May 21, 2021

Dr. Melissa R. Bailey
Agricultural Marketing Service
USDA, Room 2055-S, STOP 0201
1400 Independence Avenue SW
Washington, DC 20250-0201

SUBMITTED ELECTRONICALLY VIA REGULATIONS.GOV

RE: Docket No. AMS-TM-21-0034 Supply Chains for the Production of Agricultural Commodities and Food Products

Dear Dr. Bailey:

Thank you for requesting public comment on supply chains for the production of agricultural commodities and food products. 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. We identify the most effective solutions, mobilize resources and talent, and empower partners across the food system to make plant-based and cultivated meat ("alternative proteins") accessible, affordable, and delicious. To help create more resilient and durable food supply chains, we recommend that USDA leverage existing programs to advance open-access alternative protein research.

The Covid-19 pandemic and resulting economic crisis have revealed fragility and volatility in the food supply chain. During the pandemic, consumers faced nationwide meat shortages while farmers were forced to cull millions of animals. Tyson's CEO was quoted in full-page ads in The New York Times, Washington Post, and Wall Street Journal declaring "The food supply chain is breaking."[1]

President Biden's Consolidated Appropriations Act (CAA) and American Rescue Plan Act (ARPA) present an opportunity to mend our agricultural supply chains. Rather than merely addressing the current inefficient and fragile animal agriculture supply chain, the United States should build back better by investing in a shift to alternative proteins.

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[1]Sophie Kevany, *Millions of farm animals culled as US food supply chain chokes up*, The Guardian (Apr. 29, 2020) https://bit.ly/3tTZFRC; Zack Budryk, *Tyson Foods takes out full-page ad: 'The food supply chain is breaking',* The Hill (Apr. 27, 2020), https://bit.ly/3oeAHLq.

Alternative proteins from plants,[2] from cultivated cells,[3] and via fermentation[4] are scalable, market-based solutions that can help create a safe and resilient food system while driving economic growth. Alternative protein facilities at scale will allow producers to quickly switch between products and species to respond to consumer preferences. And because alternative protein production does not rely on the long planning timelines of conventional animal farming and the concomitant production of less valuable animal parts, alternative protein is inherently less wasteful and more efficient to produce. Finally, by removing animals from production processes, the world will be less susceptible to future economic disruptions brought on by zoonotic diseases.

USDA can play a pivotal role in ameliorating existing supply chain inefficiencies and vulnerabilities and creating a durable, resilient, and sustainable food supply for the future by dedicating CAA and ARPA funds to research that supports the growth of these sectors as part of the agency's efforts to develop a climate-smart agriculture and forestry strategy that works for all farmers, ranchers, forest landowners, and communities.

I. Alternative protein production is resilient in the face of disruption.

President Biden's executive order highlights the role of "resilient, diverse, and secure supply chains to ensure our economic prosperity and national security." Alternative proteins have a vital role to play to help protect the domestic food supply from disruptive volatility.

First, alternative protein production does not face the forecasting challenges of conventional meat supply chains. Farmers and ranchers have to predict how many animals to breed based on what demand will be when their animals are fully grown (this can range from nearly two months for chickens to upwards of two years for cattle). This often leads to boom and bust cycles in the marketplace. Bottlenecks such as slaughterhouse closures force farmers and breeders to cull multiple generations of animals that they cannot sell, threatening product availability and processor profitability. This problem is compounded by the short shelf life of most animal

[2] **Plant-based meat** consists of the same basic components as animal-based meat (namely protein, fat, vitamins, minerals, and water) derived directly from plants to provide the full sensory experience of meat and poultry. Next-generation plant-based meat, made popular by American companies such as Beyond Meat and Impossible Foods, looks, cooks, and tastes like conventional meat.

[3] **Cultivated meat** (also called cell-cultured or cultured meat) is animal meat produced by growing cells from animals. At scale, cultivated meat production will look similar to the fermentation process in beer breweries. Production begins with a small sample of cells from an animal, which are fed a nutrient-rich cell culture medium in a cultivator. During cultivation, the cells multiply many times over, producing muscle, fat, and other components of meat.

[4] **Fermentation** traditionally refers to using microbes — usually fungi or bacteria — to produce food. In industrial biotechnology, fermentation has come to mean simply the cultivation of microbial organisms. Fermentation can either produce more of the microbial organism 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 ingredients, including animal and plant proteins and fats.

products and limited cold storage capacity, meaning that even temporary disruptions in either production or demand have an outsized effect on the industry's operations and bottom line.

Plant-based and cultivated meat can be produced from stable raw material inputs into final products in a matter of hours or days. The main raw materials for plant-based meat (protein isolates, flours, flavorings, etc.) are typically ready-to-use dry powders with high stability and can be stored inexpensively for extended periods of time. Likewise, vials of frozen cells used to produce cultivated meat can be thawed and begin dividing within hours. Estimates suggest that producing a batch of thousands of kilograms of cultivated meat will require three to five weeks from start to finish, allowing production facilities to respond to shifting demand in real time. This means that during times of economic disruption, plant-based and cultivated meat production can be switched off or rapidly ramped up, making them less vulnerable to market volatilities. This will lead to less waste and greater profitability because manufacturers are not contending with flooded markets driving down prices and can more rapidly respond to demand spikes that outstrip production capacity.

Secondly, the variety of inputs used in alternative protein production will allow farmers to diversify their crops, making the crops more resilient to extreme weather, diseases, and pests. The vast majority of commodity monocultures, which are the most vulnerable to large-scale losses and crop failures due to their uniform robustness profile, are allocated toward animal feed applications, whereas crops used for alternative proteins can represent a more diverse set of species and varieties such that crop failure among only a handful of these crops is less catastrophic to the system as a whole.

Finally, given the right incentives, alternative protein production facilities can be established in rural, semi-rural, and urban areas because they do not require the same economies of scale as conventional meat processing facilities for economic viability. This widely distributed supply network will create opportunities for workers in farming and food production and keep money flowing through local economies. A distributed system will also protect against supply chain disruptions by creating an overlapping network of production.

II. Alternative protein production can be flexible to meet demand.

Plant-based and cultivated meat inputs and production platforms are flexible enough to produce different kinds of meat, which allows them to adapt more quickly to changing consumer preferences.

Meat companies typically specialize in one to three species because the production and rendering process for each species is radically different. Feed composition, barn layout, transport vehicle configuration, slaughterhouse equipment, and staffing varies across different types of livestock, such that barns and slaughterhouses cannot switch from one species to another. The meat

industry has a vested interest in maintaining consumer demand for the particular species in which they have specialized and in ratios that match their current facilities and infrastructure.

In alternative protein production, the difference between producing beef or pork or even salmon is comparatively minuscule. The major ingredients in plant-based meat are likely to be quite similar (sometimes even identical) across species, only requiring subtle changes in the flavorings and production equipment settings. Cultivated meat is designed to be similarly nimble. A single production line can switch from a shredded chicken product to a flaked tuna product with relatively little adaptation or downtime, allowing for a wider product range from a single company and greater responsiveness to consumers.

The potential flexibility of plant-based and cultivated meat producers to switch between products and species fluidly and inexpensively translates to substantial supply chain advantages.

III. Alternative protein production will reduce inefficiencies.

Producing protein from plants and cells requires fewer inputs than deriving protein from animals and also produces less waste.

Conventional methods of animal agriculture face significant inherent challenges. The vast majority of calories we feed to livestock do not get converted into edible meat. Instead, they are used by the animal to grow their entire body – including bones, feathers, and organs – to slaughter weight. Raising even the most "efficient" animal, a chicken, requires nine calories of animal feed to produce one calorie of chicken meat. Feeding crops to animals instead of directly to people creates more opportunities for supply chain disruptions. In contrast, if we consume crops directly through plant-based meat, cultivate meat directly from cells, or make proteins via fermentation, we can ensure an efficient food system that makes better use of resources.

Alternative protein production also delivers more value to the producer. Millions of tons of meat, organs, bone, and other undesired carcass fractions from conventional agriculture are forced into low-value sectors, such as animal feed and the chemicals industry (gums, glues, etc.). While some edible carcass parts can be matched with receptive buyers overseas (containers full of chicken feet from U.S. slaughterhouses are shipped to China), this leaves the industry vulnerable to geopolitics and trade disputes. Simultaneously, several of these parallel industries are innovating away from animal-origin materials and finding much higher-performing alternatives.[5]

While animal bodies are not proportioned to the ratios of products that humans actually demand, alternative protein manufacturers can produce meats in the exact ratios at which they are selling,

[5] For example, Geltor has commercialized animal-free gelatin, and an increasing number of pet food brands are now offering plant-based formulas.

allowing consumers to make their meat product selections based purely on the cuts they truly want and eliminating wasteful byproducts altogether.

IV. Alternative protein production can mitigate the chances of future supply chain disruptions.

Not only can alternative protein production mitigate supply chain disruptions brought on by external factors like pandemics, but it can also help us avoid future ones.

While the United States is starting to emerge from Covid-19, other zoonotic diseases are likely to emerge given our current food production systems. Zoonotic diseases almost always leap to humans directly from livestock or wildlife when humans are in close contact with live animals' infected tissues and fluids.[6] The high population densities, prolonged heightened stress levels, poor sanitation, and specialized diets in farmed animals all increase the likelihood of zoonotic transmission. Zoonotic viruses such as avian flu, swine flu, and Nipah virus have all emerged from these contexts. Researchers at UC Davis' One Health Institute say "Few threats to human health have the potential to cause more impact than emerging zoonoses."[7]

Even when these viruses only circulate within their animal hosts, they threaten human prosperity and food security. The African Swine Fever Virus outbreak is responsible for an estimated 50 percent drop in pork production in the world's largest pork-producing country and led to a dramatic rise in overall food prices.[8] A highly pathogenic strain of H5N1 avian flu that emerged in China in early 2020 caused many chicken farmers in locked-down regions to lose flocks due to transit disruptions of their feed supply.[9] Consumers are also subjected to food pricing volatility as a result of these vulnerabilities of animal farming. These routine viral assaults on food security demonstrate that our reliance on massive-scale animal farming is unsustainable.

Both plant-based and cultivated meat products remove the zoonotic disease concerns inherent in animal-based food by taking the animals out of the production process. Accelerating the

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[6] Ronald Rosenberg, *Detecting the Emergence of Novel, Zoonotic Viruses Pathogenic to Humans,* Cellular and Molecular Life Sciences (Nov 22, 2014), https://bit.ly/2RmhATF; Brian H. Bird and Jonna A.K. Mazet, *Detection of Emerging Zoonotic Pathogens: An Integrated One Health Approach,* Annual Review of Animal Biosciences (Nov. 16, 2017), https://bit.ly/3hEJlBN.

[7] Brian H. Bird and Jonna A.K. Mazet, *Detection of Emerging Zoonotic Pathogens: An Integrated One Health Approach,* Annual Review of Animal Biosciences (Nov. 16, 2017), https://bit.ly/3hEJlBN.

[8] Laura Reiley, *A terrible pandemic is killing pigs around the world, and U.S. pork producers fear they could be hit next,* The Washington Post (Oct. 16, 2019) https://wapo.st/2Rjmd0K; Adam Vaughan, *African swine fever helps drive world food prices to two-year high,* New Scientist (Dec. 5, 2019), https://bit.ly/3wcKZi1.

[9] Connor Perrett, *A 'highly pathogenic strain' of H5N1 bird flu has been reported in China's Hunan province,* Insider (Feb. 1, 2020) https://bit.ly/3tHQ7ZK; Li Yuan, *China Targets the Coronavirus, and Farmers Pay a Price,* The New York Times (Jan. 31, 2020), https://nyti.ms/3bu5crt.

development and deployment of diverse meat production methods that reduce these risks will help prevent massive economic disruptions brought on by zoonotic disease.

V. With the appropriate support, the alternative protein industry promises enormous potential for improving supply chain resilience and durability.

In addition to economic and public health benefits, alternative proteins can also significantly reduce food system emissions while freeing up land for climate mitigation strategies.[10] However, for these wide-ranging and urgent benefits to be fully realized, public research is crucial to increase the availability and bring down the cost of alternative proteins.

The alternative protein market is still very small compared to the market for traditional animal agriculture. Plant-based meat is approximately one percent of all dollar sales for total retail meat in the United States.[11] Additionally, while some remarkable products are on the market, nearly all plant-based meats widely available today are burgers and nuggets, and cultivated meat is only just entering the market with limited distribution exclusively in Singapore. Plus, the prices of alternative proteins are not yet competitive with conventional animal products. As the alternative protein industry grows and volumes rise, prices can be expected to go down.[12]

USDA is well-suited to prioritize alternative protein research. Specifically, USDA's Agricultural Research Service (ARS) and the National Institute of Food and Agriculture (NIFA) can fund and perform open-access alternative protein research tackling key white spaces to accelerate the growth of this sector. As the premier intramural agricultural research agency, ARS is uniquely positioned to prioritize and advance alternative protein research, much of which fits within the scope and expertise of already ongoing research programs, including the National Programs in Plant Genetic Resources, Genomics, and Genetic Improvement, Sustainable Agricultural Systems Research, and Product Quality and New Uses, among others.

Likewise, as The Good Food Institute shared in a recent meeting with ten NIFA National Program Leaders, NIFA can animate its mission to "invest in and advance agricultural research ... to solve societal challenges" by building upon its recent history of funding alternative protein research. (Last year, NIFA awarded nearly $500,000 each to plant-based meat researchers at the University of Massachusetts Amherst and Purdue University via the Agriculture and Food Research Initiative.)

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[10] The Good Food Institute, *Cultivated meat LCA and TEA: Policy recommendations* (Mar. 2021), https://rb.gy/6b2bbt.

[11] The Good Food Institute, *Plant-based retail market overview* (Apr. 2021), https://gfi.org/resource/marketresearch/.

[12] In February 2021, Impossible Foods announced a 20 percent price cut in suggested retail prices in grocery stores due to growth and economies of scale, https://rb.gy/qm37bg.

In addition, we recommend that USDA pursue an interagency initiative with the National Science Foundation (NSF) to research alternative proteins. This is a cross-cutting area of research where unique expertise at NSF and USDA can function synergistically. An interagency initiative will combine NSF's engineering and manufacturing expertise with USDA's food production, safety, and nutrition expertise. To facilitate these partnerships, The Good Food Institute is encouraging the White House to establish an interagency initiative akin to the National Nanotechnology Initiative[13] to coordinate federal research efforts on alternative proteins. This initiative can identify and perform the research and development to remove the technological barriers currently facing the alternative protein sector and ensure interagency coordination in such research efforts to improve efficiency, minimize duplication of effort, and grow workforce talent.

To develop opportunities for broader inclusivity within USDA programs, we recommend extramural grant programs explicitly for alternative proteins research as well as the establishment of alternative protein research centers and academic majors at universities with some funds reserved for 1890s and other Minority-Serving Institutions.

Both basic and applied scientific research is needed to accelerate alternative protein growth to meet the pressing timelines of fighting the climate crisis. We have identified the following areas as the most crucial research needs for alternative proteins:

Plant-Based Meat

- Crop breeding and engineering for higher protein yields and functionality.
- Protein fractionation and functionalization, including from existing agricultural side streams.
- Improved plant fat profiles.
- Novel methods for texturizing and structuring plant-based proteins.

Cultivated Meat

- Animal science and animal nutrition insights for developing cell lines and media formulations for optimal flavor, nutrition, and growth characteristics.
- Biomaterials for tunable, edible, and low-cost scaffolds that promote cell adherence and differentiation with spatial control.
- Bioprocess systems and biosensor technologies that can monitor the concentrations of specific nutrients and metabolic byproducts and adaptively control the feed inlets and outflows to optimize cell performance and reduce costs.

Fermentation

- Increased titers and yields for fermentation-produced ingredients via strain engineering.

[13] *See* National Nanotechnology Initiative, https://www.nano.gov/.

- Screening and adaptation of novel strains as commercial candidates.
- Feedstock optimization for leveraging existing biomass streams.

Addressing each of these key research areas will increase supply chain resilience. It will also enable alternative proteins to be widely available and affordable to all so that the benefits, including those to ensure U.S. economic prosperity and national security, can be fully realized.

Open-access research is essential to help the alternative protein industry offer more diverse products at greater scale, ensuring that all Americans can afford and have access to alternative proteins.

VI. Conclusion

Alternative proteins have the potential to play a leading role in USDA's efforts to increase food supply chain resilience and durability. Investing funding authorized by CAA and ARPA into alternative protein research will ensure that the United States remains a leader in agriculture while building a more secure, sustainable, and just food supply.

Thank you for your consideration and for the opportunity to submit these comments. We will follow up in July to discuss our recommendations. In the meantime, please contact GFI Director of Science & Technology Liz Specht, Ph.D. (lizs@gfi.org) if you have any questions as you consider our submission.

Sincerely,

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