SPECIAL ISSUE

FROM LIVESTOCK TO CELL-STOCK

Farmed Animal Obsolescence and the Politics of Resemblance

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Abstract

The nascent cellular agriculture industry seeks to produce cell-cultured animal tissue for human consumption. Effectively rendering farmed animals obsolete in food production could mitigate an array of harms inflicted by industrial animal farming on the environment, public health, and human and animal wellbeing, but achieving this outcome is contingent on cellular agriculture entrepreneurs successfully creating a product that closely resembles conventional meat enough to appeal to consumers despite its synthetic origins. This article examines how these politics of resemblance may shape and limit the realization of the industry's potential benefits. Specifically, it argues that, while cellular agriculture can only realize such benefits through the facilitation of agricultural animal obsolescence, its potential for positive transformations in food production may ultimately be blunted by the degree to which a failure to extend the politics of resemblance from the consumer market to the labor market renders agricultural human laborers obsolete as well.

Keywords: *cellular agriculture, animals, meat, food politics, synthetic*

Introduction

Large sectors of global capitalist production are arguably in the midst of a "synthetic revolution" characterized by the rise of artificial intelligence and the displacement of laboring bodies entirely from the production process. While automation has been accelerating in many sectors for decades, there is one kind of laboring body that has so far remained irreplaceable: the farmed animal. Recent innovations in food production have led to plant-based products – such as the Beyond Burger (see Sexton 2016) and the Impossible Burger – that closely mimic the taste and texture of specific animal-derived food products[1], but producing real cuts of meat composed of actual animal flesh still necessitates the farming and slaughtering of animals. However, if the rapidly developing cellular agriculture industry is successful, within the next decade that may no longer be true. This nascent industry is made up of dozens of new food startups developing technology for producing cell-cultured animal tissue for human consumption.

Effectively rendering farmed animals obsolete in the food production chain could simultaneously reduce an array of harms inflicted by industrial animal farming on the environ-

[1] On the history of plant-based meat analogs see Adams 2018.

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ment, public health, and human and animal wellbeing, but achieving this outcome is contingent on cellular agriculture entrepreneurs successfully creating a product that closely resembles conventional meat enough to appeal to consumers despite its synthetic origins. Cellular agriculture is an inchoate industry still in the early stages of becoming, so the initial social scientific explorations of it have been necessarily speculative, focusing on its ethical, environmental, and social promissory potential (Hocquette 2015; Sebo 2018; Sexton, Garnett, and Lorimer 2019; Stephens 2013; Stephens and Ruivenkamp 2016; Sun, Yu, and Han 2015; Wurgaft 2019), the processes of market formation in which the industry is engaging (Mouat and Prince 2018), how ideology (Chiles 2013) and metaphor (Broad 2020) could shape that market, and potential consumer responses (Hocquette et al. 2015; Macdonald and Vivalt 2017; Verbeke et al. 2015; Verbeke, Sans, and Van Loo 2015; Wilks and Phillips 2017). This article contributes to the body of speculative social scientific work on the still unclear future of cultured meat by examining how the politics of resemblance may shape and limit the realization of the industry's potential beneficial affordances.

As the outgrowth of an assemblage of scientists, environmental and animal welfare activists, venture capital investors, and start-up tech firms all seeking to create biotechnological processes for affordably producing animal products without animals, cellular agriculture has the potential to almost entirely remove nonhuman animals from the agricultural production chain, although this will depend both on consumer acceptance of cultured meat products and sufficient technological advancement in cell culture techniques.[2] Adapting techniques from the biomedical industry, these startups use bioreactors – cell cultivation tanks filled with a liquid growth medium – to culture tissue from animal cells. By the end of 2019, there were fifty-five companies in Argentina, Australia, Brazil, Canada, Chile, China, India, Israel, France, Germany, Hong Kong, Japan, the Netherlands, Russia, Singapore, Spain, Switzerland, Turkey, the United Kingdom, and the United States (Crosser et al. 2019, 6-10) that are working to bring a variety of cultured animal meats to market, including those of pigs, chickens, ducks, cows, shrimp, tuna, and yellowtail. None of these products are commercially available yet, but they have already accrued a variety of names through media coverage and industry hype, including cultured meat, cultivated meat, cell-based meat, clean meat, in vitro meat, and lab-grown meat. Researchers at other companies have also already developed techniques for producing egg whites, gelatin, and cow milk protein with the use of genetically modified microbes.[3]

Informed by insights garnered from four years of experience conducting ethnographic fieldwork on cellular agriculture – including attendance at conventions and government regulatory hearings, interviews with industry stakeholders and advocates, and visits to production facilities – as well as nine months work experience as a regulatory specialist for a cellu-

[2] For example, companies currently rely on the use of fetal bovine serum – a byproduct of cattle slaughter – as a cell culture medium. They will also need to take regular cell biopsies from a small number of donor animals until they are able to develop immortalized cell strains for each species.

[3] This technique is sometimes referred to as acellular agriculture because the final product does not contain the cells used to make it. For example, the California-based company Perfect Day recently partnered with an ice cream company to release a line of ice creams that are the first commercially available dairy products to contain whey made through this process (Watson 2020).

lar agriculture advocacy organization, I argue that the politics of resemblance upon which the commercial success of cultured meat products hinge can only deliver cellular agriculture's beneficial affordances through their facilitation of agricultural animal obsolescence. But at the same time, cellular agriculture's potential for positive transformation of the food industry may ultimately be blunted by the degree to which its failure to extend its engagement with the politics of resemblance from the consumer market to the labor market renders agricultural human laborers obsolete as well.

In the following section, I further describe the potential affordances cellular agriculture has to offer for redressing the dangers posed by industrial animal agriculture to the environment, public health, and animal wellbeing. I then examine what it would mean for cellular agriculture to render farmed animals obsolete. In the second section, I examine the centrality of the politics of resemblance – especially regarding the gustatory qualities and ontological status of cultured meat products – to the potential future success of these products, highlighting specific potential outcomes that could either facilitate or limit farmed animal obsolescence. Finally, I conclude with a consideration of the potential socio-economic costs of farmed animal obsolescence, explaining how the aspirational benefits of this novel industry could be undermined by a lack of attention to the politics of resemblance in the labor market even if cellular agriculture companies do manage to successfully navigate the politics of resemblance in the consumer market.

Affordances of cellular agriculture and animal obsolescence

With its potential to disrupt and even replace food-production markets, cellular agriculture could herald a radical transformation of animal-based industries with especially far reaching consequences for human-animal interactions in agricultural contexts. By removing animals from the production process, cellular agriculture technology could also help to mitigate multiple crises caused or aggravated by industrialized animal agriculture. Foremost, animal agriculture is a ceaseless calamity of death and incalculable suffering for over a trillion of animals per year. Approximately seventy-two billion land animals – including cows, pigs, goats, sheep, rabbits, horses, chickens, ducks, turkeys, and geese – and 1.2 trillion aquatic animals are killed annually for human consumption around the world (Zampa 2018). Due to the staggering number of animals that are continuously forced to reproduce in order to meet these slaughter rates, animal agriculture is also a major source of green house gas emissions, with the livestock sector alone contributing to "about 18 percent of the global warming effect" (Steinfeld et al. 2006). It likewise contributes to ground and water pollution through waste runoff, while it is also responsible for a significant amount of fresh water consumption. About one-third of global water consumption is used to produce animal products (Nagappan 2016). Put simply, factory farming has an immense impact on the natural world. In the words of Carolyn Mattick and Brad Allenby, "factory meat is perhaps best understood as a planetary engineering technology, and to pretend otherwise can become just a subtle way of avoiding ethical responsibility for the consequences of our own creation" (2013).

Posing a significant and potentially even existential threat to global human health, animal agriculture is also a significant driver of the spread of zoonotic viruses like SARS-CoV-2 (the virus that causes Covid-19) and novel flu strains as well as the rapid evolution and proliferation of antibiotic resistant bacteria. As we have seen throughout the Covid-19 pandemic, animal slaughtering conditions have compounded this public health threat as thousands of workers contracted the virus due to unsafe working conditions at meat processing facilities that have become hotspots of infection. Further, the temporary closing of these facilities in the early months of the pandemic compounded the suffering of animals, who were killed by the millions in mass culling by farmers who could not afford to keep feeding them, using such inhumane methods as "ventilation shutdown," a process in which pigs are killed "by sealing off all airways to their barns and inserting steam into them, intensifying the heat and humidity inside and leaving them to die overnight. Most pigs – though not all – die after hours of suffering from a combination of being suffocated and roasted to death" (Greenwald 2020).

Finally, current industrial agricultural practices are worsening global food inequality. Neo-Malthusian anxiety in food policy debates has centered on the year 2050 as a potential breaking point. The world population is predicted to increase by 2 billion people over the next 30 years, which – combined with increasing demands for animal products around the world, particularly in large, population-dense countries like China and India – will require an approximate doubling of current global crop production, with much of that going to feed animals. Not only would the production levels required to satisfy this vast increase in demand for animal products drastically exacerbate the other problems outlined above, but it would likely be impossible to achieve with current production methods. In response to these anxieties, the faith in the potential for techno-scientific innovation to solve the worlds' food-related ills by eliminating the negative impacts of current animal-based industries on the environment, public health, and animal welfare reflects an optimism shared by many in the new cellular agriculture movement (Wurgaft 2019, 88-91; see also Belasco 2006).

Along with the potential to ameliorate the ills of conventional animal agriculture, however, cellular agriculture also raises important questions about the cultural, ethical, and ontological implications of rendering agricultural animals obsolete. The idea of animal obsolescence necessarily assumes animals' objectified status as mechanisms serving human ends in the process of value production, means of production in what anthropologist Barbara Noske describes as the animal industrial complex (1989; see also Twine 2012; Sorenson 2014; Wadiwel 2015) – otherwise in what context would they be rendered obsolete? In what sense would they be replaced? Contemporary industrialized animal agriculture "is an extractive industry that treats animal bodies as self-replicating living resources," and that uses death as a means of resource extraction; "agricultural animals are killed as part of the process of value production" (Abrell 2021, 150; see also Dutkiewicz 2013, 303). Moreover, "[p]roductive death is literally instilled into animal bodies before their birth" (Dutkiewicz 2013, 302). Of course, agricultural animals are more than objects to themselves. The surplus value they generate – derived from the flesh and secretions of their bodies and the bodies of their progeny – comes from productive animal labor (Abrell 2021, 150), if we can understand the metabolic transformation of nutrients into animal-flavored fats and proteins as a form of labor, and the reproductive animal labor invested in producing new animal bodies (Wadiwel 2015, 162; see

also Beldo 2017; Cooper 2008). While animals' role within the process of food production may be an objectified means of production, for the animal subjects caught in this machine it can also be understood as a process of alienation. Animals are "alienated from their own products which consist of either their own offspring or (parts of) their own body" (Noske 1989, 18).

So what would it mean to make animals obsolete in this context? One possible way of seeing this obsolescence is as a form of liberation, not just for the animals themselves, but – as far as the environmental impacts of animal agriculture can be mitigated – for broader ecological webs as well. Indeed, the ultimate promise of cellular agriculture is the realization, through techno-scientific innovation and capital investment, of a new liberatory human-animal political ecology in which animals are no longer raised for human sustenance, and industrial animal agriculture's intensive spatial concentration of animals bodies, voracious consumption of natural resources, and constant overwhelming waste production is no longer destroying the environment, accelerating climate change,[4] creating deadly new pandemics, and destroying innumerable animal lives (see Stephens 2013).

While cellular agriculture's project of making agricultural animals obsolete has the potential to achieve these liberatory aspirations, its status as a project of the same capitalist system of production that gave us industrial animal agriculture raises questions about how capitalism might fundamentally limit that potential. Analyzing synthetic biologists' efforts to create organisms with the least genetic material necessary to sustain life, anthropologist Sophia Roosth observes that such organisms are "an ontological receding horizon: ... the most genetically minimal viable organism that synthetic biologists can build" (2017, 3). The reduction of animals used in agriculture to their most minimal viable productive capacities – their most basic living components, replicating cells – constitutes a similar ontological recession. If cellular agriculture, through this recession, succeeds in severing the reproductive labor power of animal bodies from animals themselves, how should we conceptualize the products it produces – as meat, milk, and eggs, or something new? For the fruits of cellular labor to have their intended transformative effects, they will need to be treated (if not totally understood) by consumers as exactly the same as the older forms they supplant.

Turning science-fiction fantasy into edible reality

The cellular agriculture movement is motivated by the assumption that animal welfare and environmental concerns about the impacts of industrial agriculture are unlikely to significantly change large-scale food consumption practices on their own and that consumers will require alternative products of equal quality and affordability to shift away from buying products produced through the farming of animals. This point is summed up in the words of Bruce Friedrich, co-founder and director of The Good Food Institute, a non-profit organization that promotes the development of plant-based and cellular agricultural alternatives to

[4] The degree to which cellular agriculture could help to reduce agricultural green house gas emissions will ultimately be dependent on whether and how much it is able to use low-emission, renewable energy sources.

conventional animal products: "For the vast majority of people, ethics don't figure in [to food choices]. So we want to create products that take ethics off the table" (Yale Center for Business and the Environment 2016). If companies are eventually successful in their quest to bring cultured meat products to market on a broad scale, this would also raise questions about the cultural status of the category of food called meat, especially what is included and what is excluded from that category.

In an essay entitled "50 Years Hence" – often cited in literature on the cellular agriculture industry – Winston Churchill predicted that in the future:

> *We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium. … Nor need the pleasures of the table be banished. That gloomy Utopia of tabloid meals need never be invaded. The new foods will from the outset be practically indistinguishable from the natural products, and any changes will be so gradual as to escape observation.* (1932, 397)

On August 5, 2013, only 31 years off from Churchill's prediction, Dutch biologist and cultured meat pioneer Mark Post debuted the world's first cultured meat hamburger in a televised tasting demonstration (see Stephens and Ruivenkamp 2016; Wurgaft 2019, 1-19). Virgin Group-founder and billionaire Richard Branson, an early investor in cultured meat development, later revised his British compatriot's prediction for the mass marketability of laboratory grown meat, stating in 2017, "I believe that in 30 years or so we will no longer need to kill any animals, and that all meat will either be clean or plant-based, taste the same and also be much healthier for everyone" (2017). In the succeeding seven years since Post's burger demonstration, there has been rapid progress in turning what still seems to many as a science-fiction fantasy into an edible reality. In fact, although most (if not all) cellular agriculture companies are likely still years away from producing marketable products at commercial scale, on November 26, 2020, cultured meat producers achieved an important milestone on the road to this possible future: Singapore became the first country in history to grant regulatory approval to a company to sell a cultured meat product to the public. The San Francisco-based startup Eat Just plans to start making chicken nuggets made from cultured chicken cells available at a Singapore-based restaurant before branching out to additional restaurants and eventually retail. But along with abundant optimism for continued rapid progress throughout the industry, there is also significant indeterminacy suffusing the prognostication game surrounding this particular techno-scientific future.

Worth noting in both Churchill's and Branson's quotes is the significance of gustatory resemblance between cultured meat products and their traditional forebears. Churchill says that they will be "practically indistinguishable from the natural products, and any changes will be so gradual as to escape observation;" and Branson says they will "taste the same." A chart created by journalist Alexis C. Madrigal compiles in parallel timelines every prediction made regarding the development of meat culturing technology after Churchill up to 2013 (Madrigal 2013). Madrigal's chart groups predictions into two specific product categories based explicitly on texture, "hamburger" meat and "steaky" meat (Madrigal 2013). These terms refer to two different stages in the development of cultured meat: the current

one, which is a product made of small pieces of soft cultured tissue with the texture of ground meat, and the one researchers are currently aspiring to, cultured meat made of developed muscle tissue that would resemble an actual steak or filet. Current output falls into the former category, cultured meat with the form and texture of ground meat. While possible to create in theory, the latter category still requires more refinement of techniques and equipment to achieve. The primary technological hurdle is developing efficient ways to coax cells to grow in three-dimensional structures that resemble whole cuts of meat. Technology such as scaffolds for cell growth and three-dimensional printing exist but researchers are still working to adapt them to cultured meat production (see Specht 2018). The company Finless Foods, for example, is working to create cultured Bluefin tuna that can be used in sushi, though as of April 2020, the texture of the cultured meat was closer to that of hummus according to co-founder and CEO Michael Selden (Allen 2020).

The concern about gustatory resemblance of cultured meat products to conventional ones comes from the fact that the gustatory experience – including flavor, texture, and "the mouth feel" – of eating cultured meat products is seen by cultured meat proponents as essential to their commercial success, at least if that success includes supplanting conventional meat products, which is itself a prerequisite for achieving the liberatory effects outlined above. To achieve this goal, cultured meat producers need to create products that not only resemble but precisely *replicate* conventional products. This challenge has two main components: a sensory one and an affective one. The sensory one is a strictly technical issue that is relatively easy to overcome. Take for example Mark Post's cultured burger prototype, which had already succeeded in replicating much of the experience of eating a conventional burger. In addition to cultured muscle cells from a cow, the burger had salt, breadcrumbs, and egg powder added to compensate for the lack of fat and bone cells that impart flavor in conventional meat and red beet juice and saffron added for a more meat-like pinkish color. Although the cultured burger needed these added ingredients to more closely approximate the flavor of a conventional beef patty, Austrian food trend researcher Hanni Rützle, who tasted the burger, described it as having "an intense taste, close to meat but not as juicy" with a "perfect consistency" (Coghlan 2013). In the seven years since that first taste test, companies have made significant strides in improving the gustatory experience of cultured meat. In 2017 Memphis Meats, a California-based cultured meat company, conducted its first tasting demonstrations of chicken and duck meat, and Eat Just, offered taste tests of their cultured *foie gras*. A vegan writer who participated gave the following description of the experience:

> *I cut a piece of the foie gras with my fork, raised it to my mouth, took a breath, and slowly pressed the foie gras with my tongue against the roof of my mouth. The flavor was impressive. The pâté was rich, buttery, savory, and very decadent, just as one would expect. I'm certainly not the best judge in this case, but as I closed my eyes and let the fatty liver melt on my tongue, the Hampton Creek foie gras brought me an amount of pleasure I'll confess I was a little embarrassed to admit.* (Shapiro 2018)

If cultured meat companies are able to improve their culturing processes to the point that they can produce cultured meat at a marketable scale, it is reasonable to expect that the products will be indistinguishable from conventional meat from slaughtered animals.

The bigger hurdle for companies hoping to replicate the experience of eating conventional meat is what is often referred to in the industry as the "ick factor" – an affective repulsion at the idea of eating synthetically grown meat. Just speaking anecdotally, when I have described cultured meat products to meat-eaters over the last four years, they often responded with disgust at the idea of eating meat that is "artificial" or "unnatural," echoing the responses of many participants in one early study on consumer attitudes toward the hypothetical products conducted in Europe (Verbeke et al. 2015; see also Verbeke, Sans, and Van Loo 2015; Wilks and Phillips 2017).[5] Describing this as the "naturalistic heuristic" – a consumer bias toward favoring "products that are congruent with their notion of what is 'natural' for humans to consume and what kinds of organisms/chemicals occur in the natural environment" – Bobbie Macdonald and Eva Vivalt conducted research that suggested consumers may be more easily primed by negative messaging toward embracing a naturalistic heuristic toward cultured meat than they are to expand their understanding of natural to include cultured meat (2017, 2). However, they also found some indication that creating a positive association with cultured meat's "unnaturalness" rather than trying to disprove it could provide a basis for increased acceptance (op. cit.). This suggests that consumers' attitudes are flexible, although counter-messaging by conventional meat companies will likely require creative marketing to overcome.

Based on positive or curious reactions from undergraduate students I have lectured about cultured meat in several classes over the last few years, I suspect generational attitudes toward technology may be a fertile area to focus marketing efforts, especially given Macdonald and Vivalt's findings. Younger consumers, for example, may be more open to eating such products, or even attracted to a techno chic aspect that could be exploited in marketing, but that hypothesis requires more research. The story of pink slime – a meat by-product also known as lean finely textured beef or boneless lean beef trimmings – also suggests that the ick factor may not be as significant a hurdle for cultured meat products as some fear. The product is used as a filler in meat products, such as ground beef, and consists of a blended pink slurry made of beef scraps that have been sterilized with ammonia gas or citric acid. Although use of the ingredient in processed beef products plummeted following consumer outcry resulting from a 2012 exposé about its use by US-based ABC News, pink slime usage has since risen above its previous high, and most beef-consumers seem to have forgotten or no longer care about its presence in their ground beef.

Ultimately, it is probable that cultured meat companies will be able to overcome the technical challenges to replicating the gustatory experience of eating conventional meat, and with savvy marketing they have a chance of overcoming the ick factor too. However, even if consumers do embrace cultured meat, it is not at all clear that they will embrace it as a replacement for conventional meat. One possible outcome, of course, is that cultured meat

[5] Whereas these studies focus more specifically on consumer attitudes, see Chiles 2013 and Mouat and Prince 2018 for analyses of the more complex ideological, social, and material factors that are shaping the future cellular agriculture market.

products are simply not embraced at all, and consumers reject them based on a repulsion to perceived artificiality. Conventional meat producers are actively working to leverage the naturalistic heuristic to secure this outcome (see Sebo 2018, 172–173; see Calvão and Bell, this issue, for an analysis of similar dynamics in the synthetic diamond market). The beef industry lobbying group U. S. Cattlemen's Beef Association filed a petition with the United States Department of Agriculture requesting that the agency restrict meat-related nomenclature to conventionally slaughtered animal products (2018). A little over a year later, legislators in dozens of states had introduced bills backed by various beef industry groups seeking to limit the use of meat related terms on labels. A 2018 editorial in the meat industry-focused blog *Meatingplace* highlighted the perceived stakes in the battle over consumer attitudes and cautioned conventional meat producers to change their marketing and consumer education strategies, arguing that "the only 'label' that fake meat companies are concerned by is the one in consumers' minds. As explained by Josh Tetrick, CEO of [Eat Just], fake meat won't become 'real' to consumers simply because it's found a space on the menu. 'Real is when it's the only thing on the menu'" (Berman 2018).

Another possible outcome, though, is that consumers never see these products as "real" but embrace them nonetheless precisely because of their synthetic status, treating them as a brand new animal-based food commodity that supplements rather than replaces conventional products (see Stephens et al. 2018; Rowe 2019, 28). Some cultured meat advocates use the analogy of the replacement of whale oil by petroleum products to illustrate how cultured meat could replace its conventional counterpart, arguing that culture meat is "the kerosene to factory farming's whale oil" (Anzilotti 2018). But as sociologist Richard York explains, the development of petroleum-based technology actually intensified global whaling practices, and capitalist markets adapted to the ongoing production of raw materials from whales with new commodity forms and new applications for whale oil (2017). It was not until the late 1980s that whaling mostly came to an end with an international moratorium in response to the critically endangered status of most hunted species. If the whaling analogy did in fact prove accurate, cultured meat could safely coexist with an even bigger conventional animal agricultural industry than currently exists. As an industry expert commented at a 2018 joint meeting between the United States Department of Agriculture and Food and Drug Administration on the future regulatory status of cultured meat products, "We need to produce 50 % more protein by 2050, and if 100 % of that was [cultured], it would not impact a single livestock producer on the planet." Perhaps finally succeeding in completely removing the animal laborer from agriculture by reducing her to her constituent cells can lead to the hoped for benefits of cellular agriculture, but like previous capitalist revolutions, the synthetic revolution could also lead to the intensification of production and expansion of markets in ways that could look far less liberatory than imagined. And to some extent, that outcome will depend on how synthetic consumers perceive these new products to be.

Conclusion: potential socio-economic costs of farmed animal obsolescence

It is also important to note that animals used for agriculture are not the only laborers that would be displaced should cellular agriculture render those animals obsolete. Even if these companies do prove successful in replicating the experience of eating meat, they risk also succeeding at another form of replication that would undercut their efforts to counter the dire threats of the current industrial global food chain: the replication or – worse – intensification of its socio-economic conditions. According to Hsin Huang, secretary general of the global livestock industry organization the International Meat Secretariat, "livestock are currently essential to the livelihoods of an estimated one billion poor people globally" (Carrington 2020). Cellular agriculture presents a challenging paradox in that it currently appears to be the best possible option for abolishing animal agriculture while it also has the potential to buttress other forms of inequality through its impact on the livelihoods of so many people who earn their wages working in industrial animal agriculture and related industries around the world. Slaughterhouse work, for example, is extremely dangerous and highly exploitative (see Eisnitz 2007; Fitzgerald 2010; Pachirat 2013; Striffler 2005), a fact only underscored by the eagerness of large meat companies to force workers back to the processing line in the middle of a deadly viral pandemic. But for the economically and socially vulnerable laborers who work in this industry, many of whom (in the US context at least) are undocumented migrants at risk of state violence and oppression, having no job is even worse. If we take seriously the radical potential for cellular agriculture to transform global food systems, then should we not also take seriously the possibility of unintended socio-economic consequences? Or put another way, if these companies have the opportunity to improve animal agriculture's deleterious impact on animal wellbeing, human health, and the environment, should they not also endeavor to improve its effects on social and economic inequality? If the answer to these questions is yes, the cellular agriculture industry will have to contend with how cellular agriculture's status as a capitalist project may challenge or limit its desired positive impacts.

At least some cellular agriculture entrepreneurs seem aware of the potentially negative impacts of possibly making an entire employment sector obsolete, but detailed strategies for creating alternate labor opportunities must be developed alongside this technology if they are to avoid significant unintended economic impacts. In other words, companies will need to consider the politics of resemblance in the job market as well as the consumer market. To be clear, I am not suggesting that they should try to replicate animal industry jobs in kind, just that they might attempt to avoid eradicating job opportunities without replacing them with new ones. There is already a growing "just transitions" movement focused on helping animal farmers transition to plant-based agriculture (Bookis 2020). Companies could, for example, build on this trend by formulating strategies to incorporate conventional meat industry workers into their production systems to ameliorate the negative labor impacts on those who would lose jobs if cellular agriculture were ever successful in supplanting conventional agriculture. Relatedly, and more broadly, they could adopt a strategy geared toward what Garrett Broad calls "food tech justice," an affirmative agenda that would:

actively engage with the history and present of food system marginalization and inequity, forge a just transition for animal agricultural farmers and workers, explore how new food technology could co-exist with traditional livelihoods in developing nations, and support food entrepreneurs from historically marginalized communities to emerge as cooperative business leaders and engines of culinary creativity. (2019, 225)

Or, even more radically, cellular agriculture technology could be socialized through government-funded research and production, as political scientist Jan Dutkiewicz proposes (2019). "If it can be wrested from corporate control, lab meat production could be publicly financed, with intellectual property held in the public trust, and tied to the social and ecological goals of a just economic transition" away from conventional methods (Dutkiewicz 2019). Regardless of the specific strategies, however, if it is going to effectively address the multiple crises of global industrial animal agriculture by rendering farmed animals obsolete, this burgeoning industry will need to carefully navigate both the complex politics of resemblance and the potential negative consequences of extending the synthetic revolution to industrial animal agriculture.

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