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 billion[13] – 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 (PhosAgro, 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 deaths[41] 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.

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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 (N_2O) emissions that happen post-fertilizer application[82] (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 ammonia[87] to sell on the Enhanced Oil Recovery (EOR) market.[88] In EOR, carbon dioxide (CO_2) 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-bioavailability 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 2020[103] 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 Syngenta[117] and **BASF**[118] to develop and sell similar microbe-based, biocontrol products.

Microbial products are largely unregulated[119] – 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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