THE GOOD FOOD INSTITUTE

1380 MONROE STREET NW, SUITE 229
WASHINGTON, DC 20010

July 30, 2020

SUBMITTED ELECTRONICALLY VIA REGULATIONS.GOV

RE: Docket No. USDA–2020–0003 Solicitation of Input from Stakeholders on Agricultural Innovations

Dear Deputy Secretary Stephen Censky:

Thank you for soliciting input on how to facilitate transformative breakthroughs in the sustainability of American agriculture. The Good Food Institute (GFI) is a 501(c)(3) nonprofit organization that accelerates protein innovation to sustainably feed the world's growing population. We urge you to prioritize open-access research on alternative proteins as a central component of your Agriculture Innovation Agenda. Producing 40 percent more food with 50 percent less environmental impact by 2050 is possible, but only if we find ways of making meat, eggs, and dairy products more efficiently. Research to advance progress on using plants, cell culture, and fermentation to make these familiar foods would increase the food supply without adding disproportionate stress to the environment. We submit these comments in addition to a letter that we are submitting with 28 companies and organizations that supports this open-access research.

Alternative proteins—including plant-based proteins, cultivated meat,[1] and foods produced through fermentation[2]—offer a promising way to help increase agricultural production while dramatically reducing the environmental footprint of U.S. agriculture. They also satisfy growing consumer demand for more choices in the marketplace. The research areas that will most effectively accelerate progress on alternative proteins align with the innovation clusters identified by the National Academies of Sciences, Engineering, and Medicine, which has recognized alternative proteins as a "new and exciting" part of the bioeconomy with "high growth potential."[3] Funding and performing alternative protein research should be a central part of USDA's innovation agenda in order to "do right and feed everyone" over the next 30 years.

---

[1] Sometimes called cell-based meat, cultured meat, or clean meat, cultivated meat is produced by starting with the basic building block of all life: the cell. Beginning with a small sample of animal cells, cells are grown into meat, poultry, and fish. A tank called a cultivator facilitates the same biological process that happens inside an animal by providing warmth and the basic elements needed to build muscle: water, proteins, carbohydrates, fats, vitamins, and minerals. The result is meat, identical to conventional meat at the cellular level. It looks, tastes, and cooks the same.

[2] Fermentation here refers to the process of using non-animal, single-celled organisms—like yeast—to produce proteins that may be consumed as whole products or used as ingredients in other foods. For example, most hard cheeses produced in the United States use rennet produced by fermenting yeast cells. Fermentation can be used to produce high-protein alternatives to conventional meat products and produce pure dairy and egg proteins that are indistinguishable from their counterparts from animals.

[3] Nat'l Acads. of Scis., Eng'g, & Med., *Safeguarding the Bioeconomy*, 59 (2020), https://bit.ly/2Bx2y5E; Nat'l Acads. of Scis., Eng'g, & Med., *Preparing for Future Products of Biotechnology*, 52-55 (2017), https://bit.ly/3fZSK2S.

I. Alternative Proteins Can Increase the Food Supply without Adding Disproportionate Stress to the Environment.

Global demand for meat, eggs, and dairy is expected to increase significantly by 2050.[4] Feeding the world's growing population with finite land and water resources will undoubtedly be one of the greatest challenges of the 21st century. Alternative proteins are key to addressing this challenge. Producing meats directly from plants and animal cell culture, for example, uses anywhere from 35 to 99 percent less land than their conventional equivalents,[5] and two of the most innovative plant-based burgers on the market right now use 87 to 99 percent less water than conventional beef burgers.[6] Together with the products of fermentation, and plant-based and cultivated versions of dairy and eggs, these alternative proteins present a suite of options that will allow U.S. agriculture to produce vastly more and more diverse protein options at a fraction of the environmental cost. For this reason, USDA must put alternative proteins at the center of its Agriculture Innovation Agenda in order to produce 40 percent more food with less than 50 percent of the environmental cost.

A. Alternative Proteins Offer a Radically Lighter Environmental Footprint than Conventional Animal Proteins.

Plant-based and cultivated meat have less environmental impact than animal meat, allowing more food to be produced with dramatically fewer resources. In comparison to conventional meat, plant-based meats produce fewer emissions and less pollution.[7] For example, life-cycle analyses of plant-based burgers from Impossible Foods and Beyond Meat conclude that they substantially reduce greenhouse gas emissions, producing approximately one-tenth the emissions of conventional ground beef.[8] Additional benefits are displayed in Table 1 on the following page.

---

[4] Demand for meat is expected to increase by more than 50 percent relative to 2012. Demand for eggs and dairy products is forecasted to increase by about 40 percent each. U.N. Food & Ag. Org., *The Future of Food and Agriculture: Alternative Pathways to 2050*, 8, 17, 21 (2018), https://bit.ly/3dfCIzV.

[5] Hanna L. Tuomisto, Marianne J. Ellis, & Palle Haastrup, *Environmental Impacts of Cultured Meat: Alternative Production Scenarios* (2014), https://bit.ly/2Evvjk5; Jon Dettling et al., *A Comparative Life Cycle Assessment of Plant-based Foods and Meat Foods*, Quantis USA & MorningStar Farms (2016), https://bit.ly/2AtV5E0 (hereinafter "MorningStar Farms LCA").

[6] Martin C. Heller & Gregory A. Keoleian, *Beyond Meat's Beyond Burger Life Cycle Assessment: A Detailed Comparison between a Plant-based and an Animal-based Protein Source*, Univ. Mich. Ctr. Sustainable Sys. (2018), https://bit.ly/2XIk11I (hereinafter "Beyond Meat LCA"); Sofia Khan et al., *Comparative Environmental LCA of the Impossible Burger with Conventional Ground Beef Burger*, Quantis USA & Impossible Foods (2019), https://bit.ly/2D6oVMb (hereinafter "Impossible Foods LCA").

[7] *See* The Good Food Institute, *Plant-Based Meat for a Growing World* (Aug. 2019), https://bit.ly/30bucOW.

[8] Impossible Foods LCA; Beyond Meat LCA.

Table 1: Environmental Benefits of Plant-Based Meat Products[9]

Plant-based meat product	Conventional meat comparator	Land use	Greenhouse gas emissions	Water use	Aquatic eutrophication potential
Impossible Burger 2.0[10]	Beef burger*	-96%	-89%	-87%	-91%
Beyond Burger[11]	Beef burger**	—	-89%	-99%	—
Grillers Original Burger[12]	Beef burger*	-93%	-85%	-95%	-77%
Spicy Black Bean Burger[12]	Beef burger*	-97%	-89%	-96%	-76%
Roasted Garlic & Quinoa Burger[12]	Beef burger*	-93%	-88%	-98%	-73%
Grillers Crumbles[12]	Ground beef**	-99%	-90%	-96%	—
Original Sausage Patties[12]	Pork sausage patties*	-47%	-30%	-81%	-51%
Original Chik Patties[12]	Breaded chicken patties*	-84%	-36%	-72%	-75%

*Sold frozen. **Sold fresh.
Impact reductions are calculated as follows: *(impact of conventional meat - impact of plant-based meat) ÷ (impact of conventional meat).*
Em dashes (—) are used where comparison of the relative impacts was not possible from information available in the studies reviewed.

While cultivated meat is not yet on the market, three environmental studies published so far show promising results. Cultivated chicken is projected to use 35 to 67 percent less land than current chicken production while reducing nutrient pollution by 70 percent. The positive impact of cultivated beef is even greater, reducing land use by over 95 percent, greenhouse gas emissions by 74 to 87 percent, and nutrient pollution by 94 percent.[13]

Moreover, these estimates do not account for efficiency-boosting measures that commercial meat cultivation facilities will likely take to improve productivity and profitability. Incorporating heat

[9] This table represents the results of all English-language comparative life cycle assessments that (i) employ methodologies we are highly confident produce reliable findings, (ii) assess specific plant-based meat products for which the relevant production parameters are known (as opposed to studying generalized production processes without such data), and (iii) were published prior to July 30, 2020. Because each study differs slightly in its methodology, the results from different studies cannot be precisely compared.

[10] Impossible Foods LCA.

[11] Beyond Meat LCA.

[12] MorningStar Farms LCA.

[13] The Good Food Institute, *Growing Meat Sustainably: The Cultivated Meat Revolution* 2 (Oct. 2019), https://bit.ly/2XCITaQ. GFI is preparing an additional life-cycle assessment that we expect to complete later in 2020.

exchangers, nutrient recycling, and clean energy into meat cultivation facilities will further reduce environmental impacts.[14]

B. Alternative Proteins Provide Additional Benefits to the Food Supply.

In addition to being environmentally sustainable, alternative proteins' unique production processes enable American agricultural producers to reliably meet global demand by making our food system more responsive to consumer demand, more efficient, and more resilient to future challenges.

Alternative protein production methods offer a host of benefits with regard to improved responsiveness to consumer demand. Plant-based and cultivated meat inputs and production facilities can be used to produce different kinds of meat under the same roof, meaning that a producer can switch from making plant-based beef burgers to plant-based chicken or pork with relatively minor adjustments to flavorings and manufacturing parameters. Similarly, alternative protein companies can produce only the cuts that consumers demand, solving the carcass balancing problem inherent in conventional meat production.[15] Assuming consumers continue to demand greater volumes of chicken breast than chicken feet, cultivated meat producers can choose to grow only chicken breasts, essentially eliminating the need to valorize less desirable parts of the animal.

Alternative protein production processes are also exceedingly time-efficient, requiring mere days or weeks to produce the same quantity of meat that requires months or years via conventional methods. This allows supply to be throttled up or down to respond in real time to market demand. For these reasons, and because inputs for plant-based and cultivated meat can generally be stored until market conditions are favorable, alternative protein production does not suffer from the volatile boom-and-bust cycles that currently plague conventional meat production.

In large part due to demand for inexpensive feed crops for livestock, only four crops currently dominate U.S. agriculture: corn, soybeans, wheat, and cotton. This lack of diversity creates fragility in the food supply, as a single adverse event can have widespread effects. Because plant-based and cultivated meat can be made from a wide variety of high-value crops, a shift to these methods of protein production would allow the country to diversify the crops it grows, giving farmers and consumers alike more choice while adding resilience to the food supply. For example, yellow peas are more resilient than corn, soybeans, and wheat because they require less water and are drought tolerant.[16] Peas are currently used in several plant-based meat products, with pea protein demand expected to quadruple by 2025.[17] Regardless of the benefits of any particular crop, having a greater variety of plants grown in American fields provides insurance against circumstances that would devastate just one.

---

[14] The Good Food Institute, *Growing Meat Sustainably: The Cultivated Meat Revolution* 2 (Oct. 2019), https://bit.ly/2XCITaQ.

[15] Liz Specht, *Alt-Meat Trounces Animal Meat's Massive Inefficiencies*, Wired (Aug. 19, 2019), https://bit.ly/3abxLGU.

[16] Larissa Zimberoff, *The Rise of the Pea: How an Unassuming Legume Emerged as a Frontrunner in the Race to Replace Meat and Dairy*, TIME (Aug. 15, 2019), https://bit.ly/2Xw08wB.

[17] Deena Shanker & Lydia Mulvany, *The Mighty Pea Is Everybody's New Favorite Plant-Based Protein*, Bloomberg (May 14, 2019), https://bloom.bg/2BUhpHf.

And of course, plant-based meat is completely devoid of the risk of zoonotic disease because no animals are involved. Likewise, cultivated meat is grown in a closed system, shielded from external contaminants, adding additional security and food safety to the supply chain. These production advantages mitigate against market volatility and disruptions, protecting the bottom line of alternative protein producers and suppliers while ensuring a secure, resilient, and safe food system.[18]

Given the right incentives, local facilities would become more viable for the production of alternative proteins—similar to other sectors, such as craft beer breweries—and could be located in rural and semi-rural areas. More widely distributed production and supply networks would safeguard American jobs in both farming and food production and keep money flowing through local economies. A distributed system would also create an overlapping network of protein production capabilities to protect against supply chain disruptions such as storms, droughts, wildfires, flooding, and disease outbreaks.

Establishing advanced manufacturing institutes dedicated to the development of alternative protein equipment and infrastructure would support the growth of localized food and manufacturing networks by decreasing production costs and improving performance. Increasing food production by 40 percent will require an immensely greater number of pilot- and commercial-scale facilities than currently exist to produce the necessary quantities of plant-based, cultivated, and fermentation-derived products. Many new manufacturing plants will also need to be built—and existing facilities will need to be leveraged—to make the tools and equipment used in these alternative protein supply chains, bringing back high-quality manufacturing jobs to rural areas.

Finally, with appropriate investment, alternative protein research at land-grant universities would create sustainable jobs and economic growth in rural, agricultural communities. Publicly funded research would employ and provide essential workforce training to Americans performing the research and lead to the employment of researchers and workers at the companies that use and build on the publicly funded science. For example, USDA-funded research at the University of Missouri was the foundation of technology that was licensed by Beyond Meat to create their first plant-based meat product.[19] Beyond Meat now employs hundreds of workers at two production facilities in the state, and consumers can buy Beyond Burgers in restaurants and supermarkets across the United States and on six continents.[20] The Breakthrough Institute predicts that alternative protein industries could generate more than 200,000 new jobs in the next ten years.[21] Depending on how quickly these industries grow, we expect this number could be much, much higher.[22]

---

[18] Liz Specht, *Modernizing Meat Production Will Help Us Avoid Pandemics*, Wired (Mar. 13, 2020), https://bit.ly/37HIjhl.

[19] Stephen J. Bronner, *With $72 Million in Funding, the Entrepreneur Behind Beyond Meat Pursues Innovation Over Profit*, Entrepreneur (Jan. 22, 2018), https://bit.ly/37xesr6.

[20] Ashley Williams, *Beyond Meat opens second Missouri facility to fuel plant-based demand*, Global Meat News (July 2, 2018), https://bit.ly/2YAb6A8; *Beyond Meat is Going Global*, Beyond Meat (May 8, 2018), https://bit.ly/2BdV8nn.

[21] Saloni Shah & Dan Blaustein-Rejto, *Federal Support for Alternative Protein for Economic Recovery and Climate Mitigation*, The Breakthrough Institute (May 12, 2020), https://bit.ly/3cKxkVf.

[22] *See* John Cumbers, *Investing In These 8 Bioeconomy Sectors Could Create Up To 1.6M Jobs Lost To COVID*, Forbes (June 9, 2020), https://bit.ly/30Z90eh.

C. Alternative Proteins Provide More Choices for Consumers.

As USDA prepares for the future by developing your Agriculture Innovation Agenda, we hope you will consider that the market will not only require a greater volume of food by 2050, but will also demand a greater variety of food choices, including alternative proteins. USDA should fund research that empowers American agricultural producers to meet this consumer demand and fill the protein aisles of the future with a diversity of sustainable and profitable products.

Public interest and demand for alternative proteins is growing, providing a significant opportunity to diversify and enhance the economic competitiveness of U.S. food production. However, none of the initial progress that we describe in this section obviates the need for additional research. The majority of crops currently produced are poorly suited for use as alternative protein ingredients, cultivated meat has not yet been brought to market anywhere in the world (nor have the vast majority of potential plant-based and fermentation-derived products), and almost all major technical advances to date are proprietary, primarily advantaging individual companies rather than the sector as a whole. Publicly funded, open-access research funded and performed by USDA would elevate the baseline from which these budding industries can build and provide broad benefits for U.S. agriculture and its consumers.

Over the past year, plant-based protein retail sales reached $5 billion in the U.S. and grew 11 percent, a growth rate almost five times higher than the retail food market as a whole.[23] Restaurants are capitalizing on this wave of consumer interest. Recent high-profile introductions of plant-based meat products on fast food menus in the United States include Burger King's Impossible Whopper (beef), Starbucks' Impossible Breakfast Sandwich (pork), Dunkin's Beyond Sausage Sandwich (pork), and KFC's Beyond Fried Chicken.[24] These outlets report improved sales growth and increased average check sizes as a result of these plant-based offerings, and they continue to roll out new plant-based products in global markets.[25]

Plant-based and cultivated meat also made headlines with record-setting private investment and retail product launches of new and established food companies. Beyond Meat went public with a historic IPO that Marketwatch called "the best-performing public offering by a major U.S. company in almost two decades."[26] Memphis Meats completed their Series B funding round this year, which more than doubled the total amount of prior investment in the cultivated meat industry.[27] Many conventional

---

[23] The Good Food Institute, *Plant-based Market Research Overview* (2020), https://www.gfi.org/marketresearch.

[24] *Burger King Restaurants Launches the Impossible Whopper Nationwide*, Business Wire (Aug. 1, 2019), https://bwnews.pr/3f8P39V; *New, delicious Impossible Breakfast Sandwich now available at Starbucks in the U.S.*, Starbucks (June 23, 2020), https://bit.ly/3hT7LnX; *Dunkin' and Beyond Meat Accelerate Nationwide Launch of Beyond Sausage Sandwich*, Dunkin' (Oct. 21, 2019), https://bit.ly/2Exs0cn; *KFC Brings Sneak Peek of Beyond Fried Chicken to Southern California*, Yum Brands (July 16, 2020), https://bit.ly/3jSVGRq.

[25] The Good Food Institute, *2019 State of the Industry Report: Plant-Based Meat, Eggs, and Dairy*, 49-50 (May 2020), https://bit.ly/3jU6vT2.

[26] Mike Murphy, *Beyond Meat soars 163% in biggest-popping U.S. IPO since 2000*, MarketWatch (May 5, 2019), https://on.mktw.net/30TDkaa.

[27] The Good Food Institute, *Memphis Meats' investment more than doubles global investment total, but significant public funding for industry still urgently needed* (Jan. 22, 2020), https://bit.ly/2BDNkf1.

meat companies are diversifying their portfolios to include alternative proteins, with Tyson (which recently rebranded as "a protein company") and Cargill Protein (formerly Cargill Meat Solutions) investing in cultivated meat companies[28] and Cargill, Conagra, Hormel, JBS, Perdue, Smithfield, and Tyson investing in plant-based and blended product lines in the last few years.[29] As part of their "restaurant of the future" initiative, KFC has partnered with a research laboratory to develop cultivated chicken nuggets with the same taste and appearance as their signature product and an improved environmental profile.[30] Approximately a dozen U.S. startups are currently working to develop cultivated meats and seafood, and several more startups are working on developing meat and other foods from new plant and microbial protein sources.[31] A number of other companies are developing ingredients such as milk and egg proteins through fermentation using fast-growing, highly efficient microorganisms.[32] This activity by new and established companies has resulted in an increased variety of sustainable food choices for consumers, and this welcome trend is expected to accelerate in the coming years.

II. American Agricultural Innovation Should Address Key Research Gaps to Accelerate the Growth of Alternative Proteins.

While interest and investment in alternative proteins to date is encouraging, there remains an enormous need for further research to ensure alternative protein products are able to deliver on their promise of offering consumers the taste and texture that they expect from conventional meat at a fraction of the current environmental cost. Funding and performing open-access research on alternative proteins that addresses key research gaps would yield wide-ranging benefits critical to producing 40 percent more agricultural output with 50 percent less environmental impact.

The National Academies of Sciences, Engineering, and Medicine have recognized alternative proteins as a "new and exciting" part of the bioeconomy with "high growth potential."[33] Their 2019 report, *Science Breakthroughs to Advance Food and Agricultural Research by 2030*, identifies key

---

[28] Chase Purdy, *The world's biggest meat companies are betting on cell-cultured meat*, Quartz (Jan. 30, 2018), https://bit.ly/3eiLhew; Rebekah Schouten, *Cargill invests in slaughter-free meat start-up*, Food Business Review (May 14, 2019), https://bit.ly/2Bne4Ac.

[29] *Cargill invests additional $75 million to propel PURIS pea protein production in the US to meet surging market demand*, Cargill (Aug. 28, 2019), https://bit.ly/39ELZRI; The Good Food Institute, *2019 State of the Industry Report: Plant-Based Meat, Eggs, and Dairy*, 7, 15, 30, 43 (May 2020), https://bit.ly/3jU6vT2.

[30] *Meat of the Future: KFC and 3D Bioprinting Solutions to Use a Bioprinter to Produce KFC Nuggets*, KFC (July 16, 2020), https://bit.ly/2BEvZCI.

[31] The Good Food Institute, *2019 State of the Industry Report: Cultivated Meat*, 6-10 (May 2020), https://bit.ly/39zXjyE.

[32] Katy Askew, *Feeding plant-based innovation: 'Fermentation is the future of the alternative protein industry'*, FoodNavigator (Apr. 30, 2020), https://bit.ly/339DQUd.

[33] Nat'l Acads. of Scis., Eng'g, & Med., *Safeguarding the Bioeconomy*, 59 (2020), https://bit.ly/2Bx2y5E; Nat'l Acads. of Scis., Eng'g, & Med., *Preparing for Future Products of Biotechnology*, 52-55 (2017), https://bit.ly/3fZSK2S.

innovation clusters with tremendous potential for transformative research on plant-based, cultivated, and fermentation-derived proteins.[34]

To accelerate the development of alternative proteins, fundamental research—including research within these innovation clusters—must be aggressively pursued and supported by USDA starting as soon as possible and continuing over the next 20 years. The results of this research should be made available in an open-access manner to avoid duplication of effort and kickstart commercial translation. As basic research fuels technological innovation and alternative protein markets continue to mature over the next 30 years, later-stage research and development areas will become increasingly important to include in USDA's research priorities. Commercialization of these technologies is exactly the kind of breakthrough innovation that will provide consumers an even greater variety of new products and allow USDA to meet its Agriculture Innovation Agenda goal of producing 40 percent more food using half the environmental resources by 2050.

A. USDA Should Prioritize Research to Advance Genome Design of Crops, Animal Cells, and Microbes Used in Fermentation.

Genome editing tools are integral to alternative protein development, and thus are critical to achieving the goals of the Agriculture Innovation Agenda. The application of genome editing tools to a broader range of plants, animals, and microorganisms in novel ways will unlock genetic mechanisms and controls that can be applied to creating diverse and delicious alternative proteins with greater efficiency.

Through the screening of novel crops and subsequent advanced crop breeding programs, genome design research can contribute to plant-based protein development. While plant-based proteins can be derived from a wide variety of crop inputs, the diversity of current plant protein sources is extremely limited. As such, plant-based protein producers typically rely on conventional agricultural commodities which have not been optimized for protein production. Novel crop screening combined with accelerated breeding, enabled by advanced genomic tools, would improve new inputs for plant-based products via genomic mining for desirable traits. This would increase the economic viability of a wider range of crops and empower American farmers to adapt to shifting market conditions.

Similar to plant-based proteins, fermentation-derived proteins are currently created by a limited number of microorganisms. Prospecting and mining the genetic information of novel microbes would facilitate the discovery of new proteins with unique sensory and functional properties. Additionally, novel host strains may be identified, providing new platforms for synthesizing a variety of ingredients such as flavorings, functional proteins, enzymes, animal-like fats, and binding agents. Increasing the diversity of host strains and target molecules will decrease costs while enhancing the quality of fermentation-derived alternative proteins as well as plant-based and cultivated proteins, which can be augmented with fermentation-derived ingredients. For example, fermentation can be used to cost-effectively produce growth factors, which are currently among the primary cost drivers for cultivated meat production, thus drastically reducing the cost of cultivated meat.

Genome design is also central to cell line development for cultivated meat products. Optimized cell lines are required for each species of interest (e.g., cow, pig, chicken, or salmon). Determining ideal

[34] Nat'l Acads. of Scis., Eng'g, & Med., *Science Breakthroughs to Advance Food and Agricultural Research by 2030* (2019), https://bit.ly/2XsAkRp.

cell types for different use cases and selecting or engineering for properties such as high-efficiency differentiation, enhanced proliferative capacity, and tolerance for high-density cultivation will be necessary to bring cultivated meat to market. Beyond technical hurdles, genome design will drive down the cost of cultivated meat and ensure that it becomes accessible to mainstream consumers.

B. USDA Should Prioritize Work that Advances Digitization and Automation to Improve Efficiencies in Alternative Protein R&D and Manufacturing.

Process digitization and automation will be crucial for accelerating the pace of research as well as scaling up production and driving down costs of alternative proteins. Leveraging advanced data-driven approaches such as adaptive control systems in manufacturing will also maximize the efficiencies of alternative proteins in areas such as energy consumption, water use, and input utilization. All types of alternative proteins will benefit from digitizing and automating their research and development pipeline and production methods.

Computational modeling can accelerate research and development efforts for both cultivated and fermentation-derived proteins by reducing the experimental burden for all aspects of the process. Potential areas of modeling range from strain optimization to feedstock formulation to bioprocess design. Modeling bioreactor designs, fluid dynamics of perfusion flow through scaffolds, culture media formulations, and cell signaling impacts on cellular behavior would save time and money while testing many more configurations than would be feasible through empirical approaches.

Monitoring crops during harvest and automating separation based on characteristics linked to their composition will benefit plant-based proteins by enhancing the quality of inputs. Research into measurable physical properties and how they translate to macronutrient composition will enable alternative protein manufacturers to purchase more efficient inputs. Developing rapid and automated chemical analyses measuring protein composition will further refine the determination of input quality. As it is likely that the microclimate and local nutrient availability will impact the protein quality and quantity of crops, field sensors should be developed to correct for naturally variable conditions and optimize crops as inputs for plant-based protein products.

As our understanding of the connection between molecular properties and sensory attributes of various alternative protein products grows, in-line sensors can be developed to monitor and fine-tune product quality in real time. Additional sensors for adulteration, spoilage, and other quality control parameters will prevent unnecessary human handling during production to decrease the risk of contamination. Process automation will be a critical component to scaling alternative proteins as they move from pilot scale to full production.

C. USDA Should Include Alternative Protein Supply Chains in Its Systems-Based Farm Management Efforts.

Thanks to their flexibility in production, alternative proteins are theoretically capable of utilizing a wide variety of inputs while simultaneously reducing waste streams. Many companies producing alternative proteins currently repurpose inputs primarily intended for other applications, such as using pharmaceutical-grade reagents for cultivated meat development or enriching crop sidestreams for plant-based protein production. While pragmatic, this leads to higher costs and suboptimal performance. As the alternative protein industry advances and specialized, designed-for-purpose inputs are developed, a systems-based approach will be vital to the full utilization of old and new side

streams. Applying a systems-based approach will enable people to make decisions about which displaced side streams (e.g., bone or leather) are necessary and to find alternative means of producing them in precisely the quantities required while simultaneously consuming side streams from other industries to the maximum amount possible by the alternative proteins industry.

Techno-economic modeling of alternative protein supply chains from field to plate will inform insights regarding the economic viability of various processing methods and break-even volumes. A systems-based model allows for dynamic evaluation of a variety of processing conditions and potential technical breakthroughs. This can, in turn, inform resource allocation toward research and development efforts with the greatest potential to positively impact sustainability and profitability.

Systems-based modeling can also be applied to life cycle assessments, nutritional studies, and process design to accelerate the achievement of the Agriculture Innovation Agenda's sustainability and production goals. Multiple factors can be incorporated and given different weighting in order to achieve desired goals while satisfying other considerations. For example, a minimum threshold can be placed on nutritional quality while maximizing sustainability and economic viability.

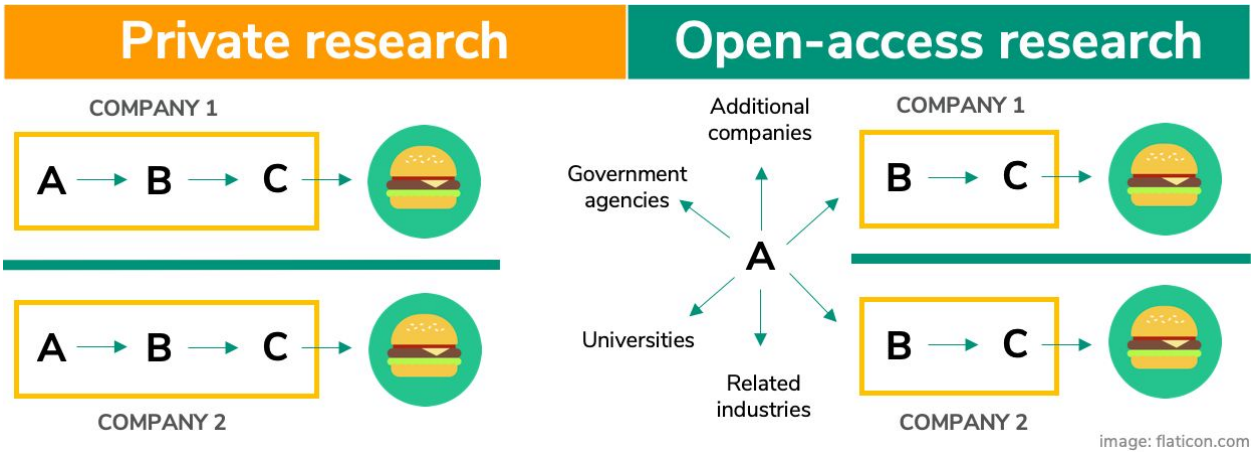
D. USDA Should Prioritize Open-Access Alternative Protein Research.

For research to be maximally impactful, insights gained related to genome design, digitization and automation, systems-based farm management, and other research areas need to be accessible by industry and applied throughout the alternative protein supply chain. New and existing programs should prioritize and coordinate open-access alternative protein research to facilitate the dissemination and effective use of scientific and technical breakthroughs. Otherwise, we risk falling behind global competitors who are already actively investing in their own alternative protein industries.

First and foremost, alternative proteins need additional open-access research. These fields of study are woefully underfunded by public programs, likely due to the common misconception that research is being adequately funded and performed by the private sector. There remains a massive need for increased public funding of research into alternative proteins in the near future if we are to realize the vision of the Agriculture Innovation Agenda.

While the results of private research can be licensed to other companies, the findings are often proprietary and primarily benefit only the company that conducted the research. These advancements may be lost altogether if the company is not successful. Further, companies performing private research often work in parallel on the same research areas, engaging in duplicative efforts to achieve the same result.

Open-access research is more efficient, allowing researchers to coordinate and explore non-parallel, complementary pursuits. In this way, public research will have a significantly broader impact, inspiring additional research and creating new opportunities to feed Americans and the world. Much of the work to be done—and all of the work described here—is of benefit to the industry as a whole and should therefore be made open-access.



Existing research programs, including programs within the National Institute of Food and Agriculture and the Agricultural Research Service, should formally recognize alternative proteins as within their programmatic scope and prioritize funding for alternative protein research. New research programs should be initiated with the expressed intent of funding work on alternative proteins as a means to achieve the goals of the Agriculture Innovation Agenda. Interagency initiatives should also be established to coordinate alternative protein research efforts to improve efficiency, minimize duplication of effort, and grow workforce talent. Such initiatives should include the Departments of Defense and Energy, as well as the National Science Foundation, the Food and Drug Administration, the National Aeronautics and Space Administration, the National Institutes of Health, the National Oceanic and Atmospheric Administration, and the National Institute of Standards and Technology, among others.

It should be noted that publicly funded, open-access research may produce spillover effects with unanticipated benefits not offered by private research. Research might yield unexpected results that have little value for an individual company but tremendous value for another area of science or industry. For example, the scale and price points needed for cultivated meat are driving innovation in growth factor production. These growth factors are components of cell culture media that are used in the biomedical industry as well. Developing cheaper methods to produce growth factors for cultivated meat could lead to price reductions and efficiency gains in the production of growth factors and other cell media components for biomedical labs and companies.

Governments around the world have recognized the value of investing in alternative protein research and development. Canada has invested over $90 million in plant protein manufacturing and allocated over $50 million to plant protein research and training over a four-year period from 2019-2023.[35] Similarly, the European Commission this year unveiled its *Farm to Fork* sustainable food strategy, a policy plan to "create more efficient, climate-smart systems that provide healthy food, while securing

[35] $90.8 million in government financing for a commercial-scale protein extraction plant to process peas and canola into food-grade protein, $51.4 million allocated via Protein Industries Canada for plant protein research, and $1.3 million granted to a university consortium to train plant protein scientists. *Winnipeg plant gets $100M in federal financing to pull protein from peas, canola*, Global News (June 22, 2020), https://bit.ly/3hH1vPS*; see* Protein Industries Canada website for project awards, https://bit.ly/3hEUa3a; Univ. of Saskatchewan, *USask-led group awarded $1.65 M to train young scientists for expanding plant protein industry* (July 11, 2019), https://bit.ly/339ibf3.

a decent living for EU farmers and fishermen."[36] The report specifically includes provisions calling for increased availability of alternative proteins, including plant-based meats,[37] and builds upon funding announced last year directing nearly $16 million toward plant protein and fermentation research.[38] The Netherlands spent $2.3 million on cultivated meat research from 2005 to 2009 and is currently spending $6.6 million on a five-year research project to improve plant-based meat manufacturing technology.[39] Singapore is investing $144 million into a variety of next-generation technologies intended to bolster its bioeconomy, including cultivated meat.[40] Germany, India, Israel, and Japan are also investing in alternative proteins.[41]

Equivalent investment by the United States in basic alternative protein research would return significant dividends in the form of improved agricultural output while simultaneously shrinking our food system's environmental footprint. To date, the United States has invested less than $1 million total in public funds in alternative protein research, representing less than a thousandth of one percent of the federal budget for research and development for a single year.[42] Though companies in the United States lead the world in alternative protein innovation—including Impossible Foods and Beyond Meat as the first next-generation plant-based meat companies, Memphis Meats as the first private cultivated meat company, and Nature's Fynd as a global pioneer in fermentation innovation—U.S. leadership in this sector cannot be taken for granted. Significant and sustained public investment in open-access research is required to maintain our country's competitive advantage in the development of alternative protein technologies and secure our position as a leader in agricultural sustainability.

---

[36] European Commission, *Sustainable food – 'farm to fork' strategy* (2020), https://bit.ly/2AlOGun (last visited July 30, 2020).

[37] European Commission, *Farm to Fork Strategy* 16 (2020), https://bit.ly/37bEyAb.

[38] $5 million for a large-scale biorefinery project to produce protein via fermentation and $10.5 million for the Smart Protein project, primarily funded by the European Union to develop protein-rich foods from plants and fungi. Katie Askew, *Affordable and scalable: 3F Bio's 'first-of-its-kind' mycoprotein biorefinery*, FoodNavigator (July 23, 2019), https://bit.ly/2V1ZpBI; Mary Allen, *This $10.5 Million Initiative is Dedicated to Developing Alternative Proteins*, The Good Food Institute (Oct. 3, 2019), https://bit.ly/34wuCA5.

[39] Elie Dolgin, *Sizzling interest in lab-grown meat belies lack of basic research*, Nature (Feb. 6, 2019), https://go.nature.com/2K3mmhs; Ariette Matser, *PPP Project Annual Report 2018*, Wageningen Univ. (2018), https://bit.ly/3hzYtxL.

[40] Yoolim Lee & Joyce Koh, *Singapore Backs Lab-Grown Meat, Robots in $535 Million Push*, Bloomberg (Mar. 27, 2019), https://bloom.bg/2XAHJ1F.

[41] *Plant-Based Proteins for Meat Lovers*, Karlsruhe Inst. of Tech. (Nov. 28, 2018), https://bit.ly/3hF3x3H; Ramya Ramamurthy, *Indian Government Grants Over $600,000 to Cell-based Meat Research*, The Good Food Institute (Apr. 26, 2019), https://bit.ly/2Le2Sdv; Niamh Michail, *Aleph Farms CEO on its 3D cultured beef: 'Unlike other companies, our meat grows together like real meat'*, FoodNavigator (May 2, 2018), https://bit.ly/2DXQkT5; Helen Marvell, *Japanese Government Part of $2.7 Million Investment in New Clean Meat Brand*, LiveKindly (June 5, 2018), https://bit.ly/2FJdr2r.

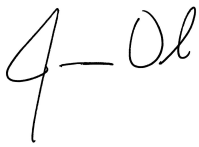
[42] This estimate is based on a review of U.S. state and federal funding over the last fifteen years directed toward open-access plant-based and cultivated meat research as of July 30, 2020.

III. Conclusion

Research that accelerates progress on alternative proteins will result in breakthrough innovations that will enable USDA to meet its Agriculture Innovation Agenda goal of 40 percent more agricultural output with 50 percent less environmental impact. USDA should prioritize the funding and performance of research to catalyze these technologies' growth and reap their many benefits.

Please contact us as you consider the opportunities identified in this submission. We would be happy to continue the discussion and welcome the opportunity to work with you to grow this sector of American agriculture.

Sincerely,



Mark Onley
Policy Associate
The Good Food Institute
marko@gfi.org

James Dale, Ph.D.
Research Funding Coordinator
The Good Food Institute
jamesd@gfi.org