THE GOOD FOOD INSTITUTE

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RE: Docket No. NIFA-2020-0001 Solicitation of Stakeholder Input for Urban, Indoor, and Other Emerging Agricultural Production Research, Education, and Extension Initiative

I. Introduction

The Good Food Institute (GFI), a 501(c)(3) nonprofit organization, appreciates the opportunity to submit these comments regarding the National Institute of Food and Agriculture's Urban, Indoor, and Other Emerging Agricultural Production Research, Education and Extension Initiative. GFI encourages innovation in alternative proteins to help feed the world's growing population and meet increasing consumer demand.

GFI's team of scientists, entrepreneurs, lawyers, and policy experts request that NIFA support research into alternative proteins as important emerging agricultural production systems by explicitly soliciting proposals that will advance the science on plant-based, cultivated, and fermented proteins. Like vertical farming, the production of alternative proteins can occur in urban, indoor settings with limited resources. Equally importantly, making meat, egg, and dairy products from plant proteins, directly from cells in cultivators, or via fermentation will ensure that urban and indoor agriculture is able to fill a dinner plate, not just a salad bowl.

A. Research into Alternative Proteins Would Bring Down Costs and Increase Choices for American Consumers.

Alternative proteins fit into three categories: plant-based proteins, cultivated meat and dairy, and fermentation-derived proteins. Each of these categories utilizes emerging agricultural production methods and, in combination with urban and indoor agriculture, can form a closed-loop local food system to meet the nutritional needs of the American people.

A food system based on alternative proteins has the potential to grow the U.S. economy, sustainably feed 9.7 billion people globally by 2050, and address global public health issues such as antibiotic resistance and zoonotic diseases. Provided that adequate research is supported and

disseminated, alternative proteins, as described below, could provide Americans the meat, eggs, and dairy they demand with greater safety and security.

Plant-based meat, eggs, and dairy are made from plant proteins — like the Beyond Burger, Good Catch tuna, JUST Egg, and Kite Hill yogurt. Though plant-based alternatives have existed for hundreds of years in simple forms such as soy milk and seitan (wheat gluten), recent advances in science and technology have enabled enterprising companies to determine the structure and composition of different types of animal products – amino acids, fats, minerals – and replicate the product from components of plants. Despite these recent advancements, plant-based meat, eggs, and dairy are not yet cost-competitive with their animal-based counterparts. Until there are a wide variety of plant-based meat, egg, and dairy products that cost the same or less and taste the same or better than their animal-based counterparts, there will be tremendous opportunity for open-access science. Specific examples of research needs for plant-based products include figuring out crop optimization for various plant-based meats, how to isolate proteins and other ingredients for these applications, and how to manufacture the products to create the texture and experience of meat. These processes will continue to have significant room for improvement in order to bring costs down and make production more efficient.

Cultivated meat and dairy are produced by growing cells from animals. Cultivated meat and dairy are not available for sale anywhere in the world, but some companies expect to launch in restaurants within the next few years. Production begins with a small sample of cells from an animal. The cells from this sample are put in a closed, sterile vessel called a cultivator and fed a nutrient-rich cell culture medium. During cultivation, the cells multiply and differentiate, becoming muscle, fat, and other components of meat or mammary gland cells. The resulting product is the same as traditional meat and dairy, down to the cellular and DNA level: it looks, tastes, and cooks just like traditional meat or dairy. Although recent years have brought tremendous advancements in basic scientific cultivation research, this area is still in its infancy. Every critical technological element, such as cell lines and culturing media, is in need of vast additional research to optimize, scale, address bottlenecks, and reduce costs.

Fermentation traditionally refers to using microbes — usually fungi or bacteria — to produce a foodstuff. This technique is used to make new flavors (as in cheeses), bioconvert one substance to another (such as sugars to alcohol), or provide nutritional benefits like probiotic cultures or increased bioavailability of nutrients (as in sauerkraut and kombucha). In industrial biotechnology, fermentation has come to mean simply the cultivation of microbial organisms. Fermentation can either produce more of the microbial organisms, like the starter cultures for any of the food fermentation applications mentioned above, or use that organism to produce another substance, such as enzymes whose use is ubiquitous in food applications. Companies are

now using fermentation to create high-quality ingredients and flavors, as well as applying gene editing and engineering techniques to use easily-cultivated microbes (often yeast) to produce desirable food components, including animal and plant proteins, fats, and other molecules. Provided additional research, fermentation has the potential to expand beyond traditional uses and can be used to fill gaps in manufacturing alternative proteins by producing food components or to produce entirely new products from whole cloth, such as Perfect Day's dairy or the forthcoming food products from Nature's Fynd.[1] At this time, optimizing host strains and developing cost-effective and sustainable feedstocks for fermentation-derived proteins are the most pressing research needs.

B. Indoor, Urban, and Emerging Agricultural Production Should Embrace Center-of-the-Plate Proteins.

Alternative proteins are a type of emerging agricultural production that can help feed the world's growing population and meet increasing consumer demand for protein. Although the plant-based protein market has experienced rapid growth recently, the whole alternative protein market is still very small compared to traditional animal agriculture. Further research and development is required in order for alternative proteins to be widely available and affordable to meet the broad protein demands of the American people.

In addition to creating emerging agricultural products, alternative protein companies are also indoor agricultural enterprises that are well-suited for production in urban areas. All alternative protein production occurs indoors and requires significantly less space and fewer resources than traditional meat production.

The benefits of alternative protein production mirror those of other types of urban and indoor agriculture, like vertical farming. As Sarah Federman, AAAS Science and Technology Policy Fellow, wrote in a 2018 USDA blog post about vertical farming:

> *Beyond providing fresh local produce, vertical agriculture could help increase food production and expand agricultural operations as the world's population is projected to exceed 9 billion by 2050. And by that same year, two out of every three people are expected to live in urban areas. Producing fresh greens and vegetables close to these growing urban populations could help meet growing global food demands in an environmentally responsible and sustainable way by reducing distribution chains to offer*

[1] Yu, D. (2020, March 24). Nature's Fynd produces microbes-based protein for food and beverage in new Chicago facility after raising $80 million. *Forbes.* https://rb.gy/rhoyba

lower emissions, providing higher-nutrient produce, and drastically reducing water usage and runoff.[2]

The benefits described by Dr. Federman — increased food production to feed a growing population using environmentally sustainable methods — are identical to those of alternative protein. Additionally, while the majority of urban and indoor agriculture is focused on producing fresh fruits and vegetables, alternative proteins can create a diversified urban and indoor food system that provides high-quality meat, eggs, and dairy to urban consumers.

Even after accounting for the processing required to turn plants into plant-based meat, studies indicate that replacing traditional meat with plant-based meat substantially reduces environmental impact, including water and land use.[3,4,5] Similarly, cultivated meat eliminates many of the externalities of traditional meat production. Cultivated meat production does not create the animal waste that currently contributes to extensive soil and water pollution around the world. In addition, it also avoids the specific challenges of raising animals in urban areas like excessive noise, odors, and restrictive municipal ordinances for urban livestock.

Cultivated meat production will also be inherently more efficient. The majority of the nutrients that animals consume are used for life processes other than the growth of muscle tissue. Since cells in culture can use most of their nutrients for the creation of more cells,[6] cultivated meat production will require far fewer natural resources than traditional meat, reducing water usage, deforestation, and biodiversity loss. Fermentation allows for similar gains in efficiency. However, additional research is required in order to bring alternative proteins to scale and make these benefits a reality.

Many of the companies developing or producing alternative proteins are based in the startup capital of the country, Silicon Valley, though others are based in New York City or Boston. As the alternative protein sector grows and matures, alternative protein infrastructure could entail greater geographical dispersion. Instead of a limited number of large production facilities across the United States, alternative protein production lends itself to smaller, more widely distributed production facilities throughout both urban and rural America. This distributed infrastructure

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[2] Federman, S. (2018, August 14). Vertical farming for the future. *U.S. Department of Agriculture.* https://www.usda.gov/media/blog/2018/08/14/vertical-farming-future

[3] Khan, S., Loyola, C., Dettling, J., Hester, J., & Moses, R. (2019). *Comparative environmental LCA of the Impossible Burger with conventional ground beef burger.* Quantis USA and Impossible Foods. https://impossiblefoods.com/mission/lca-update-2019/

[4] Heller, M. & Keoleian, G. (2018). *Beyond Meat's Beyond Burger life cycle assessment: A detailed comparison between a plant-based and an animal-based protein source*. University of Michigan Center for Sustainable Systems. https://rb.gy/qbpx1d

[5] Dettling, J., Tu, Q., Faist, M., DelDuce, A., & Mandelbaum, S. (2016). *A comparative life cycle assessment of plant-based foods and meat foods*. Quantis USA and MorningStar Farms. https://rb.gy/yrjw95

[6] Specht, L. (2018). Is the future of meat animal-free? *Food Tech, 72(1)*, 17–18. https://rb.gy/vxfcff

would create jobs and an overlapping network of protein production to protect against supply chain issues such as drought, floods, or other losses. All these changes would result in greater food security for Americans as the population expands and environmental conditions continue to change. But an optimized national system requires public research to address technological challenges.

The United States is currently home to many of the world's leading alternative protein companies. However, there are no federal research programs dedicated to alternative proteins. In contrast, other governments worldwide are beginning to recognize the economic, environmental, and public health benefits of alternative proteins. Many of these governments are now investing in research to advance alternative protein production in their countries:

- Singapore – the city-state with a population and gross domestic product of less than 2% of that of the United States – is investing $535 million in research to position its economy at the cusp of the high technology economy, including research on alternative proteins.[7]
- In an effort to secure Canadian leadership in the plant protein sphere, Canada is investing more than $50 million in the Protein Industries Canada initiative. With this funding, Canadian scientists are researching optimization for plant-based meat ingredients like pea protein and other lesser-known crops.[8]
- The European Union has approved a four-year research plan, Smart Protein, investing $9.1 million in an effort to future-proof their food system by developing plant and microbial protein products.[9]
- India has given grants to multiple research centers for cultivated meat research totaling about $640,000. The Centre for Cellular and Molecular Biology (CCMB) and the National Research Centre on Meat (NRCMeat) are using this public funding to research optimal methods to cultivate stem cells from tissue samples of mutton.[10]

If we want American agricultural products to remain competitive both domestically and abroad, the United States must invest in research on these emerging agricultural production technologies. Globally, the alternative protein sector is expected to develop at a rapid pace over the next decade. With its history of scientific leadership, the United States is uniquely positioned to lead this shift. In line with the White House's fiscal year 2021 research and development budget

[7] Lee, Y. & Koh, J. (2019, March 27). Singapore backs lab-grown meat, robots in $535 million push. *Bloomberg.* https://bloom.bg/2FI4PKu
[8] Protein Industries Canada. (2019, April). *Program Guide*. https://bit.ly/2P92vRL
[9] CORDIS (2019, November 25). *Smart Protein for a Changing World*. https://bit.ly/342y5Fh
[10] Ramamurthy, R. (2019, April 26). Indian government grants over $600,000 to cell-based meat research. *The Good Food Institute.* https://bit.ly/2Le2Sdv

priorities[11] as well as the mission of the USDA, NIFA should advance the alternative protein industry by explicitly prioritizing and increasing research in these fields.

II. Recommended Priorities for NIFA's Urban, Indoor, and Other Emerging Agricultural Production Research, Education, and Extension Initiative

To facilitate the development of emerging agricultural production in the United States, The Good Food Institute requests that NIFA include alternative proteins in the fiscal year 2020 Request for Applications for the Urban, Indoor, and Other Emerging Agricultural Production Research, Education, and Extension Initiative. We have provided responses to both questions included in this request for stakeholder input.

A. Alternative Proteins Present Urgent Research, Education, and Extension Needs

USDA asked stakeholders to share which part of the production and supply chain has the greatest and most urgent research, education, and extension (REE) need in developing urban and indoor agriculture. The Good Food Institutes thinks that agricultural production of alternative proteins has the greatest and most urgent REE needs. Despite the successes of new plant-based meat companies, plant-based meat currently makes up about 1 percent of the U.S. meat market, and even less than that globally.[12] Cultivated meat has not yet progressed to even limited commercial products. Fermentation, while widely used in niche applications, is nowhere near fulfilling its potential as a means of producing alternative proteins. Significant growth of the alternative protein sector is only possible with additional research to develop relevant technologies.

In order for these emerging technologies to meet their full potential, both basic and applied scientific research is needed. Below is an outline of the most crucial research needs for alternative proteins.

Highest Priority Research Areas:

- Characterize the protein content and qualities of a wide variety of underutilized plants and optimize those with the best potential for use as alternative protein ingredients.
- Optimize the function and cost of cell culture media for cultivated meat and dairy without the use of animal byproducts.
- Target molecule selection for fermentation-derived proteins.
- Develop sustainable feedstocks for fermentation-derived proteins.

[11] Vought, R. & Droegemeier, K. (Aug. 30, 2019). *Memorandum on Fiscal Year 2021 Administration research and development priorities.* Executive Office of the President. https://bit.ly/2zw33br
[12] The Good Food Institute (2020). 2019 U.S. State of the Industry Report Plant-Based Meat, Eggs, and Dairy. https://www.gfi.org/files/soti/INN-PBMED-SOTIR-2020-0507.pdf

Intermediate Priority Research Areas:

- Improve current methods and develop novel methods of plant-based food manufacturing to improve the taste and price of plant-based proteins.
- Develop stable animal cell lines for a variety of different agriculturally relevant animals, including cow, pig, chicken, sheep, and many species of fish.
- Explore novel methods of creating scaffolding[13] and determine those most suitable to large-scale cultivated meat and dairy operations.
- Modify bioprocess design for large-scale cultivated meat and dairy production.
- Develop host strains for fermentation-derived proteins.

By including alternative protein research in the Request for Applications for the Urban, Indoor, and Other Emerging Agricultural Production Research, Education, and Extension Initiative, NIFA will help enable these emerging industries to feed a growing population in sustainable methods.

B. By Prioritizing the Development of New Crop Varieties and Agricultural Products, NIFA Will Connect American Producers to New Markets, Particularly Consumers Interested in Plant-Based, Cultivated, and Fermented Proteins.

USDA asked commenters to prioritize the area with the greatest and most urgent REE need in developing urban and indoor agriculture that is not being adequately addressed in other Federal REE programs. Of the priorities listed, The Good Food Institute believes that **Priority G** (*developing new crop varieties and agricultural products to connect to new markets*) has the greatest and most urgent research need for urban and indoor agriculture. Currently, no federal funding for research, education, or extension is explicitly dedicated to alternative protein. All three categories of alternative proteins are novel ways of producing food which are well suited to indoor and urban environments. However, additional research is needed in order to make a wide variety of alternative proteins easily accessible and affordable for all Americans.

Although several of today's leading plant-based meat companies were established in the 1970s–90s, the plant-based food market remained small and relatively stagnant until recently. In 2019, plant-based food sales grew by 11 percent to more than $4.98 billion. Total U.S. retail food sales grew by just 2 percent during the same period.[14] However, as described above, the alternative protein market is still very small compared to traditional meat, eggs, and dairy.

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[13] Some cultivated meat products are grown on scaffolds — biodegradable or edible structures made of food-grade materials — that support the development of a desirable texture.

[14] The Good Food Institute (2020). 2019 U.S. State of the Industry Report Plant-Based Meat, Eggs, and Dairy. https://www.gfi.org/files/soti/INN-PBMED-SOTIR-2020-0507.pdf

There is great potential for alternative proteins to continue to expand to new markets. Barclays predicts that by 2030, the value of the global alternative protein market could reach $140 billion. [15] However, in order for this prediction to become a reality with the United States leading the way, crucial research needs to be conducted.

As noted above, no federal funding for research, education, or extension is explicitly dedicated to alternative protein. On-going research programs within the USDA emphasize many of the same kinds of research necessary to advance the alternative protein industry. However, as we have outlined, the research needs for plant-based meat, cultivated meat, and fermentation-derived proteins are unique in their targeted outcomes and must be the explicit focus of research if we wish to see the industry flourish. NIFA can help fill these research gaps through the Urban, Indoor, and Other Emerging Agricultural Production Research, Education, and Extension Initiative by funding research that explicitly aims to advance alternative proteins.

Although Priority G is The Good Food Institute's top priority in this request for comments, research is needed for several other priorities listed:

- **Priority C** (*Identifying and promoting the horticultural, social, and economic factors that contribute to successful urban, indoor, and other emerging agricultural production*)
    - Beyond the technical hurdles, cultivated meat faces challenges in becoming cost-competitive with its traditional counterpart. NIFA research funding can identify and mitigate the specific economic factors that prevent cultivated meat from being economically viable.
- **Priority E** (*exploring new technologies that minimize energy, lighting systems, water, and other inputs for increased food production*)
    - As described above, alternative protein production requires significantly fewer resources than traditional meat production. Even with these efficiencies, alternative proteins currently command a higher price than their traditional counterparts. Further research into optimizing inputs, the valorization of waste streams, scaling up production systems, and the recycling of byproducts can drive the efficiencies even higher and aid in making alternative proteins economically viable.

III. Conclusion

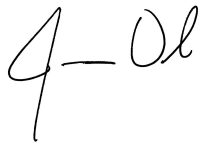
The Good Food Institute envisions a food system where urban centers, as well as rural communities, produce alternative proteins, creating jobs and food security within their

[15] Franck, T. (2019, May 23). Alternative meat to become $140 billion industry in a decade, Barclays predicts. *CNBC*. https://www.cnbc.com/2019/05/23/alternative-meat-to-become-140-billion-industry-barclays-says.html

communities. However, to enable the alternative protein sector to expand and flourish, we need a concerted effort to advance the science and technology of these fields. By prioritizing and funding research critical to the development of alternative proteins, NIFA will help build a successful alternative protein industry that sustainably feeds everyone.

Thank you for the opportunity to submit these comments. We will reach out to you next month to see if you are interested in having a virtual meeting to discuss these ideas further. In the meanwhile, please contact James Dale at jamesd@gfi.org with any questions as you consider our submission.

Sincerely,



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