SHUTTING THE GATE ON INSECT-BASED AGRICULTURE

BY

RAJESH K. REDDY*

With the publication of the U.N. Food and Agriculture Organization's 2013 report, Edible Insects: Future Prospects for Food and Feed Security, the production of insects for animal feed and human consumption has witnessed a meteoric rise. Today, facilities capable of producing insects in the trillions are being constructed in many parts of the world, with enthusiasts hailing insect-based agriculture as a means to combat climate change, global food shortages, and the proliferation of food waste, among other concerns. As this Article argues, however, the industrial production of insects for food threatens to exacerbate rather than mitigate these crises, as well as contribute to the systemic cruelties inflicted upon traditionally farmed animals. In documenting the harms externalized by industrial animal agriculture and how the mass-scale production of insects would compound them, this Article calls for the rejection of insect-based agriculture.

*Assistant Professor at Lewis & Clark Law School, where he directs the Animal Law LLM, Animal Law MSL, and Animal Law SJD programs at the Center for Animal Law Studies. In his role as a professor, he teaches International Animal Law, Animal Legal Philosophy, Introduction to U.S. Legal Studies, and an Emerging Topics in Animal Agriculture course dedicated to the protection of insects, among other offerings. Outside of Lewis & Clark, he sits on the boards of Minding Animals International, World Animal Protection, and the International Coalition for Animal Protection.

I. INTRODUCTION

It was in 2013 that the Food and Agriculture Organization of the United Nations (FAO) produced its first-ever assessment regarding the prospect of insect-based agriculture to address key challenges posed by the twenty-first century.[1] Yet despite the FAO's vanguard role in combating global food insecurity,[2] shockingly few of the dilemmas outlined in the report recognize predicted decreases in the amount and suitability of arable land, drought, depleted fisheries, and the proliferation of food waste.[3] Given that these crises will likely grow even more pronounced with the world's population expected to reach nine billion by the year 2050, food production will ostensibly need to double to meet demand.[4] It is against this dire backdrop that the FAO's report, *Edible Insects: Future Prospects for Food and Feed Security*, advances numerous environmental, nutrition-based, and sustainability arguments in favor of insect-based agriculture—both as feed for farmed animals and for direct consumption.[5] Ultimately, its promise is characterized not just as a viable measure but an arguably necessary one if a sustainable, food-secure future is to be realized.[6]

Now, just over a decade since the report's release, the FAO has already witnessed a dramatic rise in large-scale insect farming,[7] with companies striving to outcompete one another in a bid to hold the title of the world's largest insect production facility.[8] Although the majority of current production serves as feed for other farmed animals,[9] the industry has already contrived targeted marketing campaigns to pique consumer interest, particularly in industrialized Western countries, where reactions to entomophagy, or the human consumption of insects, range from food safety concerns to utter disgust.[10] Just a few of the tactics

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1 ARNOLD VAN HUIS ET AL., U.N. FOOD & AGRIC. ORG., EDIBLE INSECTS: FUTURE PROSPECTS FOR FOOD AND FEED SECURITY, at ix, xi, xiii, FAO Forestry Paper 171 (2013) [hereinafter FAO, EDIBLE INSECTS], https://www.fao.org/3/i3253e/i3253e.pdf.

2 *About FAO*, FAO, https://www.fao.org/about/about-fao/en (last visited Mar. 16, 2024).

3 *Cf.* FAO, EDIBLE INSECTS, *supra* note 1, at ix (noting issues around population growth and food production).

4 *Id.*

5 *Id.* at xiv.

6 *Id.* at 59.

7 Agnieszka Orkusz, *Edible Insects Versus Meat—Nutritional Comparison: Knowledge of Their Composition is the Key to Good Health*, NUTRIENTS, Apr. 2021, No. 1207, at 2; *see also* Lars-Henrik Lau Heckmann, *Insect Farming Goes Commercial: A Historical Perspective (1)*, FEED PLANET (Sept. 9, 2022), https://feedplanetmagazine.com/blog/insect-farming-goes-commerciala-historical-perspective-2006 (describing growth and development in the field since the FAO report).

8 Nicolás Rivero, *Why Companies Are Racing to Build the World's Biggest Bug Farm*, WASH. POST (Nov. 13, 2023), https://www.washingtonpost.com/climate-solutions/2023/11/12/biggest-insect-farm-record.

9 *Id.*; Abraham Rowe, *Insects Raised for Food and Feed—Global Scale, Practices, and Policy*, RETHINK PRIORITIES (June 29, 2020), https://rethinkpriorities.org/publications/insects-raised-for-food-and-feed.

10 FAO, EDIBLE INSECTS, *supra* note 1, at 35, 39, 113.

deployed to overcome these hurdles include the presentation of entomophagy as a historical part of the human diet, one still practiced in many regions of the world, and the portrayal of insects as a novel food for the gastro-adventurous.[11] To this end, the industry has singled out crickets, whether in whole or powdered form, as the perfect "gateway bug"[12] behind which some 1,900 other edible insect species, each bearing a distinct texture and flavor profile, wait to be the next integrated into consumers' diets.[13] But the promotion of insect agriculture has notably extended beyond the consumer experience. In the hope of appealing to conscientious consumers, insects are also being portrayed as the more nutritious, sustainable, and environmentally sound option compared to "meat."[14] While studies exist to support this claim,[15] the juxtaposition of the term "meat," meaning the flesh of an animal, with "insects" proves curious, even troubling.[16] Given the FAO's own assessment of the crises posed by animal agriculture today,[17] the depiction of insects as meat-free problematically situates them as *apart from* as opposed to *a part of* the many harms animal agriculture already externalizes.

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[11] *Id.* at 40–43, 151; *see also* Interview by Clare Taylor with Arnold van Huis, Entomologist, Wagenigen University, *Eating Insects: "Good for Your Health, the Planet and Nutritionally Equivalent to Meat"*, EUR. SCI.-MEDIA HUB (Jan. 10, 2024), https://sciencemediahub.eu/2024/01/10/eating-insects-good-for-your-health-the-planet-and-nutritionally-equivalent-to-meat (discussing strategies to address consumer reluctance regarding insect-based protein). Other noted approaches are to "disguise" the addition of insects by grinding them into powder form so as to make them "[un]recognizable to the public." *Id.*

[12] Josh Galt, *Crickets—The Gateway Bug to All Edible Insects*, ENTOVEGAN (May 4, 2019), https://entovegan.com/crickets-gateway-bug-edible-insects; Matt McFarland, *Gateway Bug: How Crickets Could Hook America on Eating Insects*, WASH. POST (Aug. 20, 2014), https://www.washingtonpost.com/news/innovations/wp/2014/08/20/gateway-bug-how-crickets-could-hook-america-on-insect-eating.

[13] FAO, EDIBLE INSECTS, *supra* note 1, at 9; Aly Moore, *Exploring the Flavor Profiles of Bugs*, INST. OF CULINARY EDUC. (June 12, 2019), https://www.ice.edu/blog/exploring-flavor-profiles-bugs.

[14] *See, e.g.*, Orkusz, *supra* note 7, at 3 (comparing "edible insects" to "meat"); Klaus W. Lange & Yukiko Nakamura, *Edible Insects as Future Food: Chances and Challenges*, 1 J. FUTURE FOOD 38, 40, 43 (2021) (discussing economic, environmental, and nutritional advantages of insect versus other animal protein); C.L.R Payne et al., *Are Edible Insects More or Less "Healthy" than Commonly Consumed Meats? A Comparison Using Two Nutrient Profiling Models Developed to Combat Over- and Undernutrition*, 70 EUR. J. CLINICAL NUTRITION 285, 289 (2016) (noting that under the Nutrient Value Scoring system, certain species of insects tested boasted a "significantly higher nutritional value" compared to beef and chicken and that no insect species were found to be nutritionally inferior).

[15] *E.g.*, Lange & Nakamura, *supra* note 14; Payne et al., *supra* note 14.

[16] *What is Meat?*, U.S. DEP'T OF AGRIC. (Mar. 3, 2023), https://ask.usda.gov/s/article/What-is-meat.

[17] *See* FAO, LIVESTOCK'S LONG SHADOW: ENVIRONMENTAL ISSUES AND OPTIONS 4 (2006), https://www.fao.org/3/a0701e/a0701e.pdf ("Livestock have a substantial impact on the world's water, land and biodiversity resources and contribute significantly to climate change.").

Appreciating that large-scale agricultural insect production is still a nascent industry,[18] this Article seeks to provide a critical assessment of its impacts, both positive and negative, within the context of animal agriculture more broadly. To this end, Part II of this Article observes key historical developments that gave rise to the industrialization of animal agriculture in the United States, the subsequent exportation of the factory farm model abroad, and its rise as the predominant mode of animal production on the international stage.[19] From here, Part II identifies key harms externalized by the industry, touching on concerns related to animal welfare, consumer and public health, environmental pollution, climate change, and sustainability—as well as the industry's attempts to mitigate and obscure these harms. Appreciating that any one of these issues could inform the substance of a standalone paper, this Article sacrifices depth for breadth with the hope of offering a multidimensional assessment of the problem. Against this backdrop, Part III scrutinizes arguments seeking to advance large-scale insect agriculture, both as a feed for other farmed animals and for direct human consumption. In doing so, the Article interrogates the prospect of insect farming in light of the harms already externalized by animal agricultural production. Notably, given the marketing of insects as a meat-free alternative, Part III weighs their likely impact against competing, plant-based solutions.[20] In conclusion, Part IV returns to the arguments advanced by the FAO's *Edible Insects* report, which has been credited for driving investment in insects as a novel food.[21] In doing so, Part IV finds that although large-scale insect agriculture may lead to reductions of certain harms, the crises facing the world today nevertheless require a

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[18] *See* Matilde Nuñez del Prado Alanes, *Meat Producers Have a New Animal to Farm*, SENTIENT MEDIA (Apr. 29, 2022), https://sentientmedia.org/insect-farming-might-be-sustainable-but-is-it-ethical (calling the insect-based food industry an "emerging sector").

[19] *See* Hannah Ritchie, *How Many Animals Are Factory-farmed?*, OUR WORLD IN DATA (Sept. 25, 2023), https://ourworldindata.org/how-many-animals-are-factory-farmed (estimating the percentage of U.S. livestock produced by factory farms at 99% and the global percentage of terrestrial livestock produced by factory farms at 74%); Fiona Harvey et al., *Rise of Mega Farms: How the US Model of Intensive Farming is Invading the World*, GUARDIAN (Jul. 18, 2017), https://www.theguardian.com/environment/2017/jul/18/rise-of-mega-farms-how-the-us-model-of-intensive-farming-is-invading-the-world.

[20] *See, e.g.,* Kenny Torrella, *There's Less Meat at This Year's Climate Talks. But There's Plenty of Bull.*, VOX (Nov. 30, 2023) [hereinafter Torrella, *Climate Talks*], https://www.vox.com/future-perfect/2023/11/30/23981529/cop28-meat-livestock-dairy-farming-plant-based-united-nations-dubai-uae (observing how meat industry leaders held immense influence during climate change talks at the United Nations COP27 summit); Rob Jordan, *How the Meat and Dairy Sector Resists Competition from Alternative Animal Products*, STAN. NEWS SERV. (Aug. 18, 2023), https://news.stanford.edu/press-releases/2023/08/18/can-alternative-meat-compete (discussing how the meat and dairy industry has lobbied to stifle competition from plant-based products, which have a lower climate impact, using exclusive labeling standards).

[21] *See* Orkusz, *supra* note 7 (crediting FAO with popularizing insects as a human food source); JoAnna Klein, *How to Develop an Appetite for Insects*, N.Y. TIMES (Sept. 30, 2019), https://www.nytimes.com/2019/09/26/science/eating-insects-entomophagy.html (noting that the FAO report drove "explosion" of efforts to promote mealworms as a human food source).

transition away from animal agriculture, insects included, if the sustainable, food-secure future of tomorrow is to be achieved.

II. THE "WONDER" AND EXTERNALIZED HARMS OF INDUSTRIAL ANIMAL AGRICULTURE

While the industrialization of animal agriculture was driven by the U.S. government's coordinated response to the historic food shortages that gripped the nation during the first half of the twentieth century, the discovery of vitamins and antibiotics made it possible. Although the term was not coined until 1912, scientists theorized about the existence of vitamins as early as the mid-1800s, with deficiencies believed to be the cause of otherwise preventable diseases.[22] Years later in 1922, scientists discovered that vitamin D deficiency caused rickets, a disease that distorts the growth of bones.[23] As there was no assurance that children would receive the necessary amount of vitamin D through their normal diet and sunlight,[24] the following decade saw milk and other staples fortified with the vitamin, which led to the eradication of rickets.[25] The impact of this discovery on animal agriculture was just as drastic; chickens likewise suffered from rickets due to being kept indoors and out of the sunlight in winter. Fortifying their feed with vitamin D yielded the same effect: elimination of the disease.[26] It also enabled farmers to begin raising poultry indoors all year round and in greater numbers.[27] This ability to confine farmed animals became even more profitable following the discovery of vitamin B12, which could be created in mass quantities as a byproduct of antibiotics manufacturing.[28]

Set against the discoveries of other vitamins and antibiotics such as penicillin, World War I-era America witnessed a period of critical food shortages and rising inflation, giving rise to the lament over the "high cost of living."[29] Faced with protests over meat prices in particular, the U.S. Department of Agriculture (USDA) was charged with ensuring

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[22] *See* Nicholas Bakalar, *Vitamin D, 1922*, N.Y. TIMES (Sept. 14, 2009), https://www.nytimes.com/2009/09/15/health/15first.html (stating term "vitamine" was coined in 1912 and noting early understanding that certain vitamins could prevent disease).

[23] *Id.*

[24] *See id.* ("[I]t is almost impossible to acquire sufficient vitamin D from diet alone, without either supplements or sufficient exposure to sunlight.").

[25] *Id.*

[26] Kenny Torrella, *How a Shipping Error 100 Years Ago Launched the $30 Billion Chicken Industry*, VOX (Feb. 9, 2024, 8:42 AM), https://www.vox.com/future-perfect/2023/2/10/23589333/cecile-steele-chicken-meat-poultry-eggs-delaware.

[27] *Id.*

[28] *See* Maureen Ogle, *Riots, Rage, and Resistance: A Brief History of How Antibiotics Arrived on the Farm*, SCI. AM. (Sept. 3, 2013), https://blogs.scientificamerican.com/guest-blog/riots-rage-and-resistance-a-brief-history-of-how-antibiotics-arrived-on-the-farm (noting that B12 and antibiotics allowed livestock to reach market weight quicker, thus lowering production costs).

[29] *Id.*

supply could meet the nation's growing demand.[30] A significant factor concerned the composition of feedstock. It was widely known that livestock were healthier and gained weight more quickly when fed diets containing animal-based protein.[31] As such, producers often supplemented livestock feed with "tankage," the byproduct of animal rendering, as well as fish meal and cod liver oil, which often had to be imported and thus proved costly.[32] As trade channels dried up in the midst and aftermath of World War II, however, the USDA sought out ways to achieve the same rate of growth at a lower cost to industry and consumers.[33] The solution came in 1948 with the isolation of vitamin B12, which not only cured pernicious anemia (a deadly global disease) but was also thought to be what distinguished plant- from animal-based proteins.[34] Upon confirmation that B12 was the missing link, the question of how to produce the vitamin at scale proved critical, as initial production methods were inefficient and cost-prohibitive.[35] After learning that it could be cheaply and quickly produced as a byproduct of manufacturing the antibiotic aureomycin, livestock feed manufacturers widely incorporated B12 into their products.[36] Experiments using B12 derived from aureomycin saw livestock growth rates 50% faster than those of livestock fed B12 from other sources.[37] Announcing the implications of this discovery for meat production, *The New York Times* hailed aureomycin-derived B12 as a "Wonder Drug,"[38] with other news outlets underscoring its implications for "the survival of the human race in a world of dwindling resources and expanding populations."[39] Equally important, when added to livestock feed at subtherapeutic levels, aureomycin-derived B12 also fended off bacterial infections, at least in the short-term.[40] Although other factors such as genetic engineering have also played major roles in the evolution of animal agriculture,[41] the supplementation of animal feed with antibiotic-laced vitamin cocktails enabled marked increases in confinement and concentration,[42] with

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30 *Id.*

31 *Id.*

32 *Id.*

33 *Id.*

34 *Id.*

35 *Id.* At the time of its discovery, vitamin B12 was extracted from animal livers, roughly a ton of which was required to yield just 20 milligrams. *Id.*

36 *Id.*

37 *Id.*

38 Richard Conniff, *The Man Who Turned Antibiotics into Animal Feed*, ALICIA PATTERSON FOUND. (Dec. 9, 2012), https://aliciapatterson.org/richard-conniff/the-man-who-turned-antibiotics-into-animal-feed.

39 Ogle, *supra* note 28.

40 *See* Conniff, *supra* note 38 (noting the use of aureomycin-derived B12 as an antibiotic to treat diseases, but also identifying the practice of supplementing animal feed with antibiotics as the cause of deadly outbreaks).

41 Elisabeth H. Ormandy et al., *Genetic Engineering of Animals: Ethical Issues, Including Welfare Concerns*, 52 CAN. VETERINARY J. 544, 545 (2011).

42 Conniff, *supra* note 38.

common husbandry practices shifting towards factory production methods.

Today, "factory farms" have all but supplanted small-scale "family farms," which generally afforded livestock access to sunlight, fresh air, and pasture.[43] In addition to rearing greater numbers of animals in intensively confined spaces, industrial farming methods also rely on the importation of animal feed, as opposed to allowing animals to graze, and generate significant waste.[44] It is fitting, then, that the Environmental Protection Agency (EPA) defines such facilities as "Animal Feeding Operations," which, if large enough based on species-specific stock numbers and other criteria,[45] are regulated as "Concentrated Animal Feeding Operations"[46] or CAFOs. This Article employs the term "CAFO" as conterminous with "factory farms," although a factory farm may not always qualify as a CAFO due to technical distinctions.[47]

Although the factory farm model received acclaim for providing food security—at least in the short term—in the mid- to late-twentieth century, in the twenty-first it is increasingly cited as the principal source of long-term, systemic harms, with these impacts externalized onto humans and animals alike. As discussed below, despite appearances of having either mitigated or eliminated these harms, animal agricultural production continues to hold dire consequences for the welfare of farmed animals, consumer and public health, the environment and climate more broadly, and prospects for a sustainable, food-secure future.

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[43] *See* Jennifer Mishler, *Does Animal Agriculture Cause Climate Change and Pandemics?*, SENTIENT MEDIA (Sept. 21, 2022) [hereinafter Mishler, *Animal Agriculture*], https://sentientmedia.org/animal-agriculture (distinguishing between "idyllic pastures" and industrial agriculture). Indeed, 99% of animals reared for food in the United States come from such factory farm settings. *Id.*

[44] JAMES M. MACDONALD & WILLIAM D. MCBRIDE, U.S. DEP'T OF AGRIC., ECON. INFO. BULL. 43, THE TRANSFORMATION OF U.S. LIVESTOCK AGRICULTURE: SCALE, EFFICIENCY, AND RISKS 1 (2009); *Animal Feeding Operations*, CTRS. FOR DISEASE CONTROL & PREVENTION, https://www.cdc.gov/healthywater/other/agricultural/afo.html (last visited Mar. 15, 2024).

[45] Concentrated Animal Feeding Operations, 40 C.F.R. § 122.23(b)(1)(i)–(ii) (2023) (noting that, to qualify, "[a]nimals . . . have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period" and "[c]rops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility").

[46] *Id.* § 122.23(b)(2)–(6).

[47] Mishler, *Animal Agriculture*, *supra* note 43. Technically, CAFOs do not include aquaculture facilities, which, though "factory farms," do not quantify production based on number of individual animals but on weight. *Animal Feeding Operations (AFOs)*, ENV'T PROT. AGENCY, https://www.epa.gov/npdes/animal-feeding-operations-afos (last visited Mar. 17, 2024); Brandon Keim, *The Surprisingly Complicated Math of How Many Wild Animals Are Killed in Agriculture*, ANTHROPOCENE (July 18, 2018), https://www.anthropocenemagazine.org/2018/07/how-many-animals-killed-in-agriculture; Matthew Zampa, *99% of U.S. Farmed Animals Live on Factory Farms*, SENTIENT MEDIA (Apr. 16, 2019), https://sentientmedia.org/u-s-farmed-animals-live-on-factory-farms.

A. Impact on Farmed Animals

More than nine billion terrestrial and untold numbers of aquatic animals—contemplated by weight rather than as individual beings—are killed for food production in the United States each year.[48] While specific rearing conditions and treatment vary based on the species being farmed and the agricultural product being produced, the common theme of cruelty persists. Reduced to living commodities, industrially farmed animals suffer not only from the physical and psychological distress of intensive confinement practices but also from the routinized mutilations and deprivations designed to extract as much value from their bodies as possible. In addition, the unnatural feed they consume and the massive amount of waste they produce have implications for their own health and well-being, as well as for those in surrounding communities.

One of the most intensively farmed animals, egg-laying hens dwell in dimly lit warehouses, confined to battery cages arranged in long rows stacked up to five high.[49] With between five to ten hens confined in every cage, each animal receives approximately sixty-seven square inches of space.[50] For context, an 8.5x11-inch sheet of paper contains ninety-three square inches. So restricted, egg-laying hens cannot spread their wings or engage in basic natural behaviors such as foraging, dustbathing, perching, and nesting.[51] Over time, the wire cage floor cuts into their feet, leaving the hens with open wounds, sores, and blisters.[52] Because the cages are stacked, the waste of the hens above soils those below.[53] While the largest egg-production CAFOs hold at least 82,000 hens, the number confined to a single operation can be as high as 5,000,000.[54] It is in these poorly ventilated warehouses that the waste leads to unhygienic conditions.[55] Furthermore, as hens naturally attack one another, the battery cage system provides no means of escape.[56] To prevent such deaths and cannibalism, it has become a customary practice for industry

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[48] *See* Keim, *supra* note 47 (noting that chickens alone account for 9 billion deaths in the United States each year).

[49] SARA SHIELDS & IAN J.H. DUNCAN, HUMANE SOC'Y OF THE U.S., A COMPARISON OF THE WELFARE OF HENS IN BATTERY CAGES AND ALTERNATIVE SYSTEMS 1 (2009), https://www.wellbeingintlstudiesrepository.org/cgi/viewcontent.cgi?article=1014&context=hsus_reps_impacts_on_animals.

[50] *Id.*; *Cage-Free vs. Battery-Cage Eggs*, HUMANE SOC'Y OF THE U.S., https://www.humanesociety.org/resources/cage-free-vs-battery-cage-eggs (last visited Mar. 27, 2024).

[51] *Cage-Free vs. Battery-Cage Eggs*, *supra* note 50; *Everything You Should Know About Battery Cages*, HUMANE LEAGUE (Dec. 2, 2020), https://thehumaneleague.org/article/battery-cages.

[52] SHIELDS & DUNCAN, *supra* note 49, at 8.

[53] *See Everything You Should Know About Battery Cages*, *supra* note 51 (noting that the bottoms of battery cages are made of wire to allow waste to fall through).

[54] *CAFOs*, SIERRA CLUB, https://www.sierraclub.org/grassroots-network/food-agriculture/cafos (last visited Mar. 18, 2024).

[55] SHIELDS & DUNCAN, *supra* note 49, at 6.

[56] *Id.* at 5.

to cut off the tips of chicks' beaks, an extremely sensitive part of their body, without the use of analgesics.[57] On top of this, some producers subject the hens to forced molting, a starvation technique used to stimulate egg production once the hens are fed again after several days.[58] As a result of these and other factory farm practices, the industrially raised hens of today produce 250 eggs a year, compared to the 100 by their counterparts a century ago.[59] Male chicks, on the other hand, holding little value for their meat and considered waste, are routinely ground alive just moments after their birth.[60]

Bred from different genetic lines, poultry bred for human consumption (as opposed to egg laying) are known as broiler chickens.[61] Like egg-laying hens, producers rear broilers in massive warehouse facilities, where they face significant health and welfare issues.[62] Although not confined to cages, broiler chickens could be described as being "trapped" in their own bodies, which have been genetically engineered to grow at incredible rates.[63] Designed to reach slaughter weight in just forty-seven days, compared to the seventy weeks of their counterparts from the 1950s, broiler chickens commonly suffer from heart attacks, lung collapse, and other forms of organ failure due to the profound stress placed upon their bodies.[64] It is also not uncommon to find crippled chickens with painful leg conditions caused by their excessive weight.[65]

Pigs bred by the modern pork industry experience similar treatment. In contrast to those in the pre-industrial era, pigs in CAFOs are held in enormous warehouses with concrete floors.[66] Housed in pens that allow little freedom of movement, the pigs often bite one another due to the

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[57] *Id.*

[58] *Battery Cages: What Are They, Why Are They Bad, and Are They Legal in the U.S.?*, FARM FORWARD, https://www.farmforward.com/issues/animal-welfare/battery-cages (last visited Mar. 18, 2024).

[59] SHIELDS & DUNCAN, *supra* note 49, at 9.

[60] *Cage-Free vs. Battery-Cage Eggs*, *supra* note 50; *see also Cracking the Label Myth*, ANIMALS' ADVOC. (Animal Legal Def. Fund, Cotati, Cal.), Winter 2010, at 4, 5 ("200 million male chicks are killed each year because they are of no use to the U.S. egg industry. Most of these newborn chicks are ground up alive in a machine called a macerator . . . .").

[61] *Welfare Issues for Broiler Chickens*, COMPASSION IN WORLD FARMING, https://www.ciwf.com/farmed-animals/chickens/broiler-chickens/welfare-issues (last visited Mar. 18, 2024).

[62] *Id.*

[63] *See id.* ("[B]roilers tend to spend much of their time lying down and many suffer from painful lameness as their legs are unable to support their heavy body weights.").

[64] *Id.*

[65] *Id.*

[66] *See* Natasha Daly, *California Voted to Improve Pig Welfare. The Pork Industry is Facing a Reckoning.*, NAT'L GEOGRAPHIC (Aug. 13, 2021), https://www.nationalgeographic.com/animals/article/california-voted-to-improve-pig-welfare-the-pork-industry-is-facing-a-reckoning (comparing industrial hog farms to traditional and small farms).

boredom and stress of confinement.[67] To prevent injuries, it has become customary practice to dock piglets' tails without the use of analgesics.[68] Where the intensive confinement of pigs generally proves a welfare concern, the treatment of breeding sows is especially inhumane. Once impregnated, CAFO operators transfer breeding sows into individual gestation crates, which restrict their movement to standing up and lying down during the entire four months of pregnancy.[69] Once she has given birth, a sow is transferred from the gestation crate to an equally restrictive farrowing crate, designed to allow her newborn piglets to suckle through the metal slats for the next three weeks.[70] The sow is then reimpregnated and returned to a gestation crate—a cycle that sows undergo roughly three times a year, producing between nine and twelve litters by the time they are slaughtered in their third or fourth year of life.[71] As with broiler chickens, industrial production techniques result in pigs reaching slaughter weight more quickly, with the average lifespan today being just six months.[72]

Although generally raised outdoors, cattle in the beef industry are nevertheless subjected to numerous harms during their captivity on feedlots, where many beef cattle spend the majority of their time.[73] While beef CAFOs hold at least 1,000 cattle, the largest can contain up to 150,000.[74] Notably, these lots, which offer no shelter from the elements, see cattle suffer from heat stress, freezing temperatures, and unsanitary conditions.[75] With respect to cattle raised for beef, common practices also include de-horning procedures carried out without the benefit of anesthesia.[76]

Unlike cattle reared for beef, dairy CAFOs keep dairy cows in indoor facilities.[77] While the breeding of egg-laying hens, broiler chickens, and cattle raised for beef is carried out to maintain or otherwise control stock numbers, dairy cows are artificially inseminated repeatedly over the

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67 *Inhumane Practices on Factory Farms*, ANIMAL WELFARE INST., https://awionline.org/content/inhumane-practices-factory-farms (last visited Mar. 15, 2024).

68 *Id.*; *Pigs*, ANIMAL WELFARE INST., https://awionline.org/content/pigs (last visited Mar. 15, 2024).

69 *Pigs*, *supra* note 68.

70 *Id.*; Daly, *supra* note 66.

71 *Pigs*, *supra* note 68; Daly, *supra* note 66.

72 *Life Cycle of a Market Pig*, PORK CHECKOFF, https://porkcheckoff.org/pork-branding/facts-statistics/life-cycle-of-a-market-pig (last visited Mar. 15, 2024); Mike D. Tokach et al., *Performance-enhancing Technologies in Swine Production*, ANIMAL FRONTIERS, Oct. 2016, at 15, 15.

73 *See* Jennifer Mishler, *How Much Time Do Cattle Spend on Feedlots?*, SENTIENT MEDIA (Jan. 25, 2023) [hereinafter Mishler, *Cattle Feedlots*], https://sentientmedia.org/cattle-feedlot (noting that cows spend 90 to 300 days on feedlots after weaning at six to eight months of age).

74 *Factory Farming Cows: What Happens to Cows in Factory Farms?*, NEW ROOTS INST. (Jan. 4, 2022), https://www.newrootsinstitute.org/articles/factory-farming-cows.

75 Mishler, *Cattle Feedlots*, *supra* note 73.

76 *Factory Farmed Cows*, NAT'L HUMANE EDUC. SOC'Y, https://www.nhes.org/animal-info-2/factory-farmed-animals-2/factory-farmed-cows (last visited Mar. 12, 2024).

77 *Id.*

course of their lives, as their productivity is intrinsically tied to their reproduction.[78] Both female and male calves are forcibly separated from their mothers shortly after birth; while the former are integrated into the dairy industry to continue the cycle, the latter are deemed a byproduct and slaughtered just weeks after birth to produce veal.[79]

Numerous other species are intensively farmed for food. With fisheries around the world being depleted, the production of aquaculture has risen in recent years.[80] Like their terrestrial counterparts, fishes in aquaculture facilities are subject to intensive confinement practices. Grown in overcrowded tanks and thus unable to move as they would in nature, farmed fishes experience heightened levels of aggression and stress, which can result in death.[81] Also like farmed terrestrial animals, fishes in the aquaculture industry are fed antibiotics to stimulate growth and stave off infection.[82] While the question of fish sentience was once a matter of unsettled science, the great weight of modern evidence indicates that fishes possess sentience and do feel pain.[83] As such, the welfare of fishes in aquaculture production has become a cause of concern.[84]

Notably, federal law extends no protections to farmed animals while being reared, whether on factory farms or otherwise.[85] Although protections exist in some states' anti-cruelty laws,[86] exemptions carved out for common husbandry practices effectively render such provisions moot.[87] As such, rather than constraining the industry, the exemptions for common husbandry practices operate as a hand-in-glove affair: the industry appears to be bound by, yet in practice manipulates, the laws meant to constrain its actions. On top of this, the industry has fought to conceal the treatment of animals in its care from public view, even lobbying for laws criminalizing the documentation of animal cruelty on their premises.[88] Appreciating that the welfare of farmed animals is a concern for consumers,[89] the industry has established a veneer of animal

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[78] *Id.*

[79] *Id.*

[80] Kelly Beaton, *Aquaculture Industry on the Rise as Wild Fishery Production Slows*, FOOD INST. (Aug. 27, 2021), https://foodinstitute.com/focus/aquaculture-industry-on-the-rise-as-wild-fishery-production-slows.

[81] Kenny Torrella, *The Next Frontier for Animal Welfare: Fish*, VOX (Mar. 2, 2021, 9:30 AM), https://www.vox.com/future-perfect/22301931/fish-animal-welfare-plant-based.

[82] *See id.* (noting the use of antibiotics in aquaculture and similarities between chicken and fish raising practices focused on increasing growth).

[83] *Id.*

[84] *Id.*

[85] Daly, *supra* note 66.

[86] *Id.*; *see also Farm Animal Protection FAQ*, HUMANE SOC'Y OF THE U.S., https://www.humanesociety.org/resources/farm-animal-protection-faq (last visited Mar. 27, 2024) (describing animal welfare statutes protecting farm and non-farm animals as "cruelty statutes").

[87] *Farm Animal Protection FAQ*, *supra* note 86.

[88] *Id.*

[89] Ryne P. Smith, *The Lawyer's Role in Improving "Humane" Meat Labeling*, 48 MITCHELL HAMLINE L. REV. 688, 689 (2022).

welfare by developing its own humane certification standards and deceptive marketing techniques to obscure the cruel treatment inherent to factory farming methods.[90]

B. Impact on Consumer and Public Health

A growing body of literature attests to the negative personal health outcomes of consuming animal products. Red meat in particular has been associated with heart disease, stroke, type 2 diabetes, and certain cancers.[91] While posing fewer risks than red meat, white meat consumption has been shown to raise low-density lipoprotein (LDL), or "bad" cholesterol, at rates comparable to red meat and thus proves a cardiovascular health risk as well.[92] Although it compares well to other meats, fish has been shown to contain mercury and chemicals from the food fishes eat and their environment.[93] Various studies have also linked increases in LDL cholesterol with egg consumption, findings that egg industry-funded research has sought to minimize.[94] In addition, the consumption of dairy, known to cause inflammation, has been associated with certain cancers, as well as joint pain, mood changes, and other health problems.[95] Presenting these and other health dangers in and of themselves, products derived from animals fed non-therapeutic antibiotics can have additional negative heath impacts on consumers, with just a few effects of these antibiotic residues being teratogenicity, toxicity, hypersensitivity, and carcinogenicity.[96]

Animal agriculture externalizes risks beyond just consumers. To be sure, the global pandemic drew international attention to the risks posed

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[90] *Id.* at 700–01.

[91] Harrison Wein, *Risk in Red Meat?*, NAT'L INST. OF HEALTH: NIH RSCH. MATTERS (Mar. 26, 2012), https://www.nih.gov/news-events/nih-research-matters/risk-red-meat.

[92] Katherine D. McManus, *When it Comes to Cholesterol Levels, White Meat May Be No Better than Red Meat—and Plant-Based Protein Beats Both*, HARV. HEALTH PUBL'G (Aug. 22, 2019), https://www.health.harvard.edu/blog/when-it-comes-to-cholesterol-levels-white-meat-may-be-no-better-than-red-meat-and-plant-based-protein-beats-both-2019082217550.

[93] Jenna Birch, *From Fish to Bacon, a Ranking of Animal Proteins in Order of Healthfulness*, WASH. POST (July 3, 2019, 7:00 AM), https://www.washingtonpost.com/lifestyle/wellness/from-fish-to-bacon-a-ranking-of-meats-in-order-of-healthiness/2019/07/02/2de2dce0-9435-11e9-aadb-74e6b2b46f6a_story.html; *Benefits and Risks of Eating Fish*, CAL. OFF. OF ENV'T HEALTH HAZARD ASSESSMENT, https://oehha.ca.gov/fish/benefits-risks (last visited Mar. 15, 2024).

[94] Laura Reiley, *Cholesterol Studies Promoted the Sunny Side of Eggs, but the Research was Hatched Out of Industry Funding*, WASH. POST (Dec. 13, 2019, 1:21 PM), https://www.washingtonpost.com/business/2019/12/13/cholesterol-studies-promoted-sunny-side-eggs-research-was-hatched-out-industry-funding.

[95] Gina Van Thomme, *5 Things to Know About Dairy and Cancer Risk*, MD ANDERSON CANCER CTR. (Nov. 9, 2023), https://www.mdanderson.org/cancerwise/5-things-to-know-about-dairy-and-cancer-risk.h00-159623379.html.

[96] Oana Mărgărita Ghimpeţeanu et al., *Antibiotic Use in Livestock and Residues in Food—A Public Health Threat: A Review*, FOODS, May 16, 2022, No. 1430, at 12, 16–17.

by the intensive confinement of animals in unhygienic conditions.[97] Although the great weight of evidence has pointed to COVID-19 as having originated in a wild animal,[98] numerous other outbreaks have stemmed from factory farm facilities. Since the 1940s, the intensification of animal agriculture operations has been responsible for over a quarter of all infectious diseases in humans and more than half of all zoonotic diseases.[99] In the midst of the COVID-19 pandemic, however, the general public paid scant attention to factory farm-related incidents, such as the outbreak of a variant of the avian flu amongst employees working with poultry animals.[100] In addition to hundreds of thousands of livestock that were killed to stem the spread of infection, the H5N6 outbreak was fatal for over half of the humans infected, a mortality rate far more severe than that of COVID-19.[101] As such, virologists have sounded the alarm as to how factory farms operate as reservoirs of disease, with the intensive confinement of genetically identical animals providing "ideal conditions" for the next pandemic.[102]

In addition, scientists have long decried the inherent dangers of supplementing livestock feed with antibiotics.[103] By increasing antimicrobial resistance, the use of antibiotics has transformed factory farms into proverbial breeding grounds for "superbugs."[104] Despite this well-known risk, however, certain countries still use eight out of ten "medically important antibiotics" to promote growth in otherwise healthy animals.[105] And while governments globally have taken steps to prohibit the prophylactic use of these antibiotics, the United States has instead

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97 Rajesh K. Reddy & Joan Schaffner, *The Convention on Animal Protection: The Missing Link in a One Health Global Strategy for Pandemic Prevention*, 10 GLOB. J. ANIMAL L., July 26, 2022, at 16–17.

98 *Id.* at 14–16.

99 U.N. ENV'T PROGRAMME & INT'L LIVESTOCK RSCH. INST., PREVENTING THE NEXT PANDEMIC: ZOONOTIC DISEASES AND HOW TO BREAK THE CHAIN OF TRANSMISSION 15 (2020).

100 John Vidal, *Factory Farms of Disease: How Industrial Chicken Production Is Breeding the Next Pandemic*, GUARDIAN (Oct. 18, 2021), https://www.theguardian.com/environment/2021/oct/18/factory-farms-of-disease-how-industrial-chicken-production-is-breeding-the-next-pandemic.

101 *Id.*; *see* Farida B. Ahmad et al., *COVID-19 Mortality Update—United States, 2022*, 72 MORBIDITY & MORTALITY WKLY. REP. 493, 495 (2023) (stating COVID-19 mortality rate in 2022 was "61.3 per 100,000 persons").

102 Vidal, *supra* note 100.

103 *E.g.*, U.N. ENV'T PROGRAMME & INT'L LIVESTOCK RSCH. INST., *supra* note 99, at 35; Ghimpețeanu et al., *supra* note 96.

104 Mimi Bekhechi, *Five Things Would Happen if Everyone Stopped Eating Meat*, INDEPENDENT (Jan. 31, 2016), https://www.independent.co.uk/voices/five-things-would-happen-if-everyone-stopped-eating-meat-a6844811.html ("Pigs, chickens and other animals on factory farms are fed a steady diet of drugs to keep them alive in these unsanitary, stressful conditions, increasing the chance that drug-resistant superbugs will develop.").

105 *Stop Using Antibiotics in Healthy Animals to Prevent the Spread of Antibiotic Resistance*, WORLD HEALTH ORG. (Nov. 7, 2017), https://www.who.int/news/item/07-11-2017-stop-using-antibiotics-in-healthy-animals-to-prevent-the-spread-of-antibiotic-resistance.

exerted global pressure to encourage it.[106] To assuage consumer concern, the U.S. animal agriculture industry has even contrived a misleading "One Health Certified" label to suggest that its use of antibiotics is somehow responsible when the label's own standards fail to deviate from industry norms.[107] In direct conflict with One Health's goal of "achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment,"[108] the industry's coopting of the One Health concept serves to functionally obscure the harms it inflicts on the heath of humans, animals, and the environment.

C. Impact on the Environment and Climate

The scale of factory farm production has had profoundly detrimental impacts on the environment in the form of air, water, and soil pollution. Both the antibiotic-supplemented feed animals consume and the waste they subsequently produce are toxic, leading to severe illness and even premature death for people who live in surrounding communities.[109] In addition to its local impacts, animal agricultural production represents one of the largest drivers of anthropogenic climate change.[110] With numerous countries already struggling to cope with rising temperatures and increases in the frequency and severity of natural disasters,[111] world leaders have acknowledged that animal agriculture's role in fueling the climate crisis deserves additional scrutiny, even as the industry lobbies against it on the international stage.[112]

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106 *See Warning to Post-Brexit Deal-Makers: Don't Lower UK Farm Standards to Match US Where Antibiotic Use Is Five Times Higher Than in the UK*, ALL. TO SAVE OUR ANTIBIOTICS (Feb. 8, 2018), https://www.saveourantibiotics.org/news/press-release/warning-to-post-brexit-deal-makers-dont-lower-uk-farm-standards-to-match-us-where-antibiotic-use-is-five-times-higher-than-in-the-uk (stating that though the United States uses at least nine times the amount of antibiotics per unit of beef than the United Kingdom, the United Kingdom may lift an existing ban on beef imports from the United States as the result of a trade deal); *Stop Using Antibiotics in Healthy Animals to Prevent the Spread of Antibiotic Resistance*, *supra* note 105 ("Many countries have already taken action to reduce the use of antibiotics in food-producing animals.").

107 Brian Ronholm & Charlotte Vallaeys, Opinion, *Consumer Reports: "One Health Certified" Label is Meaningless, Misleading*, FOOD SAFETY NEWS (July 23, 2023), https://www.foodsafetynews.com/2020/07/consumer-reports-one-health-certified-label-is-meaningless-misleading.

108 *One Health*, CTRS. FOR DISEASE CONTROL & PREVENTION (Feb. 16, 2024), https://www.cdc.gov/onehealth/index.html.

109 Sarah Kaplan, *Air Pollution from Farms Leads To 17,900 U.S. Deaths Per Year, Study Finds*, WASH. POST (May 10, 2021, 3:00 PM), https://www.washingtonpost.com/climate-environment/2021/05/10/farm-pollution-deaths.

110 *Animal Agriculture's Impact on Climate Change*, CLIMATE NEXUS, https://climatenexus.org/climate-issues/food/animal-agricultures-impact-on-climate-change (last visited Mar. 13, 2024).

111 *Climate Emergency: The Most Extreme Weather Events of 2021*, AL JAZEERA (Nov. 1, 2021), https://www.aljazeera.com/news/2021/11/1/recapping-the-most-major-weather-events-of-2021.

112 Torrella, *Climate Talks*, *supra* note 20.

With tens and sometimes hundreds of thousands of farmed animals concentrated in a single CAFO, the amount of urine and feces produced is massive in scale, with the waste discharged rivaling that of cities.[113] At beef, dairy, and pork facilities, massive waste management systems known as manure lagoons attempt to contain the waste in liquid form,[114] which will be sprayed over fields as fertilizer.[115] The gases emanating from these manure lagoons include methane, hydrogen sulfide, and ammonia, among others.[116] More than just offensive in smell, the particles are also noxious,[117] and the wind can disperse them well over a hundred miles.[118] With a diameter of just 2.5 micrometers, these particles can get lodged in the lungs and enter the bloodstream,[119] with prolonged exposure significantly heightening one's chances of stroke, cancer, heart disease, and death.[120] Recent studies have tallied the number of American lives lost each year due to air quality hazards from food production as a whole at 15,900,[121] of which 80% are directly attributable to animal agriculture.[122] With respect to emissions-related deaths, the industry exacts a greater toll than coal-fired power plants.[123] Rather than widespread, these deaths are highly concentrated, disproportionately affecting those who live closest to factory farm facilities.[124]

In addition to polluting the air, waste from animal agriculture facilities also contaminates surface and groundwater sources,[125] implicating environmental and human health concerns. Regulated by the EPA, CAFOs and other farming operations have been identified as the source of approximately 70% of pollution in U.S. waterways.[126] Applied as

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113 *Over Fifty Groups Petition EPA to Improve Oversight of Water Pollution from Concentrated Animal Feeding Operations*, EARTH JUST. (Oct. 26, 2022), https://earthjustice.org/press/2022/over-fifty-groups-petition-epa-to-improve-oversight-of-water-pollution-from-concentrated-animal-feeding.

114 *Id.*; Fresh Air, *"Tales" of Pig Intelligence, Factory Farming and Humane Bacon*, NPR (May 5, 2015, 1:15 PM), https://www.npr.org/transcripts/402584436?storyId=402584436 (discussing manure lagoons in North Carolina and accompanying issues).

115 Fresh Air, *supra* note 114. Given the sheer amount of waste, however, industry actors also over-apply waste as a means to simply dispose of it. *Id.*

116 Kaplan, *supra* note 109.

117 Fresh Air, *supra* note 114.

118 Kaplan, *supra* note 109. These dangerous particles are not just from animal waste but also from dust kicked up by livestock. *Id.*

119 *Id.*

120 Nina G.G. Domingo et al., *Air Quality-related Health Damages of Food*, PNAS, May 18, 2021, No. e2013637118, at 1.

121 *Id.*

122 *Id.* ("80% are attributable to animal-based foods, both directly from animal production and indirectly from growing animal feed.").

123 Kaplan, *supra* note 109.

124 Domingo et al., *supra* note 120, at 3; Jennifer Mishler, *Air Pollution from Factory Farms is Killing Us*, SENTIENT MEDIA (May 25, 2021), https://sentientmedia.org/air-pollution-from-factory-farms-is-killing-us.

125 JoAnn Burkholder et al., *Impacts of Waste from Concentrated Animal Feeding Operations on Water Quality*, 115 ENV'T HEALTH PERSPS. 308, 309 (2007).

126 Jake Young, *What Should Health Professions Students Know About Industrial Agriculture and Disease?*, 25 AMA J. ETHICS 264, 266 (2023).

a crop fertilizer, effluent can reach water sources as runoff.[127] It can also escape compromised lagoons as leakage or as overflow during floods.[128] Regardless of how it enters the water supply, the resulting harms are dire. In addition to containing concentrated nutrients such as nitrogen and phosphorous, the waste contains many of the same additives fed to animals, such as artificial hormones and antibiotics.[129] Introduced to bodies of water, the nutrients trigger cyanobacteria outbreaks, also known as algal blooms, which can spark mass die-offs of fishes, other animals, and plant life by choking the water of its oxygen.[130] Leaking into these waterways, contaminating the soil, and disrupting microbial activity in the environment more broadly, antibiotics further risk increasing antibiotic resistance.[131]

Industrial animal agriculture is also a key driver of anthropogenic climate change. With the world already struggling to cope with rising temperatures, sea levels, and extreme weather events, and in expectation that these issues will further intensify, increased attention is being paid to lowering greenhouse gas emissions, specifically carbon dioxide.[132] Not only is animal agriculture directly responsible for significant carbon dioxide emissions, it is also one of the largest producers of methane due to the natural enteric fermentation process of cattle, sheep, and goats.[133] As methane traps heat at a rate twenty-eight times greater than carbon dioxide, the industry's emission of 32% of the world's methane proves a significant contributor to this global problem.[134] Also emitted by animal agricultural is nitrous oxide, a product of anerobic digesters 273 times more potent than carbon dioxide.[135] All told, recent studies have identified animal agriculture as responsible for around 16.5% of total greenhouse

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127 Burkholder et al., *supra* note 125, at 308.

128 *Id.*

129 *Id.*

130 Editorial Board, Opinion, *As Dangerous Algal Blooms Grow, Agencies Need to Pick Up the Pace*, WASH. POST (July 12, 2022), https://www.washingtonpost.com/opinions/2022/07/12/algal-blooms-epa-noaa-working-group.

131 Ghimpeţeanu et al., *supra* note 96, at 16.

132 *See How Climate Change is Fueling Extreme Weather*, EARTH JUST. (July 19, 2023), https://earthjustice.org/feature/how-climate-change-is-fueling-extreme-weather (explaining that "Americans across the political spectrum are feeling the urgency of our climate deadline for action" because of massive increases in greenhouse gas emissions, with specific mention to carbon dioxide, fueling extreme weather conditions and climate disasters).

133 Rachel Graham, *How Much Does Animal Agriculture Contribute to Climate Change?*, SENTIENT MEDIA (Nov. 9, 2022), https://sentientmedia.org/does-animal-agriculture-contribute-to-climate-change (observing how, in addition to its direct release of greenhouse gases, animal agriculture is also responsible for deforestation, which both releases a significant amount of carbon dioxide and undermines the earth's ability to store carbon).

134 *Id.*

135 *Id.*

gas emissions,[136] an increase from the 14.5% estimated by the FAO in 2013,[137] the same year it published the *Edible Insects* report.[138]

Compounded further by its significant environmental and climate change impacts is animal agriculture's inefficiency as a form of food production. With respect to land use, approximately 40% of the world's non-ice landmass has been put into the service of food production.[139] Of that portion, three-quarters is dedicated, directly and indirectly, to the production of livestock—meaning the land the animals occupy and the land needed to grow the crops required to feed them.[140] A similar picture emerges when considering the water resources dedicated to animal agriculture. Globally, agricultural production comprises 69% of freshwater use,[141] which amounts to a third of the earth's fresh water.[142] Of that total, 41% is dedicated to supporting animal agriculture.[143] The percentage varies based upon the farmed species, but in all cases, the calories lost through the process of producing food to feed the animals that in turn feed humans is staggering. For example, for chicken, the loss is 9:1; for pork, 15:1; and for beef, 25:1.[144] Collectively, these deficits betray why 80% of the world's farmland, or the portion dedicated to animal production, yields just 17% of the world's calories and 38% of its protein.[145] Together, these numbers reveal the animal agricultural model to be one of inefficiency.

But more than just an inherent form of food and water waste, animal agriculture is unsustainable, dimming prospects for a livable future. Indeed, if the catastrophic loss of nature is to be reversed and the worst impacts of climate change averted, at least 30% of the world's land must

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136 *Id.* Notably, estimates vary regarding the amount of total greenhouse gas emissions emitted by animal agricultural production globally, with current ranges running between 11.1% and 19.6%. Dan Blaustein-Rejto & Chris Gambino, *Livestock Don't Contribute 14.5% of Global Greenhouse Gas Emissions*, BREAKTHROUGH INST. (Mar. 20, 2023), https://thebreakthrough.org/issues/food-agriculture-environment/livestock-dont-contribute-14-5-of-global-greenhouse-gas-emissions.

137 Blaustein-Rejto & Gambino, *supra* note 136.

138 FAO, EDIBLE INSECTS, *supra* note 1.

139 Bruce M. Campbell et al., *Agriculture Production as a Major Driver of the Earth System Exceeding Planetary Boundaries*, ECOLOGY & SOC'Y, Dec. 2017, No. 8, at 1.

140 Sophie Kevany, *UN Numbers Say Meat is Bad for the Climate. The Reality is Worse.*, VOX (May 27, 2023, 7:30 AM), https://www.vox.com/future-perfect/23738600/un-fao-meat-dairy-livestock-emissions-methane-climate-change.

141 Jens Heinke et al., *Water Use in Global Livestock Production—Opportunities and Constraints for Increasing Water Productivity*, WATER RES. RSCH., Nov. 20, 2020, No. e2019WR026995, at 1.

142 *We Need to Talk About Meat*, UNITED NATIONS CLIMATE CHANGE (May 19, 2021), https://unfccc.int/news/we-need-to-talk-about-meat.

143 Heinke et al., *supra* note 141, at 4.

144 *Disrupting Meat*, YALE CTR. FOR BUS. & THE ENV'T (Oct. 12, 2016), https://cbey.yale.edu/our-stories/disrupting-meat.

145 Hannah Ritchie & Max Roser, *Half of the World's Habitable Land is Used for Agriculture*, OUR WORLD IN DATA (Feb. 16, 2024), https://ourworldindata.org/global-land-for-agriculture.

be returned to nature.[146] Instead, increases in per capita consumption of animal products have given rise to the destruction of nature through mass deforestation to rear additional animals and grow the crops needed to feed them.[147] The destruction of the Amazon provides a clear example: 70% of the deforested area is now animal pasture, with feed crops accounting for a significant portion of the rest.[148] Given that the global population is projected to reach nine billion by 2050,[149] a continued embrace of animal-based agriculture threatens to exacerbate existential problems.

Presented with mounting evidence that highlights animal agriculture's contributions to global warming and unsustainable practices, industry leaders have adopted numerous strategies to oppose and obfuscate the issue, which has profoundly impacted consumer choice.[150] Borrowing heavily from the oil industry's playbook, the U.S. animal agriculture industry has intensely lobbied to fight climate regulations, funded studies with the express purpose of casting doubt on climate science, and argued that agricultural developments have improved efficiency, even going so far as to contend that beef production holds ecological benefits.[151] In a strategic shift, industry leaders have offered suspect commitments to "net zero" greenhouse gas emissions, as well as to ending deforestation.[152] In the meantime, the industry has touted a range of developments that they claim will reduce their environmental impact, such as algae-fed cattle who will emit less methane and methane digesters that will transform manure into energy—while continuing to engage in greenwashing practices.[153]

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146 *See* Lindsay Maizland, *The Push to Conserve 30 Percent of the Planet: What's at Stake?*, COUNCIL ON FOREIGN RELS. (Mar. 6, 2023, 1:16 PM), https://www.cfr.org/article/goal-conserve-30-percent-planet-2030-biodiversity-climate (describing the need for 30% of the earth's surface to be protected or removed from development or extractive uses, thus returned to nature).

147 Keren Dopelt et al., *Environmental Effects of the Livestock Industry: The Relationship Between Knowledge, Attitudes, and Behavior Among Students in Israel*, INT'L J. ENV'T RSCH. & PUB. HEALTH, Apr. 16, 2019, No. 1359, at 2.

148 FAO, EDIBLE INSECTS, *supra* note 1, at 59.

149 *World Population Projected to Reach 9.8 Billion in 2050, and 11.2 Billion in 2100*, U.N. DEP'T OF ECON. & SOC. AFFS., https://www.un.org/en/desa/world-population-projected-reach-98-billion-2050-and-112-billion-2100 (last visited Mar. 16, 2024).

150 Jennifer Jacquet, *The Meat Industry is Doing Exactly What Big Oil Does to Fight Climate Action*, WASH. POST (May 14, 2021, 9:19 AM), https://www.washingtonpost.com/outlook/the-meat-industry-is-doing-exactly-what-big-oil-does-to-fight-climate-action/2021/05/14/831e14be-b3fe-11eb-ab43-bebddc5a0f65_story.html.

151 *Id.*

152 *Id.*

153 *Id.* Although studies introducing seaweed to cattle diets have seen methane emissions reductions from dairy and beef cattle by up to 67% and 98% respectively, numerous questions arise as to the environmental impact of large-scale algae farming, as well as the logistical hurdles to its implementation. Tomotaroh Granzier-Nakajima, *Seaweed for Cattle Feed*, MOST POL'Y INITIATIVE (Dec. 1, 2022), https://mostpolicyinitiative.org/science-note/seaweed-for-cattle-feed; Jan Dutkiewicz & Matthew Hayek, Opinion, *Want Carbon-Neutral*

Regardless of these various and still shifting industry positions as to the harms externalized by, and the sustainability of, animal agricultural production, the industry has remained constant with respect to its core message to the consumer: to keep consuming its products. In this vein, the industry has embraced insects not just as a novel food but also as a novel solution—a form of sustenance with the prospect of sustaining the unsustainable.

III. ATTEMPTING TO SUSTAIN THE UNSUSTAINABLE WITH SIX-LEGGED ANIMAL AGRICULTURE

It was just a year after the release of the FAO's *Edible Insects* report that investment in the insect-based animal feed market exploded.[154] In 2014, a start-up called AgriProtein raised enough capital to launch its first mass-scale insect production facility.[155] Opening its doors the next year with an announcement that it would construct an additional ninety-nine facilities, the company kick-started the race to build large-scale facilities capable of producing insects on the order of tens of thousands of metric tons a year to meet animal agriculture's demand for feed.[156] In the United States, multiple facilities have been announced or are already in construction to produce black soldier fly larvae—an insect prized for its rapid growth, reproductive rates, and ability to feed on almost any substrate.[157] Slated to open in Decatur, Illinois in 2024,[158] one such facility will adjoin a corn-processing plant, the byproducts of which will serve as feed for the larvae, who will then serve as feed for other farmed animals, with their waste deployed as fertilizer.[159] In addition to reintegrating plant-based side-streams, facilities will also use byproducts

Cows? Algae Isn't the Answer, WIRED (Mar. 17, 2021, 8:00 AM), https://www.wired.com/story/carbon-neutral-cows-algae.

154 *See* Rivero, *supra* note 8 (observing how investment in the industry has skyrocketed, from $11 million in 2014 to over one billion dollars since 2020); *see also* FAO, EDIBLE INSECTS, *supra* note 1.

155 Rivero, *supra* note 8.

156 *Id.*

157 *Id.*; Martina Igini, *Insect Farming: The Sustainable Future of Food Production*, EARTH.ORG (Nov. 25, 2022), https://earth.org/insect-farming ("Not only can they eat 50 times their body weight in basically any type of food waste but female flies can also deposit between 200 and 600 eggs a day which hatch after about four days, making them an extremely prolific species.").

158 *InnovaFeed Breaks Ground in Decatur*, ECON. DEV. CORP. OF DECATUR & MACON CNTY. (Jan. 10, 2023), https://www.decaturedc.com/innovafeed-breaks-ground-in-decatur.

159 Elaine Watson, *InnovaFeed Raises $250m to Expand Edible Insect Platform, Build Plant in Decatur, IL*, FOODNAVIGATOR USA (Sept. 22, 2022, 3:14 PM), https://www.foodnavigator-usa.com/Article/2022/09/22/innovafeed-raises-250m-to-expand-edible-insect-platform-build-plant-in-decatur-il; *see* Rivero, *supra* note 8 (describing the practice of processing insects into fertilizer and feed, "often piped in from nearby farms or food processing plants"); Aryn Baker, *They're Healthy. They're Sustainable. So Why Don't Humans Eat More Bugs?*, TIME (Feb. 26, 2021, 9:31 AM), https://time.com/5942290/eat-insects-save-planet (describing "frass," the fertilizer and soil amender produced as insect waste).

from the processing of cattle, chickens, and pigs reincorporated as animal-based side-stream feed,[160] effectively recycling these byproducts as part of the production chain.

Leaders in the animal agriculture industry have hailed such insect-based auxiliary systems as testaments to the sustainability of their business models. Indeed, as the Chief Financial Officer of Tyson Foods observed upon announcing the company's partnership with Protix, a Dutch-based insect production venture, "[t]he insect lifecycle provides the opportunity for *full circularity* within our value chain, strengthening our commitment to building a more sustainable food system for the future."[161] With side-streams directed back into production, the implication is that the industry has eliminated waste from its system by taking what would otherwise be discarded as byproduct and upcycling it into feed for insects, whose own lifecycles—from breeding, incubation, hatching, and processing—would be wholly contained within the facility.[162] With a single operation able to produce tens if not hundreds of thousands of metric tons of insect protein each year,[163] the argument is that there would be less need to grow today's most common plant-based protein feeds, such as soy,[164] which not only uses land and fertilizer and requires more water than breeding insects but may also involve the use of pesticides.[165] Absent this demand, then, the crops grown to feed farmed

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160 Elizabeth Crawford, *Tyson Foods Expands into Insect Protein Production with Protix Partnership*, FOODNAVIGATOR USA (Oct. 17, 2023, 2:18 PM), https://www.foodnavigator-usa.com/Article/2023/10/17/tyson-foods-expands-into-insect-protein-production-with-protix-partnership.

161 *Id.* (emphasis added). Protix's own messaging echoes this characterization:

> The company is on a mission to create low-footprint ingredients that solve major issues in the current food system. Protix contributes to a circular food chain by using waste from the food industry as feed for the black soldier fly (BSF). In turn, the insects are processed into valuable nutrients such as proteins and lipids. Protix's customers use these proteins and lipids as high-quality ingredients for feed and food. Moreover, residual streams from the insects are used as organic fertilizer. This way, insects close the loop and bring the food system back in balance with nature.

News Release, Tyson Foods, Tyson Foods Announces Partnership with Protix for More Sustainable Protein Production (Oct. 17, 2023), https://www.tysonfoods.com/news/news-releases/2023/10/tyson-foods-announces-partnership-protix-more-sustainable-protein.

162 Crawford, *supra* note 160. Additionally, low-value byproducts, or waste, from other forms of agricultural production and food waste itself could be integrated as insect feed, thereby saving it from landfills, which would represent another benefit. Owusu Fordjour Aidoo et al., *Insects as Food and Medicine: A Sustainable Solution for Global Health and Environmental Challenges*, FRONTIERS NUTRITION, June 14, 2023, No. 1113219, at 5.

163 Matt Reynolds, *Insect Farming is Booming. But is it Cruel?*, WIRED (Mar. 16, 2023, 7:00 AM), https://www.wired.com/story/insect-farming-sentience.

164 A. Vauterin et al., *The Potential of Insect Protein to Reduce Food-Based Carbon Footprints in Europe: The Case of Broiler Meat Production*, J. CLEANER PROD., Aug. 25, 2021, No. 128799, at 3 ("It has been shown that insects can replace partly or all the soybean meal used in the feed without compromising the [feed conversion rate] value." (internal citations omitted)).

165 Eduardo Garcia, *You Might Not Want to Eat Bugs. But Would You Eat Meat That Ate Bugs?*, N.Y. TIMES, https://www.nytimes.com/2019/09/21/climate/insects-animal-feed-climate-change.html (Sept. 24, 2019).

animals could be repurposed to feed a growing population, advocates say.[166] On its face, the incorporation of insect farming into factory farm operations has enabled the industry to point to concrete steps it has made toward reducing its climate impact and arguably becoming more sustainable.

Although the integration of mass-scale insect farming may help mitigate certain harms externalized by the animal agriculture industry as a whole, fundamental concerns remain. For example, while present conditions may yield sufficient side-streams to provide the substrate needed to farm insects, how reproducible this model is remains unclear. Even now, skeptics question whether these facilities are actually feeding insects side-stream rather than grain.[167] The latter appears to be the case at least in part, undercutting—if not eliminating—any environmental and sustainability gains.[168] Concerns have also been voiced regarding the risk of disease outbreaks.[169] Because insects are taxonomically far removed from humans, the risk of zoonotic disease spread is arguably minimal.[170] That said, other risks arise out of the use and handling of animal-based side-streams, with contaminated substrates from ruminant animals in particular being a cause of significant worry.[171] Perhaps the most concerning issue, however, relates to the prospect of farmed insects within a facility coming into contact with those outside. As one study revealed, the vast majority of the insect production facilities that underwent inspection were colonized by parasites, transforming the insects into disease vectors.[172] Should any insects escape, disease could

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166 *See* FAO, EDIBLE INSECTS, *supra* note 1, at 161 (advocating for the potential use of insects to partially replace expensive ingredients in feed so that grains currently used could be used instead for human consumption).

167 *See* Lewis Bollard, *The Promise and Perils of Insect Farming*, OPEN PHILANTHROPY (May 10, 2021), https://www.openphilanthropy.org/research/the-promise-and-perils-of-insect-farming (contending that insect farms are not using dry food waste, as recommended by insect farming proponents, but rather grains and high-quality agricultural byproducts which would otherwise be fed to other farm animals). When fed grain, crickets were found to have a protein conversion efficiency comparable to that of broiler chickens fed the same diet, thereby calling into question their value if not fed high-value side-stream substrates. Mark E. Lundy & Michael P. Parrella, *Crickets Are Not a Free Lunch: Protein Capture from Scalable Organic Side-Streams via High-Density Populations of* Acheta domesticus, PLOS ONE, Apr. 15, 2015, No. e0118785, at 9–10.

168 Philip Lymbery, *Insect Farming Isn't Going to Save the Planet*, TIME (July 27, 2023, 1:53 PM), https://time.com/6298660/insect-farming-isnt-going-to-save-the-planet ("Insects are increasingly intensively farmed, where they are commonly reared by feeding them on cereals and soya that could be feeding people.").

169 *See, e.g.*, *id.* ("[I]nsects . . . have been shown to accumulate hazardous chemical pesticides, heavy metals, pathogens and allergens.").

170 FAO, EDIBLE INSECTS, *supra* note 1, at 66.

171 *Id.* at 65–66; Remigiusz Gałęcki et al., *Foodborne Diseases in the Edible Insect Industry in Europe—New Challenges and Old Problems*, FOODS, Feb. 10, 2023, No. 770, at 7.

172 Aidoo et al., *supra* note 162, at 8 ("The study revealed parasites in 244 out of 300 examined insect farms. Interestingly, 206 of the cases had parasites that were pathogenic for insects only; 106 had parasites pathogenic for animals; and in 91 cases, parasites were pathogenic for humans." (internal citation omitted)).

rapidly spread through conspecifics and taxonomically closely related species.[173] Even if not infected by disease, however, non-native insects could readily destabilize local economies and entire ecosystems given their fecundity.[174]

Even assuming sufficient amounts of side-streams exist, the industry realizes expected efficiency levels, and facilities eliminate all risks of pathogenic outbreaks, the fundamental question remains whether the gains reaped through these mitigation efforts justify animal agriculture as a whole. As observed in Part II, the industry has a profound impact on the welfare of farmed animals, consumer and public health, environment, and the climate more broadly,[175] with questions still lingering as to the sustainability of its overall model.[176] As an auxiliary to this system, insect production serves to further those harms. While the FAO report's argument for the production of insects as an animal feed might rightly be rejected in view of the various externalized harms, a more difficult question is whether consumers should eschew conventional meat and other products for insects.

As a standalone enterprise, the production of insects for direct human consumption offers certain benefits over the current factory farm model. While values vary based upon the insect species, their metamorphic stage, substrate used, and rearing conditions,[177] insects often feature higher feed-conversion efficiency rates than traditionally farmed animals.[178] For example, to produce 1 kilogram (kg) of traditionally consumed meat requires 2.5 kg of feed for chickens, 5 kg of feed for pigs, and 10 kg of feed for cattle.[179] In comparison, producing 1 kg of crickets requires only 1.7 kg of feed.[180] Factoring in edible weight, insects prove even more efficient by comparison given that a greater

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173 *See* Michiel van Deursen, *The Drawbacks of Insect Farming: A Critical Analysis*, VEVOLUTION (June 22, 2023), https://www.vevolution.com/articles/the-drawbacks-of-insect-farming-a-critical-analysis (highlighting the risks of insect farming, including "the spread of diseases . . . and the potential for contamination during processing and distribution").

174 *Id.*; Rachael Pells, *How France Became the Unlikely Home of the Insect-Farming Industry*, NATURE (Feb 2, 2023), https://www.nature.com/articles/d41586-023-00290-z ("Today, there's not much regulation on what insects you're allowed to import. You can bring in insects that threaten local livelihoods and ecosystems if they escape from where they're being farmed—and they do escape." (quoting ecologist Åsa Berggren)).

175 It should be noted that while it is possible to develop animal feed with black soldier fly larvae produced using manure as a substrate, numerous health and other concerns present themselves with regard to the presence of pesticides, pharmaceuticals, antibiotic-resistant bacteria, heavy metals, and other chemicals. A. van Huis, *Manure and Flies: Biodegradation and/or Bioconversion?*, 5 J. INSECTS AS FOOD & FEED 55, 56 (2019). As such, the use of manure as substrate for animal feed is expressly prohibited in several countries and the European Union. *Id.*

176 Pells, *supra* note 174 ("As long as you are still farming animals in an industrial way, you are creating issues like carbon emissions, pollution of the water and of the land." (quoting Benoit Granier, spokesperson for France's Climate Action Network)).

177 FAO, EDIBLE INSECTS, *supra* note 1, at xiv.

178 *Id.* at 60.

179 *Id.*

180 *Id.*

percentage of their body mass is edible.[181] Sixty percent protein by dry weight, insects also offer higher levels of important minerals than traditional meat products such as beef.[182] Insects are also a source of fiber, unlike their traditionally farmed counterparts.[183] Capable of being mass-produced in facilities or farmed in one's home, insects by weight compare favorably with common livestock species with regard to the land use, water use, and feed requirements.[184] In addition, the most farmed insect species generate far fewer greenhouse gas emissions—in some cases a hundred times less—than would be generated to produce the same amount of pork.[185] Insects also produce just a tenth of the ammonia of pigs,[186] a significant benefit considering the chemical's negative health impacts on surrounding communities.[187] While their production is not without risk of pathogenic spread,[188] the ability to rear them without antibiotics presents an opportunity to reserve medically important antibiotics for human use, in effect embracing the human consumption of bugs to combat the rise of superbugs.

As the FAO's *Edible Insects* report states in light of these and other findings, "[t]he case needs to be made to consumers that eating insects is . . . good for the planet."[189] And in making its case, the FAO report challenges Westerners in particular to consider how their biases against insect consumption implicate adverse impacts.[190] Yet with the industry having already identified the cricket as a "gateway bug" to hook the West, consumers might be remiss to swallow entomophagy whole, especially considering the industry's own framing of the act as a proverbial point of no return.

As observed earlier, the juxtaposition of "insects" with "meat" is curious, if not concerning, as the marketing of insects as meat-free or as meat alternatives problematically situates their production as *apart from* instead of as *a part of* animal agriculture at large. Exacerbating this disconnect, enthusiasts have coined the labels "entovegan" and "entomovegan" for those who, having tried the gateway bug, now eschew

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181 *Id.* ("[A study] estimated that up to 80 percent of a cricket is edible and digestible compared with 55 percent for chicken and pigs and 40 percent for cattle. This means that crickets are twice as efficient in converting feed to meat as chicken, at least four times more efficient than pigs, and 12 times more efficient than cattle." (internal citation omitted)).

182 Baker, *supra* note 159 ("Grasshoppers, crickets and mealworms are rich in protein, and contain significantly higher sources of minerals such as iron, zinc, copper, and magnesium than beef.").

183 Orkusz, *supra* note 7, at 5.

184 Baker, *supra* note 159; FAO, EDIBLE INSECTS, *supra* note 1, at 104, 110.

185 FAO, EDIBLE INSECTS, *supra* note 1, at 63; *see also id.* ("Among insects, only termites, cockroaches, and scarab beetles produce [methane].").

186 *Id.* at 63.

187 Kaplan, *supra* note 109.

188 FAO, EDIBLE INSECTS, *supra* note 1, at 65–66.

189 *Id.* at 161.

190 *Id.* at 40.

all animal products save insects.[191] Oxymoronic portmanteaus, these terms notably blur the line between consuming insects and not consuming animal products at all. To resolve their internal inconsistencies, of course, requires conceiving of "animals," the flesh of whom is "meat," as excluding "insects." Ultimately, these contrivances betray the industry's attempt to dissociate entomophagy from what it is, the practice of meat consumption, and associate it with what it is not, plant-based.

As to the purpose the dissociation serves, a straightforward framing of insects as animals would compromise the FAO report's call for consumers to adopt entomophagy for the planet's good.[192] If securing a sustainable, food-secure future demands eating insects instead of meat, confronting the fact that insects are themselves a form of meat would cast doubt upon the report's conclusion. With the relationship between insects and meat no longer obscured, it is easy to appreciate the production of insects for food as little different from, and indeed merely a six-legged variation on, animal agriculture as the world has always known it. Going further, one might ask if a sustainable future requires a transition away from meat, whether replacing one form of meat with another is the best, or even a sensible, path forward.

To be sure, with a shift towards a plant-based diet, the world could dispense entirely with species- and substrate-specific feed-conversion efficiency rates, as the food produced for people could be consumed directly by them. Doing so would free existing farmland, whose yields would no longer suffer conversion-based losses through the production of animal agriculture,[193] including insect-based agriculture,[194] before reaching humans. Of course, a powerful argument can be made in favor of restricting all side-streams for insect production to plant-based ones only. That said, the data show that the world already produces crops in sufficient numbers to feed not just a projected nine billion people in 2050 but upwards of four billion more than already exist today.[195]

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191 Josh Galt, *About*, ENTOVEGAN, https://entovegan.com/about (last visited Feb. 4, 2024); *Getting Started Eating Entomo*, GASTROBUG, http://www.gastrobug.com/guide/getting-started-eating-entomo (last visited Feb. 4, 2024).

192 FAO, EDIBLE INSECTS, *supra* note 1, at 1–2.

193 Jonathan Foley, *A Five-Step Plan to Feed the World*, NAT'L GEOGRAPHIC, https://www.nationalgeographic.com/foodfeatures/feeding-9-billion (last visited Feb. 4, 2024) ("For every 100 calories of grain we feed animals, we get only about 40 new calories of milk, 22 calories of eggs, 12 of chicken, 10 of pork, or 3 of beef.").

194 For every two kilograms of feed, mealworms yield less than one kilogram of body mass in return. Alexandre Thévenot et al., *Mealworm Meal for Animal Feed: Environmental Assessment and Sensitivity Analysis to Guide Future Prospects*, 170 J. CLEANER PROD. 1260, 1261 (2018).

195 Emily S. Cassidy et al., *Redefining Agricultural Yields: From Tonnes to People Nourished per Hectare*, ENV'T RSCH. LETTERS, Aug. 1, 2013, No. 034015, at 4 (discussing how redirecting crops from animals and other uses, such as biofuels, to humans would increase available calories by up to 70%, translating to an additional 4 billion people who could be fed using existing farmland). With regard to the United States alone, the shift to a plant-based diet could feed an additional 350 million people, more than the population of

Furthermore, by adding six-legged animal agriculture to the traditional forms of animal farming that the FAO report encourages Westerners in particular to reject, the world could finally see the harms externalized by the industry relegated to the past.

IV. CONCLUSION

Realizing such a future requires wholesale, systemic change—as opposed to investing further in attempts to mitigate the harms and bolster the efficiencies of an inherently unsustainable production model. Embracing systemic change would not only make the presently dim prospects of a sustainable, food-secure future brighter, but also provide much-needed relief to those directly affected by the animal agriculture industry. Such a shift away from animal agriculture would reduce dietary health impacts associated with the consumption of animal products and limit the emergence of recurring and novel infectious disease outbreaks, both among animals and crossing the species barrier into humans. It would see medically important antibiotics reserved for humans rather than animals. Communities living near manure lagoons would benefit from cleaner air and water. More broadly, the immediate global reduction in methane, which is more potent than carbon dioxide but shorter-lived in the atmosphere, could significantly mitigate the worst of climate change.[196] And insofar as farmland is no longer needed to feed animals for human consumption, returning it to nature would further help to restore ecosystems and support biodiversity.

Then, of course, there are the intrinsic interests of the animals themselves. No longer produced and subjected to intensive confinement and the routinized cruelties inflicted by the industry—and for a net loss in calories, no less—their suffering could finally come to an end. While it is not possible to redress the suffering that generations of factory farmed animals have been forced to endure, the need to put an end to the industrial production of insects before it has a chance to cement itself could not be clearer or more urgent.

Admittedly, comparatively less is known about invertebrate sentience,[197] with even less known about that of insects in particular. The science regarding insect sentience, including their capacity to feel pain

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the country itself. Alon Shepon et al., *The Opportunity Cost of Animal Based Diets Exceeds All Food Losses*, 115 PNAS 3804, 3806 (2018) ("Concurrently replacing all animal-based products in the mean American diet . . . with nutritionally comparable or superior plant alternatives can sustain ≈350 million additional people . . . [well above the expected benefits of] completely eliminating all conventional food losses in the United States." (internal citations omitted)).

196 *See Methane and Climate Change*, INT'L ENERGY AGENCY, https://www.iea.org/reports/global-methane-tracker-2022/methane-and-climate-change (last visited Feb. 4, 2024) (stating that methane, although far more potent, stays in the atmosphere for about a decade).

197 Robyn J. Crook, *Behavioral and Neurophysiological Evidence Suggests Affective Pain Experience in Octopus*, ISCIENCE, Mar. 19, 2021, No. 102229, at 1.

and experience pleasure, has begun to emerge, however. Employing eight foundational markers of sentience, the most robust study to date found that flies, termites, mosquitoes, and cockroaches satisfied seven of the criteria, and did so with a high level of confidence.[198] Supplementing this study, others have determined that insects experience chronic, neuropathic pain, an indicator of complex cognitive functioning,[199] as well as suffer from "depression-like" states, ones that were able to be ameliorated using the same lithium treatment used with patients diagnosed with major depressive disorders.[200] Although scientific consensus as to the sentience of insects as a taxonomic class or with respect to individual orders is likely years away, the existing evidence raises ethical inquiries into not just how production facilities might provide for insect welfare, as the FAO report echoes,[201] but also whether it is appropriate to rear them at all given the myriad ways that the industry has contrived to kill them, including boiling, steaming, roasting, freezing, mincing, and microwaving them while still alive.[202] Posed within this larger context, whether the industry's gateway bug is palatable enough for consumers to swallow whole is one question. Whether insect-based agriculture, in light of its attendant harms, is something that society can stomach is an altogether separate one.

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198 Meghan Barrett, *Short Research Summary: Can Insects Feel Pain? A Review of the Neural and Behavioural Evidence by Gibbons et al. 2022*, EFFECTIVE ALTRUISM (Nov. 22, 2022), https://forum.effectivealtruism.org/posts/yPDXXxdeK9cgCfLwj/short-research-summary-can-insects-feel-pain-a-review-of-the (summarizing a study that applied 8 criteria used to evaluate the prospect of sentience in invertebrates: 1) nociception; 2) sensory integration; 3) integrated nociception; 4) analgesia; 5) motivational trade-offs; 6) flexible self-protection; 7) associative learning; and 8) analgesia preference).

199 Thang M. Khuong et al., *Nerve Injury Drives a Heightened State of Vigilance and Neuropathic Sensitization in* Drosophila, SCI. ADVANCES, July 10, 2019, No. eaaw4099, at 5.

200 Ariane-Saskia Ries et al., *Serotonin Modulates a Depression-like State in* Drosophila *Responsive to Lithium Treatment*, NATURE COMMC'NS, June 6, 2017, No. 15738, at 2–3 (2017).

201 FAO, EDIBLE INSECTS, *supra* note 1, at 65.

202 Reynolds, *supra* note 163.