

Beyond the Impossible

The Futures of Plant-based and Cellular Meat and Dairy

In recent years, breakthroughs in food science have enabled companies such as Beyond Meat, Impossible Foods, JUST, Ripple, and others to produce meat and dairy analogues that replicate the taste profile of animal products. Plant-based dairy now constitutes 13 percent of the U.S. market, and the U.S. market for plant-based meat grew by 24 percent in 2018 alone. Millennials and Generation Z are leading the demand for these products, which are mainly consumed by flexitarians.

At the same time, cellular biologists and entrepreneurs are attempting to produce commercially viable forms of cell-based meat and dairy that can be grown outside the animal, without an animal-based medium and to scale. The use of cells or microbes (such as yeast or bacteria) to reproduce fats and proteins, a process known as acellular agriculture, is well-established for rennet and vanillin. Similar opportunities are opening up to generate non-animal derived gelatin, collagen, silk, and leather.

Why and Why Now?

Meat analogues (such as tofu, seitan, and tempeh) have existed for centuries, as has milk from almonds and soybeans. However, these products were often substitutes for the “real” thing, and associated with moral, physiological, and spiritual purity rather than pleasure, festivity, or social or economic status. Concerns about the spread of intensive animal agriculture and its negative consequences for the environment, biodiversity, human health, and animal welfare have spurred investors, entrepreneurs, and animal activists to use innovations in food science to develop foodstuffs that match or surpass the taste, affordability, and availability of the originals. A particular focus is animal agriculture’s greenhouse gas (GHG) emissions—at least 14.5 percent of the total. These are set to increase as a growing and urbanizing human population consumes more and more animal products and production rises to meet demand. By mid-century, according to the UN, poultry consumption is projected to double, and beef and pork consumption will rise by 69 and 42 percent respectively above 2012 levels.

It has been possible to grow animal muscle in the lab for twenty years. In 2013, Dutch biochemist Mark Post introduced a

proof-of-concept cell-based beef patty. Four years later, Memphis Meats unveiled a cell-based chicken nugget, and in December 2018, Israeli company Aleph Farms revealed it had created a cell-based beefsteak. Currently, these and other versions rely on fetal bovine serum (FBS) as part of the medium to develop the muscle tissue, and the race is on to find a non-animal derived serum. Possible sources include algae and fungi.

Why Not Just Eat Plants? (And Other Complaints)

At this early stage, although many entrepreneurs and voices in these industries are vegan, public perceptions about veganism are either confused or negative, and the numbers of vegans in the U.S. (around two percent) has remained unchanged for decades. Bruce Friedrich, executive director of the Good Food Institute, has argued that plant-based and cultured meat and dairy could form the default for those who wish to continue eating animal

products, while vegan strategist Tobias Leenaert has suggested that this would make it easier for individuals to retroactively supply moral reasons for their change.

Others are more skeptical. They question the health profiles of processed foods and claims that cellular meat will be “cleaner” or use less energy than farming practices such as agro-ecology or regenerative agriculture. They have questioned the safety of some companies’ use of GM and CRISPR technology, and have complained about Impossible Foods’ decision in 2019 to use GM-soy in its burger. Plant-based physician Dr. Dean Ornish has criticized Impossible’s decision to add *heme* (which gives the “meat” its

bloody look and slightly metallic taste). Studies have suggested that *heme* might be an allergen and potentially carcinogenic. Food sovereignty activists such as Vandana Shiva have railed against the technologization of “faux” meat, and its adoption by multinational corporations, such as Cargill, ADM, and Tyson—all of whom are investors in or are producing their own versions of plant-based or cellular meat products.

Meanwhile, the EU has moved to legislate against allowing cellular meat to call itself *meat*, and the U.S. Cattlemen’s Association has petitioned the government to request that *beef*



and *meat* labels not be attached to products “not derived directly from animals raised and slaughtered.” In 2018, the state of Missouri passed legislation determining *meat* as a product only “from harvested production livestock or poultry.” The U.S. Dairy Pride Act would enforce labeling of butter and milk as only coming from a “hooved mammal.”

Current Realities and Possible Futures

At the moment, whole-food, plant-based cuisine, and organic or “grassfed” beef from well-managed pastures, constitute a negligible percentage of American diets. The urgent need to address the growing appetite for animal foods will require major systemic changes, if the 2015 Paris Accord’s goal of keeping global surface temperature to 1.5°C above pre-industrial levels is to be met. Reducing food loss and waste is imperative; consuming other forms of biotic life (such as insects) would lower the environmental impact; but producing and eating less animal meat and dairy may well be mandatory.

Climate change is likely to leave arable and pastoral land more vulnerable to drought or flooding, reducing yields, and causing farmed animals heat stress and to become less productive. Rural populations, unable to make a living through farming, will continue to move to cities or leave countries, further threatening food production, and putting more pressure on ecosystems.

At this stage in the emergence of a new generation of plant-based meat and dairy and at the cusp of the creation of cellular meat and dairy it’s neither a given these products will displace farmed animal equivalents nor that their implementation will be delayed by Big Ag or those worried about GM pollution or food sovereignty. Technological change and adaptation are inevitable; they’ve always played a role in agriculture. The localization and downscaling of cellular meat production are as much a possibility as centralization and vertical integration. Whatever these products are—or, more significantly, what they might become—will depend on continuous engagement and dialogue among farmers, technologists, business, government, and the public.

Recommendations

Encouraging Diversity: Currently, these industries, and the R&D organizations associated with them, are concentrated in New York and the Bay Area. Expanding into other regions of U.S. would encourage other voices, especially of consumers and small farmers, who might provide valuable feedback on how or whether these novel products could be acceptable to the mainstream and keep farmers on the land. Food security and food justice activists would be invaluable, as would a

commitment to ensuring that *all* communities, particularly African-American and Latinx (who’ve been particularly disadvantaged by the current food system), gain access to the knowledge, employment, and entrepreneurial possibilities in these industries.

Exercising Diligence: Food is not an app; an unsafe product could set the industries back years. Due diligence, third-party verification, and policing of claims, procedures, and rollouts cannot just be left to the USDA or FDA, the agencies that will determine the safety and nomenclature of cellular meat and dairy. A commitment to open-source research, long-term studies, and even some patent-free processes would encourage transparency and thoroughness.

Practicing Discernment: Burgers, dogs, and other processed foods aren’t meant to be healthy; their plant-based or cellular versions, however, could be. New companies could push for non-GM soy; cellular meat could be adapted to have less saturated fat, or added fiber. But these claims need to be honest, communicated clearly, and consumer concerns addressed. These industries would benefit from hearing from more ethicists and social scientists, who might investigate how a plant-based and cellular agricultural future can meet the need to conserve land, help small farmers, feed a growing population, and reduce the number of farmed animals. Faculties engaged in animal studies, the environmental humanities, and social science might convene with businesspeople, futurists, and natural scientists to open up new conceptual possibilities.

The plant-based and cellular meat and dairy worlds are oriented toward consumer choice and accommodating current business and agricultural practices. This isn’t surprising, given investors’ and entrepreneurs’ wish not to stir up industrial or governmental opposition. But not embracing public policy is itself a policy; avoiding ethics is itself an ethical position. Current U.S. agriculture is a system skewed to low-value commodity crops and animal products whose costs to public health, the environment, and climate change are externalized. Silence on existing government policies that support Big Ag for fear of “politicizing” the space would seem only to risk reinforcing business-as-usual that is inefficient, insupportable, and threatening the planet’s support systems. ■

Photo: Emily Lavieri-Skull

This policy brief is part of the Vegan America Project (VAP), a conceptual space that employs veganism as a heuristic to examine the social, economic, psychological, and cultural changes that will both occur and be necessary as the United States and the world confront climate change. VAP is an independent project of Brighter Green, funded by VegFund (<https://vegfund.org>). For more information, and to read the full paper, visit veganamericaproject.com.