

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

- 1 Casey Laughman, “The 2021 Top 100 Food and Beverage Companies,” *Food Engineering Magazine*, 27 August 2021: <https://www.foodengineeringmag.com/articles/99594-the-2021-top-100-food-and-beverage-companies>.
- 2 Both estimates come from industry intelligence reports sold by Research and Markets (<https://www.researchandmarkets.com/>): <https://www.prnewswire.com/news-releases/global-meat-products-market-report-2021-covid-19-impact-and-recovery-forecast-to-2025-2030-301244469.html> and <https://www.businesswire.com/news/home/20210920005477/en/Global-Meat-Markets-2021-2025-by-Product-Chicken-Beef-Mutton-Pork-and-Others-Type-Raw-and-Processed---ResearchAndMarkets.com> ; the lower figure refers to “[t]he global meat products market” and the higher figure refers to “[g]lobal meat market.” It is not clear from the two reports’ descriptions how their methodologies differ, and the high costs of the reports prevent ETC Group from clarifying.
- 3 Brian Deese, Sameera Fazili, Bharat Ramamurti, “Addressing Concentration in the Meat-Processing Industry to Lower Food Prices for American Families,” U.S. White House briefing, 08 September 2021: <https://www.whitehouse.gov/briefing-room/blog/2021/09/08/addressing-concentration-in-the-meat-processing-industry-to-lower-food-prices-for-american-families/>.
- 4 Erasmus K. H. J. zu Ermgassen, Javier Godar, Michael J. Lathuilière, Pernilla Löfgren, Toby Gardner, André Vasconcelos, Patrick Meyfroidt, “The origin, supply chain, and deforestation risk of Brazil’s beef exports,” *PNAS*, 117 (50), 15 December 2020, pp. 31770-31779: <https://doi.org/10.1073/pnas.2003270117>.
- 5 Kimberly Kindy, “More than 200 meat plant workers in the U.S. have died of covid-19. Federal regulators just issued two modest fines.” *Washington Post*, 13 September 2020: https://www.washingtonpost.com/national/osha-covid-meat-plant-fines/2020/09/13/dca3e14-f395-11ea-bc45-e5d-48ab44b9f_story.html.
- 6 Taylor Telford and Kimberly Kindy, “As they rushed to maintain U.S. meat supply, big processors saw plants become covid-19 hot spots, worker illnesses spike,” *Washington Post*, 25 April 2020: <https://www.washingtonpost.com/business/2020/04/25/meat-workers-safety-jbs-smithfield-tyson/>.
- 7 Julie Creswell, “Your Steak Is More Expensive, but Cattle Ranchers Are Missing Out,” *New York Times*, 23 June 2021: <https://www.nytimes.com/2021/06/23/business/beef-prices.html>.
- 8 Rod Nickel and Tom Polansek, “Drought forces North American ranchers to sell off their future,” *Reuters*, 03 September 2021: <https://www.reuters.com/business/sustainable-business/drought-forces-north-american-ranchers-sell-off-their-future-2021-09-03/>.
- 9 Jacob Bunge, “JBS Paid \$11 Million to Resolve Ransomware Attack,” *Wall Street Journal*, 09 June 2021: <https://www.wsj.com/articles/jbs-paid-11-million-to-resolve-ransomware-attack-11623280781>.
- 10 Anon., “African swine fever is spreading rapidly in China, again,” *Economist*, 28 August 2021, accessible on 21 August 2022 from this page: <https://www.economist.com/taxonomy/term/76972/Last%20of%20the%20companies?page=2696>.
- 11 Jackie Linden, “Five Asian states record new cases of avian flu in poultry,” *WATTpoultry.com*, 29 September 2021: <https://www.wattagnet.com/articles/43656-five-asian-states-record-new-cases-of-avian-flu-in-poultry>.
- 12 BRF, Vion and NH Foods attributed their modest revenue declines to Covid-related declines in restaurant-eating, which weren’t entirely offset by high beef prices and increases in grocery shopping for home-cooking.
- 13 Anon., “Vion Invests in supply chain and plant based meat,” *fleischwirtschaft.com*, 25 March 2021: <https://english.fleischwirtschaft.de/economy/news/vion-invests-in-supply-chain-and-plant-based-meat-50183>; see also Tom Polansek, “U.S. senators scrutinize meat packers’ big profits during pandemic,” *Reuters*, 30 March 2020: <https://www.reuters.com/article/us-health-coronavirus-usa-meat-packing/u-s-senators-scrutinize-meat-packers-big-profits-during-pandemic-idUSKBN21H38M>; Nayara Figueiredo and Ana Mano, “Brazil’s JBS profit bolstered by weak currency, strong Chinese and U.S. markets,” *Reuters*, 24 March 2021: <https://www.reuters.com/article/jbs-results-idAFL1N2LM3EZ>.
- 14 FAO, “Meat market review: Overview of global meat market developments in 2020,” Rome, March 2021, p. 3: <http://www.fao.org/3/cb3700en/cb3700en.pdf>.
- 15 Anon., “ACCC raises vertical integration issues over JBS’s Rivalea pork deal,” *Beef Central*, 16 September 2021: <https://www.beefcentral.com/processing/accc-raises-vertical-integration-issues-over-jbss-rivalea-pork-deal/>.
- 16 David Cloughton and Peter Somerville, “JBS finalises deal to buy pork processor Rivalea,” *ABC Rural*, 04 January 2022: <https://www.abc.net.au/news/rural/2022-01-05/jbs-seals-the-deal-on-rivalea-pork/100738828>.
- 17 Grady McGregor, “The father-son beef that is rattling the world’s largest pork processor,” *Fortune*, 25 August 2021: <https://fortune.com/2021/08/25/wh-group-smithfield-foods-china-pork-family-feud/>.
- 18 Agnieszka de Sousa, “From Printing Steaks to Raising Cash for Cultivated Beef Rollout,” *Bloomberg/Quint*, 07 July 2021: <https://www.bloombergquint.com/markets/from-printing-steaks-to-raising-cash-for-cultivated-beef-rollout> ; see also Jennifer Marston, “Brief: Qatar plans cell-cultured meat hub through \$200m+ investment in partnership with Eat Just,” *AgFunder News*, 31 August 2021: <https://agfundernews.com/qatar-plans-cell-cultured-meat-hub-through-200m-investment-in-eat-just.html>.
- 19 Oliver Morrison, “Cell-based prices forecast to drop ‘significantly below conventional foods’ in five years as alt proteins attract record \$3.1bn in 2020,” *Food Navigator*, 18 March 2021: <https://www.foodnavigator.com/Article/2021/03/18/Cell-based-prices-forecast-to-drop-significantly-below-conventional-foods-in-five-years-as-alt-proteins-attract-record-3.1bn-in-2020>.
- 20 ETC Group and IUF, “Lab-grown meat and other Petri-protein industries,” 01 April, 2019: <https://www.etcgroup.org/content/lab-grown-meat-and-other-petri-protein-industries>
- 21 See Good Food Institute’s company database here: <https://gfi.org/resource/alternative-protein-company-database/>
- 22 <https://www.crunchbase.com/home>
- 23 Sally Ho, “Nestlé Begins Cell-Based Meat Research with Israel’s Future Meat,” *Green Queen*, 14 July 2021: <https://www.greenqueen.com.hk/nestle-cell-based-meat/>.
- 24 OECD/FAO, *OECD-FAO Agricultural Outlook 2021-2030*, Paris: OECD Publishing, 2021, p. 164: <https://doi.org/10.1787/19428846-en>.
- 25 Marc Fawcett-Atkinson, “Plant-based meats are on the rise. But are they sustainable?” *Canada’s National Observer*, 3 December 2020: <https://www.nationalobserver.com/2020/12/03/>

- news/plant-based-meat-sales-surging-sustainable-alternative-protein .
- 26 Tom Philpott, “Is Lab Meat About to Hit Your Dinner Plate?” *Mother Jones*, 02 August 2021: <https://www.motherjones.com/food/2021/08/is-lab-meat-about-to-hit-your-dinner-plate/> .
 - 27 Joe Fassler, “Lab-grown meat is supposed to be inevitable. The science tells a different story.” *The Counter*, 22 September 2021: <https://thecounter.org/lab-grown-cultivated-meat-cost-at-scale/> .
 - 28 Tom Phillips, “Amazon deforestation surges to 12-year high under Bolsonaro,” *The Guardian*, 30 November 2020: <https://www.theguardian.com/environment/2020/dec/01/amazon-deforestation-surges-to-12-year-high-under-bolsonaro> .
 - 29 Dom Phillips, “Meat company faces heat over ‘cattle laundering’ in Amazon supply chain,” *The Guardian*, 20 February 2020: <https://www.theguardian.com/environment/2020/feb/20/meat-company-faces-heat-over-cattle-laundering-in-amazon-supply-chain>; see also, Clifford Krauss, David Yaffe-Bellany and Mariana Simões, “Why Amazon Fires Keep Raging 10 Years After a Deal to End Them,” *New York Times*, 10 October 2019: <https://www.nytimes.com/2019/10/10/world/americas/amazon-fires-brazil-cattle.html> .
 - 30 Dom Phillips, “Meat company faces heat over ‘cattle laundering’ in Amazon supply chain,” *The Guardian*, 20 February 2020: <https://www.theguardian.com/environment/2020/feb/20/meat-company-faces-heat-over-cattle-laundering-in-amazon-supply-chain> .
 - 31 X Xu, P. Sharma, S. Shu et al., “Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods,” *Nature Food*, 2, 2021, pp. 724–732: <https://doi.org/10.1038/s43016-021-00358-x> .
 - 32 Michael Pooler and Emiko Terazona, “Brazilian meatpackers’ commitment to emissions targets under scrutiny,” *Financial Times*, 27 June 2021: <https://www.ft.com/content/03267414-b068-4b05-9d84-ocaa794f8d57> .
 - 33 Michael Pooler and Emiko Terazona, “Brazilian meatpackers’ commitment to emissions targets under scrutiny,” *Financial Times*, 27 June 2021: <https://www.ft.com/content/03267414-b068-4b05-9d84-ocaa794f8d57> .
 - 34 U.S. Securities and Exchange Commission press release, “SEC Charges Brazilian Meat Producers With FCPA Violations,” 14 October 2020: <https://www.sec.gov/news/press-release/2020-254> .
 - 35 Lisa Sorg, “Partial hog lagoon breach spills 3 million gallons of feces, urine in Sampson County,” NC Policy Watch blog, 15 June 2020: <https://tinyurl.com/32phh5dz> .
 - 36 Mark Bittman, *Animal, Vegetable, Junk: A History of Food, from Sustainable to Suicidal*, Mariner Books, 2019, p. 254 (ebook).
 - 37 Professor Lourdes Gouveia quoted in Don Walton, “Line Speed is Non-Negotiable,” *Lincoln Journal Star*, 01 June 2003.
 - 38 See, for example, U.S. Department of Labor, Occupational Safety and Health Administration, *Meatpacking*: <https://www.osha.gov/meatpacking> .
 - 39 Colin Kinniburgh, “How the Meat Industry Became a Global Health Liability,” *France 24*, 24 May 2020: <https://www.france24.com/en/20200524-covid-19-how-the-meat-industry-became-a-global-health-liability> .
 - 40 USDA Food Safety and Inspection Service, “Tyson Foods Inc. Recalls Ready-To-Eat Chicken Products Due to Possible Listeria Contamination,” 03 July 2021: <https://www.fsis.usda.gov/recalls-alerts/tyson-foods-inc.-recalls-ready-eat-chicken-products-due-possible-listeria> .