FA8650-23-S-5020
Request for Information
Defense Production Act Investments Program

Interested Party:
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Charlotte Chumack
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Air Force Research Laboratory
Wright-Patterson Air Force Base

RE: FA8650-23-S-5020: Defense Production Act Investments (DPAI) Program Request for Information; Domestic Industrial Capability for Distributed Manufacturing Enabled by Modular Bioindustrial & Reusable Assets

Dear Ms. Sherer and Ms. Chumack,

On behalf of the Good Food Institute, we thank you for the opportunity to respond to this Request for Information (RFI) regarding investment in technologies of interest to United States national security. We are submitting our response to underscore the value of emerging technologies that enable alternative proteins, including plant-based, cultivated, and fermentation-derived foods. Investing in the production of alternative proteins under the Defense Production Act would help unlock a diverse array of national security, economic, and social benefits across the country.

The Good Food Institute (GFI) is a nonprofit think tank and open-access resource hub developing the roadmap for a sustainable, secure, and just protein supply. Alongside scientists, businesses, and policymakers, GFI advances alternative proteins as an essential solution needed to meet the world's climate, global health, security, and biodiversity goals. GFI is not an alternative protein company or trade association. We analyze the industry and work closely with companies across the entire supply chain and value chain to accelerate growth and innovation.

As you are aware, this RFI comes at a time of strong interest in and support for the bioeconomy from the Biden Administration. The Executive Order on Biotechnology and Biomanufacturing (E.O. 14081) coordinates a whole-of-government approach to advance biotechnology and biomanufacturing towards innovative solutions in health, climate change, agriculture, supply chain resilience, and national security. Section 3 of the Executive Order, "Harnessing Biotechnology and Biomanufacturing R&D to Further Societal Goals," highlights cultivating alternative food sources as an area of interest for food and agricultural innovation.[1] The administration's subsequent "Bold Goals for U.S. Biotechnology and Biomanufacturing" report, released in March 2023, sets ambitious goals for the bioeconomy, including developing new food sources, with an emphasis on alternative proteins as a key priority.[2]

[1] Executive Office of the President. (2022). *Executive Order 14081: Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy*.
[2] The White House Office of Science and Technology Policy. (2023). *Bold Goals For U.S. Biotechnology And Biomanufacturing.* The *Bold Goals* report highlights "engineering circular food protein production systems" as a goal (p. 9). R&D needs include conducting R&D on plants and microbial communities to produce new, less carbon-intensive feedstocks and scaling up biotechnology-based protein production (p. 10). The report also describes goals of developing new food sources, "including production of novel or enhanced protein and fat sources," enhancing food nutrient density, and reducing foodborne illness, all of which investment in alternative protein technology supports (p. 17). R&D needs include researching the structural design of alternative protein products and food components that increase the palatability and affordability of novel foods (p. 20).

This RFI advances many of the same objectives by seeking information regarding biomanufactured products that benefit military capabilities, supply chain resilience, and environmental sustainability. Repeated mentions in the RFI of "tailored proteins" and "food/cultivated meat" are significant causes for optimism—and suggest that the Department of Defense (DoD) recognizes the need to promote domestic alternative protein production. DoD's recent "Biomanufacturing Strategy" addresses severe limitations to date in biomanufacturing infrastructure and public investments in critical biotechnology.[3] Alternative proteins can address defense needs through improved national security and food supply chain resilience. With proper public investment, DoD could significantly advance alternative protein product development and commercialization, helping to usher in a new era of American agricultural leadership.

Below we share specific responses to many of the questions in DoD's RFI as they relate to alternative proteins technology. While the three technology platforms of alternative proteins—plant-based, cultivated, and fermentation-derived foods—have many similarities, we have provided specific information for each platform where relevant.

PRODUCTS:

1. What is your current or intended product for defense, and/or commercial applications?

The current product, alternative proteins, includes plant-based proteins, fermentation-derived proteins, and cultivated meat. Alternative proteins represent finished products for sale to consumers. Plant-based meat is produced directly from plants. Instead of relying on animals to convert plants into meat, producing plant-based meat is more efficient by directly turning plant ingredients into meat.[4] Fermentation is a powerful, flexible process for using microorganisms to produce alternative proteins. Precision fermentation can create final food products or ingredients for plant-based or cultivated products.[5] Cultivated meat is meat produced directly from cells. The process of cultivating meat uses the basic elements needed to build muscle and fat and enables the same biological process that happens inside an animal. Cultivated meat is identical to conventional meat at the cellular level.[6]

2. If known (or estimated), what is the current Technology Readiness Level of your product?

Plant-based: Plant-based proteins have attained a TRL9 for their use in plant-based meat, eggs, and dairy, with approximately one million metric tons of plant-based meat sold globally in 2022.

Fermentation: Fermentation technology for alternative protein production has attained a TRL9. There are long-term, full-scale facilities currently producing fermentation-derived alternative proteins.

Cultivated meat: Cultivated meat has attained a TRL6 and arguably a TRL7. As of June 1, 2023, cultivated meat is not available for sale in the United States; however, two companies have completed the final step in the pre-market regulatory review process and are expected to begin

[3] Office of the Under Secretary of Defense for Research and Engineering. (2023). *U.S. Department of Defense Biomanufacturing Strategy*. Department of Defense.
[4] The Good Food Institute. (n.d.). *Plant-Based Meat.* The Good Food Institute. https://gfi.org/plant-based.
[5] The Good Food Institute. (n.d.). *Fermentation.* The Good Food Institute. https://gfi.org/fermentation.
[6] The Good Food Institute. (n.d.). *Cultivated Meat*. The Good Food Institute. https://gfi.org/cultivated.

sales in summer 2023. Leading manufacturers in the industry are still at relatively small scales (~1,000L reactors) compared to their end targets (stated between 20,000 and 250,000L). Equipment, media, and processes are likely to change along the path to reaching TRL9.

3. What prices per unit volume for the material would you likely target once capacity is established? What is the magnitude of reduction required from your current state to achieve a competitive price?

The competitive market price range for alternative proteins is price parity with conventional meat. Infrastructure investment, including larger manufacturing facilities, will drive price parity, which is expected for plant-based and fermentation-derived proteins within one to five years.

Plant-based: Analysis of multiple data sources indicates that, in 2022, the overall price premium for plant-based meat was 67 percent and for plant-based eggs was 122 percent.[7] Relative to their animal-based counterparts, the price premium was 21 percent for plant-based beef, 129 percent for plant-based chicken, and 158 percent for plant-based pork.

Fermentation: Currently, mycoprotein finished products are more expensive than processed animal-derived meat. For example, Quorn ground mycoprotein meat is sold in 12-ounce packages for $5.79, with a unit cost of $7.72 per pound, a 55 percent price premium over the average cost of ground beef ($4.99 per pound).

Cultivated meat: The current production cost of cultivated meat is unknown, so the retail sale price of cultivated meat is also unknown. Various techno-economic assessments have been performed, but are based on assumptions subject to change.[8] Estimated production costs have significantly progressed. The first cultivated meat product cost $300,000 to create in 2013; two years later, researchers reduced the cost to $11. With increased research, development, and capacity investment, cultivated meat has a path to price parity within five to 10 years.

4. Please describe the intended markets (both DoD and Commercial) that your company would target if you had/have the capability to manufacture the material.

For DoD, alternative protein procurement can provide key benefits, perhaps most notably by fostering increased food system security and reliability of food supply. Given their simplified production process, reduced perishability, and other factors, alternative proteins can reduce the costs and risks of food transport in extended global supply chains. Unlike conventional animal meat production, alternative proteins could be manufactured locally at individual military bases abroad, as well as at micro-manufacturing facilities at sea or even in space.[9]

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[7] The Good Food Institute. (2023). *U.S. Retail Market Insights For the Plant-Based Industry*. The Good Food Institute. https://gfi.org/marketresearch/#closing-the-price-gap.

[8] For the best guidance on understanding predicted cost bottlenecks, *see* Vergeer, R., Sinke, P., & Odegard, I. (2021). *TEA of Cultivated Meat. Future Projections For Different Scenarios*. CE Delft. Retrieved June 14, 2023, from https://cedelft.eu/publications/tea-of-cultivated-meat; Humbird, D. (2021). *Scale-up Economics For Cultured Meat*. Biotechnology and Bioengineering, Volume 118, Issue 8. Retrieved June 14, 2023, from https://onlinelibrary.wiley.com/doi/full/10.1002/bit.27848; Swartz, E. (2022). *Cultivated Meat: Moving Down the Cost Curve*. The Good Food Institute. Retrieved June 14, 2023, from https://www.slideshare.net/ElliotSwartz/cultivated-meat-cost-curvepdf.

[9] National Aeronautics and Space Administration. (2023). *NASA Selects Winners, Announces Final Phase of Space Food Challenge.* NASA. https://www.nasa.gov/press-release/nasa-selects-winners-announces-final-phase-of-space-food-challenge.

Investment in alternative proteins can significantly increase the security of food supply for the nation's defense. Following the Covid-19 pandemic and the Russian invasion of Ukraine, the United States witnessed a global grain shortage and skyrocketing food prices. One-third of the global grain supply is used for animal feed. As the production of plant-based and cultivated meats uses significantly less grain, diversifying our protein supply will reduce our reliance on foreign-grown grain. The supply chains for alternative protein products have relatively fewer links that require less coordination and fewer perishable components, resulting in an overall system more resistant to shocks and disruptions.[10]

Widespread adoption of alternative proteins would also decrease the risks and associated threats of future global pandemics. The United Nations Environment Programme recently identified increasing demand for animal protein and unsustainable agricultural intensification as two of the most likely causes of the next global pandemic.[11] As highlighted by the Center for Strategic and International Studies (CSIS), disease emergence and transmission present significant vulnerabilities to animal agriculture supply chains. According to CSIS, "[d]e-risking global food systems—in combination with finding more sustainable methods of food production—is central to global health generally and pandemic prevention specifically," and alternative proteins provide a major de-risking tool.[12]

Expanding alternative protein production supports environmental goals and helps meet the diverse dietary preferences of a growing workforce. Through incorporation into Meals Ready to Eat (MRE) and conventional meals, alternative proteins can offer nutritional benefits and improved health outcomes for soldiers and other military personnel.[13] Alternative proteins present opportunities to improve warfighter performance—with studies demonstrating improved athletic performance associated with the consumption of plant-based meat relative to conventional meat.[14] Beyond defense applications, alternative proteins can help address food insecurity challenges, including among service members and their families. In 2020, nearly a quarter of active-duty service members experienced food insecurity, more than double the rate for the general public.[15] While currently at a relative price premium at the market level, once manufacturing scaling is achieved, alternative protein products are expected to provide greater affordability and a more diverse range of healthy protein options for families.

Commercially, alternative protein companies are targeting a national and global market, including customers regularly purchasing conventional animal-based products. The impact of

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[10] Purvis, N. & Friedrich, B. (2022). *Plant-Based Proteins Are Too Expensive*. Foreign Policy. https://foreignpolicy.com/2022/10/08/alternative-protein-meat-agriculture-food-security-plant-based-environment.

[11] United Nations Environment Programme. (2020). *Preventing the Next Pandemic: Zoonotic Diseases and How to Break the Chain of Transmission.* https://www.unep.org/resources/report/preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and.

[12] Swanson, Z., Welsh, C., & Majkut, J. (2023). *Mitigating Risk and Capturing Opportunity: The Future of Alternative Proteins.* Center for Strategic and International Studies. Retrieved June 14, 2023, from https://csis-website-prod.s3.amazonaws.com/s3fs-public/2023-05/230511_Swanson_Alternative_Proteins.pdf?VersionId=Za76gtRSXe0eahjwFvr5hw54uHzCXuT5.

[13] The Good Food Institute. (2022). *Plant-Based Meat Is More Nutritious.* The Good Food Institute. https://gfi.org/resource/plant-based-meat-nutrition-facts.

[14] Guest, N. & Lynch, H. (2021). *Plant-Based Diets and Athletic Performance*. Sports Nutrition & The Modern Athlete. Retrieved June 14, 2023, from https://www.aspetar.com/journal/upload/PDF/202151116040.pdf.

[15] Office of the Under Secretary for Personnel & Readiness U.S. Department of Defense. (2022). *Strengthening Food Security in the Force: Strategy and Roadmap*.

government investment would thus expand beyond defense applications to allow Americans to fully access alternative proteins and the associated health, economic, social, and other benefits.

5. Highlight any known or presumed market acceptance challenges for your item, such as meeting existing product specifications, extended testing/certification requirements, and/or establishing new specifications.

Multiple studies show that taste and price are essential drivers of alternative protein demand. Current price premiums and a lack of taste parity with animal products hinder alternative protein brands' abilities to attract new consumers to the space. Today, consumer adoption is a central bottleneck to the plant-based industry, and reaching price parity with conventional meat remains a significant barrier to mass adoption. Research shows that cost is a major factor identified by almost a third of consumers who stop purchasing plant-based meat or dairy.[16] Cultivated meat is expected to help close the taste gap for alternative protein products, but price parity is critical—few consumers are willing to pay more for cultivated meat.[17] In addition, the regulation of some alternative protein product categories is relatively new, and regulatory hurdles can slow industry growth. Domestic plant-based and cultivated meat companies, for example, have faced labeling censorship that puts them at a disadvantage in the marketplace.[18]

While taste and price represent obstacles to market acceptance, additional investment in research efforts will enable alternative proteins to become comparable to animal products on both fronts. Blue sky research, commercial-scale research, and demonstration projects can lead to additional breakthroughs. One of the biggest opportunities for price reduction is production scale-up. With sufficient investment and successful commercialization, alternative protein companies will benefit from economies of scale, lower product costs, and increased market share.

PROCESSES:

1. Describe your current in-house production process capabilities and capacity. Where is it located? What increased capability/capacity is needed?

Current Capacity:
Plant-based: Based on 2022 retail sales data, industry interviews, and a survey of existing facilities, GFI estimates that the global plant-based meat production capacity was roughly 2.2 million metric tons in 2022, with approximately 748,000 metric tons in North America (34 percent). Although current capacity is well-utilized, even moderate market growth may outstrip the industry's ability to serve demand within the next few years.[19]

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[16] Panescu, P., et al. (2023). *2022 State of the Industry Report: Plant-Based Meat, Seafood, Eggs, and Dairy*. The Good Food Institute. Retrieved June 14, 2023, from https://gfi.org/wp-content/uploads/2023/01/2022-Plant-Based-State-of-the-Industry-Report-1-1.pdf.
[17] Bomkamp, C., et al. (2023). *2022 State of the Industry Report: Cultivated Meat and Seafood*. The Good Food Institute. Retrieved June 14, 2023, from https://gfi.org/wp-content/uploads/2023/01/2022-Cultivated-Meat-State-of-the-Industry-Report-1-1.pdf.
[18] The Good Food Institute. (2022). *An Overview of Food Label Censorship.* The Good Food Institute. https://gfi.org/resource/an-overview-of-food-label-censorship.
[19] Bess, A., et al. (2023). *Plant-Based Meat Manufacturing Capacity and Pathways For Expansion*. The Good Food Institute. Retrieved June 14, 2023, from https://gfi.org/wp-content/uploads/2023/01/Plant-based-meat-manufacturing-capacity-and-pathways-for-expansion.pdf.

Fermentation: According to GFI research, as of June 2023, fermentation-derived protein manufacturing capacity in North America is 5.4 million liters from 31 commercial facilities, including private and contract manufacturing organizations. North America represents 34 percent of global fermentation-derived protein product manufacturing capacity, the majority of which is based in the United States, which is home to 30 out of the 31 total facilities in North America.

Cultivated meat: As noted above, cultivated meat is not currently for sale in the United States. Leading manufacturers in the industry are still at relatively small scales (~1000L reactors) compared to their end targets (stated between 20,000 and 250,000L).

Location:

Alternative protein production, untethered from many environmental considerations, offers more flexible facility locations relative to conventional meat. Production centers can be located in either urban or rural regions, while both rural and urban producers can grow inputs for alternative protein products. Currently, alternative protein production facilities in the United States range from Wilson, North Carolina (Believer Meats) to Richmond, Indiana (Liberation Labs) to Emeryville, California (UPSIDE Foods).[20] According to industry surveys, the top factors driving facility location are access to industrial utilities and buildings, a reliable supply chain, skilled and experienced labor, feedstocks, and the support of the local and state governments. CEO of Liberation Labs Mark Warner explained the decision to locate the company's commercial-scale precision fermentation plant in Indiana as follows: "The three things a biomanufacturing facility like ours needs are sugar, power and people, and Richmond, Indiana, has them all."[21]

Alternative protein facilities can create economic opportunities for rural communities throughout the United States. For plant-based and precision fermentation meat manufacturing, companies are likely to site facilities in the Midwest in close proximity to feedstock crops—improving supply chain resilience while fostering economic opportunity. For instance, Illinois, Iowa, and Minnesota are the top producers of domestic soybeans.[22] For cultivated meat, production facilities present significant geographical flexibility. Thus, expanding alternative protein production would allow the Biden administration to achieve key priorities of ensuring economic opportunities in all parts of the nation, while also increasing the resilience of the nation's supply chains by building on regional diversity.[23]

Increased Capabilities/Capacity Required:

Plant-based: Even moderate market growth may outpace the plant-based industry's ability to serve demand over the next several years. To meet future market demand, avenues for growing capacity include expanding existing facilities, building new manufacturing facilities, and

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[20] Believer Meats. (n.d.). *Bite Into the World's Best Meat*. Believer. https://www.believermeats.com; Liberation Labs. (n.d.). *Industrial Biotech's Fabrication Partner.* Liberation Labs. https://liberationlabs.com; UPSIDE Foods. (n.d.). *Meet the New Meat.* UPSIDE Foods. https://www.upsidefoods.com.

[21] Piatt, Z. (2023). *Biomanufacturing Company Building Facility in Richmond's Midwest Industrial Park*. Pal Item. https://www.pal-item.com/story/news/local/2023/01/27/liberation-labs-building-biomanufacturing-facility-in-richmond/69845845007/.

[22] Statista. (2023). *Major Soybean Producing U.S. States From 2018 to 2022*. Statista. https://www.statista.com/statistics/192076/top-10-soybean-producing-us-states.

[23] The White House. (2021). *Building Resilient Supply Chains, Revitalizing American Manufacturing, And Fostering Broad-Based Growth: 100-Day Reviews under Executive Order 14017.* The White House. Retrieved June 14, 2023, from https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf.

retrofitting facilities from suitable industries.[24] According to our research, to satisfy an anticipated minimum of 25 million metric tons in annual global market demand for plant-based meat by 2030, at least 810 factories with an average annual production of 30,000 MT each must be in operation. Greenfield construction and operation of these facilities will cost roughly $27 billion in global capital expenditures and at least $17 billion in annual operating costs.[25]

Fermentation: Fermentation capacity is insufficient at all scales. The United States lacks facilities suitable for food, rather than biopharma, based on input from stakeholders and ongoing studies. Manufacturing capacity is one of the most significant bottlenecks in the fermentation industry, particularly for precision fermentation. Increasing scale, decreasing feedstock cost, and improving strain productivity and downstream yield would all optimize cost efficiency.[26]

Cultivated meat: As of late 2022, several leading cultivated meat companies are transitioning to pilot-scale facilities that will manufacture the first wave of commercialized products. As noted above, two companies have completed the final step in the pre-market regulatory review process and are expected to begin sales in summer 2023. For cultivated meat, further scaling will require commercial production in significantly larger facilities than what currently exists, as well as solving an array of complex challenges that will influence the cost of production.[27] Specific infrastructure gaps include fermentation facilities for making growth factors and recombinant proteins, facilities for mixing media components, and bioreactor capacity for the animal cell culture itself. A recent McKinsey analysis estimates that producing 1.5 million tons of cultivated meat—just half of one percent of the global 2030 meat supply—would require between 220 to 440 million liters of fermentation capacity, approximately 22 times the current global pharmaceutical industry's capacity.[28]

3. If known (or estimated), what is the current Manufacturing Readiness Level of the manufacturing process for your product?

Plant-based: Plant-based proteins have attained a BioMRL8 to BioMRL10, depending on the protein and texturization technology applied. For soy, pea, and wheat gluten proteins that are low-moisture extruded to form restructured meat products, a BioMRL10 level is appropriate. High-moisture extrusion is a BioMRL9. Even with these technologies, ingredient supply and infrastructure/equipment bottlenecks may persist in reaching the throughput and scale necessary to feed a significant portion of the population. For example, if six percent of the meat market in 2030 is plant-based meat, the plant-based industry would need three times the forecasted volume of soy concentrate and more than 800 facilities with roughly 2,000 extrusion lines.

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[24] Gertner, D. (2023). *Plant-Based Meat Manufacturing Capacity and Pathways for Expansion.* The Good Food Institute. Retrieved June 14, 2023, from https://gfi.org/wp-content/uploads/2023/01/SCI23006_PB-manufacturing-capacity-action-paper_Industry_FINAL.docx.pdf.

[25] Troya, M., et al. (2021). *Plant-Based Meat: Anticipating 2030 Production Requirements*. The Good Food Institute. Retrieved June 14, 2023, from https://gfi.org/wp-content/uploads/2021/11/Plant-based-meat_-anticipating-2030-production-requirements.pdf.

[26] Carter, M. et al. (2023). *2022 State of the Industry Report: Fermentation: Meat, Seafood, Eggs, and Dairy*. The Good Food Institute. Retrieved June 14, 2023, from https://gfi.org/wp-content/uploads/2023/01/2022-Fermentation-State-of-the-Industry-Report-2.pdf.

[27] The Good Food Institute. (n.d.). *The Science of Cultivated Meat.* The Good Food Institute. https://gfi.org/science/the-science-of-cultivated-meat.

[28] Brennan, T., et al. (2021). *Cultivated Meat: Out of the Lab, Into the Frying Pan.* McKinsey & Company. Retrieved June 14, 2023, from https://shorturl.at/fpU13.

Novel texturization technologies, such as wet spinning and 3D printing, have achieved BioMRL6 to BioMRL8 but could significantly improve the texture of plant-based products if their scale and cost are improved. Similarly, the processing of proteins from novel sources such as duckweed, seaweed, canola, sunflower, and potato has achieved BioMRL6 to BioMRL9 but could improve the functionality and taste of plant-based foods if scaled affordably.[29]

Fermentation: Precision fermentation for alternative protein production has achieved a BioMRL9 for some ingredient products, most notably Leghemoglobin H, the heme-binding protein in Impossible Burgers. Other precision fermentation products have attained a BioMRL8. In biomass fermentation for alternative protein production, mycoprotein has achieved a BioMRL10. It is mass-produced at scale and has been consistently operational since 1987 with continuous process optimization and improvement. Other biomass production approaches and organisms have achieved a BioMRL9, with a variety of low-rate production products.

Cultivated meat: While it is unclear exactly what stage leading cultivated meat manufacturers are at, GFI estimates that cultivated meat has attained a BioMRL5 and arguably a BioMRL6.

4. Are your products suitable to flexible (modular) manufacturing, such that more than one item can be produced from shared or substantially shared equipment in a single facility?

Plant-based: Yes, manufacturers in pet food, pasta, breakfast cereal, dry snacks, and other suitable industries can act as contract manufacturers for the plant-based meat industry. Manufacturers can look to diversify if the incumbent industries are flat or growing slowly in regions that also feature strong plant-based meat markets. Diversifying production lines would allow manufacturers to respond quickly to changing market conditions.[30]

Fermentation: Yes, fermentation can make use of generalized bioreactors for microbial growth and production. Following growth and production, fermentation-derived proteins and other ingredients are separated and purified using downstream processing equipment (centrifuges, filtration systems, spray dryers) used across many fermentation and food-processing industries.

Cultivated meat: Yes, a single facility can produce multiple product forms (e.g., nuggets, burgers, sausages) from multiple species (e.g., chicken, cows, pigs). Likewise, manufacturing seafood products is not expected to significantly differ from manufacturing avian or mammalian products. These processes can also create products like flavorings or broths.[31]

5. Does your process generate any side-stream material? If yes, please describe the material, and address if it is waste, potentially reclaimed, or of secondary value?

Plant-based: Protein-rich sidestreams generated from alternative dairy milk processing, such as okara, could be extracted and used in manufacturing other plant-based food products. These sidestreams could also be converted into amino acids, which are components of the growth media used in fermentation and cultivated meat production.

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[29] The Good Food Institute. *Plant Protein Primer*. (2021). The Good Food Institute. https://gfi.org/resource/plant-protein-primer.
[30] *See* Footnote 24.
[31] Ferrer, B. (2020). *Cell-Based Shrimp: Shiok Meats Lands US$12.6M For Commercial Pilot Plant Launch*. FoodIngredientsFirst. https://shorturl.at/aFQX0; PetFoodIndustry. (2022). *Wild Earth Develops Broth*. PetFoodIndustry. https://shorturl.at/vBCLZ.

Sidestreams from plant protein concentrate and isolate ingredient processing should be explored as a method to reduce the cost of plant protein products. Pulse proteins are increasingly popular alternative meat ingredients. Pulse Canada has identified the development of high-value applications for pulse starches as a priority for the pulse industry.[32] Specifically, Pulse Canada has demonstrated that pulse starches could be utilized in alternative protein products and other food and beverages as a thickener, gelling agent, and stabilizer, and they could also be used in industrial products like bioplastics, pharmaceuticals, and paper. Additionally, pulse starch enzymatic, chemical, and physical modifications can further improve their functionality for different end-use applications.[33] Other non-pulse plant proteins with crop sources that also have good oil, starch, or fiber contents, such as oat and duckweed, would also benefit from improved byproduct utilization. Soy protein is a sidestream of the soy oil industry and is typically used for animal feed.

Fermentation: Microbial biomass could be valorized for its high nitrogen and carbon content. These could be used as feedstocks for other fermentations, fertilizers, or potentially food ingredients.

Cultivated meat: Cultivated meat is expected to produce high amounts of the metabolic byproduct lactate (~3,200 tons per 10,000 tons of cultivated meat) that could be valorized for use in food or bioplastics production.[34] Further studies are needed to determine this feasibility, however. Cultivated meat is expected to produce lower amounts of the metabolic byproduct ammonia (~16 tons per 10,000 tons of cultivated meat) that could be valorized for use in fertilizers. However, ammonia is toxic to cells and there will be a large incentive to reduce ammonia production in cell culture.[35] It is unclear if this would be a meaningful sidestream, as feasibility of recovery would also need to be assessed. Other potential byproducts include growth factors or conditioned media for use in veterinary regenerative medicine or as a B2B product.

8. What is/would be the origin of feedstocks, critical equipment, and key constituents for your manufacturing capacity and product at increased scale?

Alternative protein feedstocks include plant ingredients such as peas and soybeans for plant-based meats or amino acids and growth factors for cultivated meats. While some internationally sourced inputs may be required, domestic inputs can be prioritized for supply chain needs. Due to the simplification and localization of production processes, a shift to alternative proteins nevertheless reduces supply chain vulnerabilities.

9. Please describe ideal geographic location of CMO, LRIP, and/or full-scale production of your product, and what advantage is gained by your preferred location.

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[32] Pulse Canada. (n.d.). *Pulse Starches*. Pulse Canada. https://pulsecanada.com/processing/pulse-starch.
[33] Pulse Canada. (n.d.). *Improving Starch Functionality Through Modifications*. Pulse Canada. https://pulsecanada.com/improving-starch-functionality-through-modifications.
[34] Sinke, P., et al. (2023). *Ex-Ante Life Cycle Assessment Of Commercial-Scale Cultivated Meat Production In 2030.* The International Journal of Life Cycle Assessment. Retrieved June 14, 2023, from https://link.springer.com/article/10.1007/s11367-022-02128-8.
[35] *Id.*

Alternative protein production offers greater flexibility for facility location relative to conventional meat. As discussed in previous sections, alternative protein facilities can be located in a wide range of locations, including urban or rural and coastal or non-coastal regions.

As CSIS emphasized, the overall resilience of the domestic food system can improve with increased regional diversity of protein production, enabled by the adaptability of alternative protein supply chains.[36] Given a sufficient workforce, companies can locate plant-based meat manufacturing facilities near crop feedstocks to achieve supply chain proximity, while cultivated meat facilities are feasible in any place with available electricity and supplies. Combining regional diversity with alternative proteins' simplified production processes, including significantly fewer grain and other required inputs and supply chains with relatively fewer links, alternative protein production is more resistant to disruptions than conventional meat.

The DoD's "Biomanufacturing Strategy" correctly identifies the need to support emerging industries like alternative proteins: "The biomanufacturing revolution is happening now, and the United States will continue to lead the way in biotechnology, as it did in semiconductors. However, the Nation must act swiftly and deliberately to maintain its competitive advantage." The United States is currently at the forefront of the alternative protein industry thanks in large part to the investment of the private sector, but several countries—in particular, China, Israel, and Singapore—are ramping up their own investments in alternative protein technology.[37] The United States government must defend its leadership through deliberate public investment in research, workforce development, and manufacturing infrastructure.

Conclusion

We urge you to identify alternative proteins as high-value and high-priority biomanufactured products under the Defense Production Act. As previously stated, GFI is a nonprofit think tank working to improve the global food system. We work closely with alternative protein companies and are glad to serve as a resource in answering further questions, including connecting with alternative protein stakeholders best equipped to provide relevant information.

Sincerely,

Curt Chaffin J.D., Director of Policy
Margaret Badding, Policy Associate
The Good Food Institute

cc: Dr. Georgia Lagoudas, Senior Advisor for Biotechnology and Bioeconomy

[36] *See* Footnote 12.
[37] For more information about global investments, *see*, Good Food Institute. 2021 State of Global Policy Report (2022). https://gfi.org/wp-content/uploads/2022/10/POL22005_State-of-Global-Policy-Report.pdf.