Will Cultivated Meat be the Next GMO?

Learning from the Past to Shape the Future of Food Innovation

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1. Executive Summary

The concept of meat grown from animal cells without livestock rearing and slaughter, also known as cultivated meat (CM), promises major environmental benefits in the face of rising meat consumption constrained by our world's ecological resources. Nevertheless, **CM risks inheriting and repeating the mistakes of genetically modified organisms (GMOs)**. Like GMOs, CM faces skepticism over safety, "unnaturalness," and opaque corporate practices.

This brief addresses key parallels with GMOs, as well as hurdles unique to CM, to identify several recommendations for the CM space. To avoid GMO-style backlash, CM can:

1. Proactively open its processes to independent research and voluntary labeling.

2. Use tailored, benefit-focused messaging that addresses misconceptions directly.

3. Build coalitions with diverse stakeholders working towards the same sustainable food systems goals, from regenerative ranchers to food-insecure nations.

4. Identify receptive early adopters and explore non-food applications for cultivated cells.

2. Scope of Problem

Climate change and nutrition are inextricably linked. However, there is little recognition among the climate change community that acknowledges nutrition as an adaptive response and the nutrition community is ill prepared for compounding extreme weather events and their impacts on malnutrition.

Global meat production has more than tripled over the past 50 years – now producing more than 350 million tonnes each year.[1] Despite the steep environmental costs of livestock production – livestock uses more land and water than any other food source[2],[3], drives deforestation[4], and contributes 14.5% of global greenhouse gas (GHG) emissions[5] – global meat consumption is projected to increase by an additional 47.9 million tonnes by 2034.[6] As such, animal meat alternatives derived from plants, precision fermentation, and cultivated sources have steadily become regarded as solutions to reducing livestock consumption and its environmental impact. For example, replacing 50% of major animal-sourced foods (ASF) globally with alternatives alone would almost fully halt net reduction of forest and natural lands, while agriculture and land use GHG emissions would decline by 31% by 2050 compared to 2020.[7] While other plant-based alternatives to ASF are increasingly becoming available to consumers, particularly in high-income countries, cultivated (also, "cell-cultured" or "lab-grown") alternatives are facing pushback on two fronts: politically surrounding regulatory approval, and socially from public scrutiny concerning health implications.

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[1] Hannah Ritchie, Pablo Rosado, and Max Roser, *"Meat and Dairy Production," Our World in Data*, 2019, https://ourworldindata.org/meat-production.
[2] Jonathan A. Foley et al., "Solutions for a Cultivated Planet," Nature 478, no. 7369 (2011): 338, https://doi.org/10.1038/nature10452.
[3] Chiara Govoni, Davide Danilo Chiarelli, and Maria Cristina Rulli, "A Global Dataset of the National Green and Blue Water Footprint of Livestock Feeds," Scientific Data 11, no. 1 (2024): 1, https://doi.org/10.1038/s41597-024-04264-2.
[4] Hannah Ritchie, "Drivers of Deforestation," *Our World in Data*, Global Change Data Lab, 2021, https://ourworldindata.org/drivers-of-deforestation#article-citation.
[5] Food and Agriculture Organization of the United Nations, *Livestock Solutions for Climate Change* (Rome: FAO, 2017), 3, https://openknowledge.fao.org/server/api/core/bitstreams/0d178ab7-b755-4eb2-a6cd-05ba1db35819/content.
[6] Organisation for Economic Co-operation and Development (OECD) and Food and Agriculture Organization of the United Nations (FAO), *OECD-FAO Agricultural Outlook 2025–2034* (Paris: OECD Publishing, 2025), 85, https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/07/oecd-fao-agricultural-outlook-2025-2034_3eb15914/601276cd-en.pdf.
[7] Marta Kozicka, Petr Havlík, Hugo Valin, et al., "Feeding Climate and Biodiversity Goals with Novel Plant-Based Meat and Milk Alternatives," *Nature Communications* 14 (2023): 5316, https://doi.org/10.1038/s41467-023-40899-2.

Often derisively described as “Franken-meat” by skeptics, cultivated meat (CM) – being meat produced directly from cells, identical to conventional meat at the cellular level[8] – echoes a public backlash historically familiar to food technology innovation, that of the originally labeled “Frankenfood”: Genetically Modified Organisms (GMOs), defined as organisms containing altered DNA.[9] Both GMOs and CM were born with the intent to meet the world’s demand for food, with GMOs aimed to increase crop yields, and CM seeking to supplement ASF consumption and minimize its environmental and climate impacts. Nevertheless, both technologies face similar criticisms centered on perceptions of unnaturalness and concerns over health safety.[10],[11]

In many respects, CM has become the next iteration of GMOs in the court of public opinion. CM is not only battling its own respective challenges (e.g., current production costs and/or the need to perfect the sensory experience of meat), but also inherited lingering distrust and criticisms shaped by the decades-long GMO debate that began with the introduction of the Flavr Savr tomato, the first commercially grown crop modified to delay ripening, in 1994.[12],[13] Despite some similarities in their underlying science (i.e., some CM involves genetic modification [GM]) and regulatory oversight, CM differs substantially from GMOs in terms of its production ecosystem and how consumers interact with it. These distinctions present both unique challenges and opportunities. As this brief seeks to accomplish, by acknowledging the similarities and differences, the CM industry can not only learn from the pitfalls of GMOs but also develop strategies to overcome them.

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[8] Good Food Institute, “Cultivated Meat,” GFI, accessed August 21, 2025, https://gfi.org/cultivated/.
[9] Manreet Sohi, Maurice Pitesky, and Joseph Gendreau, “Analyzing Public Sentiment toward GMOs via Social Media between 2019-2021,” *GM Crops & Food* 14, no. 1 (2023): 1, https://doi.org/10.1080/21645698.2023.2190294.
[10] Sara Nawaz and Terre Satterfield, “On the Nature of Naturalness? Theorizing ‘Nature’ for the Study of Public Perceptions of Novel Genomic Technologies in Agriculture and Conservation,” *Environmental Science & Policy* 136 (2022): 291–303, https://doi.org/10.1016/j.envsci.2022.06.008.
[11] J. Mohorčich and Jacy Reese, “Cell-Cultured Meat: Lessons from GMO Adoption and Resistance,” *Appetite* 143 (2019): 104408, https://doi.org/10.1016/j.appet.2019.104408.
[12] Sohi, Pitesky, and Gendreau, “Analyzing Public Sentiment.”
[13] National Academies of Sciences, Engineering, and Medicine, *Genetically Engineered Crops: Experiences and Prospects* (Washington, DC: National Academies Press, 2016), chap. 3, https://www.ncbi.nlm.nih.gov/books/NBK424540/.

3. Key Learning from GMOs: Parallels & Pitfalls to Avoid

3.1 Scientific Consensus ≠ Social Consensus

Despite decades of empirical evidence supporting the safety of GMOs for human consumption, public skepticism persists. In 2016, the well-respected scientific body, the National Academy of Sciences (NAS) reviewed over 900 studies and 700 public comments, ultimately confirming no adverse health effects from GMO crops.[14],[15] Yet consumers perceive GMOs as significantly riskier than experts assert.[16] In 2015, Pew Research reported 88% of scientists from the American Association for the Advancement of Science considered GMOs safe versus only 37% of United States (US) adults; a subsequent 2020 Pew survey across 20 countries found a median of 48% of adults viewed GMOs as unsafe to consume.[17] A stark example of this divide and its consequences is Golden Rice, which is genetically engineered to produce beta-carotene to combat Vitamin A deficiency. Despite decades of evidence affirming its safety and potential health benefits, Golden Rice was stalled for over a decade due to public mistrust, political resistance, and regulatory hurdles. As a result, the crop's promised humanitarian impact was never realized: one case study found the delay in technology approval translated to at least US$1.7 billion in perceived costs and 1.4 million life years lost over a decade in India.[18]

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[14] Ibid.
[15] International Food Information Council, "GMO Crops: Safety, Regulation, and Sustainability Insights," *IFIC*, December 11, 2020, https://ific.org/insights/gmo-crops-safety-regulation-and-sustainability-insights/.
[16] Wieke P. van der Vossen-Wijmenga et al., "Perception of Food-Related Risks: Difference between Consumers and Experts and Changes over Time," *Food Control* 141 (2022): 109142, https://doi.org/10.1016/j.foodcont.2022.109142.
[17] John Stanton, Golnaz Rezai, and Stephen Baglione, "The Effect of Persuasive/Possessing Information Regarding GMOs on Consumer Attitudes," *Future Foods* 4 (2021): 100076, 2, https://doi.org/10.1016/j.fufo.2021.100076.
[18] Justus Wesseler and David Zilberman, "The Economic Power of the Golden Rice Opposition," *Environment and Development Economics* 19, no. 6 (2014): 738, https://doi.org/10.1017/S1355770X1300065X.

Golden Rice illustrates how a lack of public trust can derail even scientifically sound innovations with profound humanitarian potential. CM, while emerging under different circumstances, faces comparable risks. Despite its regulatory approvals in Singapore, the US, Israel, and Australia – and authorization for pet food in the United Kingdom (UK)[19],[20] – its novelty and associations with "unnaturalness" make it particularly vulnerable to public skepticism and misinformation, much like GMOs before it.[21],[22]

Misinformation widens the gap between scientific consensus and public perception, especially in industries with secretive intellectual property. A 2022 media analysis of articles about GMOs published between 2019–2021 found that about 9% of the 535 articles reviewed were factually inaccurate[23], while another 2023 study found 30.92% of over one million Twitter (X) posts from 2020–2022 contained misinformation or conspiracy theories relating GMOs to diseases, vaccines, Monsanto, and Bill Gates.[24] Many tweets suggested that GMOs cause cancer, while others argued GMOs are being used to control the world's food supply.[25] While CM-specific analyses are limited, a review of over 285 million Twitter (X) posts related to meat and dairy between 2022–2023 found 948,000 (or ~3%) featured misinformation. The report found 78% of the posts categorized as disparaging towards meat and dairy alternatives contained misinformation, while 22% of the narratives that promoted meat and dairy products exhibited misinformation.[26] Much like the GMO-related tweets, the most common misinformation about alt proteins were claims of unhealthiness (24% of dataset) and conspiracies of being used as a tool for the elites' "Great Reset." (37% of data).[27]

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[19] Andy Coyne, "Protein Pioneers: The Countries Which Have Approved Cultivated Meat," *Just Food*, June 19, 2025, https://www.just-food.com/features/protein-pioneers-the-countries-which-have-approved-cultivated-meat/.
[20] Good Food Institute, *2024 State of Global Policy: Public Investment in Alternative Proteins to Feed a Growing World* (April 2025), https://gfi.org/wp-content/uploads/2025/04/2024-State-of-global-policy-Public-investment-in-alternative-proteins-to-feed-a-growing-world.pdf.
[21] A. Janet Tomiyama et al., "Bridging the Gap between the Science of Cultured Meat and Public Perceptions," *Trends in Food Science & Technology* 104 (2020): 144–52, https://doi.org/10.1016/j.tifs.2020.07.019.
[22] Nawaz and Satterfield, "On the Nature of Naturalness?"
[23] Mark Lynas, Jordan Adams, and Joan Conrow, "Misinformation in the Media: Global Coverage of GMOs 2019–2021," *GM Crops & Food* 16, no. 1 (2022): 20–21, https://doi.org/10.1080/21645698.2022.2140568.
[24] Dmitry Erokhin and Nadejda Komendantova, "GMO Discussion on Twitter," *GM Crops & Food* 14, no. 1 (2023): 3–4, https://doi.org/10.1080/21645698.2023.2241160.
[25] Ibid.
[26] Changing Markets Foundation, *Truth, Lies, and Culture Wars: Social Listening Analysis of Meat and Dairy Persuasion Narratives* (November 2023), https://changingmarkets.org/report/truth-lies-and-culture-wars-social-listening-analysis-of-meat-and-dairy-persuasion-narratives/
[27] Ibid.

3.2 Political & Regulatory Backlash

As CM gains regulatory approval, it simultaneously has faced several bans in the European Union (EU) and US. Italy was the first EU country to enforce a ban, despite the EU's Technical Regulation Information System (TRIS) procedure that prevents national governments from EU member states from passing legislation that could affect the rest of the EU market without consulting fellow member states or the Commission. TRIS is what limited Hungary from passing its own ban on CM, and this holding indicates that Italy's CM ban may be unenforceable.[28] Seven US states have also enacted laws banning the sale of CM. The wave of bans come just two years after the USDA and FDA granted federal approval for the commercial sale of cultivated chicken from two companies, UPSIDE Foods and GOOD Meat.[29] The synthesized rationale across the Italian and US state bans are primarily centered around protecting human health, the sanctity of natural food, and domestic farmers from losing business.[30],[31]

GMOs are no stranger to the ban status. While roughly 18 million farmers in 29 countries around the world currently grow GMO crops, 39 countries and 13 sub-national regions have total or partial bans on GMOs.[32] Much like the CM bans, proponents of GMO bans are critical of health concerns and negative impacts to traditional farming practices.

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[28] Good Food Institute, *2024 State of Global Policy Report*.
[29] Madyson Fitzgerald, "Texas Becomes Seventh State to Ban Lab-Grown Meat," *Stateline*, June 30, 2025, https://stateline.org/2025/06/30/texas-becomes-seventh-state-to-ban-lab-grown-meat.
[30] Paul Kirby, "EU Considers New GMO Rules," *BBC News*, November 17, 2023, https://www.bbc.com/news/world-europe-67448116.
[31] Fitzgerald, "Texas Becomes Seventh State."
[32] Genetic Literacy Project, "Where Are GMO Crops and Animals Approved and Banned?" accessed August 22, 2025, https://geneticliteracyproject.org/gmo-faq/where-are-gmo-crops-and-animals-approved-and-banned/.

3.3 Trust Issues Inheritance

Public distrust for biotechnology appears to be a legacy passed down from GMO to CM. Biotech giants like Corteva and Bayer own most licensing rights (for agricultural uses) and patents for GM seeds, which means future offspring of GMO plants cannot be used by plant breeders or farmers without the permission of the patent holder.[33] This seed monopolization does more than restrict what farmers can grow and sell; it also exposes them to the threat of legal action. Monsanto (acquired by Bayer) was notorious for their lawsuits against farmers who allegedly breached its patents, filing 144 patent-infringement lawsuits against farmers between 1997–2020.[34]

Public disdain for Monsanto runs deep and helps explain the origin for prominent (and misguided) criticism for GMOs. In the 1990s, Monsanto launched RoundUp Ready, a package that paired a glyphosate herbicide with GMO seeds resistant to it. Glyphosate was soon classified by global health institutions like the World Health Organization (WHO) as "probably carcinogenic to humans," so while glyphosate is not itself a GMO – rather the herbicide Monsanto's GMO seeds were designed to resist – the fact that both were originally sold together blurred the distinction in the public's mind, inextricably linking the reputation of one to the other.[35] CM lacks the same confounding variable of misattributing herbicides' impact with GMOs; however, the lingering doubt for one type of biotech extends to all others – especially ones regarded as threats to the livelihoods of traditional farmers. While CM patents don't directly harm farmers, the patents perpetuate the shroud of suspicion people already have for CM biotech. Additionally, CM has inherited the anti-agriculture reputation as a replacement for livestock meat.

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[33] Katherine Dolan, Eva Gelinsky, Nina Holland, et al., *Biotech Giants Exposed* (Brussels: Corporate Europe Observatory, October 2022), 9–10, https://corporateeurope.org/sites/default/files/2022-10/G2_BIOTECH_GIANTS_EXPOSED.pdf.
[34] Ibid.
[35] Cait Mack, "How Did GMOs Become So Controversial?" *Food Unfolded*, October 9, 2024, https://www.foodunfolded.com/article/how-did-gmos-become-so-controversial#ref2.

4. Unique Obstacles for CM to Overcome

4.1 Direct-to-Consumer Visibility

Unlike GMOs, CM products generally sit at the center of the plate, while the former can be "hidden" in the ingredient list of food products or dishes. For example, over 95% of animals used for meat and dairy in the US eat GMO crops.[36] In this case, GMO involvement is one step removed from end consumers, as the "unnatural" crop is fed to a source of meat perceived as naturally occurring. Conversely, the CM currently commercially available is unfiltered, with its "unnaturalness" unhidden.

4.2 Cultural Centrality of Meat

While GMOs may challenge food producers with their restrictive patents, a meta-analysis found that GM crops on average have increased crop yields by 22%, reduced chemical pesticide use by 37%, and increased farmer profits by 68%.[37] GMOs generally add value, improving climate resiliency, extending shelf life, and preventing damage from pests, insects, and diseases[38] – without requiring sacrifices from consumers. CM, by contrast, must compete with traditional meat for taste, experience, and cultural acceptance, particularly in meat-centric countries like the US, Brazil, and China. Even plant-based alternatives are often met with a higher level of willingness to try and purchase compared to CM.[39]

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[36] U.S. Food and Drug Administration (U.S. FDA), "GMO Crops, Animal Food, and Beyond," accessed August 22, 2025, https://www.fda.gov/food/agricultural-biotechnology/gmo-crops-animal-food-and-beyond.
[37] W. Klümper and M. Qaim, "A Meta-Analysis of the Impacts of Genetically Modified Crops," *PLOS ONE* 9, no. 11 (2014): 4, https://doi.org/10.1371/journal.pone.0111629.
[38] U.S. FDA, "GMO Crops, Animal Food, and Beyond."
[39] Jiqing Hansen, Catalina Sparleanu, Yahan Liang, Jessica Büchi, Somya Bansal, Miguel Ángel Caro, and Frank Staedtler, "Exploring Cultural Concepts of Meat and Future Predictions on the Timeline of Cultured Meat," *Future Foods* 4 (2021): 100041, https://doi.org/10.1016/j.fufo.2021.100041.

4.3 Perceived as a Luxury Product

Finally, while CM companies have managed to reduce production costs by 99% in less than a decade, they are still at least five years away from achieving cost parity with conventional meat.[40] Until then, CM will continue to be out of reach for most consumers. CM is often positioned and priced for affluent buyers, a distinction GMOs do not share, as GMO crops can increase farmer profits.

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[40] McKinsey & Company, "What Is Cultivated Meat?" September 13, 2023, accessed August 22, 2025, https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-cultivated-meat.

5. Recommendations

5.1 Embrace Transparency & Cooperation: Research & Regulation

CM should continue working with regulatory bodies and implement voluntary labeling to signal goodwill and avoid backlash. The priority here is to avoid GMO-style resistance to providing consumers information. One study found that many consumers simply want manufacturers to label the existence of GMOs in their products.[41] Another study found that even among the participants concerned about GMOs, roughly half would still buy them if labeled.[42] What the CM movement does not need is the proliferation of a Non-GMO Project-equivalent antagonist to promote conventional meat. The Non-GMO Project Verified label is used by over 5,000 brands for more than 60,000 ingredients, inputs, and retail products.[43] There's a considerable difference between what GMO and CM producers can handle, where the former are large biotech and food companies that remain profitable despite the breadth of the Non-GMO Project, and the latter being start-ups currently developing CM products that are barely on the market. A non-CM label would give conventional meat (dominated by their own multi-billion-dollar companies) a positive signaling device to use on consumers, while simultaneously delegitimizing CM.

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[41] Mohorčich and Reese, "Cell-Cultured Meat."
[42] Stanton, Rezai, and Baglione, "The Effect of Persuasive/Possessing Information," 7.
[43] Non-GMO Project, "Find Non-GMO," accessed August 22, 2025, https://www.nongmoproject.org/find-non-gmo/.

In addition to receiving approval from government agencies, CM companies should make their products and processes available for third-party investigation from reputable health and science associations, non-governmental groups, and research institutions. Regardless of the industry, any company that makes unverified (positive) claims about its proprietary products are bound to manifest an audience of skepticism. Bringing CM into the public domain by engaging universities and trusted health organizations to conduct life cycle assessments and health safety studies can help dispel the distrust around biotech secrecy and preempt misinformation. Examples include the WHO and American Medical Association (AMA), both of which significantly improved one study's participants' views on GMOs, garnering a 46% and 56% decrease, respectively, among those that originally thought GMOs are bad for human health.[44] This proactive approach should extend to cultural and religious certification bodies, such as Kosher and Halal authorities.

5.2 Tailored Communication to Address Public Perceptions

While the CM industry inherited baggage from its GMO predecessor, it also can learn from GMO food acceptance research, which shows that messaging informed by the target audience's pre-existing beliefs – designed to directly address misconceptions or consumer-relevant benefits, particularly around health and nutrition – is more persuasive than abstract or long-term claims.[45] One study found that strong, tailored arguments reduced preference for non-GM potatoes by 16–17% amongst participants, and increased preference for GM potatoes with direct health benefits by 25–36%; weak arguments failed to produce meaningful shifts, leaving non-GM preference unchanged or slightly higher.[46] As such, communicators should emphasize concrete health and environmental benefits rather than vague reassurances, as facts alone without tailoring and context will not overcome skepticism or misinformation.

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[44] Stanton, Rezai, and Baglione, "The Effect of Persuasive/Possessing Information," 5-6.
[45] Patrycja Sleboda and Carl-Johan Lagerkvist, "Tailored Communication Changes Consumers' Attitudes and Product Preferences for Genetically Modified Food," *Food Quality and Preference* 96 (2022): 104419, https://doi.org/10.1016/j.foodqual.2021.104419.
[46] Ibid.

Communicating these benefits has been found to be effective for increasing willingness to try alternative (alt) proteins, but oversharing may backfire by reinforcing perceptions of CM as overly processed, unnatural, or artificial – the leading barrier to acceptance.[47] How CM companies decide to handle this delicate balance is crucial. Interestingly, informative messaging that reframes the issue by highlighting the unnatural aspects of conventional meat, rather than insisting CM is natural, has proven significantly more effective.[48]

In action, this could manifest through a two-pronged approach. Short-form advertising and marketing mediums (billboard ads, social media) should utilize bold, honest messaging that playfully challenges convention meat while highlighting factually how CM addresses those issues, paired with calls-to-action (e.g., QR codes to brand websites). Long-form channels (websites) can house the science – explaining the production process and quantifying impacts – for consumers who like to read the fine print. This strategy mirrors successful examples in animal-free and health foods sectors. Plant-based milk brand Oatly is famous for its witty self-awareness across social media marketing and in-person advertising that amuses consumers, while also directing individuals to their yearly sustainability report online that acknowledge Oatly's environmental impact failures alongside celebrating successes. The marketing and communications for dietary supplements Seed synbiotics and Athletic Greens powder heavily relies on accessible science, with clinical research of their products available to review online. Medicine and supplement companies are highly recommended for analysis, as the unnatural methods of ingestion (pills, powders) are not just destigmatized but normalized as an image of healthy living.

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[47] Daniel L. Rosenfeld and A. Janet Tomiyama, "Toward Consumer Acceptance of Cultured Meat," *Trends in Cognitive Sciences* 27, no. 8 (2023): 689–691, https://doi.org/10.1016/j.tics.2023.05.002.
[48] Christopher J. Bryant, Joanna E. Anderson, Kathryn E. Asher, Che Green, and Kristopher Gasteratos, "Strategies for Overcoming Aversion to Unnaturalness: The Case of Clean Meat," *Meat Science* 154 (2019): 37–45, https://doi.org/10.1016/j.meatsci.2019.04.004.

5.3 Coalition-building to Scale & Solve

To tailor communications, CM industry players need alignment on 1) what they are challenging, 2) who shares their systemic goals (via different methods), and 3) who their true customer base is. Much like with GMOs, people worry about big biotech harming small farmers. In the case of meat, power lies with industrial giants like Cargill, JBS, and Tyson, who, despite being competitors, present a unified front through lobbying and marketing campaigns. This cohesion is missing across not only the CM or wider alt proteins sector, but also the broader consortium of food system solutions. CM is not a silver bullet; it supplements other higher impact strategies such as reducing food loss and waste, promoting whole-food, plant-forward diets, and transitioning conventional (crop and livestock) farming to regenerative, organic, or agroforestry practices. Rising meat consumption while we transition industrial animal agriculture towards more ethical farming systems will ensure consistent demand for small-scale farmers, while creating a supply gap that CM can help fill.

At this point, it is ineffective to wholly argue for realities where the majority of our global population transition en masse to fully plant-based diets. In acknowledging that conventional meat consumption will continue to occur, the CM space can position itself as a complement – not a threat – to smallholder and family-operated farms to ensure more sustainable production of animal meat – on the farm and in the lab.

Beyond forming allies with more ethical meat producers, CM should continue building strong relationships and infrastructure with countries like Singapore – island nation states with food security priorities and limited arable land. Singapore imports around 90% of its food[49], making it vulnerable to global supply chain disruptions, whether due to climate change, geopolitical tensions, or pandemics. Under its "30 by 30" goal (produce 30% of its nutritional needs domestically by 2030), the Singaporean government and its sovereign wealth funds have invested heavily into the research, development, and commercialization of alt proteins, including CM, as both a resilience strategy and a tech-sector growth engine. Furthermore, partnering with universities and research institutions there helps validate, develop, and normalize CM locally. Other locations with similar vulnerabilities, resources, and strategic priorities include Hong Kong and Taiwan. China presents a contrasting case, as one of the largest meat producers in the world, yet also its largest food importer.[50],[51] As such, it is investing in CM research and innovation at a large scale while embedding meat-reduction targets into its national dietary guidelines, reflecting an integrated approach for food security and sustainability.

5.4 Intentional Identification and Targeting of Initial Adopters

Characterizing early CM adopters is crucial. Appeals to animal welfare or even environmental benefits alone have proven insufficient for growing a consumer base for alt meats. Targeting vegans and vegetarians is also limited, as certain CM processes still require extracting cells from live animals and thus are not recognized as "vegan" by certification organizations like The Vegan Society.[52] Activations like UPSIDE Foods' "Freedom of Food" event in Florida before the July 2024 CM ban were creative in leveraging American identity narratives of innovation, freedom, and choice[53], but mainly function as publicity stunts to drive sampling – lacking a strong enough resonance to secure repeat purchases.

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[49] Singapore Food Agency, *Singapore Food Statistics 2021*, accessed August 20, 2025, https://www.sfa.gov.sg/docs/default-source/publication/sg-food-statistics/singapore-food-statistics-2021.pdf.
[50] Ritchie, Rosado, and Roser, "Meat and Dairy Production."
[51] Xiang Wang, Xin Li, Libang Ma, Jing Bai, Li Li, and Simin Yan, "Impacts of China Food Trade on Global Resource and Environment: A Sustainable Development Assessment," *Geography and Sustainability* 6, no. 6 (2025): 100339, https://doi.org/10.1016/j.geosus.2025.100339.
[52] Alexander Huntley and Lorna Fenwick McLaren, *Cultured Meat Research Briefing* (The Vegan Society, November 2, 2024), https://www.vegansociety.com/sites/default/files/uploads/downloads/Cultured%20Meat%20Research%20Briefing.pdf.
[53] S. Gerber, H. Bae, I. Ramirez, et al., "Publicly Tasting Cultivated Meat and Socially Constructing Perceived Value Politics and Identity," *Science of Food* 9 (2025): 94, https://doi.org/10.1038/s41538-025-00449-0.

Much like the dietary supplement users, CM may have more appeal among consumers who seek to maximize certain nutrition or fitness goals by taking supplements. Commentary around CM often point to its technical ability to grow only desired tissue, fat, or other specific cells, eliminating the waste of bones, skin, and other animal parts humans don't consume[54]. CM should target the health-conscious consumers that are comfortable relying on "unnatural" supplements to fulfill nutritional needs, especially amidst a rising demand trend for high-protein foods.[55],[56] Regulatory approval required for CM, such as from the FDA in the US, provides an additional credibility advantage that supplement companies lack.

Expanding non-food consumption further, cultivated cells have the potential to integrate as animal-free inputs within markets that rely on animal-derived ingredients like dietary supplements, medicines, personal care products (cosmetics, skincare), and pet foods (as recently approved in the UK). This approach could provide scalable market opportunities while replicating the "hidden" presence GMOs have in many products, thereby increasing exposure and normalization for cultivated biotechnology.

[54] Ava Eucker, "How Lab-Grown Meat Is Revolutionizing What We Eat," *Global Landscapes Forum*, January 22, 2025, https://thinklandscape.globallandscapesforum.org/71653/how-lab-grown-meat-is-revolutionizing-what-we-eat/.
[55] Kaitlin Sullivan, "Do Nutritional Supplements Really Work? Regulation," *NBC News*, January 5, 2025, https://www.nbcnews.com/health/health-news/do-nutritional-supplements-really-work-regulation-rcna186045.
[56] Donna Eastlake, "High-Protein Demand Straining Food and Beverage Industry," *FoodNavigator*, May 2, 2025, https://www.foodnavigator.com/Article/2025/05/02/high-protein-demand-straining-food-and-beverage-industry/.

6. Conclusion

CM sits at a crossroads as it awaits regulatory green-lights from more government agencies around the world.

On one path lies the fate of GMOs, marked by entrenched distrust, fragmented regulation, and decades of defensive communication. On the other lies the opportunity to set a new precedent for how biotechnology integrates into the food system. The difference will be aided by the industry's willingness to embrace openness, build alliances, and communicate with precision. CM's scientific potential is significant: reducing the land, water, and emissions footprint of meat production while meeting rising global demand; however, technology alone will not win hearts, plates, or policies. By internalizing the lessons of the GMO era – particularly the importance of public trust, transparent governance, and inclusive messaging – the CM industry can cultivate more than just meat; it can help cultivate a more resilient and sustainable future for protein.

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