friends of the Earth offers a comprehensive overview.¹⁴²

With the advent of gene editing, it becomes technically possible to develop a far more dangerous and disruptive technology: gene drives. Gene drives are a new genetic engineering technology that seeks to rapidly spread human-directed genetic changes through entire populations of animals, insects and plants. Unlike first generation GMOs targeting commercial crops, gene drive organisms (GDOs) can be designed to manipulate both domesticated and wild populations. Gene drives aim to be invasive – to persist and to spread and, in some cases, even to extinguish an entire population or species; early proponents suggest the use of gene drives to spread “auto-extinction” genes to wipe out agricultural “pests.” So far only smaller start-ups such as Agragene are openly developing gene-drives for agriculture – mostly in insects. In June 2021 scientists successfully implemented gene drives in crops for the first time.

See ETC Group’s December 2019 report: *Gene Drive Organisms: An introduction to a dangerous new technology putting Africans at risk*: <https://www.etcgroup.org/tags/gene-drives>.

2. RNAi Pesticide Sprays

The Fat Four pesticide powerhouses (Bayer, BASF, Corteva and Syngenta), as well as many high-tech start-ups, are actively developing novel pesticide spray technologies, based on synthetic, ribonucleic acid (RNA) molecules, that are designed for widespread release in farmers’ fields and in forests.¹⁴³

“Gene-silencing pesticides,” also known as RNA interference or RNAi pesticides¹⁴⁴ are designed to kill pests by switching off or “silencing” genes essential for the organism’s survival. RNAi is the molecule of the moment, and RNAi is biotech’s newest techno-fix for agriculture.

For agrochemical giants, the appeal of “RNA-based biocontrol” sprays is irresistible: they seek to manipulate the cellular machinery of an insect, weed or pest and claim that it is all based on natural, biological processes – enabling them to escape scrutiny from pesky GMO regulators and a public that overwhelmingly rejects GMOs. Despite major gaps in knowledge about the environmental, health and safety impacts of this novel pesticide technology, RNAi-based insecticidal sprays are already being field tested in the U.S.¹⁴⁵

How does it work? First discovered in 1998,¹⁴⁶ RNA interference (RNAi) involves the use of double-stranded RNA (dsRNA) to block messenger RNA from performing its usual function (that is, instructions to make a specific protein within the cell).¹⁴⁷ RNAi can potentially switch off the specific nucleotide sequences that are unique to a target pest without harming beneficial insects or humans. One biotech booster likens the targeted precision of RNAi-based pesticides to “smart bombs” used in the military.¹⁴⁸

Just like conventional pesticides, RNAi-based products could be sprayed on crops, injected into soil or tree roots. When applied to a crop, the RNAi pesticide could kill the targeted pest on contact, or after the bug munches on a leaf and ingests the pesticide that has been absorbed by the plant. Either way, the interfering RNA enters the insect’s gut and turns off a gene that is essential for its survival. The pest ultimately dies.

Beyond Sprays: RNAi molecules can also be delivered within a genetically engineered crop plant or insect. Crops that are genetically engineered with traits triggered by RNAi are not new,¹⁴⁹ but in 2022 Bayer (formerly Monsanto) plans to sell the first GE crop that contains insecticidal RNAi in its genes – a genetically modified corn variety equipped with RNAi to kill the Western corn rootworm; in addition, the “SmartStax” corn will be loaded with Bayer’s proprietary Bt toxins.¹⁵⁰

Bringing Toxic Chemicals Back to Life? In the longer term, agrochemical firms are also exploring a far more lucrative pursuit: how to silence enzymes in weeds that make them resistant to cash-cow chemical weed-killers like glyphosate.¹⁵¹ The use of RNAi for genetic “reversal” of glyphosate resistance in weeds aims to expand and fortify markets for genetically engineered herbicide tolerant traits, and entrench the use of older, chemical products. To avoid public controversy, industry is likely to focus initial efforts on RNAi products that are deemed more socially and environmentally acceptable (i.e., the use of RNAi bio-based sprays to substitute for dangerous chemicals).

Research and development (R&D) on RNAi pesticide sprays is gaining traction because the technology can be developed relatively fast, without the public stigma, cost or constraints associated with existing GMO regulations.¹⁵² The success of closely related mRNA technology in Covid-19 vaccines will also be played upon to build public support. In addition, it's getting a lot cheaper to manufacture synthetic RNA strands. A gram of RNA initially cost upwards of US\$100,000. The price plummeted to US\$100 a gram in 2014, and now it's under a dollar per gram.¹⁵³

Proponents of RNAi pesticide technologies claim:

- RNAi sprays are designed with “precise target specificity,” and are based on natural, biological processes that enable the interfering RNA to dismantle the protein-making cellular machinery of a target insect, weed or other pest without harming non-target organisms.
- RNAi molecules will degrade rapidly, with little or no environmental impact.
- RNAi pesticide sprays are not a form of genetic engineering because “the nucleotide sequences in dsRNA pesticides do not code for protein, and are not inserted into the genome and are not heritable like transgenes.”¹⁵⁴

What Could Go Wrong? In stark contrast, critics of the technology assert that RNAi pesticides must be regulated as a form of genetic engineering. While the RNAi spray itself is *not* genetically engineered, the technology is *designed to modify organisms in the open environment*. According to a report by a team of scientists at Friends of the Earth: “Organisms may start out life as non-GMO and be modified partway through their life, constituting a vast, open-air genetic experiment.”¹⁵⁵ RNAi pesticides can result in genetic changes in exposed organisms as well as altered traits that can be passed down to offspring.¹⁵⁶ Scientists have documented ways in which interfering RNAs can result in heritable alterations.¹⁵⁷

RNAi pesticide sprays are a novel technology designed for widespread environmental release. As science writer Antonio Regalado put it in his 2015 article for *Technology Review*: “RNA may be natural. But introducing large amounts of targeted RNA molecules into the environment is not.”¹⁵⁸ There are enormous knowledge gaps, and a host of potential risks.

Despite industry’s claims of “precise target specificity,” a study published by Monsanto (now Bayer) in 2018 found that its genetically engineered corn equipped with RNAi to kill the Western corn rootworm also killed non-target beetles in laboratory experiments.¹⁵⁹

How will RNAi degrade and where will it go? Do degraded RNAi molecules pose a risk to target or non-target organisms? Double-sided RNA molecules are larger and heavier than molecules in conventional pesticides.¹⁶⁰ Will syn-

thetic RNA spread via groundwater? The question is relevant because proponents envision delivery of RNAi pesticide sprays via irrigation.¹⁶¹

Plant scientists already know that insects, pests and weeds can evolve resistance to RNAi pesticides, just as they have to conventional sprays (both chemical and biological). Laboratory tests have already confirmed this scenario.¹⁶²

Special Delivery? Potential ecological and human health risks are made even more complex because a number of companies are conducting research on novel delivery mechanisms to enhance the efficacy of RNAi sprays. Companies seek to encapsulate the RNAi in synthetic nanoparticles – so that the interfering RNA can penetrate plant cells more efficiently, or to make them degrade more slowly in the environment. The fate of engineered nanoparticles in the environment and their impact on the health and safety of target or non-target organisms raises even more unanswered questions.¹⁶³ ETC Group has been monitoring the development of nano-scale technologies since 2000. Most scientists agree that many engineered nanomaterials create novel risks that require new forms of toxicity evaluation, but risk assessment is still in its infancy. There are no internationally-accepted scientific standards governing lab research or the introduction of nanomaterials in commercial products.

An October 2020 report by Friends of the Earth (FOE) provides an excellent, in-depth introduction to RNAi pesticide technologies, their risks and concerns. FOE's major findings:

- RNAi pesticides must be regulated as a form of genetic engineering, as they can result in genetic changes in exposed organisms as well as altered traits that can be passed down to offspring.
- Country-level regulatory authorities have failed to acknowledge RNAi pesticides as a form of genetic engineering and have therefore failed to enact proper assessments or precautions for this novel application of the technology.
- Given the potential risks and major gaps in knowledge surrounding RNAi pesticides, it is imperative that civil society, farmers, and concerned scientists push for strong regulations before this technology is commercialized.

Source: Friends of the Earth (FOE), *Gene-Silencing Pesticides: Risks and Concerns*, October 2020, <https://foe.org/resources/gene-silencing-pesticides-risks-and-concerns/>

Who's Running Interference? Sampling of Start-ups focusing on RNAi-based Pesticide Sprays

Company (Headquarters)	R&D focus & partners
Greenlight (USA)	RNAi pioneer focusing on pharma and agriculture. Has conducted over 20 field trials of dsRNA targeting Colorado Potato Beetle in U.S. ¹⁶⁴
RNAissance (USA)	Using genetically engineered microorganisms to make dsRNA; conducting research on nanoparticle delivery technology; R&D focus on injection of RNAi compounds in fruit and nut trees.
AgroSpheres (USA)	Partners with Adama, subsidiary of Syngenta on RNAi-based insecticide targeting the Diamondback Moth (DBM); conducts research on nanoparticle delivery technology w/ RNAissance.
DevGen (Belgium), now owned by Syngenta	Acquired by Syngenta for US\$523 m in 2012; RNAi for pest control.
Viaqua Therapeutics (Israel)	Aquaculture; RNA-based RNAi for viral control in shrimp; partners w/ Nutreco and Thai Union Group PCL.

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Synthetic fertilizers



Synthetic Fertilizer companies sell inorganic plant nutrients manufactured via chemical processes. The three main macronutrients used in agriculture are nitrogen (N), phosphorous (P) and potassium (K). Nitrogen is the most frequently applied nutrient, mostly in the form of urea (derived from ammonia produced from petrochemicals via an energy-intensive process), followed by phosphorus in the form of phosphates and potassium in the form of potash.¹ The global fertilizer industry is fragmented; however, it has historically operated in export cartels organized by fertilizer type (sometimes government-sanctioned and involving state-owned companies). State ownership / investment in fertilizer production and trade is still common. Many fertilizer companies are expanding offerings to include so-called specialty fertilizers (e.g., containing micro-nutrients and/or microbe-based formulations) and digital agriculture.

Synthetic Fertilizer Sales of the Leading Companies, 2020

Rank	Company (Headquarters)	Fertilizer Products / Segments	Fertilizer Revenue \$US million
1.	Nutrien ² (Canada)	“Retail Crop Nutrients,” Phosphate, Potassium, Nitrogen	9,484
2.	Yara ³ (Norway)	Nitrogen Fertilizers	9,423
3.	The Mosaic Company ⁴ (USA)	Phosphate, Potash	8,014
4.	CF Industries Holdings, Inc. ⁵ (USA)	Nitrogen (ammonia, granular urea, urea ammonium nitrate solution [UAN] and ammonium nitrate [AN], NPK compound fertilizers)	4,124
5.	ICL Group Ltd. ⁶ (Israel)	Potash, Phosphate Solutions, Innovative Ag Solutions	3,769
6.	PhosAgro ⁷ (Russia)	Phosphate based products; Nitrogen based products	3,351
7.	Sinofert ⁸ (China)	Potash, nitrogen and phosphate fertilizer	3,099
8.	Eurochem ⁹ (Switzerland, nominally)	Nitrogen, phosphate, potash and complex fertilizers	2,945
9.	Uralkali ¹⁰ (Russia)	Potash	2,387
10.	K+S Group ¹¹ (Germany)	Potash, Fertilizer specialties	1,940
Total Top 10			48,536
Total Worldwide Synthetic Fertilizer Sales (est.)¹²			127,570

Sources: ETC Group, company annual reports

While global market figures for fertilizer tend toward the speculative, a reasonable estimate for the market's value in 2020 is \$128 billion¹³ – almost three times the size of the market for seeds (US\$45 billion) and twice as big as the market for agrochemicals (US\$62.4 billion). The top 10 synthetic fertilizer companies, therefore, would account for about 38% of global synthetic fertilizer sales. But viewed as individual macronutrient production, the level of concentration is even higher. For example:

- The top seven suppliers of Muriate of Potash (MOP), a potassium fertilizer, account for 84% of global supply.¹⁴ Just four countries (Canada, Russia, Belarus, China) produce about 80% of the world's traded potash.¹⁵
- China is one of the largest producers of fertilizers in the world, with 31% global share of urea and 42% of Diammonium Phosphate (DAP) capacity.¹⁶
- Morocco, via state-owned company OCP, is the world's largest phosphates exporter,^{17,18} controlling 72% of global phosphate reserves. This includes the phosphate rock it mines from occupied Western Sahara.

One reason the level of corporate concentration in the global fertilizer industry is difficult to pin down is that it overlaps with related industries such as mining, shipping and industrial chemical production. The sector has a history of operating within a “corporate sociology of collusion”¹⁹ and coordinates production levels to match demand to keep prices high, not unlike OPEC's manipulation of the petroleum market.²⁰ Fertilizer producers are central to their local economies and are often intertwined with national governments, which means that geopolitics can play a significant role in trade.²¹ The government of Norway, for example, owns more than 40% of Yara (#2);²² Sinofert (#7) is controlled by Sinochem, which is a Chinese state-owned enterprise;²³ the government of Morocco owns OCP, a major phosphate fertilizer producer and the country's largest company;²⁴ and the Eastern European fertilizer manufacturers (PhosA-gro, Uralkali and EuroChem) are largely controlled by a cadre of oligarchs.

Trends: chew on this

ETC finds that:

- Fertilizer prices increased in 2020, with concomitant food price inflation in 2021.
- Fertilizer companies sharpened their focus on new fertilizer revenue streams – specifically targeting organic farming, microbe-based products, digital agriculture and alternative ways to produce ammonia – with acquisitions, mergers and collaborations/joint ventures increasing in these new segments.
- Like other industrial agriculture sectors, fertilizer companies are cashing in on the climate crisis. Fertilizer giants are going “green” and “blue” with so-called sustainable ammonia. The production of “green” ammonia involves renewable energy and “blue” ammonia aims to capture production-related greenhouse gases (see box below.)

Fertilizer prices increased in 2020, with concomitant food price inflation in 2021.

Covid-19 lockdowns and supply-chain disruptions decreased China's phosphate production,²⁵ the world's biggest supplier. After months of decline, phosphate prices bounced back in the second half of 2020 owing to an increase in crop prices in Brazil and good growing conditions in India, Australia and North America.²⁶ Similarly, urea prices increased after mid-2020, reflecting higher costs of natural gas feedstocks.²⁷ Potash prices declined owing to oversupply and lower demand from China.²⁸

2021 took a dramatic turn when prices of some synthetic fertilizers rose to their highest level since the food price crisis of 2008,²⁹ hurting farmers and causing food prices to skyrocket again.³⁰ Hurricane Ida hit the hub of US fertilizer production in late August, driving prices up further.³¹ High prices for coal led to a rise in the price of urea.^{32,33} In China, the main feedstock of nitrogen production is coal as opposed to natural gas in other regions.³⁴ To tackle surging raw material costs and to address domestic food security concerns, China curbed its fertilizer exports in October, followed by Russia in November.^{35,36} The biggest buyers of China's fertilizers – India, Pakistan and other countries in Southeast Asia – felt the crunch.^{37,38} Acute shortages caused long queues,³⁹ protests,⁴⁰ and even deaths⁴¹ in some Indian towns, and the government announced record subsidies to counteract exorbitant input costs.⁴²

Fertilizer companies are focusing on new fertilizer segments.

Specifically, organic farming through acquisitions and new technologies, microbe-based products, digital agriculture and alternative methods of ammonia production (for nitrogen fertilizer manufacturing). Acquisitions, mergers and collaborations are accelerating along with some divestments of traditional fertilizer assets.

The production and use of synthetic N fertilizers account for 2.4% of global emissions.⁴³ This comprises nitrous oxide emissions released post-soil application, and carbon dioxide emissions from the production process involving fossil fuel combustion and from transporting these chemicals. After decades of destroying soil health and polluting the atmosphere and waterways, fertilizer manufacturers are now aiming to demonstrate their contributions to “clean and green” solutions. Table 2 is a partial list of recent ventures into so-called sustainable ammonias (also see Box A below), digital products and microbial fertilizers (some produced via gene-editing).⁴⁴

Table 2: “Sustainable” acquisitions, mergers or partnerships by synthetic fertilizer companies in 2020-2021

Company	Selected Fertilizer Company acquisitions, partnerships, divestments and mergers
Yara	Yara landed research and distribution collaborations in Japan on “clean ammonia bunkering;” and “clean ammonia” supply chains; ^{45,46} launched HEGRA in Norway, a “green ammonia” company co-owned by Aker Clean Hydrogen and Statkraft; ⁴⁷ collaborated with Danish energy giant Ørsted to produce ammonia in the Netherlands using offshore wind; ⁴⁸ Yara Marine Technologies acquired Lean Marine, which aims to lower emissions in shipping; ⁴⁹ Yara Growth Ventures invested in US carbon credits startup Boomitra and in venture capital firm SP Venture, focused on agri-food tech startups across Latin America (BASF, Syngenta and others are also investors); ^{50,51} signed MoU with Trafigura, a commodity trading company to develop lower-emissions shipping fuel; ⁵² signed MoU with Air Liquide, Borealis, Esso S.A.F., TotalEnergies to develop carbon capture and storage (CCS) in France (storage in North Sea); ⁵³ acquired Ecolan Oy, Finnish recycled fertilizer producer, its first acquisition in the organic fertilizer segment; ⁵⁴ Yara and IBM launched a digital farming platform; ⁵⁵ Yara invested US\$3 million in Boost Biomes to develop microbial fertilizers; ⁵⁶ launched the Agoro Carbon Alliance to incentivize farmers via carbon credits to plant so-called climate-smart crops; ⁵⁷ Yara Pilbara (Western Australia) and Australia’s ENGIE entered a collaboration to build an electric hydrogen plant; ⁵⁸ sold its 25% share in Qatar Fertiliser Company; ⁵⁹ sold its Salitre phosphate mining project in Brazil to Eurochem; ⁶⁰ sold its stake in LIFECO (Libyan Norwegian Fertiliser Company) to Libya’s National Oil Corporation. ⁶¹
Nutrien	Nutrien and Belgian shipping firm EXMAR are collaborating to build a ship powered by low-carbon ammonia for ammonia transport; ⁶² launched a carbon program for farmers, which includes a digital platform and access to carbon markets; ⁶³ acquired Brazilian agriculture retailer and soybean seed business Tec Agro; ⁶⁴ acquired Brazilian agriculture retailer Agrosema. ⁶⁵
CF Industries	CF Industries, with 10 other companies including Air Liquide, Hyundai, Shell and Toyota, launched Hydrogen Forward to develop hydrogen technologies in the U. S.; ⁶⁶ signed an MoU with Mitsui & Co., Inc. to develop blue ammonia projects in the U. S.; ⁶⁷ joined the Hydrogen Council, a global CEO-led initiative focusing on hydrogen and low-carbon ammonia; ⁶⁸ signed a contract with thyssenkrupp to develop a 20-megawatt alkaline water electrolysis plant to produce so-called green hydrogen. ⁶⁹
The Mosaic Company	The Mosaic Company and Sound Agriculture (formerly Asilomar Bio) entered a strategic partnership to develop and distribute microbe-activating fertilizers for soybean and corn; ⁷⁰ entered into a similar collaboration with BioConsortia, Inc. to develop and launch nitrogen-fixing microbial products for corn, wheat and other major non-legume row crops; ⁷¹ launched collaboration with Agbiome to develop microbe-based fertilizers. ⁷²
ICL	ICL acquired Brazilian specialty fertilizer company Fertiláqua; ⁷³ acquired Compass Minerals’ South American Plant Nutrition Business, another Brazilian specialty fertilizer business; ⁷⁴ signed a 5-year agreement with Transkhimtrade, a Ukrainian fertilizer distributor, to sell its “Polysulphate” fertilizer (which it claims is certified organic and increases nitrogen efficiency); ⁷⁵ acquired Growers, a U.S. precision ag company. ⁷⁶
PhosAgro	FAO and PhosAgro launched the Soil Doctors Programme, establishing regional networks in Africa, Latin America and the Middle East focused on assessing fertilizer quality and safety; it will also develop and distribute soil-testing kits to 5,000 farmers in developing countries; ⁷⁷ inked collaboration with Exact Farming to develop digital ag services in Russia. ⁷⁸
Uralkali	Uralkali, now controlled by Uralchem, signed a cooperation agreement with Moscow-based, high-tech R&D company Innopraktika to introduce digital ag and other new technologies including microbial fertilizers; Uralchem became a member of the Association of Economic Cooperation with African States (AECAS) to access African markets; Uralkali announced support for Action Africa: Thriving Farms, Thriving Future founded by Yara and backed by the UN World Food Programme aiming to promote fertilizers, agrochemicals and digital ag capabilities; Uralkali joined the UN’s corporate sustainability initiative, Global Compact; launched a pilot project to use electricity from renewable energy sources in its facilities; Uralchem’s subsidiary Digital Agro, Agrosignal and Cognitive Pilot (an autonomous driving JV) entered a strategic partnership to accelerate digital ag in Russian farming.

Like companies in other industrial ag sectors, fertilizer companies are cashing in on the climate crisis by going “green” – and “blue” – focusing on “sustainable” ammonia.

Needing to burnish its Environmental, Social and Corporate Governance (ESG) reputation,⁷⁹ the energy-guzzling and GHG-belching industry is now scrambling to stay profitable, devising ways to monetize the climate crisis by selling “blue” and “green” ammonia (see Box A below), especially to the shipping industry.⁸⁰ They are also introducing digital platforms that tout more efficient fertilizer-use,⁸¹ manufacturing organic or bio-stimulant fertilizers, and trading in carbon credits.

Many shades of ammonia: but all green(washing) The manufacture of synthetic nitrogen fertilizers commonly involves the production of ammonia from fossil fuels via the energy-intensive Haber-Bosch process. The fertilizer industry categorizes ammonia using color-coding that ostensibly reflects the carbon footprint of particular production methods. Grey or brown ammonia is manufactured by the century-old Haber-Bosch method, which uses fossil fuels as feedstock. Green ammonia uses electrolysis (from renewable energy) to extract hydrogen from water, which is combined with nitrogen to make ammonia. Blue ammonia is produced by capturing the carbon emitted during the ammonia-production process and “sequestering” it. However, these eco-labels ignore the nitrous oxide (N₂O) emissions that happen post-fertilizer application⁸² (the proposed solution for which is “more efficient” fertilizer use via precision agriculture) as well as the trail of failures that CCS (carbon capture and storage) projects have left behind.⁸³

Yara established a clean ammonia unit in February 2021,⁸⁴ and it has already started running green ammonia pilots in Australia (for which it received government funding),⁸⁵ Netherlands and Norway. CF Industries announced both green and blue ammonia projects,⁸⁶ while Nutrien installed carbon capture facilities to manufacture blue ammonia⁸⁷ to sell on the Enhanced Oil Recovery (EOR) market.⁸⁸ In EOR, carbon dioxide (CO₂) is pressurized and pumped into “spent” oil wells to free residual crude oil that was previously unattainable, enabling more GHG release when that oil is burned!

Solving fertilizer wastage – a longstanding concern – is also seen as key to being seen as green. Proponents of precision agriculture claim that digital ag tools can provide field-specific (or even plant-specific) fertilizer-dosage recommendations that will reduce overall waste. The same tools give these companies access to massive amounts of data on profitable and unprofitable farmlands,⁸⁹ information about on-farm practices that involve sensors,

drones and other mobile applications,⁹⁰ as well as evidence of farmers' compliance (or noncompliance) with technology user agreements.⁹¹

See ETC's fuller discussion on potential harms related to digital ag's platforms including land grabs and farmer-privacy breaches (see "Critical Trends" section in full report). Table 3 highlights some of the digital ag platforms offered by fertilizer companies.

Table 3: Digital agriculture platforms of some synthetic fertilizer companies

Company	Digital Agriculture Platforms
Yara	Yara's digital platform AtFarm ⁹² offers crop-monitoring services using satellite images and a hand-held device called N-Tester BT that measures nitrogen content, chlorophyll content, and provides variable rate and fertilizer dosage recommendations. Other services include soil and leaf analysis and a range of mobile apps like CheckIT (imaging to detect nutrient deficiencies) and TankmixIT (a compatibility tool for mixing Yara fertilizers with agrochemicals).
Nutrien	Nutrien's digital platform is Echelon and offers dosage recommendations, soil and tissue testing, photosynthetic activity measurements (known as NDVI), yield data visualization, utility farm maps, variable rate recommendations and new remote sensing technology trials. ⁹³
ICL	ICL acquired digital-ag company Growers; ICL's digital platform is Agmatix. It also offers AngelaWeb 2.0, an online fertilizer recommendation tool for ornamental crops and fruits and vegetables.
K+S	K+S partnered with the pan-African fintech company MFS Africa in a joint venture to invest in Akorion, an agritech company in Uganda to promote its EzyAgric App across Africa and connect small farmers to markets. ⁹⁴ K+S and Spacenus, an agri-tech start-up, agreed to collaborate on a smartphone-based tool to assess levels of nitrogen, phosphorus, potassium, sulfur and magnesium in crops to make relevant fertilizer recommendations. ⁹⁵
PhosAgro	PhosAgro-Region, a PhosAgro subsidiary, and Exact Farming partnered to build a digital system to provide recommendations for mineral fertilizers based on crop conditions.
Mosaic	Mosaic partnered with Indian agri-tech start-up Unnati to digitalize the retail channel, enable payments and credit flow to retailers. Unnati will also enable retailers to source products, engage with farmers directly, and extend credit. It will also train retailers to enable farmers to sell their farm output through Unnati's tech platform. ⁹⁶ Mosaic also partnered with Instagro in Brazil, an online selling platform to sell its inputs to small farmers. ⁹⁷
Uralkali	Digital Agro is a subsidiary of Uralchem and provides precision fertilizer application services, as well as crop inspection (scouting) with its digital services; Digital Agro, Agrosignal and Cognitive Pilot (joint venture of Sberbank and Cognitive Technologies Group that sells an AI-based driving system for farm equipment) entered a strategic partnership to develop a unified digital-ag platform to accelerate the digitalization of Russian farming.

Big Ag Bets on a Great Green Input Upsell.

As fertilizer usage has come under increasing scrutiny for its environmental impacts, the industry is hunting for ways farmers can reduce input volumes without reducing company profits. Yara, which claims to be the world's largest nitrogen fertilizer producer,⁹⁸ imagines new ways of doing business amid climate-change pressures: “New models can include outcome-based business models, new pricing models, such as subscriptions or charge per hectare, or *establishing low-carbon, organic and organo-mineral offerings* which we do not have today.”⁹⁹

Using microbes to deliver nutrients and to protect from plant-pests is increasingly seen as a green alternative/supplement to synthetic fertilizers and agrochemicals. Companies are betting that “microbial solutions”¹⁰⁰ can give them an additional and unproblematic revenue stream – one that ticks all the boxes: environment-sustaining, profit-sustaining and climate-smart.¹⁰¹ Microbe-based inputs (“microbials” or “bioinoculants”) are products derived from living organisms that could, their promoters claim, confer increased nutrient-bio-availability or pest-resistance to crops. And they aren't new: beginning in the nineteenth century, certain rhizobacteria have been added to soils with an aim to boost crops' nitrogen uptake. And the pest-controlling bacterium *Bacillus thuringiensis*, or Bt, has been used in agriculture (including organic agriculture systems) for more than a half-century. Now, so-called superweeds – that have acquired resistance to traditional chemical pesticides – are spurring companies to take a second look at microbials. Such technologies could also, claim their promoters, reduce the agriculture sector's greenhouse gas emissions. Big Data processing-capacity can speed up the identification of potentially-potent microbes, while new technologies – such as synthetic biology and gene-editing – can allow naturally-occurring microbes to be “genetically remodelled”¹⁰² to tailor them to work with particular crops and/or soils.

The market for bio-based agricultural inputs is comparatively tiny – just US\$1.5 billion for bio-fertilizers in 2020¹⁰³ and US\$4 billion for bio-control (pesticide) products,¹⁰⁴ according to agribusiness consultancy IHS Markit – but future prospects are bright, with growth expected to be at least 10% and 12% annually over the next several years.

Start-ups are developing new microbial products that can be added to soils, incorporated into seeds or sprayed on crops in the field. Companies work on their own or in collaboration with the biggest industrial ag players. Bio-fertilizer R&D largely focuses on improved nitrogen fertilizer efficiency and uptake. US-based **Kula Bio** claims to have developed a nitrogen-fixing microbial that can replace up to 100% of conventional nitrogen fertilizer;¹⁰⁵ the start-up has raised more than US\$72 million in venture capital, including from AgFunder.¹⁰⁶ **Pivot Bio** sells a nitrogen-fixing microbial for corn; Pivot Bio's funders include **Breakthrough Energy Ventures** (backed by Bill Gates, Jeff Bezos, Jack Ma, Mukesh Ambani, Mark Zuckerberg, George Soros and other billionaires) as well as grain-trading giants **Bunge** and **Continental Grain**.¹⁰⁷

Mosaic and **BioConsortia** began collaborating in 2020 to develop nitrogen-fixing microbials; the collaboration also gives Mosaic access to BioConsortia’s pipeline of microbial products that solubilize phosphorus and potassium, which could be marketed alongside traditional fertilizers that Mosaic already sells.¹⁰⁸ **Yara** is collaborating with **Boost Biomes**¹⁰⁹ to “identify microbial products with important commercial roles.”¹¹⁰ **Bayer** has invested in US-based **Andes**,¹¹¹ which makes a microbial seed treatment for nitrogen fixation, and it has a joint venture with **Gingko Bioworks**, called **Joyn Bio**, to develop a microbial that allows crops to grab nitrogen out of the air.^{112, 113} Other companies focus on biocontrol. A decade ago, **Novozymes**, the world’s largest enzymes producer, partnered with **Syngenta** to develop a microbial fungicide for fruits and vegetables, now on the market as Taegro. Novozymes’ collaboration with **Bayer** (then **Monsanto**) began in 2014. Their exclusive partnership, “AgBio Alliance,” is now defunct,¹¹⁴ but Novozymes continues to partner with Bayer and with other agchem and fertilizer giants to help them supplement their traditional offerings. Novozymes is working with **FMC** to develop a microbial product to fight Asian soybean rust,¹¹⁵ and **UPL** now sells Novozymes’ microbials in South America.¹¹⁶ **AgBiome**, a microbial developer backed by the Gates Foundation, has partnered with Syngenta¹¹⁷ and **BASF**¹¹⁸ to develop and sell similar microbe-based, bio-control products.

Microbial products are largely unregulated¹¹⁹ – companies don’t have to prove they work to sell them, for example – and many appear to perform differently in the field from in the lab.¹²⁰ What’s more, while microbial products are “based on”¹²¹ naturally-occurring microbes, it’s not clear in what ways the new (and proprietary) microbial strains on the market differ from their natural counterparts living in the environment. Syngenta claims, for example, that its branded microbial bio-fungicide Taegro, “based on *Bacillus amyloliquefaciens*,” has been certified for use in organic agriculture systems.¹²² But what does it mean for a proprietary product to be “based on” a known and naturally-occurring microorganism? To what extent has it been tweaked, and what are the toxicology implications of those tweaks? As scientists have pointed out, some species of organisms used in microbial agricultural inputs are known to act as opportunistic pathogens.¹²³ When new technologies like gene-editing are involved, the regulatory landscape and the biosafety implications get even more muddled.¹²⁴ Scientists have warned that introducing microbial strains in the environment – especially ones that aren’t well understood and/or are “remodeled,” gene-edited versions of natural strains – raises biosafety concerns.¹²⁵

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Livestock genetics



The **Livestock Breeding/Genetics** sector focuses on breeding material (e.g., live animals, semen, embryos) and reproductive technologies for industrial production. The dominant species include chickens, turkeys, pigs, cattle, and high-value farmed fish and seafood (salmon, tilapia, trout and shrimp). The industry typically selects for genetic traits to maximize production (i.e., rapid growth and high yields) and to facilitate production, processing and transport of uniform animal protein products on a massive scale. Industrial breeds can't survive without high-protein feeds, expensive medications and climate-controlled housing.

Leading Livestock Genetics Companies, 2020

Company/ Headquarters	Ownership and 2020 Sales, US\$ million, where available	Species Activity / Subsidiaries
CP Group (Thailand) Charoen Pokphand Group Co., Ltd. is the major shareholder of Charoen Pokphand Foods (CP Foods)	The Chearavanont family, owners of CP Group, rank among the richest families in the world. CP Foods reported sales of 18,867 in 2020. ¹	One of the world's biggest industrial ag firms, including breeding, production and processing of poultry, pigs and shrimp. Operates in China, Vietnam, Taiwan, India, Turkey, Russia, Cambodia, Philippines, Laos and Poland.
Tyson Foods (USA)	Publicly-traded; 43,185 (all segments); Tyson doesn't report its genetics revenue separately; total chicken segment revenue 13,234 ²	Giant, vertically-integrated meat grower & packer. Cobb-Vantress subsidiary is leading breeder of chicken broilers; production capacity 47 million chickens per week (2021). ³
Mowi (Norway)	Publicly-traded; 4,288 ⁴	World's largest producer of Atlantic salmon (estimated 20% global market share). Mowi claims "full internal control of our own genetics." ⁵ Presence in 25 countries, 12,000 employees.
EW Group GmbH (Germany)	Private, family-owned holding group with 277 companies. EW Group generates an estimated 3,250 in annual sales (all companies). ⁶	World's largest poultry breeding and genetics firm. Broilers/turkeys: Aviagen and its subsidiary, Hubbard . Layers: Hy-Line International ; acquired Novogen from Groupe Grimaud, 12/2021. Leader in aquaculture genetics, especially salmon, trout, tilapia. AquaGen , farmed salmon and trout breeding. Largest tilapia breeder: GenoMar Genetics , Aqua-bel , AquaAmerica , AquaPorto , Vaxxinova .

Genus, plc (UK)	Publicly-traded, 708 ⁷	Swine and cattle genetics; acquired 39% stake in Xelect , aquaculture genetics company; acquired Sergal (boar genetics).
Groupe Grimaud (France)	Private	Specialty poultry, rabbit breeds. Choice (swine division) present in 37 countries. Blue Genetics (shrimp genetic selection).
Hendrix Genetics (Netherlands)	Private; 50% owned by private equity firm Paine Schwartz, with investment from Mitsui & Co. (Japan)	Turkeys, layers, traditional poultry, swine, salmon, trout and shrimp. Brands include: Hybrid, ISA, Dekalb, Bovans, Shaver, Babcock, Hisex, SASSO, Hypor, Kona Bay, Troutlodge and Landcatch . More than 3,500 employees; operations in more than 25 countries.

Source: ETC Group, from company reporting and industry news

Trends: chew on this

ETC finds:

- Ever increasing concentration in livestock genetics; multi-species breeders and private equity firms flock to aquaculture and fish genetics.
- China's supersized stake in livestock production/consumption/genetics.
- Widespread applications of digital technologies; genomics and gene editing research.

Despite the explosive growth in animal protein consumption worldwide and the massive contribution of industrial livestock to greenhouse gas emissions, very few are monitoring the degree to which a handful of transnational firms supply the breeding stock and reproductive technologies for an ever-increasing share of the world's industrial meat, milk, eggs and farmed fish/seafood.

Smaller and less visible than any other sector of the industrial food chain, the global market for livestock genetics will reach an estimated US\$8.9 billion by 2024.⁸ However, market intelligence on this sector is notoriously unreliable because many of the biggest players are privately held, highly secretive and rely on proprietary genetics. The threat of virulent diseases (e.g., highly pathogenic avian influenza, African swine fever) also requires stringent biosecurity measures that further shroud the livestock genetics industry in secrecy.

Globally, the widespread adoption of industrial livestock genetics is the primary driver of the loss of farm animal genetic diversity. With the introduction of industrial breeding stock, native animals are subject to rapid replacement or genetic dilution.

Although the value of the livestock genetics sector is relatively tiny (less than one-fifth the size of the global seed industry, for example), its proprietary genetic

stock underpins a massive animal protein industry that has far-reaching impacts on greenhouse gas emissions and the environment (including water and soil pollution and the import of feed from countries with high levels of deforestation), livestock diversity, animal welfare and more. In this report we focus on three sub-sectors of industrial livestock genetics: poultry, swine and aquaculture.

INDUSTRIAL POULTRY BREEDERS

With an estimated market value of US\$311 billion in 2020, poultry is the world’s most popular animal protein, and consumption is growing at a faster rate than any other animal protein sector.⁹ Analysts predict that the poultry meat market will hit US\$422 billion by 2025.¹⁰ Globally, poultry is expected to account for 41% of all the protein from meat sources by 2030.¹¹

Poultry: Who Rules the Roost?

Commercial Poultry Genetics – Leading Companies by Sector, 2020

Broilers



Layers



Turkeys



EW Group (Germany)
Hendrix Genetics (Netherlands)
Tyson Foods (USA)

EW Group (Germany)
Hendrix Genetics (Netherlands)
Novogen (France) –
acquired by EW Group in 2021

EW Group (Germany)
Hendrix Genetics (Netherlands)

Source: ETC Group

Globally, just three companies control commercial poultry genetics, making it the most concentrated sector in the industrial food chain.

EW Group and **Hendrix Genetics** are both family-owned dynasties that focus on multi-species livestock genetics. (As of November 2021, Hendrix Genetics is 50% owned by private equity firm Paine Schwartz Partners.¹²)

Tyson Foods (US\$43 billion sales, 2020¹³) is the world’s 5th largest food & beverage firm, and its wholly-owned subsidiary, **Cobb-Vantress**, is one of the world’s three largest chicken meat (broilers) breeders.

Layers (chickens raised for eggs)

Two privately-held companies dominate worldwide:

(1) EW Group’s **Hy-Line Genetics**; 2) **Hendrix Genetics**. The third multinational breeder of layer genetics, **Novogen** (formerly owned by France-based Groupe Grimaud), was acquired by EW Group in December 2021.¹⁴

China, the world's largest egg market, accounts for more than 40% of world egg production. In 2009, China's small farmers, not factory farms, produced over 75% of China's eggs.¹⁵ Today, China's layers are rapidly industrializing. The vast majority of China's breeding stock for industrial laying hens comes from EW Group and Hendrix. In 2019, EW Group's Hy-Line Genetics estimated that its genetics accounted for a 60% share of the total Chinese layer market.¹⁶

Broilers (chickens raised for meat)

Two companies dominate industrial breeding worldwide: 1) **Tyson Foods** subsidiary: **Cobb-Vantress**; 2) EW Group (subsidiaries: **Aviagen**; **Hubbard**). In 2020, China produced 18.6 million metric tons of chicken, virtually all of it sourced from imported breeding stock.¹⁷

Turkeys

Two companies overwhelmingly dominate: **Hendrix Genetics** and **EW Group**. Smaller breeders that specialize in heritage breeds exist, but they do not compete on the same scale. The global turkey meat market peaked at almost US\$13 billion in 2019. The U.S. accounts for about 45%, by volume, of worldwide production.¹⁸

Market Concentration in Poultry Genetics Breeds Dependence & Vulnerability

- Some countries and even continents depend on just two industrial breeders to provide the genetic stock for their chicken broiler industry.¹⁹ According to Australia's Chicken Meat Federation, "almost all" of the country's broilers are based on two hybrid strains (commonly referred to as Ross and Cobb) that are owned by two companies (EW Group and Tyson, respectively).
- Even countries that are self-sufficient in production of chicken meat recognize that their dependence on imported breeding stock raises serious food security concerns. In 2020, Russia imported 98% of its broiler breeding stock from multinational firms.²⁰ Already in 2020, the Russian government feared "that possible sanctions affecting the import of cross-breeds could drive the Russian poultry industry to the edge of collapse."²¹
- In 2020, China produced 18.6 million metric tons of chicken, virtually all of it sourced from imported breeding stock. In December 2021, Chinese breeders unveiled three new domestically bred varieties that they hope will end the country's 17-year reliance on imported genetic resources.²²

Industrial livestock genetics is penetrating all regions of the globe, even under the guise of "sustainable agriculture." For example, in some African and Asian countries, where indigenous birds still account for up to 80% of the poultry population, imports of poultry breeding stocks could be imminent.²³ In 2019 Hendrix Genetics was awarded a multi-year grant from the Bill & Melinda Gates Foundation for the Sustainable Access to Poultry Parental Stock

to Africa (SAPPSA) program.²⁴ The goal is “to provide better breeding stock and genetic solutions” for poultry farmers in Sub-Saharan Africa (e.g., Mozambique, Zambia, Zimbabwe, Burkina Faso and more). According to Hendrix, the company provides disease-free breeding stock and instruction on how to build biosecure poultry housing that will allow for export of quality genetics.²⁵ The project claims that it will introduce crossbreeds that are suited to challenging environments²⁶ and even contribute to achieving the UN’s Sustainable Development Goals.²⁷ The concern is that the introduction of imported stock and technologies will ultimately create greater dependence on capital intensive inputs, marginalize local livestock producers and accelerate the loss of indigenous breeds.

Fast-Growing Broiler Breeding Backfires

Today’s industrial chicken broilers have become the world’s most prolific and popular protein. But industrial breeding is also undermining the birds’ fitness. The consolidation of industrial chicken breeding in the hands of just two companies has resulted in two fast-growing hybrid lines that account for 90% of all broiler chickens worldwide: 1) EW Group’s Ross 308; and 2) Tyson’s Cobb 500.²⁸ Despite their spectacular feed-conversion rates, the altered genetics of these birds has spawned a number of physical maladies that degrade the texture of chicken meat and harm animal welfare.²⁹ Many industrial chickens (including both Ross and Cobb) suffer from muscle myopathy, resulting in conditions such as “spaghetti breast,” “woody breast” and “white striping disease.” When the birds gain weight too quickly their circulation systems can’t keep pace. Portions of the breast become dead tissue because they don’t have adequate blood supply. Woody breast syndrome causes muscle tissue to harden. (In 2016, the *Wall Street Journal* reported that 5-10% of boneless chicken breast fillets worldwide were affected by woody breast.)³⁰ Spaghetti breast results in soft and mushy muscle fibre that comes apart in stringy sections. When birds are affected with these muscle disorders, the low-quality meat must be discarded or sold at a discount. Some heavy, large-breasted birds are developing an additional health problem: subcutaneous cellulitis, a condition that results from sitting in damp manure.³¹ Food processors are now under increasing pressure from the public to sell “humanely raised meat” – including demand for “slower growing broilers.” But it takes time to modify global flocks; according to one industry spokesperson, there’s a three-to-five-year gap between genetic selections made at the pedigree level and the chicken on your plate.³²

The Weakest Link

Almost 10 years ago, FAO warned that “livestock health is the weakest link in our global health chain.”³³ Over 70% of novel human diseases that have emerged in recent decades are of animal origin,³⁴ and factory farms are incubators for zoonotic diseases (those transmitted from animals to humans). The genetically-uniform traits that underpin the spectacular growth of industrial livestock breeds is precisely what makes these flocks and herds exceptionally vulnerable to disease outbreaks. One veterinarian describes the threat of avian influenza to industrial chickens: “They all have the same immune system, or lack of an immune system, so once a virus gets inside a barn, it’s going to spread like wildfire.”³⁵ If a virus that emerges on a factory farm mutates, it can pose dire threats to human health. A 2018 study examining the emergence of 39 highly pathogenic avian viruses found that all but two came from industrial poultry farms.³⁶

Gene Editing for Ethical Eggs?

Gene editing research is underway in the poultry sector worldwide, especially related to the development of vaccines (e.g., avian influenza, Marek’s disease and infectious bursal disease). To sidestep public resistance to a controversial genetic engineering technology, advocates of gene editing are touting it as the key to improving animal welfare for factory farm animals.³⁷ Ironically, this means addressing standard industry practices that are now deemed “unethical.” For example, the layer chicken industry disposes of 4 billion day-old male chicks per year.³⁸ Research teams in the UK, Australia and Israel are exploring the use of CRISPR gene editing to control the sex of chicken offspring to dramatically reduce culling in the poultry industry.³⁹ If hens produce only female chicks, it would prevent the killing of billions of unwanted, day-old male chicks that are culled after hatching.⁴⁰ Germany and France have already passed laws to ban the culling of day-old chicks beginning in 2023. However, alternative methods of embryo sexing (e.g., sorting based on sex hormones; MRI scans) are being developed that do not involve genetic engineering.⁴¹

INDUSTRIAL SWINE GENETICS

Most swine genetic companies are privately-held, with limited financial disclosure requirements. That makes it hard to assess company-level performance and the sector’s level of concentration. The UK’s **Genus Plc**, which owns PIC (Pig Improvement Company) and is among the few publicly-traded animal genetics companies, claims 16% global market share for pig genetics.⁴² Just like poultry breeders, pig breeders rely on a narrow range of uniform breeds to facilitate increasingly intensive livestock operations (because uniform breeds imply uniform feed and infrastructure requirements).⁴³

Pig Virus Provides Pandemic Preview

In January 2020, when WHO began reporting on Covid-19, a highly transmissible and potentially deadly virus circulating in China,⁴⁴ the country's pork industry had been dealing with its own highly transmissible virus for more than a year. African Swine Fever (ASF) – a hemorrhagic disease in pigs that is almost always fatal – broke out in August 2018 and quickly spread; there is no vaccine and no effective treatment for ASF. The virus decimated China's pig population. In the first year of the virus outbreak, researchers estimate that more than 43 million pigs in China died of ASF or were culled to prevent AFS-transmission.⁴⁵ By the time the epidemic was (mostly⁴⁶) reined in, in 2020, the toll amounted to as much as 60% of China's pig herd.⁴⁷ The world's biggest pork-consuming and pork-exporting country responded to the crisis, first, by securing imports for domestic consumption, then by restocking its breeding herd to recoup production capacity – at an estimated cost of US\$60 billion.⁴⁸

Throughout 2020, thousands of breeding sows and boars flew to China by chartered plane; it was a welcome lift to an airline industry languishing due to Covid-related travel restrictions.⁴⁹ China's record imports brought rewards for the biggest pig breeders outside China, though not indefinitely. **Axiom** (France), **Genus Plc** (UK), **Topigs Norsvin** (Netherlands) and **Genesis** (Canada) exported in record numbers; at the same time, Chinese companies began expanding their own production-capacity as pork prices peaked in late 2019 and early 2020.⁵⁰ By September 2020, China's **Muyuan Foods** had opened the world's largest pig production facility near Nanyang. The multistorey site can house 84,000 sows and aims to produce more than 2 million pigs per year.⁵¹

Fattening China's Pig Farms

The ASF epidemic also catalyzed a drastic reduction in the number of China's small-scale, family-owned pig farms,⁵² a shift that had been on the government's agenda before the ASF outbreak and was already underway.⁵³ Just before the turn of this century, China was home to more pig diversity than any other country (with 72 breeds),⁵⁴ but, by 2005, 74% of China's pigs were raised in industrial systems.⁵⁵ With industrialization, one hybrid breed replaced breeds of different sizes and attributes previously raised on small family farms.⁵⁶

In 2021, Canada's **Genesis** updated its rankings of the world's top 40 "mega producers" – that is, pork producers with more than 100,000 sows – based on late 2020 counts.⁵⁷ China has more companies on the list than any other country (15 of the 40), including all of the list's top five: **Muyuan Foods**, **Wens Group**, **WH Group (Smithfield Foods)**, **Zhenbang Group** and **New Hope Group**; state-owned **COFCO** is #18. Five of the 15 Chinese firms are on the list for the first time, suggesting the breakneck pace of industrialization and the breathtaking speed with which China re-stocked its herd, with an aim to (eventually) wean itself from foreign

breeding stock. (**Genus Plc** claims it sells breeding material to one third of the top 50 pork producers in China⁵⁸ and receives royalties from its proprietary genetics based on “key performance variables,” such as pig weight at slaughter.⁵⁹) China’s blockbuster swine market enticed Thailand’s **CP Foods** to amass 43 swine-related firms in the country (39 swine farming operations and four pork processing companies) in a deal valued at more than US\$4 billion.⁶⁰ The acquisitions give CP Foods a capacity of 7.2 million pigs annually in 22 of China’s provinces.⁶¹ CP Foods’ massive investment in China follows its 2019 acquisition of Canadian pork processor **HyLife** for US\$272 million.⁶²

Smart Swine?

Pig farming’s intensification also intensifies challenges to feeding, containing, monitoring, processing and sanitation, and, of course, new technologies are proposed to help overcome those challenges. A package of artificial intelligence technologies that process massive amounts of data in real-time includes electronic tagging, facial and voice recognition (to identify distressed piglet squeals) and heat-sensing. AI packages – such as Alibaba’s “ET Agricultural Brain”⁶³ – are being used in the world’s biggest swine operations.⁶⁴

“Given the computation time, the data required, the hardware infrastructure needed, and the cost, it currently makes sense to utilize AI only if you are raising millions of pigs, not just one or two... The logic is striking. A demand for pork drives industrialized farming of pigs, which increases disease transmission. The constant emergence of diseases drives the implementation of new technologies like AI pork farming. These technologies go on to make pork cheap, driving even more availability and demand... AI is not the balm to any problem—it is just one piece of the ever-hungry quest for scale.” – from Xiaowei Wang, *Blockchain Chicken Farm and Other Stories of Tech from China’s Countryside*

While companies apply artificial intelligence technologies to enable bigger and bigger swine operations, some companies are also aiming to apply genetic technologies to alter the pigs themselves. New ‘gene-editing’ technologies like CRISPR-Cas9 make it possible to delete or rearrange pieces of an animal’s genetic material in order to ‘engineer’ particular traits, such as disease-resistance or heat-tolerance. Genus’s PIC has produced hundreds of gene-edited pigs – with thousands of progeny – that have been engineered to resist the virus that causes Porcine Reproductive and Respiratory Syndrome (PRRS). PRRSv is highly infectious and affects pig farms in the U.S. particularly.⁶⁵ While Genus reports that its edited pigs are making their way through the regulatory process in both the U.S. and China, company researchers admit that newborn edited piglets exhibit the ‘correct’ edit only about 20 to 30% of the time.⁶⁶

AQUACULTURE GENETICS / BREEDING

Industrial livestock breeders, as well as private equity investors,⁶⁷ are flocking to fish farming and genetics because aquaculture is booming worldwide, and the potential to apply genetic selection and genomics to high-value species is relatively untapped.

- Globally, since 2016, aquaculture has been the primary source of fish available for human consumption.⁶⁸ From 1990 to 2018, global aquaculture production shot up 527% and is projected to keep growing.⁶⁹
- The global aquaculture market was valued at an estimated US\$204 billion in 2020 and analysts predict it will reach US\$262 billion by the end of 2026.⁷⁰
- Asia is by far the world's largest and most diverse aquaculture producer, and China alone accounted for 58% of the global aquaculture volume and 59% of its value in 2017.⁷¹
- Multinational livestock genetics firms that conduct R&D in aquaculture are focusing on a handful of high-value aquaculture species: primarily salmon, shrimp, trout and tilapia. By contrast, aquaculture globally encompasses around 425 farmed species (fish, shellfish and seaweeds).⁷²
- Only 11% of the world's total aquaculture harvest is traded internationally,⁷³ and it focuses on relatively few species from just a handful of countries. Salmon, shrimp, catfish and tilapia collectively account for about one-third of internationally traded seafood by value, but only 8% of global seafood production.⁷⁴

Atlantic salmon is industrial fish farming's most profitable and high-tech superstar – generating an estimated US\$18 billion in annual sales.⁷⁵ Norway and Chile are the world's largest producers. Similar to terrestrial factory farms, industrial salmon operations have become massive breeding grounds for environmental pollution, diseases and parasites.⁷⁶

Big Data and Genomics

The application of genetics and genomics technologies to industrial aquaculture is the focus of both public and private sector research. Gene-editing (CRISPR Cas 9) experiments are underway worldwide, with most of the focus on traits such as faster growth, disease resistance and sterility.⁷⁷

One target of gene editing is the goal of developing parasite-resistant salmon. Industrial salmon operations worldwide are plagued by parasites that feed on fishes' skin and blood, causing lesions and mass mortality in crowded pens. A team of Canadian and Japanese researchers are focusing on genes that confer resistance to sea lice in wild Pacific salmon, with the goal of using gene editing to engineer the same trait in farmed Atlantic salmon.⁷⁸

Perhaps more fanciful, Chinese scientists are using gene editing to develop "bone free" carp species.⁷⁹ The prospect of "genetically filleted fish" is a complex, longer-term goal, but Chinese researchers have reportedly knocked out at least two genes that control boniness.⁸⁰

CRISPR Salmon with Reversible Sterility: AKA Terminator

Every year hundreds of thousands of farmed Atlantic salmon escape into the wild.⁸¹ The escape of salmon and the possible interbreeding with wild salmon threatens to pollute the wild gene pool and spread disease.⁸² One focus of gene editing is the development of salmon that are engineered to be sterile so that escapees can't interbreed with wild salmon. In addition to biocontainment, engineered sterility offers, in theory, the additional benefit of protecting the company's proprietary fish stock.⁸³ A team of researchers in Norway is using gene editing (CRISPR-Cas9) to knock out the "dead-end" gene in salmon, yielding salmon embryos that lack germ cells and are hence sterile. By injecting the genetically sterile embryos with messenger RNA technology, the scientists have successfully restored the fish's fertility – allowing for the development of fertile broodstock that will produce sterile offspring for hatcheries. The research opens the door to "a possibility for large-scale production of germ-cell free Atlantic salmon offspring through the genetically sterile broodstock, which can pass the sterility trait on to the next generation."⁸⁴ For ETC Group, and anyone familiar with the history of Terminator seed technology, the prospect of commercializing gene-edited salmon with engineered sterility genes is a nightmare scenario: the engineered sterility is reversible and cannot function as a reliable biocontainment tool.⁸⁵ The gene-editing research on salmon sterility in Norway is still in early stages and has not yet undergone ecological impact assessment, regulatory review or public debate. The aquaculture genetics industry is – thus far – skittish about publicly endorsing controversial genetic engineering technologies.⁸⁶

Industrial fish farms already employ a vast array of high-tech, data-intensive technologies at all levels of breeding, production and processing, including artificial intelligence and surveillance for biosecurity and tracing. For example, one of the world's largest salmon producers, Cermaq, is pioneering its iFarm in Norway that uses real-time facial recognition technology that reportedly allows identification of each individual salmon and ensures that the fish are healthy.⁸⁷ The technology is also designed to cut costs by monitoring sea lice.

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Machinery

for big ag



MACHINERY FOR BIG AG refers to manufactured equipment used in agriculture. This includes, for example, tractors, haying and harvesting machinery and equipment used for planting, fertilizing, ploughing, cultivating, irrigating and spraying. Today, the world's largest farm equipment companies are gearing up to control digital ag technologies and farm data as their number one strategy for expanding market share. Digitalised agriculture implies other machinery used down on the farm – drones, sensors and devices that run apps, for example – as well as internet connectivity.

Table 1: Sales of the Leading Farm Equipment Companies, 2020

Rank	Company (Headquarters)	Sales 2020, US\$ millions	% Market Share 2020
1.	Deere & Company (USA) ¹	22,325	17.5
2.	Kubota (Japan) ²	14,140	11.0
3.	CNH Industrial (UK/Netherlands) ³	10,916	8.5
4.	AGCO (USA) ⁴	9,150	7.2
5.	CLAAS (Germany) ⁵	4,609	3.6
6.	Mahindra & Mahindra (India) ⁶	2,480	2.0
	Total Top 6	63,620	49.8
7.	Iseki (Japan) ⁷	1,399	1.1
8.	SDF Group (Italy) ⁸	1,307	1.0
9.	Kuhn Group (Switzerland) ⁹	1,164	<1.0
10.	YTO Group (China) ¹⁰	984	<1.0
	Total Top 7 - 10	4,854	<4.1
	Total Top 10	68,474	<53.9
	Worldwide Farm Machinery Sales (est.)¹¹	127,800	

Source: ETC Group, based on company annual reports

According to the Mechanical Engineering Industry Association (VDMA) based in Frankfurt, the worldwide market for agriculture equipment reached US\$128 billion in 2020.

- The top 4 companies account for 44% of the global ag machinery market.
- The top 6 companies account for one half of the global ag machinery market.

In some regions and countries, farm machinery markets are even more consolidated.

For example:

- In the United States, just three companies – Deere, CNH and AGCO – account for more than 90% of high-horsepower tractor sales.¹²
- Mahindra & Mahindra controls more than 40% of India's farm equipment market.¹³

Trends: chew on this

ETC finds that the major trends in the industrial ag machinery market include:

- **Market Volatility**
- **A Push to Automate**
- **Drive to Digitalize Fuelling Ag Machinery Markets**
- **Continuing Battle over Who Owns and Controls Farm Data**
- **Drones Take Flight**

Market Volatility: A Bumpy Ride

In 2020-21, ag machinery markets experienced pandemic-induced volatility. After the cease fire in the China-U.S. trade dispute resulted in growing demand for corn and soybeans, US tractor sales revved up by double-digit percentages.¹⁴ In India, Mahindra & Mahindra saw its June 2021 domestic sales increase by 31% over the previous year,¹⁵ and the European Agricultural Machinery Association reported 25% more tractors registered across Europe in the first six months of 2021 compared to the same period in 2020.¹⁶

But supply chain challenges caused headaches. Big farm machinery manufacturers scrambled to keep up with new orders in 2021¹⁷ due to depleted inventory, shortages in labour and raw materials (including semiconductors¹⁸) and rising freight costs.¹⁹ In May 2021, Deere warned that the chip shortage

posed a significant risk and noted that raw material and freight costs would double for the year.²⁰ Nevertheless, in August, Deere forecast record net income for 2021, double its 2020 figure.²¹ Two months later, 10,000 unionized Deere workers went on strike to protest low wages and inadequate retirement benefits.²²

A Push to Automate

Pandemic-induced lockdowns and restrictions on the cross-border movement of migrant workers led to farm labour shortages, giving the ag equipment sector even more incentive to accelerate a long-promised shift to automation. According to global data platform for intelligence on start-ups, Dealroom, investment in farm robotics/automation start-ups, including vertical and indoor farms, jumped 40% from January to August 2020.²³ In 2020, Kubota unveiled its first completely autonomous tractor – dubbed “the dream tractor”²⁴ – and is now working with start-ups developing technologies for growing/harvesting crops that require a dextrous handling (fruits such as strawberries, apples, grapes, for example)²⁵ – an area the company views as especially ripe for automation.

Governments are supporting automation in agriculture, too. In 2020, the U.K. Research and Innovation agency awarded £2.5 million to a consortium of academic and private sector firms developing the world’s first robotic farm, dubbed “Robot Highways.”²⁶ The project claims that its autonomous tech will enable a 40% reduction in labour and help move the sector toward a carbon zero future.²⁷ In Thailand, the Ministry of Agriculture and Cooperatives established tech-focused subcommittees on Big Data, Smart Agriculture, E-Commerce and Agribusiness.²⁸ The government also developed “TraceThai,” a national, digitalized traceability system that will start with tracking organic foods.²⁹ Industrial agriculture is notorious for exploitation of farm labour and, contrary to companies’ claims, the current push to automate farm equipment threatens to amplify exploitation by increasing worker surveillance, pressures to meet inhumane machine-designated targets and the deskilling of workers.³⁰

Table 2: Selected acquisitions/investments related to automation and precision farming by Big Ag Machinery corporations (2019-2021)

Farm Machinery Company	Acquisition/Investment
Deere & Company	Acquired Bear Flag Robotics for US\$250 million to develop autonomous tractors; ³¹ Deere is collaborating with tech start-ups: Nori (carbon offset platform based on digital recordkeeping), Nvision Ag (data modelling and aerial imaging for corn farmers to manage nitrogen levels), Scanit (early detection of airborne pathogens), and Teleo (turning existing equipment into remote-controlled robots). ³²
CNH Industrial	Acquired precision agriculture pioneer Raven Industries for US\$2.1 billion; ³³ holds minority stake in Augmenta (automates farming operations); ³⁴ minority investment in US-based Monarch Tractors. ³⁵
CLAAS	Holds a minority stake in AgXeed (to build field robots). ³⁶
AGCO	Precision Planting, LLC (subsidiary of AGCO) acquired Headsight, Inc. (precision agriculture harvesting); ³⁷ acquired Farm Robotics and Automation S.L (“Faromatics”), a precision livestock farming company. ³⁸
Kubota	Bought an additional stake in Indian tractor manufacturer Escorts (total 15%); ³⁹ bought stake in Israeli start-up Tevel (flying autonomous fruit-picking robot); ⁴⁰ collaboration with Aurea Imaging (autonomous orchard and vineyard farming).
Mahindra & Mahindra	Acquired stake in Resson, a predictive data analytics company (other investors include Monsanto Growth Ventures and McCain Foods); ⁴¹ acquired a stake in Swiss agritech firm Gamaya (hyperspectral imaging, AI and machine learning algorithms). ⁴²

Drive to Digitalize Fuelling Ag Machinery Markets

“We are transforming from a machinery company into a smart technology company.” – Martin Kremmer, director ETIC, John Deere European Technology Center⁴³

“...[E]nvironmental narratives are legitimizing a digital transition in the food system that might otherwise raise critical questions about issues such as data sovereignty, increased surveillance and corporate control over farming practices.” – Louisa Prause, Sarah Hackfort and Margit Lindgren writing in *Agriculture and Human Value*⁴⁴

For all agriculture sectors – from livestock breeding and ranching to industrial farming – data is itself a precious commodity, which some have dubbed “the new soil” and others “the new cash crop.”⁴⁵ The farm equipment sector is no exception, and digitalization is driving the growth strategies of all the major companies.⁴⁶ (IHS Markit estimates that the global digital farming market was worth US\$5-7 billion in 2020 – less than 5% of the total farm equipment market – but is forecast to increase to US\$15 billion by 2027.⁴⁷)

With heaps of data on soil quality, weather, input levels – such as seeds, pesticides and fertilizers – farm equipment makers have refashioned themselves into tech companies.⁴⁸ Agricultural machinery now also implies drones,

sensors and robots equipped with artificial intelligence (AI) and/or machine learning capabilities to target individual plants or plots, with the promise of “precision” – just the right amount of water or fertilizer or pesticide: good for the crop, good for the environment and good for the farmer’s bottom line, go the claims. Deere & Company now employs more software engineers than mechanical engineers.⁴⁹

In reality, precision ag’s claims to save time, money and labour stand on shaky ground due to unequal digital access, a narrow focus on a few commercial crops, inaccurate GPS systems, sensors and other hardware and software components – especially algorithms – and the inability of these technologies to gauge complex farm realities, practices and micro-climates.⁵⁰

“Precision farming” can imply multiple technologies, including:

Robots for weeding,⁵¹ fruit and vegetable picking, irrigation, and spraying pesticides;

- **Drones** to scan soil fertility, to monitor crop health, to apply pesticides, herbicides and fertilizers, and even to plant seeds;⁵²
- **Sensors** (hyperspectral, multispectral, thermal and LiDAR) that capture information that may not be visible to the naked eye, such as soil moisture, plant stress levels, presence of weeds, or pests;
- **Data analytics** to process the gathered data in order to give recommendations on how, where and when to irrigate, apply pesticides and fertilizers;
- **Satellite imagery** to assess yields, crop damage, growth rates;⁵³
- **GPS (Global Positioning System) and BeiDou Navigation Satellite System (BDS)** for on-farm navigation of machinery;
- **Cloud providers**, making possible storage and processing of massive datasets;
- **Internet connectivity**, which underpins all the other technologies.

Ag machinery companies, together with agrochemical and seed industry firms, have successfully propelled the narrative that precision agriculture is the key to productivity, sustainability and climate resilience. Working hand-in-hand with industry, many national governments, philanthro-capitalists (e.g., the Bill & Melinda Gates Foundation) and the Consultative Group on International Agricultural Research (CGIAR, which has received more than US\$1 billion from the Gates Foundation⁵⁴) have embraced the drive to digitalize the global South and peasant agriculture.⁵⁵

Global collaborations, like the Agricultural Innovation Mission for Climate (AIM for Climate) launched at the UN’s 2021 Climate Conference (COP26) by the U.S. and U.A.E., are pushing “climate-smart agriculture,” advocating

for more investments in ag tech and on-farm data collection, and continuing extractive agriculture.⁵⁶ Even public sector techno-optimists are endorsing digital ag for the global South with scant empirical evidence of how these technologies may impact peasant farming communities.⁵⁷ In her budget speech for the financial year 2022-23, the Finance Minister of India declared that the “use of ‘Kisan Drones’ will be promoted for crop assessment, digitization of land records, spraying of insecticides, and nutrients.”⁵⁸ In the words of researcher Glenn Davis Stone, “there is significant movement towards surveillance-based, decision-appropriating technologies being developed and deployed for peasants in the global South.”⁵⁹

Some academics warn that the ability to “harvest new data sources” from peasant farmers will amplify the global land grab.⁶⁰ They explain that the extraction of previously-inaccessible, farm-level micro-data will allow better assessments of profit potential, thus accelerating land grabs in the global South.⁶¹

Table 3: Selected digital agriculture platforms of farm equipment manufacturers and inter-sector collaborations

Deere & Company	
Digital Ag Platform	Deere Operations Centre (farm management)
Some components	JD link (data transfer); John Deere Mobile Weather; Ag Logic (remote work management); Field and Water Management
Interoperability; Digital Ag collaborations	U.S. Agency for International Development, Corteva, John Deere and Global Communities work on precision ag in Zambia; data integration agreement between E-luminate, Golden Harvest’s (Syngenta’s corn and soybean seeds) digital ag platform and Deere Operations Center; ⁶² Deere, CLAAS, CNH Industrial and 365FarmNet formed a data interface project called Data-Connect that will enable farmers operating machinery from different cooperating brands to view and exchange machine data; ⁶³ partnered with Volocopter to develop an agricultural drone (VoloDrone) for agrochemical spraying
AGCO	
Digital Platform	Fuse; FendtONE (operating system) by Fendt (AGCO subsidiary)
Some components	AGCO Connect (machine focused telemetry software, yield monitoring system; AccuBoom (targeted spraying); Climate FieldView app (agronomy decision and visualization)
Digital Ag Collaborations	AGCO partnership with Climate FieldView; AGCO entered into a collaboration with Robert Bosch GmbH, BASF Digital Farming and Raven Industries Inc. to work on targeted spraying technology ⁶⁴
Kubota	
Digital Ag Platform	KSAS (Kubota Smart Agri System), cloud-based agricultural management support service
Some components	Plans to include fertilizer application, chemical spraying, and business support system ⁶⁵
Collaborations	Partnered with US Chipmaker Nvidia to develop self-driving farm tractors; ⁶⁶ partnered with Aurea Imaging for “crop intelligence” for fruit growers; ⁶⁷ Japanese subsidiary of Mahindra & Mahindra collaborated with Kubota for joint IoT solutions, OEM supply arrangements; ⁶⁸ collaborated with Microsoft to shift to its Azure cloud services; part of AGROS, collaboration between Wageningen University & Research and 26 private partners, including BASF

CLAAS

Digital Ag Platforms	CLAAS Connect; 365FarmNet (CLAAS Subsidiary); CLAAS E-Systems (CLAAS Subsidiary)
Some Components	CLAAS Telematics, BASF AgSolutions Finder (pesticide measures), Agopressure by Michelin (Components of 365FarmNet)
Collaborations	Bayer, CLAAS collaborate to expand Climate FieldView digital farming platform

CNH Industrial

Digital Ag Platforms	AGXTEND
Some components	CropXplorer (uses sensors for nitrogen application and other uses); FarmXtend (provides sensor-based detailed agronomic recommendations); SoilXplorer (soil sensors); NIRXact (Near Infrared sensors providing recommendations for application)
Collaborations	CNH Industrial partnered with AGCO, Bayer, Jacto, Nokia, Solinftec, TIM and Trimble under ConectarAGRO to push precision farming in Brazil; CNH Industrial, Accenture and Microsoft for increasing CNH's digital capabilities; ⁶⁹ partnered with DroneDeploy to deliver a packaged deal of a DJI drone/camera and the company's software for plant health analysis

Mahindra & Mahindra

Digital Ag Platforms	Krish-E (India); DigiSense 4G
Some components	Soil mapping, drone spraying, pest management
Collaborations	Mahindra & Mahindra's Japanese subsidiary, Mitsubishi Mahindra Agricultural Machinery Company and Kubota announced collaboration for Japanese domestic operations

Continuing Battle over Who Owns and Controls Data

The legal ownership of data collected on-farm is murky at best.⁷⁰ Deere, for example, has famously argued that when a farmer buys one of the company's tractors, they receive a "license to operate the vehicle" but they are not the owner of the equipment, the software embedded in it or the data generated by the equipment.⁷¹ By asserting themselves as the ultimate data-owners, farm equipment manufacturers seek to retain control of a product that itself has enormous value. This is also evident in the partnerships between the big agrochemical/seed companies and farm equipment manufacturers (see Table 3). These collaborations involve the sale or exchange of data, which are analysed to deliver prescriptions to the farmer – for example, which seeds to plant on which plot of land or the application rates of other inputs. The company that controls farm data is positioned to use its farm management platform to link the farmer to preferred products (i.e., its own and those of its partners). The immediate goal is to optimize sales on the company's platform. In the longer term, the ag machinery/tech firms are positioned to further usurp farmer autonomy and decision-making by creating technology lock-ins. For example, in order to qualify for credit or to meet food safety standards, farmers could be compelled to adopt particular precision ag technologies and products.⁷²

Additionally – and relatedly – equipment repair services are a profitable revenue stream for farm machinery manufacturers. Companies like Deere say

it's illegal for farmers or independent technicians to tinker with embedded software, which is considered proprietary. Equipment repairs are time consuming and costly for farmers, and waiting for a company-approved technician to show up at harvest time can mean tens of thousands of dollars in lost income. The “Right to Repair” movements across the world are fighting against manufacturers like Deere (as well as Apple and Tesla) that want to prevent farmers/consumers from fixing the products they've bought. Anti-trust researchers believe that Deere's aggressive attack on the right to repair demonstrates the company's attempt to monopolise the market for digital agricultural information.⁷³ In July 2021, the Biden administration took steps to push back on the manufacturers' anti-competitive repair restrictions in the U.S., but the new rules are still being written.⁷⁴

Drones Take Flight: Bedrock of Digital Ag is in the Sky

*“I am the eye in the sky
Looking at you
I can read your mind...”* – from “Eye in the Sky,”
lyrics by Eric Woolfson, Alan Parsons

Cameras and other sensors attached to drones function as the eyes of the digital ag-machine bundle. Sensors can map terrain and capture detailed images of farmland, and drones can shoot seeds in the ground and spray chemicals on crops. In some cases, drones are being used in “precision ranching” to track cattle and monitor health.⁷⁵ The leading farm equipment manufacturers have become drone devotees, especially through collaborations with other, drone-centred companies: Deere & Company has partnered with Volocopter to develop a drone (VoloDrone) for agrochemical spraying;⁷⁶ CNH Industrial teamed up with DroneDeploy to deliver a packaged deal of a DJI drone/camera plus DroneDeploy software to assess plant health analysis (with the capability to zoom in to “inches above the plants”);⁷⁷ and Kubota has recently invested in fruit-picking drone company Tevel.⁷⁸

Seeds and agrochemical companies, too – Bayer, Corteva AgriScience and BASF, for example – are partnering with (mostly private) drone hardware manufacturing companies like DJI (the largest seller that accounts for about 70% of the drone market),⁷⁹ XAG⁸⁰ and Delair⁸¹ (see Table 4). AGCO manufactures its own drones while Mahindra & Mahindra is expected to launch ag-drones soon after getting conditional permission from the Civil Aviation Ministry of India to conduct drone-based agricultural trials and precision spraying on paddy and hot pepper crops in Telangana and Andhra Pradesh, respectively.⁸²

Whose ag-drone software will dominate has not yet become clear: Slanrange,⁸³ Taranis,⁸⁴ PrecisionHawk,⁸⁵ FarmLens (owned by AgEagle) and Climate Corporation (owned by Bayer) all sell programs that analyze agricultural data to provide input recommendations to farmers.

Table 4: Partnerships between Drone Manufacturers, Ag Input Companies and other actors

Drone company	Partnerships
XAG (China)	XAG partnered with Bayer and Alibaba Rural Taobao to form the “Sustainable Farming Programme” in China focused on digital ag; ⁸⁶ with Bayer to commercialize digital farming technology in Southeast Asia & Pakistan (SEAP); ⁸⁷ with Federal University of Paraná (UFPR), Brazil and Timber to plant trees; ⁸⁸ with The National Centre for Precision Farming, Harper Adams University, U.K. to develop drones and robotics for UK and European farmers ⁸⁹
AgEagle Aerial Systems (USA)	BASF ’s xarvio FIELD MANAGER integrated with AgEagle’s senseFly’s eBee X fixed-wing drone platform; ⁹⁰ (AgEagle acquired senseFly from Parrot in 2021 ⁹¹)
DJI (China)	With Syngenta Japan to promote ag drones in Japan; ⁹² CNH Industrial and DroneDeploy sell a packaged deal of a DJI drone/camera plus software for plant health analysis; an agreement with Syngenta Korea to be its sole drone partner, and to promote jointly aerial pesticide application in South Korea; ⁹³ Corteva owns a fleet of 400 DJI drones ⁹⁴

Unsurprisingly, Big Tech has already beefed up its involvement in digital agriculture. Gartner, a technology-focused consultancy, calculates that spending on cloud services will reach nearly 10% of all corporate spending on information technology in 2021, while Andreessen Horowitz, a venture-capital firm, estimates that many tech start-ups already spend 80% of their revenues on cloud services.⁹⁵ The proliferation of digital ag companies is a gold mine for Big Tech, which will sell cloud services to enable massive volumes of agriculture-related data to be stored and processed. BASF⁹⁶ and Bayer⁹⁷ use Amazon Web Services (AWS) to process and analyse data on their digital platforms while Syngenta, Corteva Agriscience and BASF use Google Cloud services (via their collaborations with DroneDeploy⁹⁸ and Taranis⁹⁹). The cloud services market is tightly consolidated: AWS held 41% of the cloud services market in 2020, and the top five cloud service providers accounted for 80% of the market.¹⁰⁰ More than half of Amazon’s operating income comes from AWS.¹⁰¹

Notes

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Animal pharma



Animal Pharma The animal pharmaceutical industry (also known as the animal health industry) sells commercial products for livestock productivity/health and companion animal (pet) health, including medicines and vaccines, diagnostics, medical devices, nutritional supplements, veterinary and other related services. This sector does not include livestock feed and pet food products (although in some cases it may include medicated feed additives).

Leading Companies by Animal Pharmaceutical Sales, 2020

Rank	Company / Headquarters	Animal Health Sales, \$US millions	% global market share
1.	Zoetis (USA) ¹	6,675	19.7
2.	Merck & Co. (USA) ²	4,703	13.9
3.	Boehringer Ingelheim Animal Health (Germany) ³	4,699	13.9
4.	Elanco (USA) + Bayer Animal Health (UK) ⁴	4,400 <i>pro forma</i>	13.0
Total Top 4		20,477	60.5
5.	IDEXX Laboratories (USA) ⁵	2,532	7.6
6.	Ceva Santé Animale (France) ⁶	1,344 [2019]	4.0
Total Top 6		24,353	72.1
7.	Virbac (France) ⁷	1,065	3.2
8.	Dechra Pharmaceuticals PLC (UK) ⁸	661	2.0
9.	Phibro Animal Health Corporation (USA) ⁹	527	1.6
10.	Kyoritsu Seiyaku Corporation (Japan) ¹⁰	524	1.6
Total Top 10		27,130	80.5
Total World Animal Pharma Market¹¹		33,800	

ETC Group research, based on company reporting

According to Vetnosis, total worldwide animal pharma sales reached US\$33.8 billion in 2020.¹²

The top four firms control 60.5% of the global animal pharmaceutical market. The top six firms control 72% of the global animal pharmaceutical market.

The top four animal pharma companies are subsidiaries or spin-offs of the world's largest pharmaceutical companies. **Zoetis** is a spin-off of Pfizer; **Elanco**, now independent, was a spawn of Eli Lilly; **Boehringer Ingelheim Animal Health** and **Merck Animal Health** are subsidiaries of their respective parent companies.

Trends: chew on this

ETC finds that:

- **The animal pharmaceutical industry continues to consolidate.**
- **The pet-related market is driving industry growth; leading firms are competing to take a bigger bite of the “companion animal” sector.**
- **In both the companion animal and industrial livestock sectors, big data and digital services are targets of recent mergers and acquisitions.**
- **The animal pharma industry is embracing digital technologies – especially digital diagnostics/analytics, remote monitoring and identification/tracing services, and online vet services.**

Dog-Eat-Dog Consolidation: In August 2020, **Elanco** completed its US\$6.9 billion acquisition of **Bayer Animal Health**. In June 2021 Elanco announced its intention to acquire Kindred Biosciences, with the expectation that it will deliver a blockbuster drug for the billion-dollar pet dermatology market. In 2021, the world's leading vet pharma firm, **Zoetis**, announced it would acquire Jurox, an Australia-based animal health company.

Gone to the Dogs: Globally, the animal pharma industry derives an estimated 59% of its market from the food animal sector and 41% from companion animal products/services.¹³ Nevertheless, the “humanisation of pets” is driving the largest share of growth in the animal pharma industry – a trend that's accelerating during the global pandemic.¹⁴

The global market for the animal pharma industry was almost US\$34 billion in 2020, but US pet owners alone spent nearly three times that amount – a record US\$104 billion – on pet-related expenses in 2020 (ranging from food, toys, grooming and daycare, to vet-related services).¹⁵ In China, pet ownership increased by 300% from 2013 to 2019, and the pet economy shot up 400% during the same period.¹⁶ Another barometer of the surge in the pet economy is that 2021 saw 44 mergers and acquisitions in the pet food industry worldwide, a 75% jump over the previous year.¹⁷ Once unimaginable products and services (e.g., dating apps for pooches, pet massage treatments and doggie ice cream treats) are just the tip of the tail, and that’s precisely why the animal pharmaceutical industry is rapidly diversifying beyond the traditional boundaries of drugs and medical vet services.

Beyond Therapeutics: Animal pharma giants seek to become the one-stop-corporate-shop for pets and livestock health needs. They may not own the vet (yet), but these firms are competing to develop new revenue streams – beyond therapeutic products. The same company that sells animal meds and vaccines may now offer online subscription services for routine medical care and veterinary services; it may sell direct-to-consumer pet insurance or own the veterinary clinic and the diagnostic lab that determines what meds your animal needs. Ownership of all of these – and a growing suite of proprietary, high-tech, digital tools that analyze/diagnose and monitor animal health and industrial livestock performance – are rapidly consolidating in the hands of animal pharma leaders. Recent investments by the world’s largest animal pharma firms tell the story:

In April 2019 **Merck Animal Health** acquired Antelliq, a company focusing on digital identification, traceability and monitoring of livestock, for US\$2.4 billion. The self-described leader in “animal health intelligence and data expertise,” Merck has since established a separate business unit for its smart data products/services for animal ID, monitoring and traceability of livestock, fish and pets. Among Merck’s recent data-driven acquisitions:

- Sure Petcare, a suite of pet technology products that monitor the day-to-day activities of pets (feeding, sleeping, exercising) to indicate when a pet may need special care. Merck’s Sure Petcare offers veterinary hospitals a commission for each online sale that results from the vet’s recommendation of select Sure Petcare products.¹⁸
- Poultry Sense Limited, maker of digital tools to monitor and assess parameters of industrial flocks such as weight, water usage, humidity, light, temperature and carbon dioxide levels.¹⁹
- New Zealand-based Livestock Improvement Corporation Ltd (LICA) that specialises in automation and technology for dairy herds (i.e., milk-testing sensors that measure fat, protein, somatic cell counts, lactose, conductivity, and volume while a cow is being milked).²⁰
- IdentiGEN, a company that specialises in DNA-based animal traceability for livestock and aquaculture;

- Vaki, maker of real-time video monitoring for industrial fish farming;
- Quantified Ag, a data and analytics company that monitors cattle body temperature and movement in order to detect illness.

In 2020, **Zoetis**, the world’s largest animal health care company, launched a new pet insurance unit dubbed Pumpkin,²¹ a direct-to-consumer pet care and pet insurance company that enables customers in the U.S. “to make data-informed care decisions based upon their individual pet’s health needs.”²²

Animal pharma isn’t the only industrial food and ag sector drooling over the rapidly expanding market for pets. **Mars, Inc.**, the world’s sixth largest food and beverage processor, now makes more revenue from pet food and veterinary clinics/hospitals than it does from its chocolate candy bars and human food products. In 2017 Mars spent US\$7.7 billion to acquire VCA, a company that owns about 800 animal hospitals and vet lab businesses, and dog day-care franchises. Mars has since expanded its stable of veterinary businesses with acquisitions in Japan, Brazil and Europe²³ and owns more than 2,500 vet businesses globally.²⁴ Private equity firm IVC became Europe’s largest vet care provider with a buying spree of more than 1,500 veterinary practices – once considered a “cottage industry” in many countries.²⁵

- **Zoetis** has invested more than US\$2 billion since 2018 to acquire veterinary diagnostics (equipment as well as regional laboratories).²⁶ The ownership of veterinary labs in the U.S. is now tightly concentrated in the hands of three giant firms, with “relatively nothing left to acquire,” according to industry analysts.²⁷
- In 2020, **Zoetis** acquired cattle management software company Performance Livestock Analytics to help industrial feedlots analyze cattle feed efficiencies, evaluate costs and performance, and monitor health of individual animals.
- In early 2021, **Boehringer Ingelheim** announced the creation of Pawru, Inc. as a separate entity within the company’s animal health portfolio to expand its digital platform, including a mobile app that links pet owners with veterinarians for telemedicine appointments, prescription refills, messaging, pet health care content and more.²⁸

Notes

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Agricultural commodity trading



Agricultural Commodity Traders are diversified firms that produce, procure, process, transport, finance and trade grains, food, fibre, meat, livestock, sugar, etc. on a global scale. They are involved in all phases of production and trade, from origination¹ to processing, marketing, financial instruments, risk management and distribution. The colossal firms that control global commodity trading are among the most powerful and least-transparent companies in the industrial food chain. The total value of global agricultural commodity markets is difficult to estimate because much of the information is proprietary and supply chains are opaque: three of the world's top-ranking ag commodity traders are privately held, and one is state-owned.

Sales of the Leading Agricultural Commodity Traders, 2020

Rank	Company	2020 Sales, US\$ million	Company Profile
1.	Cargill (USA) ² Private	134,000	Largest privately held company in the U.S.; presence in 70 countries, 155,000 employees. Producer, distributor, processor, transporter of agricultural products including sugar, oils, grain, chocolate and meat and plant-based protein, as well as financial management.
2.	COFCO Corp (China) State-owned	105,000 <i>pro forma</i> 71,800 ³ (COFCO Group) + 33,000 (COFCO Intl) ⁴	In 2021, state-owned COFCO Corp (China National Cereals, Oils and Foodstuff) announced plans to merge its international trading division (COFCO Intl, Switzerland, 60% owned by COFCO Corp) with its domestic agribusinesses to create a new Chinese-owned commodity trading firm. In 2020, COFCO handled over 130Mt* of ag commodities. COFCO's core business is grain, edible oil, sugar and cotton, processing capacity of 90Mt/year and an annual port transit capacity of 65Mt. In China alone, COFCO has processing capacity of more than 60Mt. *See <i>note below this table for definition of Mt.</i>
3.	Archer Daniels Midland (ADM) (USA) ⁵ Public	64,000	The world's largest corn processor and diversified oilseed business, ADM procures crops from 449 locations, 32 feed and food processing operations, with 39,000+ employees. In 2020, ADM handled 54Mt of processed corn and oilseeds. Since 1994, ADM has partnered with Wilmar (#4) and holds a 22% stake in Wilmar.

4.	Wilmar (Singapore) ⁶ Public	50,530	Self-described as Asia's leading agribusiness group; Wilmar's agribusiness includes cultivation, milling, processing of palm oil and sugarcane; edible food products; animal feeds and industrial agri-products (e.g., oleochemicals and biodiesel). Operates more than 500 manufacturing plants throughout China, India, Indonesia and around 50 other countries, and has around 100,000 employees. Kuok Group (Malaysia) and ADM (USA) are major investors in Wilmar. ⁷
5.	Bunge (USA) ⁸ Public	41,400	Major oilseed processor and producer of specialty plant-based oils and fats. More than 23,000 employees; 350 facilities located in more than 40 countries. Traded 160Mt of ag commodities in 2020.
6.	Itochu (Japan) ⁹ Public	35,908	With operations in 62 countries, Itochu trades in textile, machinery, metals, minerals, energy, chemicals, food, real estate, information and communications technology, and finance. ¹⁰ Ag commodities and food account for approximately 38% of the company's revenues. ¹¹
7.	Louis Dreyfus (Netherlands) ¹² Private	33,600	Louis Dreyfus' business covers the entire agriculture and food value chain, and operates in more than 100 countries, with 17,000 employees. In 2020, Dreyfus sold a 45% stake in the company to a state-owned holding company in the United Arab Emirates (U.A.E.) managing US\$110 billion in assets. The sale included a long-term pact to ship food to the U.A.E.
8.	Viterra Group (Netherlands) ¹³ Private	28,114	Glencore Agriculture changed its name to Viterra in 2020. The trading firm is a strategic partnership between Swiss-based Glencore (49.9% ownership), CPP Investments (Canada) and British Columbia Investment Management Corporation (Canada). Viterra operates across 180 storage facilities, 31 processing facilities and 25 ports, with a shipping fleet and rail assets in strategic locations worldwide; 16,000+ employees, operates in 37 countries.
9.	Olam International (Singapore) ¹⁴ Public	24,701	Olam ranks among the 30 largest primary listed companies on the Singapore Exchange (based on market capitalisation). ¹⁵ With more than 81,000+ employees globally and operations in more than 60 countries, Olam's businesses include nuts, spices, dairy, coffee, cocoa, grains, animal feed and protein, edible oils, rice, cotton and financial services. ¹⁶
10.	Conagra (USA) ¹⁷ Public	11,054	Self-described as one of North America's leading branded food companies; Conagra's businesses include grocery and snacks, refrigerated and frozen food products, branded food products sold internationally, food services that include branded and customized food products.

Source: ETC Group, from company reporting.

*Note: Weights in the table are expressed in megatonnes (Mt). One Mt is one million metric tonnes, or one billion kilograms.

Together, the leading global food and ag commodity traders piled up more than *one-half trillion dollars in 2020 revenues*. Global trade in *all* agricultural products reached an estimated US\$1.33 trillion in 2019.¹⁸ The top ten ag commodity traders account for at least 40% of the global market. (However, the leading companies' market share, taking into account major grain crops and feedstuffs only, would be far greater.)

TOP 10 COMMODITY TRADERS



TOP 10 COMMODITY TRADERS
\$528,307 MILLION

GLOBAL MARKETS



SEEDS
\$45,000 MILLION



SYNTHETIC FERTILIZER
\$127,570 MILLION



AG MACHINERY
\$127,800 MILLION

Trends: chew on this

ETC finds:

- **Market volatility: Big Ag's commodity boom bonanza**
- **Consolidation continues**
- **Food security for sale**
- **Traders jump on the blockchain bandwagon**
- **Dangerous liaisons**

Market Volatility: Big Ag's Commodity Boom Bonanza

In 2020, market volatility and soaring demand for grains, oilseeds and meat meant turbo-charged profits for most of the world's leading ag commodity traders. Industry analysts describe Big Ag's commodity trading boom as a "mini-supercycle" – that is, a period where commodity prices rise above their long-term price trend – a cycle that could continue for the next 2-4 years.¹⁹ China is driving the worldwide demand for grain. In an effort to rebuild its pork production after a devastating outbreak of African Swine Fever, China was forecast to import 26 million metric tonnes of corn in the 2020-2021 season, up more than 240% from the previous year.²⁰

In its 2021 Annual Report, Cargill – the world’s titanic agricultural commodity trader – describes the challenges of the past pandemic year as “unprecedented, historic and unforgettable,” and “nothing short of extraordinary.”²¹ Extraordinary, perhaps, because in the midst of a global pandemic, deepening hunger crisis and supply chain gridlock, Cargill posted the biggest profits in its 156-year history – up 64%.²² The optics of record-breaking profits amid global chaos may be one reason that privately-owned Cargill discreetly announced in 2020 that it will no longer make its financial results public.²³



CHANGING CONCENTRATION IN THE AGRICULTURAL COMMODITY TRADING SECTOR

Consolidation Continues with Chinese Ag Trading Dynasty: In March 2021, state-owned COFCO Corp, China’s largest food company, announced plans to merge its international trading division, COFCO International (based in Switzerland), with its China-based agribusinesses to create a new, super-sized Chinese-owned commodity trading dynasty.²⁴ The Chinese merger creates a trading behemoth that will be second only to Cargill in global agricultural commodity sales, approaching over US\$100 billion in revenue per annum (see table).

Food Security for Sale: In November 2020, a family heir to Louis Dreyfus Company sold a whopping 45% stake of the firm to a state-owned holding company in the oil-rich United Arab Emirates (U.A.E.),²⁵ a move that starkly illustrates the geopolitics of global grain trading amidst climate chaos. As part of the deal, Louis Dreyfus enters a long-term pact to supply agricultural goods to the U.A.E. and marks the first time in the private company’s 170-year history for ownership to extend beyond the family. The U.A.E. currently imports over 90% of its food supply. As one industry analyst told the *Wall Street Journal*, “...they have the oil but what they don’t have is the foodstuff.”²⁶

The mass privatisation and financialisation of land (foreign control of productive farmland) is not new. Global land grabs are increasingly well-documented thanks to civil society organizations such as GRAIN and others.²⁷ The sale of 45% of one of the world's largest commodity firms, Louis Dreyfus, to a sovereign state signals a new era of “agro-security mercantilism.”²⁸ Cash-rich countries are positioning to climate-proof food security via offshore food production with little consideration for sustainability or the notion of regional food self-reliance. The Louis Dreyfus-U.A.E. deal suggests that climate chaos and supply chain uncertainty may accelerate efforts by cash-rich states to secure strategic food reserves via equity investments in Big Ag companies.

Teaming Up on the Blockchain Bandwagon

Six of the world's largest commodity firms (Cargill, ADM, COFCO, Bunge, Louis Dreyfus, Viterra) have joined forces to create a new digital platform called Covantis (a blockchain-powered digital ledger system) that was officially launched in March 2021.²⁹ The Covantis blockchain aims to digitalize and automate global agricultural shipping transactions; it will initially cover exports of corn and soybeans from Brazil before expanding to global trading operations. The six commodity giants that jointly own Covantis (based in Geneva) claim that the technology will streamline global trade transactions, increase transparency and security.

The private blockchain is a members-only business network. Although Covantis membership includes, by necessity, additional players in the global commodity shipping operations, the governance of Covantis is tightly controlled by its six corporate founders. The Board of Directors consists of one member from each of the six giant commodity trading companies, and the Board is chaired by one of the Directors (to be rotated annually).³⁰

According to Covantis, its blockchain is about “unlocking value through collaboration” and “removal of information silos.”³¹ But not everyone is sanguine about the prospect of competing firms that operate in an already oligopolistic market teaming up on a private blockchain.

Dangerous Liaisons? Legal scholars point out that, in highly consolidated markets, private blockchain technology could be used to engage in anticompetitive practices.³² With a distributed ledger shared by competing firms, each firm has access to everyone else's transaction data, such as prices and quantities. Some kinds of data sharing (e.g., price) could foster collusion such as price-fixing and bid-rigging. In this scenario, “competitors that form or participate in blockchain ventures might use price, cost, or out-put data to enter into unlawful horizontal agreements.”³³ It is also possible that participating firms could exclude others from access to the blockchain, impeding competition.

Other observers point out that blockchain technology, in theory, is designed to build trust among participants by increasing transparency; it eliminates

top-down control, and thus fosters decentralization of the economy.³⁴ With the appropriate regulatory policies, they argue, antitrust regulators would have an easier time monitoring transactions on a blockchain, and proof of collusion would be easier to document. It is also worth noting that blockchains, once thought “unhackable,” have been breached and are vulnerable to cybercrime.³⁵

Ultimately, cartel-like behaviour in oligopoly markets does not depend on blockchain technology. The world’s largest global commodity trading firms are no strangers to anti-competitive practices.³⁶ For example, in 1996, Archer Daniels Midland paid a US\$100 million fine after pleading guilty to price-fixing of food ingredients.³⁷ In 2004, Cargill agreed to settle for US\$24 million in a lawsuit that accused the company of conspiring with two other companies (Archer Daniels Midland and A.E. Staley) to fix prices of high fructose corn syrup.³⁸ The tip of the iceberg? Antitrust experts estimate that, in the post-World War II era, the percentage of *detected* cartels is only between 10% and 33%.³⁹

In 2018, Switzerland-based Public Eye published an in-depth study of commodity trading firms. It notes that the risk of tax dodging and corruption is high within agricultural production and trading firms, and that human rights violations are endemic, including forced and child labour, and occupational health and safety hazards.⁴⁰

Notes

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Big meat & protein



Big Meat/Protein The corporate meatpacking industry involves the slaughtering, processing, packaging and distribution of animal protein from cows, pigs, sheep, chickens, fish and other livestock. Increasingly, the industrial meat sector is also linked to the production of “alternative proteins” – i.e., high-protein foods processed from plants, insects, fungi, or via cell-culture or fermentation (synthetic biology) techniques – aimed at replacing or co-existing with conventional animal- and fish-based proteins on the market.

World's Leading Meat Companies, 2020

	Company (HQ)	2020 Food Sales, US\$ Millions	2019 Food Sales, US\$ Millions
1.	JBS (Brazil)	50,690	48,795 (Dec. 2019)
2.	Tyson Foods (USA)	43,185	42,405 (Dec. 2019)
3.	Cargill (USA)	32,375	31,700 (May 2019)
4.	Smithfield Foods / WH Group (China)	24,463	23,346 (Dec. 2019)
5.	Marfrig (Brazil)	13,107	12,658 (Dec. 2019)
6.	NH Foods (Japan)	10,655	10,878 (Mar. 2020)
7.	Hormel Foods Group (USA)	9,608	9,497 (Oct. 2019)
8.	Danish Crown (Netherlands)	9,294	8,472 (Sep. 2019)
9.	BRF (Brazil)	7,664	8,490 (Dec. 2019)
10.	Vion (Netherlands)	5,588	5,629 (Dec. 2019)

Source: Food Engineering Magazine, September 2021¹

Estimates of the value of the global market for meat can vary widely – from well below US\$1 trillion to more than US\$2 trillion² making calculating market share especially fraught. However, country-level and sector-level studies reveal high levels of concentration. In the U.S., for example, a recent Biden administration briefing states that “just four firms control approximately 55-85% of the market for [beef, pork, chicken].”³ In Brazil, just three companies account for well over two-thirds of all beef exports (and those same three companies dominate the domestic market).⁴

Trends: chew on this

Even with a global pandemic injecting volatility into markets and disruption into supply chains, the trends ETC Group identified in late 2019’s *Plate Tech-tonics* still hold:

- **Big Meat fattens up via mergers and acquisitions (M&As) and muscles into alternative proteins, including aquaculture.**
- **Climate chaos threatens profits...but meatpackers keep finding a way.**
- **Meat is still dirty business with “regular” instances of contamination, corruption and worker injuries/death.**

Since ETC Group’s 2019 survey (based on 2018 revenues), the meat sector as a whole has faced daunting challenges: due to a lack of safety protocols, thousands of slaughterhouse workers got sick with Covid-19 – hundreds died in the USA⁵ – forcing temporary plant shut-downs;⁶ though the pandemic increased consumer demand for beef on grocery shelves, shutdowns created backlogs at feedlots, which lowered prices for live cattle;⁷ worsening drought spanning all of North America forced ranchers to sell off cows at “fire sale” prices;⁸ a high-profile ransomware hack of JBS, the world’s largest meat processor and Brazil’s largest company by revenue, led to temporary plant shutdowns in Australia and USA (the company paid US\$11 million in bitcoin ransom);⁹ a 2019 outbreak of African Swine Fever in China decimated the country’s pork production (and continues to threaten it),¹⁰ while the spectre of avian flu continually hangs over the industrial poultry sector, with outbreaks reported in nine Indian states, and in other countries, in 2021.¹¹ Then there’s the “regular” pollution, corruption and contamination-related recalls associated with the sector.

Big Meat bulks up. Meatpackers must really be hurting, you might think. But think again: seven of the Big 10 posted *higher* food revenues in 2020 compared to pre-pandemic revenues,¹² and even where sales sagged, profits soared.¹³ (It was the ranchers and feedlot operators who suffered financially;

slaughterhouse workers suffered most – financially and physically.) Despite the pandemic, the biggest meat-exporting countries (i.e. Brazil, U.S., Canada, Russia, European Union countries and Mexico) shipped more meat in 2020 than they had in 2019.¹⁴

And after a brief lull, M&As regained momentum:

- In August 2021 **Cargill** (#3) and **Continental Grain Company** announced they're teaming up to buy U.S.-based **Sanderson Farms** for US\$4.53 billion; they plan to merge it with Continental Grain's poultry-processor subsidiary, **Wayne Farms**. Sanderson is the third largest poultry processor in the U.S.
- On a perpetual buying spree, it seems, Brazil's **JBS** (#1) dove into the seafood sector with a bid for **Huon Aquaculture**, Australia's second-largest salmon producer. (The US\$313.5 million acquisition hasn't been finalized as of this writing.)
- JBS dug deeper into the "plant-based space" in 2021, buying **Vivera**, a Netherlands-based meat substitute (soy and wheat) company, for US\$408.1 million. JBS already owns **Planterra Foods**, an alt-protein subsidiary launched in the U.S. in 2020.
- **JBS** also announced plans to buy the 20% of U.S. poultry producer **Pilgrim's Pride** it doesn't already own – just after Pilgrim's Pride announced its plan to acquire Ireland-based **Kerry Group's Meats and Meals** business for almost a billion dollars. (That deal was finalized in September 2021.)
- And **JBS** isn't done: the company made a US\$175 million bid for Australia's **Rivalea**, which accounts for 26% of the country's pork processing. Australia's Competition Commission expressed some "concerns,"¹⁵ but ultimately approved the deal.¹⁶ JBS is already Australia's largest beef processor.
- Through its subsidiary **JBS USA**, **JBS** bought US-based meat processor **Empire Packing Company** for US\$238 million in 2020.
- Brazil's other meat giant, **Marfrig** (#5), is buying a 33% stake in **BRF** (#9), Brazil's second largest poultry producer (behind **JBS**). Competition authorities greenlighted that deal in September 2021.

- **WH Group** (#4), the world's largest pork producer, battled African Swine Fever in its home country (China) – while company executives battled each other¹⁷ – but it still managed to acquire US-based **Edelmann Provision Company**, specializing in pork sausage, in 2020, and – via WH's subsidiary **Smithfield Foods** – it bought **Mecom Group**, a Central European processed (packaged) meat company, in 2021. (Details of those deals were not disclosed.)

Big Meat turns to small (fake) meat. Big Meat companies are generally agnostic about plant-based and other alternative proteins. If there's money to be made, they're all for it. They aren't leaving the farm, but they're enticed by the prospect of fewer animal welfare, worker safety and environmental downsides compared to the conventional protein chain. And, in some cases, they may find a new revenue stream for other commodities they sell (e.g., Cargill sells both meat and grains). Their alt-protein activities could earn them some green "cred" and maybe some carbon credits along the way. While Big Meat companies have a modest stake in the development of alternative proteins, some governments in the Middle East – such as Israel, Qatar and United Arab Emirates – view alt-proteins as a potential route to food security.¹⁸

Each of the top 10 meat companies has its **own alternative protein line** (e.g., **Smithfield's Pure Farmland** plant-based meat; **Danish Crown's Tulip** brand alt-bacon), **is developing alt-protein products with collaborators** (e.g., **Marfrig and ADM's joint venture called PlantPlus Foods; NH Foods' joint venture with Japan's IntegriCulture Inc.** to produce cell-cultured beef) and / or **is investing in alt-protein startups** (e.g., **BRF's investment in Aleph Farms' cell-cultured beef**).

From Wonder Bread to wonder meat: A century-old familiarity with ultra-processed foods has primed the pump of market acceptance for alternative proteins. Despite the questions of cost and health, most consumers already accept that fish protein can be "sticks" and chicken can be extruded, blended to homogeneity and formed into shapes collectively known as "nuggets." Animal protein "analogues" – including "bleeding" burgers derived from soy and fungi-based "steaks" – go beyond the 20th century's convenience and fast foods (and well beyond that quintessential and humble alt-protein offering, the bean burger). The proposition remains the same, however: in a kind of alchemy, food engineering technologies can turn one substance into another substance, which then has the potential to turn a bigger profit for its sellers.

The Good Food Institute (GFI) – an international lobby group – is the go-to resource for bullish projections of alt-proteins’ success. GFI identified a record US\$3.1 billion in investments in alternative proteins in 2020, three times the amount identified in 2019.¹⁹ GFI divides the sector into three categories: 1) plant-based substitutes (think of the old-school “bean burger” and the more “advanced” ultra-processed pea protein); 2) “meat” produced via cell-culture technologies, most often starting with animal stem cells with fetal calf serum as the growth medium; and 3) alt-proteins produced via fermentation, including “precision fermentation” (i.e., synthetic biology), which requires engineering microorganisms to produce specific “functional ingredients” such as flavours, enzymes and proteins. (The three categories can overlap; ETC Group has referred to proteins derived from cell-culture and synthetic biology as “petri-proteins.”²⁰) To date, there are *almost 800 companies* in GFI’s database,²¹ and – by a wide margin – the majority are producing plant-based meat substitutes. Using data from Crunchbase²² and company press releases, ETC Group compiled the following table to show a sampling of small alt-protein companies involved with Big Protein (and/or Big Ag) companies that are investing or otherwise collaborating.

Sampling of Alt-Protein Companies and their Big Meat/Big Ag Partners

Company (HQ)	Public or Private	Technology / Product	2020 Revenue / Funding Raised US\$ Millions	Involvement of Big Protein/Big Ag?
Aleph Farms (Israel)	Private	Cow cell-cultured protein	236.4 Funding	Investments by BRF, Cargill, Thai Union Group (world's largest canned tuna processor)
Upside Foods (formerly Memphis Meats) (USA)	Private	Cow, chicken, duck cell-cultured protein	206 Funding	Investments by Cargill Ventures, Cargill, Tyson Ventures, Continental Grain Co.
Nature's Fynd (USA)	Private	Fermented microbial (fungi) protein producing mycelial biomass for generic alt-protein	508 Funding	Investments by Archer Daniels Midland Co., ADM Ventures, Danone Manifesto Venture
Beyond Meat (USA)	Public	Plant-based proteins from pea, mung bean, faba bean and rice as substitutes for chicken, cow, pig	406.8 Revenue	[Investment by Tyson Ventures, pre-IPO]
Impossible Foods (USA)	Private	Plant-based proteins from soy and potato as substitutes for chicken, cow, pig; "cow" and "pig" products contain soy leghemoglobin ("heme") produced using GMO yeast	1,600 Funding	Investment by Continental Grain Co.
ENOUGH (UK)	Private	Fermented microbial (fungi) protein producing mycelial biomass for generic alt-protein	78.1 Funding	Investment by SHV Holdings (parent of Nutreco, animal/fish feed company); collaboration with Cargill to provide grain for feedstock; Unilever will buy its alt-protein.
Mirai Foods (Switzerland)	Private	Cow cell-cultured protein	4.5 Funding	Investment by PINC, venture arm of Paulig Group (Finnish food and beverage co.)
Future Meat Technologies (Israel)	Private	Cow and chicken cell-cultured protein	40.8 Funding	Investment by Archer Daniels Midland Co.; ADM Ventures; Tyson Ventures; Rich Products Corp (frozen foods); Rich Products Ventures; Unternehmensgruppe Theo Müller (dairy, packaged foods); research partnership with Nestlé ²³
Good Catch (subsidiary of Gathered Foods, USA)	Private	Plant-based proteins from peas, lentils, chickpeas, soy, fava beans and navy beans as substitutes for fish	77.1 Funding	Investment by Louis Dreyfus Co.
Shiok Meats (Singapore)	Private	Shrimp cell-cultured protein	20.4 Funding	Vinh Hoan (aquaculture, Vietnam)

Sources: ETC Group; Crunchbase (<https://www.crunchbase.com>)

Animal protein still prime choice. The world’s biggest meat companies’ investment in developing alternative proteins demonstrates their interest in the profit potential, while backing from some governments may reflect hope that alt-proteins can contribute to food security. But so-called meat analogues are not on the verge of replacing animal protein; they aren’t even making a dent. That’s partly because consumption of animal protein is *increasing* around the world – in spite of the explosion of plant-based options already on the market. FAO predicts global consumption of animal protein will increase 14% by 2030 over current, already unprecedented levels.²⁴ (Of course, plant-based proteins can be unsustainable, too, especially when ingredients come from monoculture, pesticide-intensive crops supplied by industrial ag giants like Cargill and ADM.²⁵) Another reason animal protein reigns supreme is that the technology to produce the “meatiest” fake meat – petri-proteins grown in the lab from animal stem cells – is technologically challenging to scale up and it’s energy intensive. Two important articles – first from Tom Philpott at *Mother Jones*;²⁶ and another by Joe Fassler in *The Counter*²⁷ – pour cold water on the notion that “cell-cultured” protein production can be scaled up significantly in a sustainable way any time soon.

It’s a problem that the issue has been framed – technologically, environmentally, financially and socially – as a means of finding a way to “have our meat and eat it, too.” The environmental, health and climate costs of plentiful and cheap industrial meat aren’t going away. Key problems include:

Big Meat plays a leading role in climate change. Here’s how:

- Destruction of the Amazon rainforest reached a 12-year high in 2020,²⁸ with illegal clearing/burning to create grazing areas for cattle the major culprit.²⁹ Brazil’s biggest meat companies – JBS, Marfrig and BRF – pledged more than a decade ago not to buy cattle from suppliers who illegally allow cows to graze in protected areas of the Amazon, but “cattle laundering” is rampant: companies claim that tracking cows from birth to grazing to fattening to slaughterhouse is too difficult (even though they’ve been offered – and have rebuffed – a free digital tool to help with monitoring).³⁰
- A study published in *Nature Food* in September 2021 found that animal-based foods are responsible for 57% of agricultural greenhouse gas (GHG) emissions, 34% of which are associated with cattle farming (i.e., beef and dairy).³¹ In Brazil, bovine digestion is responsible for an estimated 70% of the country’s agricultural GHG emissions.³²

Big Meat is turning green? Companies big and small have committed to cleaning up their act and are declaring net zero targets to curb climate change (i.e., they are making commitments to emit no more GHGs than they “capture,” at some point in the future). Tyson says it’ll get there in 2050; Smithfield (WH Group) aims to be carbon negative in 2030; and JBS is targeting net zero by 2040. Given Big Meat’s outsized contribution to GHGs in

the atmosphere, companies will need to reverse course fast (and will likely require creative carbon-footprint calculators). In mid-2021, JBS publicly committed to spend US\$100 million on R&D related to “regenerative agriculture” projects by 2030.³³ It sounds like a serious effort – until you realize that’s about one third the amount JBS and its owners were forced to pay in fines in 2020 after pleading guilty to an extensive bribery scheme that helped the company become a dominant player in the U.S. protein market.³⁴

Big Meat’s big downsides. Net-zero targets focused on GHG emissions don’t address Big Meat’s other big failings – namely, significant groundwater contamination and risks to worker-safety. Livestock farming (and Concentrated Animal Feeding Operations, or CAFOs, specifically) produces lots of animal waste, usually stored in lagoons that can – and do – fail at containment.³⁵ How much waste? As an example, it would take *168 million people* to produce the amount of waste produced by the confined livestock in the US heartland state of Iowa; that’s 53 times the state’s current (human) population.³⁶

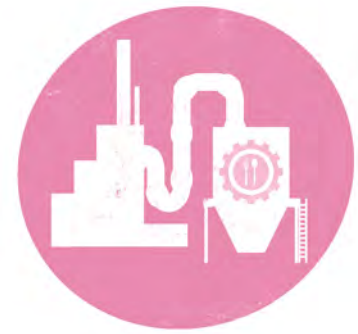
Even in the absence of a global pandemic, big meat is risky for workers. Almost 10 years ago, meat processing line speed was identified as meatpackers’ “sacred cow...uncompromising high speed is not an occasional problem. It’s permanent. It’s inherent. And it’s non-negotiable.”³⁷ Musculoskeletal disorders and illnesses from exposure to hazardous substances (e.g., ammonia, animal feces and blood) are common among workers;³⁸ Covid-19 proved particularly deadly.³⁹ But line speed also compromises food safety, which harms meat-eating consumers. With worrying regularity, food safety inspectors in countries around the world alert the public via internet postings to product-recalls due to the presence of pathogens or foreign materials or unlabelled allergens. When Big Meat’s products are involved, the numbers can be staggering, like Tyson Foods’ recent recall of *8.5 million pounds* (3.9 million kg) of chicken due to possible contamination with *Listeria monocytogenes* bacterium, which causes listeriosis, a potentially life-threatening disease.⁴⁰

Notes

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Food & beverage processing



Food & Beverage Processing: The food and beverage industry focuses on the post-harvest processing of raw agricultural commodities into consumer products – both foodstuffs and feedstuffs for human and animal consumption.

Overlapping Links in the Chain: The food and beverage (F&B) sector illustrates overlapping links in the industrial food chain: The world's top 10 food and drink companies (ranked by F&B sales) include two of the world's leading ag commodity traders (Cargill, Archer Daniels Midland²) and three of the world's top ranking meat companies (JBS, Cargill, Tyson). See sections on Agricultural Commodity Traders and Big Meat/Protein.

Leading Companies by Food & Beverage (F&B) Sales, 2020

Rank	Company / Headquarters	F&B Sales, 2020 US\$ millions	Total Company Sales, 2020 US\$ millions
1.	Pepsico (USA)	70,372	70,372
2.	Nestlé (Switzerland)	67,708	79,114
3.	JBS (Brazil)	50,690	52,467
4.	Anheuser-Busch InBev (Belgium)	46,881	46,881
5.	Tyson Foods (USA)	43,185	43,185
6.	Mars (USA)	37,000	37,000
7.	Archer Daniels Midland Co (USA)	35,395	64,355
8.	The Coca-Cola Co (USA)	34,300	34,300
9.	Cargill (USA)	32,375	114,600
10.	Danone (France)	26,927	26,927
Top 10 (F&B Sales only)		444,833	
11.	Mondelez (USA)	26,581	26,581
12.	Kraft Heinz (USA)	26,185	26,185
13.	Smithfield Foods/WH Group (China)	24,463	25,589
14.	Olam International (Singapore)	22,842	25,975
15.	Lactalis (France)	22,755	22,755
Top 100 (F&B sales only)		1,316,312	

Source: *Food Engineering Magazine*, September 2021: <https://www.foodengineeringmag.com/2021-top-100-food-beverage-companies>

Top Heavy:

- The F&B sales of each of the top 4 firms surpassed US\$45 billion in sales. Sales of the top 10 companies each surpassed US\$25 billion.
- The top 10 F&B behemoths collectively account for a US\$445 billion global market share, close to half a trillion dollars.³
- The F&B sales of the top 100 companies collectively exceed US\$1.3 trillion.⁴

Really Big Food: The world's top 10 F&B companies account for over one-third (34%) of the sales earned by the top 100 F&B companies worldwide (food & bev sales only). The world's top 4 F&B firms account for 18% of the sales posted by the top 100 companies in 2020.

Trends: chew on this

ETC finds:

- **Volatility and asymmetry**
- **Consolidation on the fast track**
- **Digital path to market power: closing in on the consumer**
- **Climate-driven techno-fixes**

Volatility: The uncertainty and economic upheaval spawned by Covid-19 are rattling every link in the industrial food chain. In 2021 F&B firms hiked product prices in response to labour shortages and soaring costs for raw materials, manufacturing, packaging and shipping.⁵ Supply chain seizures are confounding access to everything from computer chips to potato chips. In the absence of vigorous anti-trust regulations, some of the world's largest food companies are using the pandemic-induced supply chain gridlock as an excuse to raise prices. In other words, the problem isn't just supply chain chaos; it's corporate greed.⁶

Big Food's Under-Belly: According to FAO's 2021 report on hunger, moderate or severe food insecurity has been climbing for the past six years and now affects nearly one-third of the world population.⁷ In 2019, around 3 billion people could not afford healthy food due to spiralling food prices and pervasive income inequality.⁸ A record 193 million people faced acute food insecurity in 2021, even before the outbreak of Russia's war in Ukraine.⁹

Consolidation on the Fast Track: The global pandemic hasn't diminished the F&B sector's appetite for mergers and acquisitions (M&A). 2020 saw a 36% increase in the number of M&A deals – totaling US\$110 billion – compared to a 10% drop in the number of deals in 2019.¹⁰ Big Food & Beverage deals include:

2021:

- International Flavors & Fragrances seal the deal on a US\$26.2 billion megamerger with DuPont’s Nutrition & Biosciences division, creating a food ingredient powerhouse worth US\$45.4 billion.¹¹
- PepsiCo agrees to sell its controlling stake in Tropicana and Naked Juice brands to French private equity firm PAI Partners for US\$3.3 billion.
- Hormel Foods acquires Kraft Heinz’s snack-nut business (Planters Peanuts) for US\$3.3 billion.
- Coca-Cola announces its biggest-ever acquisition: a US\$5.6 billion deal to acquire full control of BodyArmor sports drink.

2020:

- Coca-Cola bottlers/distributors in Europe (CCEP) swallow Australian Coca-Cola bottler, Amatil, for US\$6.6 billion.
- PepsiCo gulps down Rockstar (energy drink) for US\$3.8 billion.
- Lactalis, the world’s largest dairy, buys natural and specialty cheese business from Kraft Heinz for US\$3.2 billion.
- Beer behemoth, AB InBev, sells its Australian subsidiary to Asahi Group Holdings (Japan) for US\$11 billion.

2019:

- Froneri joint venture buys Nestlé’s US ice cream business for US\$4 billion.
- Investment firm KKR swallows the international operations of Campbell Soup Co for US\$2.2 billion.

Big Food’s Digital Quest: Closing in on the Consumer

Big Food is vying to become “consumer-centric.”¹² With many customers eating, working, playing and staying at home, F&B manufacturers aren’t content to sit back and watch giant food retailers dominate e-commerce. Instead of allowing its big brand products to sit passively on the grocer’s shelf, F&B industry giants are increasing investment in digital tech and mining “customer data platforms.”¹³ For example:

- AB/InBev, the titanic brewer that sells about one-third of the world’s beer, is hawking and delivering beer with its BEES B2B e-commerce platform, BeerHawk.co.uk and Zé Delivery platform (Brazil). CEO Carlos Brito says, “We are now more closely connected than ever to the 6 million+ customers and 2 billion+ consumers we serve worldwide through our clear commercial strategy, our revamped innovation process, digital platforms and our ongoing operational excellence.”¹⁴
- Nestlé is adding to its “dietary management” and “personalized nutrition” portfolio with, for example, the recent US\$2.6 billion acquisition of bio-pharma firm and peanut-allergy treatment maker, Aimmune. In 2020, Nestlé also acquired Freshly, a “healthy” meal delivery services firm, for US\$950 million. Both acquisitions aim to forge direct links to

the consumer, exploit the overlap between food and nutrition and amplify the digital path to market power.

- With the onset of Covid-19, PepsiCo took just 30 days to launch its direct-to-consumer platforms, Snacks.com and PantryShop.com

F & B Trends: Products perceived as “healthy” and “good-for-you” continue to be M&A “targets of choice” for the F&B industry, according to *Financial Times*.¹⁵ So-called “performance nutrition” and low-sugar options are among them: For example:

- PepsiCo is selling its controlling stake in sugary-drinks Tropicana and Naked Juice brands for US\$3.3bn in order to focus on calorie-free beverages and energy drinks.¹⁶
- Nestlé is in talks to buy the maker of Nature’s Bounty vitamins and minerals, a multi-billion deal that seeks to bolster its “wellbeing” portfolio.¹⁷
- Even once-dominant sugar titan Tate & Lyle plans to shed its controlling interest in bulk sweeteners.¹⁸

Climate-Driven Techno-Fixes:

The seismic shocks of climate chaos promise far greater disruption than the global covid pandemic, and in addition food systems account for more than one third of global greenhouse gas emissions.¹⁹ In hot pursuit of “green haloes,” industrial food giants are rolling out ambitious sustainability pledges to “decarbonize” their business models in myriad ways – from embracing “regenerative agriculture” and “carbon-footprint” product labeling, to genetic tinkering and geo-engineering.

Regenerative Agriculture: Climate-Friendly or Business as Usual?

Many of the world’s largest food & beverage corporations are pledging to achieve “net zero” carbon emissions in the next two decades by supporting “regenerative farming,” a shape-shifting term without a standard definition. Industry proponents include PepsiCo, Unilever, Cargill, Nestlé, General Mills, JBS and private equity firms, among others. In some cases, *regenerative farming* may include practices such as cover cropping, reduced tillage, and crop rotation, or the collection of on-farm data to assess the impact of these practices. But the term is now used so indiscriminately by some corporations that it may even refer to the use of pesticides and GMOs in monoculture cropping when combined with livestock production.²⁰

According to Nestlé, two thirds of its greenhouse gas emissions come from agriculture and to reach its ambitious climate goals, it plans to funnel US\$1.3 billion by 2025 into regenerative agriculture across its supply chain.²¹ Cargill and General Mills pledge to push regenerative agriculture practices across 10 million acres²² of farmland and 1 million

acres of farmland²³ by 2030, respectively; PepsiCo plans to spread regenerative farming practices across 7 million acres by the same year.²⁴ In 2019, 19 food and agriculture-related companies – including Kellogg Company, DSM, McCain Foods, Nestlé, Unilever, Yara – and the World Council for Sustainable Development formed the “One Planet Business for Biodiversity” partnership, ostensibly to “protect and restore biodiversity within their supply chains and product portfolios.”²⁵ “Scaling up regenerative agriculture practices to protect soil health” is a central focus.²⁶ The Food and Land Use Coalition (FOLU), a key architect of the UN Food Systems Summit, is a corporate lobby group (funded by Yara and Unilever) masquerading as a think tank.²⁷ FOLU advocates the use of digital technologies and GMOs to scale regenerative agriculture to “transform food and land use.”²⁸ Critics point out that it does nothing to address profound inequities in access to land and land rights.²⁹

In the absence of a universal standard for regenerative agriculture, Big Food & Ag is directing investments to data-fuelled digital agriculture projects, soil carbon measurement initiatives, including establishing carbon marketplaces and promoting farming practices like no-till. Cargill’s “RegenConnect” program, which pays farmers on the basis of soil health and environmental outcomes, includes payment per metric ton of carbon sequestered.³⁰ Cargill partners with a carbon measurement firm Regrow, which uses in-field data, remote sensing and crop and soil health modelling to measure soil carbon.³¹ These offsets are then sold to corporations, which can tout their climate-saving bona fides without having to make material changes to their polluting operations. Cargill itself bought carbon offsets from its RegenConnect farmers.^{32, 33} Similarly, the Bayer Carbon Program pays growers for implementing “carbon-smart” practices like no-till, strip-till and cover crops for sequestering carbon in the soil, including the cultivation of GMO crops.³⁴

Promoting soil carbon sequestration as a reliable climate mitigation tool seems particularly specious in light of recent research that finds the potential of soil to soak up carbon has likely been overestimated.³⁵ JBS, which committed to invest US\$100 million by 2030 to strengthen and scale regenerative farming practices, including carbon sequestration and on-farm emission mitigation technologies,³⁶ actually *increased* its emissions by 51% between 2016 to 2021.³⁷

Lofty pledges to slash greenhouse gas emissions often exclude supply chains and consumer waste, and involve murky accounting.³⁸ Recent in-depth reports from civil society organizations are revealing corporate greenwashing and fraudulent climate pledges.³⁹ The bottom line, according to Friends of the Earth International: “‘Greenwashing’ hardly suffices as a term to describe these efforts to obscure continued growth in fossil emissions – ‘ecocide’ and ‘genocide’ more accurately capture the impacts the world will face.”⁴⁰

“The big myth in the corporate sustainability world is the idea of ‘win-win’ — that a company can maximize profits and still stay environmentally friendly... We have 30 years of data that we can look at and say that doesn’t work.” Roland Geyer, professor of industrial ecology at the University of California, Santa Barbara⁴¹

Monetizing Brand “Sustainability”: Unilever (a “Principal Partner” for the UN 2021 climate summit in Glasgow) and maker of 75,000 products is testing carbon-footprint labelling on its products, and is also proposing the idea of “carbon-friendly” aisles in supermarkets.⁴² Carbon labelling is designed to appeal to climate-conscious consumers, but it also feeds the false notion that personal choices tied to consumption, rather than systemic changes, are the best way to cut emissions from greenhouse gases. Meanwhile, a 2021 report by Break Free from Plastic reveals that Unilever was #3 (after Coca-Cola and PepsiCo) on the list of the world’s Top 10 Corporate Plastic Polluters.⁴³ (The data was collected from over 11,000 volunteers who conducted 440 brand audits in 45 countries.) Not surprisingly, the top 10 corporate plastic polluters include six of the companies appearing on our list of the world’s 15 largest food and beverage firms.⁴⁴

ADM: Geoengineer to the World? In April 2021 Archer Daniels Midland declared that its Illinois-based experiment had successfully captured and stored one million metric tons of carbon dioxide (CO₂) over a period of three years.⁴⁵ Carbon capture and storage (CCS) refers to the mechanical capture of CO₂ emissions from power plants or other industrial sources; ADM is injecting CO₂ emissions from its coal-fired, corn-based ethanol processing plant more than 6,500 feet underground. Carbon capture is a lucrative source of corporate welfare for ADM. Since 2017 the US government has granted over US\$280 million to support ADM’s experiment,⁴⁶ and the company stands to receive tax credits of US\$20 per metric ton of carbon stored underground.⁴⁷ Critics point out that carbon capture and storage is itself an inefficient and energy-intensive process that sustains the fossil fuel industry.⁴⁸ Although ADM’s CO₂ storage is meant to be permanent, no one really knows if the captured CO₂ will stay underground, taint soil or groundwater, or cause seismic activity.⁴⁹

Climate-Driven Supply Chain Disruption: When it comes to Big Food’s dependence on traditional export commodities from the global South, the food and beverage sector is following its business-as-usual instincts: to secure raw materials inputs at lower costs and dodge geo-political unrest. The quest for cheaper raw materials and input substitution is nothing new, but investment in climate-driven techno-fixes is heating up. Two examples:

Chocolate-Covered Techno-Fix? Cargill, one of the world’s largest buyers of cocoa beans, is partnering with AeroFarms (New Jersey) to secure future cocoa bean supplies in the face of climate change⁵⁰ – presumably without soil or the 5 million farming households that depend on cocoa as a cash crop.⁵¹ Details are sparse, but AeroFarms specializes in “controlled environment agriculture,” vertical farming and “soilless growth media.” The company prides itself in being “able to disrupt traditional supply chains.”⁵²

Wake Up and Smell the Petri-Beans: With climate chaos threatening the sustainability of future coffee harvests, the food industry is betting that bio-reactor-brewed petri-beans may be in your future. Coffee is harvested on an estimated 12.5 million farms worldwide, of which 67–80% are smallholder farms in the global South.⁵³ In September 2021 researchers at the VTT Technical Research Centre of Finland announced they had sipped the world’s first lab-grown coffee.⁵⁴ Using synthetic biology, researchers coaxed engineered microbes and coffee plant cells to brew in bioreactors. Despite a lukewarm review of its aroma and taste (“...our trained sensory panel...found the profile of the brew to bear similarity to ordinary coffee”), lead researcher Heiko Rischer optimistically forecasts that his lab is “only four years away from ramping up production and having regulatory approval in place” for synbio-brewed coffee.⁵⁵ California-based synthetic biology start-up, Compound Foods, is also pioneering the development of a “beanless coffee.”⁵⁶

What is Synthetic Biology? Synthetic biology brings together engineering and the life sciences in order to design and construct new biological parts, devices and systems that do not exist in the natural world or to tweak the designs of existing biological systems. Synthetic biologists, engaged in a kind of extreme genetic engineering, hope to construct designer organisms that perform specific tasks such as producing biofuels or other high-value compounds.

Notes

- 1 Food revenue is only about 28% of Cargill's total revenue.
- 2 Food revenue accounts for about 55% of ADM's total revenue.
- 3 The top 100 food & beverage companies (food & beverage sales only) collectively account for a global market of US\$1,316,312 million. The information was gleaned from *Food Engineering Magazine's* database. Source: *Food Engineering Magazine*, September 2021: <https://www.foodengineeringmag.com/2021-top-100-food-beverage-companies>.
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Grocery

retail



Companies in the **Grocery Retail** sector sell perishable and non-perishable foods (“edible grocery”) to consumers via retail outlets (stores – including membership-only retail stores – or online). The world’s largest grocery retailers sell both non-food products (“non-edible grocery”) and food. According to retail industry analyst Edge by Ascential, worldwide consumer spending on retail food & beverage totaled \$8,271 billion (US\$8.3 trillion) in 2020.

Sales of Leading Grocery Retailers, 2020

Rank	Company (Headquarters)	Edible Grocery Sales 2020 US\$ million	% Market Share of Top 10 Grocery Retailers
1.	Walmart (USA)	271,937	29.70
2.	Schwarz Group (Germany)	121,155	13.21
3.	Kroger (USA)	81,497	8.9
4.	Costco (USA)	79,910	8.7
5.	Carrefour (France)	63,205	6.9
6.	Aldi Süd (Germany)	62,164	6.8
7.	Tesco (UK)	60,389	6.6
8.	Seven & I Holdings (Japan)	60,374	6.6
9.	Ahold Delhaize (Netherlands)	58,669	6.4
10.	Rewe Group (Germany)	57,477	6.3
Total Top 10		916,777	
Total Global Consumer Spending on Grocery, 2020		8,270,580	

Source: Edge by Ascential

- The top 10 grocery retailers control approximately 11% of global consumer spending on groceries, about the same share as in 2018.
- Walmart accounts for almost one third of sales by the world’s top 10 grocery retailers.
- In 2020, global consumer spending on food and beverage topped US\$8 trillion for the first time.

Introduction: The consumer-facing, global grocery retail sector is more varied than other sectors of the industrial food chain, selling its wares via multiple channels (e.g., corner stores, supermarkets, convenience stores, big box/discount clubs, online outlets). *The Economist* claimed, early in 2021, that Covid-19 gave grocery retailers “a crash course in reinvention,”¹ but grocery retailers didn’t re-invent themselves; more accurately, one of the sector’s channels – e-commerce – got an unexpected and timely boost at the expense of other channels. Or, as the *Wall Street Journal* put it, “The pandemic packed 10 years of consumer e-commerce adoption into a single quarter, and forced every company that wasn’t Amazon... to scramble to offer consumers new and better ways to shop from home.”² In fact, the food giants – even e-commerce giants – continue their fight for “omni” channel dominance.

Trends: chew on this

ETC finds that while 2020’s sector trends are recognizable from our earlier research, in some cases, the global coronavirus pandemic intensified them:

1. The **long-standing consolidation trend** continues in most major markets (except where national regulators step in to limit it).
2. Retailers are increasingly **investing in ways to bolster online grocery sales**. ETC highlighted that trend previously, but hadn’t anticipated that folks would be stuck-at-home under lockdown – self-imposed or otherwise – in 2020, and many would rely on e-commerce (and delivery) almost exclusively. Amazon, Alibaba, Walmart and JD.com dominate in grocery e-commerce, but all major retailers are looking ahead toward a “seamless” integration of on-line and off-line grocery shopping.
3. At first glance, the global grocery sector’s relatively low level of market concentration may suggest healthy competition. But **competition in this sector is illusory**. The world’s largest asset management firms (e.g., Blackrock, Vanguard, State Street, etc.) are among the largest institutional shareholders of the leading grocery retailers. High levels of “horizontal ownership” (as well as concentration at national levels) discourages competition.³

Consolidation in the global grocery sector remains an ongoing trend, though India and China have recently seen some pushback. For example:

India: India's national grocery retail sector is estimated to be the third largest in the world (after China and the United States); according to Euromonitor International, India's grocery retail sales reached US\$410 billion in 2020.⁴ Neighbourhood mom-and-pop shops – known as kirana stores – dominate, accounting for an astonishing 90% of India's grocery market.⁵ According to Mumbai-based app-developer Ashish Kumar, early in the pandemic (February 2020), fewer than 9% of kirana stores had an online presence, but people felt most comfortable buying from small stores that didn't require them to leave their neighbourhoods.⁶ So shop owners improvised, introducing digital buying on the fly via websites, WhatsApp groups and digital payment apps. With the pandemic fueling 10% growth in India's grocery sector in 2020,⁷ it's no surprise that large tech firms crave a bigger slice of the country's retail pie. They see e-commerce expertise as the way to make inroads and, ultimately, diminish the market power of corner-shop outlets.⁸

In 2021, Tata Group acquired a majority stake (64.3%) in BigBasket, India's biggest e-grocery player, buying out Alibaba's 30% stake. That means Tata is now a competitor to Amazon Fresh, FlipKart (majority-owned by Walmart) and JioMart (subsidiary of Jio Platforms, which is owned by Reliance, the Mumbai-based multinational conglomerate).⁹ Facebook invested US\$5.7 billion in Jio Platforms in 2020, focusing on JioMart-Whatsapp interoperability for grocery e-commerce.¹⁰ Google, which launched its "India Digitization Fund" in mid-2020 (committing US\$10 billion over 5-7 years) and Reliance are both backing Dunzo, the newest ultra-fast grocery delivery darling operating in "the complex micro-ecosystems" of India's cities.¹¹ At the same time that e-commerce titans are upping their game, Swiggy, one of India's two dominant food delivery apps, shifted its business focus away from prepared foods and towards grocery.¹²

China: During 2020's lockdowns, China's consumers also embraced buying groceries online – including fresh food – with convenience-store owners or apartment-complex managers organizing group buying, commonly using Tencent's ubiquitous WeChat messaging. China's biggest e-commerce players saw an untapped market and were willing to burn cash to beat out competitors. Pinduoduo, along with titans Alibaba, JD.com and Meituan, quickly upped their grocery game, especially in smaller cities.¹³ Alibaba bought a controlling stake (72%) in big box/supermarket chain Sun Art for US\$3.6 billion. JD.com, reportedly with China's most sophisticated logistics network, adapted to handle fresh produce.¹⁴ Pinduoduo, which incorporates gaming to attract users (it's "both Costco and Disneyland" according to its founder and CEO)¹⁵ and gets almost all of its revenue from ad sales (sellers on the platform buy ads to attract buyers), raised US\$6 billion in 2020 for grocery operations.¹⁶ Another group-buying behemoth, Meituan, the world's largest food-delivery company and China's third largest internet company after

Tencent and Alibaba, launched its grocery group-buying app in mid-2020. A few months later, Meituan announced it was expanding to more than 1,000 towns across the country, with plans for even further expansion.¹⁷

Beginning late 2020, China's antitrust regulator began investigating the country's big tech companies for potential harms to competition, consumers and workers. In December 2020, the Communist party newspaper published a commentary scolding China's Big Tech for its cut-throat competition: "Don't just think about a few bundles of cabbage, [or] the online traffic driven by a few pounds of fruit,"¹⁸ which pretty much sums up the e-commerce business model in the rest of the world. In 2021, China's State Administration for Market Regulation fined Alibaba an unprecedented US\$2.8 billion for pressuring sellers to use its e-commerce platform exclusively; Meituan was subsequently fined US\$530 million for similar antitrust violations.¹⁹ Given that the levied fines represented well below 5% of each company's annual domestic sales, it's not yet clear what lesson they will learn from their formal rebuke.

Other Consolidation Moves: In most of the rest of the world, mergers, acquisitions and sell offs moved forward – less hindered and in more expected ways:

- Ahold Delhaize (# 9), Europe's largest publicly-traded grocery seller, is also one of the largest players in the United States and is looking for more acquisitions there, focusing on smaller stores that lack the capital to invest in e-commerce. Ahold Delhaize already earns three-fifths of its revenue in the U.S.²⁰ In 2020, the company bought a majority stake (80%) in FreshDirect, a pure-play (ie dedicated) e-grocer headquartered in New York City, for an undisclosed price.²¹
- In early 2021, Walmart (#1) sold its majority stake in Asda Group (the UK's 3rd largest grocery chain) to an investment firm and UK billionaire brothers Zuber and Mohsin Issa for US\$8.8 billion. Walmart retained a minority stake and a seat on the board,²² but some analysts believe the move indicates that Walmart is shifting focus to its domestic tussle with Amazon for retail dominance.²³
- Out-bidding other private equity firms in a competition that came down to a frenzied, one-day auction, US-based Clayton, Dubilier & Rice bought Wm Morrison Supermarkets, the UK's 4th largest grocery chain (founded in 1899), for US\$9.4 billion in October 2021.²⁴ Private equity firms are now eyeing Sainsbury's, the UK's 2nd largest grocery chain (behind Tesco, #7 globally), as a possible next target.²⁵
- Apollo Global Management, the private equity firm that bought Smart & Final in 2019, sold the big box grocery chain operating in the southwestern U.S. two years later, to Bodega Latina, a subsidiary of Mexican retailer Grupo Comercial Chedraui, for US\$620 million.²⁶

Where are Amazon and Alibaba? Even with the surge in online grocery shopping due to the pandemic, supermarkets and neighbourhood stores still dominate worldwide food and beverage sales, accounting for about 40% of the total.²⁷ That dominance is predicted to diminish over the next five years, with e-commerce – no surprise – seeing the highest growth among retail channels.²⁸

While the world’s biggest online retailers, Alibaba and Amazon, aren’t among the Top 10 grocery retailers, their e-expertise gave them an edge when the pandemic hit. For comparison, in mid-2021, retail consultancy Edge by Ascential estimated Alibaba’s annual online grocery sales were US\$20.6 billion and Walmart’s about half of that (US\$10.1 billion) with Amazon’s estimated US\$14.5 billion in online grocery sales trailing Alibaba but beating Walmart; however, Edge by Ascential put Walmart’s store-based grocery sales at US\$238 billion.²⁹ That’s more than *ten times* the value of Alibaba’s online sales, even during a period when online grocery sales got an unprecedented boost due to the pandemic.

Going forward, the distinction between e-commerce and brick-and-mortar will become less and less relevant. As ETC Group pointed out in *Plate Technics*, the goal of retailers is to seamlessly integrate shopping online and offline. Alibaba has been selling groceries out of its Freshippo stores since 2016, and those stores double as fulfillment centers for online sales. Amazon bought the brick-and-mortar Whole Foods in 2017 and customers can shop in-store or buy groceries online from the store’s website or using its app, choosing delivery or curb-side pick-up. In addition, Amazon has been growing its own line of private label products commonly found on grocery store shelves – dog food, snack foods, baby wipes, diapers – and needs retail outlets in order to sell more of them. Since stores like Target and Walmart aren’t keen to provide a “showroom” for a rival’s products – especially one that notoriously undercuts them on price – Amazon is looking to expand its own brick-and-mortar retail space.³⁰ In 2020, Walmart introduced Walmart Plus, a subscription service modelled on Amazon Prime, which reduces or eliminates shipping and delivery fees. According to *The Economist*: “the grocery wars have barely begun.”³¹

War or Détente? While commentators like to use bellicose language suggesting fierce, tactical competition between the giant grocery retailers, it’s important to keep in mind that these rival armies enlist many of the same generals, who may even coordinate battle plans. In many cases, institutional investors (with voting rights) hold shares in more than one company operating in the same sector – an example of “horizontal shareholding” – which incentivizes them to influence those companies to lessen competition in order to increase the total value of their portfolios.³² Scholars have documented institutional investors’ influence related to corporate governance choices – including board composition and manager compensation – with

an aim to *lower* individual firm efficiency and competitiveness.³³ At the time this report was written, Blackrock, Vanguard and State Street – known as the “Big Three”³⁴ index fund families – are the top three or are among the top four institutional shareholders for the behemoth US-based, publicly-traded retailers Walmart, Kroger, Costco and Amazon.³⁵ Vanguard and State Street are also among the top three institutional shareholders of Ahold Delhaize (#9);³⁶ Vanguard is the top institutional shareholder in Carrefour³⁷ (#5) and Blackrock is the top institutional shareholder in Tesco (#7).³⁸ The value of the funds “under management” by the Big Three is staggering and muddles the meaning of “public” in the definition of “publicly-traded.” At the close of 2020, Blackrock had US\$8.7 trillion under management;³⁹ Vanguard US\$7.1 trillion;⁴⁰ and State Street was managing US\$3.5 trillion.⁴¹

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Food delivery



The **Food Delivery** sector refers to digital, on-demand platforms for ordering and paying for prepared food and, increasingly, groceries and other retail items. Restaurants/retailers fill the orders and couriers deliver them to customers within a prescribed timeframe.

Last Mile / Last Link: World's Biggest e-Commerce Food-Delivery Companies

Company (HQ)	Private or Publicly-traded	2020 Revenue US\$ Millions	Business Focus / Notes
Meituan (China)	Publicly-traded (Hong Kong, OTC in USA) FY end 31 Dec. 2020	9,604 Food Delivery ¹ (Total revenue: 16,637)	So-called super app service company: food delivery (restaurant and grocery); group buying; movie tickets; hotel and travel booking (with ownership stake in hotels), crowdsourced healthcare (until 2021), pet care.
Deliveroo (UK)	Publicly-traded (London, OTC in USA) FY end 31 Dec. 2020	5,263 ²	Restaurant food delivery; posted a loss of US\$309 million in 2020. ³ Amazon bought 16% of the company before its “disastrous” IPO, March 2021; ⁴ Delivery Hero owns 5%. Launched Deliveroo Hop – grocery delivery – in London in 2021.
Uber Eats (subsidiary of Uber) / Postmates (USA)	Publicly-traded (USA, Mexico, Europe) FY end 31 Dec. 2020	3,904 ⁵	Uber Eats acquired privately-held Postmates July 2020; divested Uber Eats India in exchange for 9.9% ownership stake in Zomato; completed acquisition of Cornershop Cayman – online grocery delivery in Chile and Mexico – in June 2021. ⁶ Delivery segment reported operating loss in 2020. ⁷
Ele.me (China) “consolidated subsidiary” of Alibaba Group (acquired 2018)	Publicly-traded (Alibaba is traded globally) FY end 31 March 2020	3,593 ⁸	Delivery of prepared (restaurant) food, groceries; integrated with Koubei, Alibaba’s restaurant guide platform. In 2021, both became part of Alibaba’s new Lifestyle division, along with AutoNavi (mapping app) and Fliggy (travel app).
DoorDash (USA)	Publicly-traded (USA) FY end 31 Dec. 2020	2,886 ⁹	Food and grocery delivery in the USA, Australia, Canada and Japan. Posted net loss of US\$461 million in FY 2020. ¹⁰

Just Eat Takeaway / Grubhub (Netherlands)	Publicly-traded (London, Europe, OTC in USA) FY end 31 Dec. 2020	2,850 ¹¹ (includes Just Eat's 2020 revenue; excludes Grubhub's 2020 revenue of 1,800)	Delivers food and grocery. Takeaway bought Just Eat (UK) in 2020 and Grubhub (USA) in 2021; Delivery Hero owns 7.4%. Posted US\$168 million loss for the FY. ¹²
Delivery Hero (Germany)	Publicly-traded (USA, Europe, London) FY end 31 Dec. 2020	2,819 ¹³	Food, groceries, flowers, pharmaceuticals delivery; operations in 50 countries; in 2020, acquired Instashop (Middle East, North Africa), Honest Food Company GmbH (virtual kitchens, Central Europe) and Glovo's Latin American food delivery operations; grocery delivery via "DMarts" in Middle East and Asia and via foodpanda in Germany; Prosus (tech investor giant) owns 27%. Posted US\$1,020 million operating loss in 2020. ¹⁴
iFood (Brazil)	Private Reporting for calendar year 2020	494 ¹⁵	Food delivery in Argentina, Brazil, Colombia (joint venture with Delivery Hero), and Mexico. Company is a subsidiary of Movile (Brazil), but Just Eat Takeaway holds a 33.3% stake (Prosus is Movile's majority shareholder); acquired SiteMercado (online grocery sales) in 2020.
Swiggy (India)	Private FY end 31 March 2020	375 ¹⁶	Subsidiary of Bundl Technologies Private Limited; prepared food (restaurant) delivery; cloud kitchen; grocery delivery via Swiggy Go; reported loss of US\$508 million in 2020; ¹⁷ Prosus (tech investor giant) holds 40% stake in Bundl Technologies.
Zomato (India) (Uber has 9.99% ownership stake)	Publicly-traded (India); IPO July 2021. FY end 31 March 2020	370 ¹⁸	Prepared food (restaurant) delivery; reported loss of US\$322 million; ¹⁹ acquired Uber Eats India Jan. 2020; restaurant reservation booking; grocery delivery; owns 9.3% of Grofers (grocery delivery); supplier to restaurants via Zomato Hyperpure.

Source: ETC Group Notes: 1) Ownership stakes noted in the table reflect the situation in mid-November 2021. **2)**

Differing fiscal-year reporting periods were unusually consequential due to the global coronavirus pandemic. App-based food delivery usage increased when and where consumers experienced lockdowns; therefore, the financial impact of the lockdowns may be unequally reflected in company revenues (e.g., companies with fiscal years running 01 April 2019 to 31 March 2020 do not reflect the full 'positive' impact of the pandemic on business operations).

Historically, ETC Group has considered consumer-facing Food Retail the industrial food chain's last link. Now, for the first time, we highlight companies that cover the "last mile" – those that enlist couriers – who drive cars, ride motorcycles or bikes – to deliver food into consumers' hands at their home or office door. The sector was revving up before the Covid-19 pandemic, but 2020 saw turbo-charged growth as food delivery became a frontline service in the midst of lockdowns. Nonetheless, the sector's pre-pandemic features and trends still hold:

- **Rapid Consolidation:** Ownership is a moving target as companies jostle for regional hegemony and buy/sell/swap stakes in competitors.

- **Worker Exploitation:** The ambiguous legal status of couriers is integral to the on-demand business model. Along with related “sharing economy” sectors such as ride-hailing – also now firmly in the grasp of Big Tech²⁰ – food delivery has invited worker exploitation. Around the world, governments and courts have only recently begun to address the issue.
- **Slow to Deliver Profits:** Venture capital and technology investment has fueled the sector, but companies have yet to deliver profits – even in the sector-friendly circumstances of the global pandemic when delivery became more necessity than convenience. Tweaking the business model to move toward profitability – most prominently by adding grocery delivery – is underway. (User-data is its own reward, however, and gives companies unprecedented access to customers’ preferences and, literally, their tastes.)

On-demand, platform-based food delivery is part of urban e-commerce: it doesn’t exist in the absence of smartphone apps, Internet connectivity and population density. The original business model, a 21st century invention, looks similar in cities around the world: start-up companies created apps for ordering prepared food and partnered with restaurants that pay a commission to have their menus represented on the apps;²¹ customers then download the apps, order and pay for food and delivery using a credit card or a mobile payment app (e.g., Alipay, Apple Pay); couriers – whose (multiple) deliveries and routes are chosen by algorithms and guided by GPS for maximum efficiency – bring the orders from the restaurant to the customers within an agreed-upon timeframe.

Delivery platforms claim to be helping local businesses connect to customers, who benefit from the “affordable convenience” of eating-in (without meal prep), all while offering “meaningful work” to “underemployed” people drawn to the flexibility of the gig economy.²² Low overheads is integral to the business model with restaurant workers supplying the food and the delivery labour force – the “dashers,” “riders” or “partners” – considered independent contractors instead of employees (and therefore not eligible for social security, injury compensation or other benefits).

From the beginning, the model has been, explicitly, less about food service and more about logistics, e-commerce (including customer-data collection) and attracting technology-focused venture capital investors.²³ Competition in the new sector quickly heated up: some players were gobbled up, and those that remained raised even more investment cash – while buying and swapping stakes in competitors. The kings of e-retail, Amazon and Alibaba, both invested (see table).

Trends: chew on this

Delivering Revenue but No Profit: The business model’s most glaring flaw – though not its most egregious one – is that it isn’t financially profitable. So far, in most places in the world, the cost of doing business exceeds revenue (though the additional value of the trove of exploitable data on customer tastes and habits is great²⁴). A review of company annual reports makes the lack of profitability abundantly clear (see table above, “Last Link/Last Mile”, and accompanying endnotes, where seven of the 10 companies finished fiscal year 2020 clearly in the red by US\$ hundred-millions or even billions²⁵). Analysts note that the sector’s losses weren’t necessarily problematic, at least at first, because profitability wasn’t the goal: the companies were “just trying to get traction for their start-ups, all of which needed to attract customers quickly to establish a dominant market position, elbow out competitors and justify their soaring valuations.”²⁶ In practice, jostling for dominance meant offering deep discounts to customers – to get them on the apps and to keep them there – even when that necessitated a “cash burn.”²⁷ Persistent losses have led platforms to emphasize metrics other than revenue to demonstrate success and keep investors excited, such as their increasing numbers of deliveries or app downloads or growing “gross transaction values” (which basically means more folk splurging on the large pizza, ending up with bigger tabs).

There may be “a limit to how far you can push the economics of a platform to make it work”²⁸ – as some analysts posit with regard to food delivery – but companies haven’t reached it yet. In an attempt to move toward profitability, platforms have tweaked their algorithms – sometimes with disastrous results for couriers²⁹ – to try to get more deliveries out faster; they’ve created “cloud” or “ghost” kitchens, which are closed to diners but where meals from several restaurant menus can be prepared in one space for more efficient pick-up and delivery; and, in some cases, they’ve begun to raise fees – commissions for restaurants and delivery prices for diners. Across the board, they’ve expanded their delivery offerings to include groceries and other items (see table).

The Gig is Up? Will Courier Conditions Improve? What may ultimately put the brakes on food delivery is the sector’s inhumane and (possibly) untenable labour practices, though the promise of advanced automation may mute the calls for change. With little or no protections or perks, couriers put themselves in danger (by speeding, breaking traffic laws, travelling through high-crime areas) rather than risk being fined or fired if they don’t deliver often enough and fast enough.³⁰ While gig work is supposed to allow people to choose how much and when they work, the reality is that the platforms are in control. Zomato, for example, can disable the account of any courier who turns down three delivery jobs in one day.³¹ Couriers in China can be fined US\$300 (about a week’s wages) if a dissatisfied customer sends an email complaint to the platform.³² Couriers have begun protesting – sometimes in acts of desperation³³ – and self-organizing, in both the global North and South.³⁴

There are some indications that governments may be ready to enact labour reforms and put an end to the platforms’ free ride. In July 2021, China’s antitrust regulator issued a directive to delivery platforms to improve how they treat couriers, including by reducing the demand for fast deliveries.³⁵ In September, the country’s delivery giants – Meituan and ele.me (Alibaba) – promised to stop forcing couriers to register as self-employed business owners.³⁶ The European Commission is now considering ways to improve the working conditions of platform workers, generally, and food delivery workers specifically.³⁷ Just months after Spain announced it will require platforms to recognize delivery workers as employees – the first EU country to do so – Deliveroo announced it was ceasing operations there.³⁸ Deliveroo’s home country UK, on the other hand, seems to have settled the issue the other way: delivery workers are self-employed, UK courts have affirmed.³⁹ In the USA, New York City became the first to pass legislation to regulate the food delivery sector, establishing minimum pay and other worker protections.⁴⁰

Will food delivery survive this “crisis of technology crashing into reality”?⁴¹ It’s hard to root for its survival, especially considering some of the other problems the sector has created, including dasher-dodging on overcrowded city sidewalks,⁴² significant increases in trash from takeaway packaging,⁴³ and the deskilling of an overburdened labour force that is constantly controlled (directed and surveilled) by the platforms.⁴⁴ But as more and more people move to cities (beyond the more than 55% of world population that is already urbanized⁴⁵), income inequality will likely result in both increased demand for the convenience of food/grocery delivery and a desperate workforce willing to deliver food in order to eat. As others have noted, reeling in corporate greed in the food/grocery delivery sector will require both collective action and changes to employment laws.⁴⁶

Notes

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The (bio)digital takeover of food and agriculture

ETC's ongoing research shines a critical light on the world's looming dependence on Big Tech across the Industrial Food Chain. It also looks at the impact that the digitalization of agriculture is already having on corporate consolidation, as well as the wellbeing, autonomy and knowledge of small farmers and peasants across the world and thus on food sovereignty. Here are a few tasters showing what's currently on the worrying menu.

From Food Chains to Blockchains

Cross-sectoral convergence and digital dependence are emerging in parallel, and this is especially evident in the attempt to impose digital blockchains along the entire industrial agrifood chain, with the stated aim of transparent and secure tracking.

Blockchains are digital ledgers that are capable of tracking a contract or an activity with the use of computers via the internet in such a way as to reassure the parties involved that the contract or procedure has been carried out. Blockchains can be used by bankers and drug cartels alike (among many others) to reduce transaction costs and increase confidence that the arrangement has been completed.

Virtually all of Big Ag – in particular the largest grain and food commodity traders – have signed on to Covantis, the most advanced of these new blockchain pacts. Even more ambitious is the TraceHarvest Network, developed in collaboration with Bayer, which emphasizes traceability – from seed to stomach. In this case, traceability is explicitly seen as a way to thwart 'buy local' trends.¹ With blockchain tracing, you can supposedly "know your farmer" from half a world away – food miles be damned. TraceHarvest also builds in the possibility for "smart contracts" – self-executing, automated

agreements that govern food market transactions, taking autonomy away from farmers and consumers and handing it over to those who write and structure the code for these digital agreements.

Biodigital Barons

Faced with expiring patents, herbicide-resistant weeds and efforts by some governments to rein in chemical toxins and climate-changing greenhouse gases (GHG), Big Ag and Big Tech giants are developing supposedly “green” products based on new proprietary genetic and digital technologies. These include RNA-based pesticide sprays, “CRISPR” crops and animals, alt-proteins and new microbial pesticides and fertilizers that rely on genetic manipulations – including gene editing. To win consumer acceptance and escape regulatory oversight, industry insists that gene-edited plants and animals are not GMOs (genetically modified organisms) arguing they may not involve the integration of foreign DNA. But gene editing can still be used to introduce new genetic sequences, and even the deletion or change of a single base point can have uncertain impacts on how an organism functions.

RNA interference (RNAi) pesticides are designed to kill certain plants or insects by switching off or “silencing” genes essential for the organism’s survival.

Gene editing or genome editing techniques are a form of genetic engineering (GE) used to alter the genetic material of an organism, plant or animal by inserting, deleting or changing the DNA at a specific target site in the genome. This may cause a series of unexpected changes in the chromosomes. **CRISPR** is the most well-known among today’s gene editing techniques (CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats).

Taking advantage of the climate crisis

The energy-guzzling and GHG-belching fertilizer industry is joining the seed and pesticide firms in devising ways to monetize the climate crisis, burnishing their so-called Environmental, Social and Corporate Governance (ESG) credentials along the way. Under the umbrella of digital ag services, Big Ag and Big Tech giants are developing carbon credit schemes for farmers – and all of the verification methods depend on Big Data, of course. Participation in these schemes helps ensure technological “lock-ins” – that is, farmers and

end-users are obliged to surrender their own data in order to gain access to an expanded menu of proprietary ag inputs and digital services, potentially through multi-year contracts and for guaranteed prices and carbon payments.

The world's largest fertilizer corporations are also touting so-called sustainable ammonias for nitrogen fertilizer production (using renewable energy sources or relying on carbon-capture technologies during production). However, promotion of these “green” fertilizers conveniently ignores the resulting environmental damage when they are applied to farmland, including nitrous oxide (N₂O) emissions.

Big Tech meets Telecom meets Big Ag

Agricultural drones, sensors and automated farm machinery are as useful as rocks unless they are connected to the Internet. So, for example, Deere & Company, the largest player in Machinery for Big Ag, has expressed interest in expanding rural Internet connectivity by partnering with telecom giant AT&T in North America,² while other telecom service providers like Verizon and T-Mobile have championed the role of 5G (fifth generation broadband cellular networks) in the future of farming.^{3,4} China, with more than 500 million 5G users, has the largest 5G network in the world and is promoting “smart farms” running on the 5G network.⁵

Satellites are touted as being doubly useful: not only do they enable digital agriculture, but they will also, purportedly, bring Internet connectivity to rural areas across the globe. Big Tech is therefore investing in Low Earth Orbit satellite constellations to “connect the unconnected” and close “the rural broadband gap.”⁶

These operational satellites (especially Low Earth Orbits) also require ground stations that are costly to build and maintain.⁷ Data processing and storage add to the cost of satellite operation. Cloud-computing service providers have jumped at the opportunity to land a piece of the market and now offer satellite operators the option to use ground stations on a ‘pay-per-use’ or subscription basis, reducing their capital expenditure.⁸

Big Tech's forays further out into space have similar critical implications for the future of food and agriculture systems. In 2020, Morgan Stanley estimated that the global space industry could generate revenue of more than US\$1 trillion or more in 2040, up from US\$350 billion in 2020; satellite broadband will account for half of the projected growth.⁹

Data crunching driving new space race

According to estimates by the Union of Concerned Scientists, there were about 6,000 satellites circling Earth's orbit in April 2020, of which less than half were operational¹⁰ (the rest are space junk!). More than half of the working satellites were launched for commercial purposes:¹¹ 61% for communications (like satellite TV, Internet of Things connectivity and Internet) and 27% for Earth observation.¹² Low-cost (or free) satellite imagery is usually low- or medium-resolution; higher-resolution images – key to digital agriculture – are costly, and such large-scale data-crunching relies on Big Tech's AI algorithms and cloud-computing capacity.¹³

Amazon runs the “Earth on AWS” programme through which it hosts numerous satellite data sets, while Google hosts more than 600 public satellite, weather, population and other data sets through its Earth Engine platform.¹⁴ Planet Labs, an Earth imaging company based in San Francisco, calls itself the “Bloomberg Terminal for Earth data”¹⁵ and owns approximately 15% of commercial satellites, collecting ~25 terabytes of data every day.¹⁶ About one quarter of Planet Lab's revenue comes from data related to agriculture and the company expects that contribution to grow in the coming years.¹⁷

In September 2021, Corteva Agriscience signed a three-year agreement to use Planet Labs' satellite imaging products, with which it was already monitoring about 600,000 fields.¹⁸ Other major Big Ag players such as Bayer, BASF and Syngenta are also using Planet Labs' technology, as is the U.S. Department of Agriculture.¹⁹ Planet Labs is also part of The European Carbon+ Farming Coalition, a World Economic Forum-led coterie of Big Ag players pushing “climate-smart” agriculture practices, along with BASF, Bayer, COPA-COGECA, CropIn, European Conservation Agriculture Federation (ECAAF), Yara International ASA, Zurich Insurance Group and others.²⁰ In 2021, Planet Labs started trading on the New York Stock Exchange after a SPAC merger²¹ backed by Google and BlackRock, among other investors.²²

Both Microsoft (via Azure Orbital) and Amazon have entered the “GSaaS” (Ground Station as a Service) market, enabling satellite operators to communicate and control their satellites and process the data with their AI services.²³

Elon Musk's SpaceX plans to send 42,000 satellites into space in the next few decades and, as of early January 2022, it had already launched more than 1,900 Starlink satellites.²⁴ In October 2020, Microsoft partnered with SpaceX to connect its Azure cloud computing network to the Starlink satellite Internet service.²⁵ Competing with SpaceX is Ama-

zon, which plans to launch 3,236 satellites under its “Project Kuiper;”²⁶ Amazon acquired Facebook’s satellite Internet team in 2021.²⁷ Similarly, China’s state-owned telecommunications carriers plan to launch about 10,000 low-Earth orbit satellites in the next few years.²⁸ India’s telecom giant Bharti Group and the government of the United Kingdom invested in OneWeb, another satellite Internet company, which has already signed agreements with US telecom giant AT&T.²⁹

Deep Sea Cable Cartels

“People think that data is in the cloud, but it’s not... it’s in the ocean.” – Jayne Stowell, Strategic Negotiator, Global Infrastructure at Google³⁰

Despite these leaps into space, Internet infrastructure is still largely made possible by underwater cables criss-crossing the oceans: Big Tech is consolidating its power and influence in both the clouds and the seas.

Submarine cable culture

As of 2019, Microsoft, Google, Facebook and Amazon owned or leased more than half of the undersea bandwidth, earlier the domain of pure-play telecom companies.³¹ In June 2021, Google announced a plan to build a new subsea cable, dubbed Firmina, which would connect the east coast of the U.S. and Las Toninas in Argentina, with landings in Brazil and Uruguay.³² Earlier in 2021, Google and Facebook had announced they would jointly fund two new undersea Internet cables, running from the US West Coast to Indonesia and Singapore.³³ In a move seen as countering Western and Indian dominance in telecommunications infrastructure, China is also installing massive networks of submarine cables for its “Digital Silk Road” project that aims to connect the country to its “BRI” (Belt and Road Initiative) partners – 140+ countries across the globe, including more than 40 in Sub Saharan Africa.³⁴

Notes

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Conclusions

Reclaiming Power to the People: Recognizing and challenging corporate hegemony

ETC Group has traditionally monitored the “Top 10” corporations wielding power in different sectors of the Industrial Food Chain. However, our most recent research, as outlined in this report – a “2020 snapshot” looking at eleven key industrial agrifood sectors – shows that many of these Big Ag sectors are now so “top heavy” that this is no longer possible. Some are now controlled by just four to six dominant firms, enabling these companies to wield enormous influence over markets, agricultural research and policy-development, and undermining food sovereignty.

We find that the Food Barons – including giant traders, food processors, grocers, technologists and financiers – are continuing to (re)design and refine the Industrial Food Chain so that they can control it ever more effectively and leach ever more value away from producers and the natural environment. They are swelling their own coffers, whilst providing poor quality and mostly unhealthy food to people and animals, destroying soils and biodiversity along the way.

Today’s Industrial Food Chain enables the world’s biggest Food Barons to hold more economic power than the world’s 3.6 billion farm families, fishers and producers put together.¹ This is deeply inefficient, perverse and extractive. Even World Bank economists acknowledge that the industrial global food system’s US\$8 trillion value is largely cancelled out by its negative externalities – costs that are conservatively estimated, by them, at over US\$6 trillion (including the costs associated with malnutrition, food loss and waste, insufficient food safety, environmental degradation and greenhouse gas emissions).²

Our report also points to three developing multi-sectoral critical trends that are enabling increased control along the Industrial Food Chain by Big Ag, Big Data and Big Finance.

1. New technologies are enabling the Food Barons to further consolidate their wealth and control, especially via the digitalization of agriculture: they are busily promoting digitally-based and genetic technologies and schemes, including as planet-saving techno-fixes, to maximize investment.
2. We observe the rising power of Asian (especially Chinese) Big Ag food giants.
3. Finally, we find that the increasing involvement of asset management companies in food and agriculture creates the semblance of competition, but diminishes actual competition.

With the help of philanthrocapitalists such as The Bill & Melinda Gates Foundation, the reach of Big Tech food and agriculture is now expanding to peasant and smallholder agriculture in the global South, from rural markets through to urban mega-cities. Yet the new forms of control and value extraction that these technologies bring with them threaten to further usurp farmer autonomy and decision making, while potentially facilitating and expediting a new era of land grabbing and new forms of control over small farmers.

Reclaiming Power for peasants, communities and food sovereignty: recognising and challenging corporate hegemony

In contrast to the increasing concentration and power of these giant Food Barons, as detailed in this report, it is important to remember who feeds the majority of the world. The Peasant Food Web still feeds the equivalent of 70% of the world's people³ with less than 30% of the world's land, water and agricultural resources, even though the Food Barons are trying to extend their tentacles through further land- and water-grabs and technological appropriation of the commons. The Peasant Food Web provides an essential counterweight to the grim tale of concentration and profiteering that we detail in this report, through its inspiring diversification and proliferating territorial food initiatives that re-distribute and share the inherent power of sun, soil, seed and animals amongst people – providing food to billions.⁴

Food activists often focus themselves on intervening in certain sectors along the chain. We decry Big Meat, Big Food and Big Biotech, denounce the big grocery retailers' unscrupulous treatment of workers, expose food processors' unscrupulous manipulation of consumers, and demand an end to the use and abuse of the planet's resources. Our findings indicate that if we are to advance towards challenging the Industrial Food Chain in its entirety, we also need stronger collective reactions from civil society, that go beyond sector-specific campaigns, as well as enhancing solidarity between different

food and agriculture-related struggles and other movements, such as those fighting for climate justice or critical of digitalization. We need to support and collaborate to expand the Peasant Food Web, both to nourish the world and to mount an effective challenge, returning power (and food) to peasants, rural and urban communities.

Here are ETC's key proposals for action:

1 Support food sovereignty

It is urgent to recognize the vital importance of non-industrial food systems in this time of food, health and environmental crises. Food Barons are not feeding the world and it is not in their interest to do so. The Industrial Food Chain – and every one of its links – function only if “food” is good financial business. In direct contrast, feeding people is recognised as a real need and is the core concern of the Peasant Web and food movements.

La Vía Campesina, the biggest organization of peasants, landless workers, indigenous people, pastoralists, fishers, migrant farmworkers, small and medium-size farmers, rural women and peasant youth from around the world, sets a very clear path to be able to feed the world and rebuild the planet: food sovereignty and agroecology. Proposals from the grassroots – such as the International Planning Committee for Food Sovereignty's Nyéléni Process⁵ – aim to put farmers, growers, fishers, hunters and consumers back at the heart of the food system and undo the power usurped by Food Barons promoting industrial agriculture. Establishing new movements and civil society-led technology assessment spaces is also emerging as a cross-movement demand.

2 Divest from the chain

Institutions under pressure from civil society have already succeeded in partly directing funds away from tobacco, arms and fossil fuels on moral grounds. Grassroots climate movements have successfully named fossil fuel majors as the obstruction to meaningful climate action. Food movements should follow suit: it is a logical next step to demand divestment from the Industrial Food Chain.

With our research we aim to provide the information needed to understand where corporate power lies and where critical divestment is most needed. We hope that it will provide a useful roadmap for a new wave of campaigns to divest from the Industrial Food Chain. Schools, universities, pension funds, local authorities and other public institutions holding investments in the identified companies should consider withdrawing their funds from specific Food Barons and even from the entire destructive Industrial Food

Chain, making a strategic switch to transparent and unconditional long-term support for agroecology and food sovereignty. A pioneering example of such action is the Extractive Agriculture Investor Dataset developed by Adasina Social Capital. Adasina uses ETC's data from this report, to identify the most harmful publicly traded companies for divestment from their portfolios.⁶

3 Technology horizon scanning, assessment, governance and sovereignty

Just as the threats posed by “Gene Giants” and pesticide companies were apparent to peoples’ movements in earlier decades, it is now obvious that the Food Barons – Big Data, Big Tech and Big Biotech firms – are increasingly exercising a major cross-chain stranglehold on food systems as they deploy a suite of powerful new technologies including blockchains, drones, ag robots, AI platforms, RNAi, alt-proteins, designer microbes and gene drives.

The participatory assessment of technologies based on precaution, as well as the development and support for the implementation of socially and ecologically useful technologies, should be a top priority for governments, multilateral communities or fora, and civil society. Food governance bodies such as the Committee on World Food Security and its High Level Panel of Experts should prioritize horizon scanning, technology assessment and monitoring of new technologies that impact food systems.

The creation of bottom-up participatory technology assessment is especially crucial. Civil society Technology Assessment Platforms such as RED TECLA⁷ in Latin America or AfriTAP⁸ on the African continent are working to understand the ways in which agrifood and digital technologies are used to strengthen corporate power. In particular we need a cross-sectoral technology assessment process to analyse and propose policies to confront the rapid digitalization of the food system. A civil society-led Food, Data and Justice (FDJ) Dialogue is helping to set the stage to ensure that digital and biodigital technologies are subject to precautionary and rights-based oversight as a counter to the vast power of the Food Barons. The Food, Data and Justice Dialogue is a step towards bringing together the food sovereignty movement and technology equity activism, to assess the ongoing deployment of digital technologies throughout food systems, understand the threats to food sovereignty, and identify principles for the governance of digitalization in agriculture.

Anti-monopoly action and competition treaties

Most states maintain at least nominal tools to limit overbearing and unfair power in the marketplace, even if they are rarely (and imperfectly) applied. Competition offices and justice departments can investigate, and rule and levy fines against mega-mergers and unfair business behaviours in the name of maintaining ‘competition’. They also have the power, at the national and regional levels, to break up overly-large companies in the name of competition. That restraint does not exist at the international level, even though the companies highlighted in this report are mostly operating transnationally.

However, some major national economies are taking modest steps to restrain corporate power and promote competition, especially in relation to Big Tech. For example, in China, tech titans such as Alibaba have received substantial fines, and the European Parliament has attempted to censure Facebook. The EU is also beginning to grapple with the problems created by the data-dependent “gig economy”. In addition, under the Biden Administration new rules are being written on the “right to repair” to prevent manufacturers of devices (including cell phones and tractors) from imposing restrictions on consumers’ right to fix equipment they own.

In 2021, finance ministers from nearly 140 countries reached agreement on a 15% global minimum tax on large, profitable multinational corporations (based on where their products/services are sold, rather than where they operate).⁹ The global pact aims to end corporate tax havens that siphon much-needed corporate tax revenues away from governments. The agreement has many shortcomings and its fate is uncertain, but it signals that governments can take collective action to reform policies and rein in corporate excess. With applied pressure from citizen action, the scope could be expanded.

Anti-competition regulators must develop new mechanisms to understand and restrict the cross-chain powers of data giants and horizontal shareholders and require much greater transparency among private equity and other corporate actors. At a global level, an International Treaty on Competition with teeth could enable international oversight of corporate power (including the Food Barons).¹⁰ Food movements, consumers and civil society should have legal standing to intervene in reference to corporate mergers. Given the overwhelming Northern character of the Food Barons that dominate the Industrial Food Chain, Southern governments, in particular, should actively engage in the creation of a multilateral instrument to protect local/territorial food systems, instead of the World Trade Organization’s trade rules which work in the opposite direction. The development and implementation of these instruments should be undertaken in consultation with civil society, peasant farmers’ and indigenous peoples’ organizations.

Last word

In conclusion, it can be daunting to imagine taking on the Food Barons, but their power is not inevitable – it is a historical oddity that is barely a century old and still only feeds less than a third of people on the planet, and badly at that. They may be backed by the titans of capital, have their claws in around 10% percent of the global economy and be ruthlessly proactive in buttressing the Industrial Food Chain with new technologies and slick false promises – but as more and more of the food chain comes under the control of fewer and fewer entities these companies also become more exposed and vulnerable to being toppled.

Agribusiness is also in a moment of significant transformation, as it is challenged by new players and seeks to regain legitimacy amidst the climate crisis and biodiversity collapse that it has itself caused.

This is a moment to see the Food Barons for what they are, to find their structural weaknesses and to take strategic collaborative action to take them on. This report provides some useful intelligence for food sovereignty movements and their allies in the battles ahead.

Notes

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- 5 <https://www.foodsovereignty.org/nyeleni-process/>
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