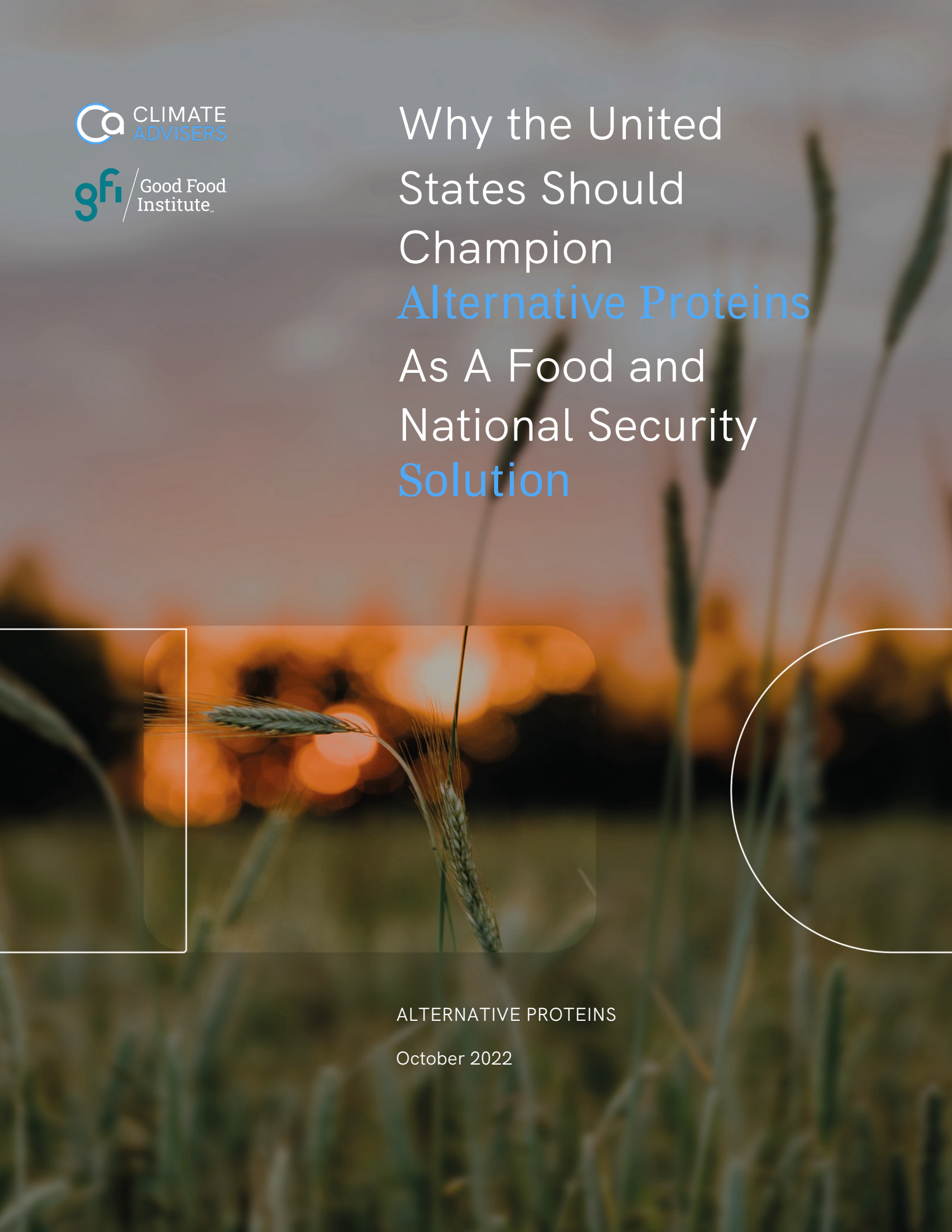

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Good Food Institute

Why the United States Should Champion Alternative Proteins As A Food and National Security Solution

ALTERNATIVE PROTEINS

October 2022

Acknowledgements

This brief is part of a collaboration between Climate Advisers and the Good Food Institute.

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The Good Food Institute is a nonprofit think tank working to make the global food system better for the planet, people, and animals. Alongside scientists, businesses, and policymakers, GFI's teams focus on making plant-based and cultivated meat delicious, affordable, and accessible. Powered by philanthropy, GFI is an international network of organizations advancing alternative proteins as an essential solution needed to meet the world's climate, global health, food security, and biodiversity goals. To learn more, please visit www.gfi.org.

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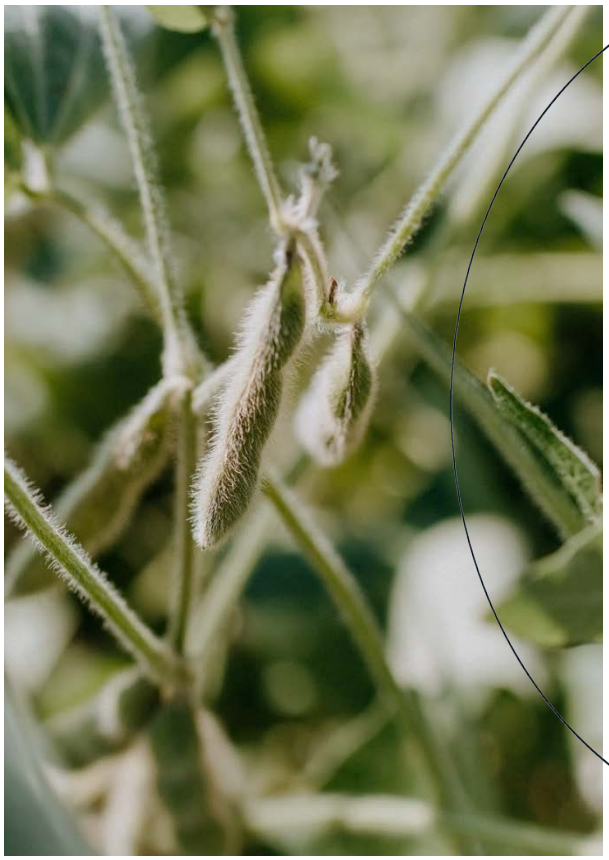
I. Summary



In addition to exacerbating global hunger and nutrition crises, food insecurity threatens U.S. national security by increasing the risks of conflict, unrest, and violent extremism. Animal protein production makes a significant, though little-recognized, contribution to food system insecurity, driving up prices for grains and other staple crops, making supply chains less resilient, and worsening climate change. None of this is true of alternative proteins—foods that create the experience of eating animal products without the inefficiencies and other harms involved in cycling crops through animals.

A large-scale shift from animal products to alternative proteins therefore has tremendous potential food and national security benefits. Right now, the primary obstacles to greater uptake of alternative proteins are taste and price, but experts believe we can make alternative proteins comparable to animal-based products on both fronts with further efforts by researchers. In addition, alternative proteins face a markedly easier path to implementation than many other system transformations of similar scale and impact, making them a winning strategy to reduce food insecurity, enhance national security, and strengthen climate action. For all these reasons, the United States should make international cooperation on alternative proteins a top diplomatic priority. This policy brief offers policy recommendations that the United States can and should adopt in order to accelerate innovation in alternative protein technologies.

II. Food Security is a Growing National Security Concern

The events of the past two years have set back efforts to eradicate global hunger and malnutrition substantially. The Covid-19 pandemic, which sent 150 million people into extreme poverty globally, resulted in a January 2022 estimation by the Food and Agriculture Organization of the United Nations (FAO) that "over 43 million people in 38 countries across the globe are now at risk of falling into famine or famine-like conditions, unless they receive

immediate life and livelihoods-saving assistance." World Food Programme head David Beasley warned at the time that "2022 and 2023 could be the worst two years in the humanitarian world since World War II," referring to the impacts caused by the pandemic, supply chain disruptions, and climate change.

Just one month later, Russian soldiers invaded Ukraine, disrupting Ukraine's substantial agricultural exports and sending shock waves through the global grain trade. Subsequent sanctions and export limits further reduced Russian exports around the world. After just 100 days of war, the world scrambled to fill a 46 MMT gap in the global grain trade.

Besides increasing food insecurity, the global food emergency has exacerbated national security threats including conflict, unrest, and political instability. Ukraine's exports alone feed 400 million people each year, and, together, Russia and Ukraine supply half of Lebanon and Tunisia's cereal supply, two-thirds of Libya's and Egypt's, and nearly all of Somalia's wheat. As a result, global wheat prices rose 56% in a year, and it has pushed Somalia to the brink of famine. High food prices were among the many concerns that drove protesters into the streets at the beginning of the Arab Spring (2011). It is hardly far-fetched to think they might soon do so again.

Through a combination of vaccines, infection-acquired immunity, better treatments, and new safety protocols, the Covid-19 pandemic will likely be behind us soon. The war in Ukraine will end too, though not—sadly—without doing immense harm to the country, its residents, and the vulnerable populations throughout the world that have depended on its grain. Yet other forces will continue to drive food insecurity. As the world's population grows, growing demand for food and especially meat will increase competition for land and drive up food prices. Climate change will continue to cause droughts, heat waves, and other extreme weather events that imperil harvests and upend traditional farming practices. Perhaps worst of all, these and other

factors could initiate a vicious cycle in which food insecurity leads to conflict or instability that exacerbates food insecurity.

Big problems demand bold solutions. One of the most neglected of these is changing the ways the world produces and consumes food. Combating hunger and malnutrition requires that people be able to consume adequate levels of protein. Yet producing livestock—currently the primary source of dietary protein for billions of people all over the world—accounts for about 20 percent of greenhouse gas emissions and uses three-quarters of agricultural land.[i] Even as the world shifts toward renewable energy and electric vehicles and makes progress on the contribution of oil and gas leaks to global methane production, climate emissions attributed to meat production will continue to rise as the growing global middle class drives demand for meat ever higher.

If policymakers want to increase food security while achieving global climate and biodiversity goals and feeding a growing population, they need to find a better way to get people the protein they want and need. Fortunately, there is a way to do this: "alternative proteins," which are foods that create the experience of eating animal products without the inefficiencies and other harms associated with traditional animal agriculture. These innovative, climate-smart and resource-efficient products have the potential to increase the resilience of our food systems while making protein more abundant, affordable, climate-friendly, and resource-efficient without demanding major sacrifices from consumers.

What are alternative proteins? There are two primary types of alternative proteins: plant-based and cultivated. Just as the goal with renewable energy and electric vehicles is to make them interchangeable with conventional energy and combustion-powered vehicles, so too are plant-based and cultivated meat focused on winning in the marketplace by producing products that taste the same or better to consumers and that cost the same or less, thus requiring no intentional behavior change.

- Plant-based meat and seafood are made from plants but reproduce the taste and texture of animal-based products. The products are focused on fully satisfying meat-eaters. Because their production is so much more efficient than conventionally produced meat, as they scale, they should be able to compete on price.
- Cultivated meat and seafood are real animal products cultivated directly from animal cells. The resulting meat is identical to conventional meat (but without the drug residues and other contaminants), and, as with plant-based meat, scaling up should allow prices to come down such that it will compete in the marketplace with conventional meat.
- Alternative proteins are designed to replace conventional meat and seafood by competing on taste and price.
- To date, no plant-based or cultivated meat product both tastes the same or better to consumers of meat and costs the same or less. Yet the pace of innovation on alternative proteins has been impressive, with cost and taste improving rapidly.
- Just like electric cars and renewable energy, alternative proteins are speeding down the cost curve and should prove highly attractive to general consumers as soon as they meet price and taste metrics.

III. Global Food Insecurity is a Threat to U.S. National Security

Food insecurity and resource scarcity are well-known drivers of conflict. Rising food prices and sudden scarcity have led to destabilizing riots from the French Revolution to the Arab Spring and have played a disastrous role in recent civil wars in Sudan, Yemen, and Syria. Even before Russia invaded Ukraine, the Center for Strategic and International Studies had warned that these "storms of political instability, food insecurity, and conflict" are "unlikely to disappear from forecasts of the next few decades."

With the invasion of Ukraine, Putin has weaponized the connection between food security and political unrest, using food as a weapon in Russia's war with Ukraine. As U.S. Secretary of State Antony Blinken remarked in May 2022, "The food supply for millions of Ukrainians and millions more around the world has quite literally been held hostage." Secretary Blinken was accusing Russia of withholding both crop and fertilizer exports, making it harder for net importers to feed themselves and driving up the price of crops globally. This intentional effort to inflate crop and fertilizer prices has resulted in yield reductions in places as far removed from the war as Nairobi and as wealthy as the United Kingdom. Citing concerns that this disruption could lead to food riots and political unrest, the Wall Street Journal called for the U.S. military to intervene and escort grain shipments out of the Black Sea.

The threat to U.S. interests from food insecurity is not limited to traditional forms of warfare. Rather, in an era of nontraditional warfare and extremist insurgencies, food insecurity gives malicious actors opportunities to manipulate vulnerable populations. As former Department of Defense and National Security Council official Matt Spence explains, "While heading up Middle East policy at the Pentagon, I saw how ISIS leveraged drought and crop failures to win the support of vulnerable populations and expand its reach." There are few human motivations more powerful than the desire to feed oneself and one's family.

A more resilient global food system that is less susceptible to disruption by exogenous and unpredictable forces like Putin's invasion of Ukraine would be less vulnerable to manipulation by bad actors seeking to advance their malign objectives. In addition, a world where the tools available to such actors are less powerful and food systems are more stable is safer and less prone to conflicts and unrest that could harm American interests. From this perspective, the contribution of animal agriculture to the present and future food crises deserves special scrutiny.

IV. Animal Protein Production and Consumption Exacerbate Food Insecurity

Animal agriculture contributes to food insecurity in three ways—through its inefficient use of feed crops that could otherwise be consumed by people and associated upward pressure on prices, the ways it increases the vulnerability of the food system to shocks, and its contribution to climate change.

Animal agriculture makes incredibly inefficient use of resources. The vast majority of the calories consumed by a chicken, pig, or cow are used to keep the animal alive, so animals require far more calories of food than they ultimately provide to humans. See chart below.

Key Parameters Used in Evaluating US Feed Allocation and Conversion Among Animal Categories, Energy (Caloric), and Protein Efficiency

Parameter (±Std. Dev.)	Units	Beef	Poultry	Pork	Dairy	Eggs
Feed intake per LW	kg/kg LW	14 ± 4	1.9 ± 0.4	3.1 ± 1.3	N/A	N/A
Feed intake per EW	kg/kg EW	36 ± 13	4.2 ± 0.8	6 ± 2.5	N/A	N/A
Feed intake per CW	kg/kg CW	49 ± 9	5.4 ± 1.4	9 ± 4	2.6 ± 0.6	2.4 ± 1.2
Feed caloric content	kcal g−1	2.3 ± 0.6	3.4 ± 1.4	3.6 ± 2	2.8 ± 0.9	3.4 ± 2.4
Food caloric content	kcal g−1	3.2 ± 0.3	2.3 ± 0.1	2.8 ± 0.2	1.2 ± 0.1	1.4 ± 0.1
Caloric conversion efficiency	%	2.9 ± 0.7	13 ± 4	9 ± 4	17 ± 4	17 ± 9
Feed protein content	%	12 ± 3	17 ± 7	17 ± 11	15 ± 5	17 ± 12
Food protein content	%	15 ± 2	20 ± 2	14 ± 1.4	6 ± 0.6	13 ± 1.3
Protein conversion efficiency	%	2.5 ± 0.6	21 ± 7	9 ± 4.5	14 ± 4	31 ± 16

Note: LW = live weight (USDA reported slaughter live weight); EW = edible weight (USDA reported retail boneless edible weight); CW = consumed weight (USDA reported loss-adjusted weight). N/A, denotes 'not applicable' as the parameter is relevant only for CW. Feed caloric content refers to metabolizable energy and feed protein content refers to crude protein.

Animals already consume one-third of the global harvest of staple crops, and that figure is getting larger: In developing economies, researchers have found that diversion of crops toward animal feed is growing as global livestock production systems shift "from using mostly waste products, crop residues, and marginal lands to more industrial systems that require less land and use higher value feed crops."

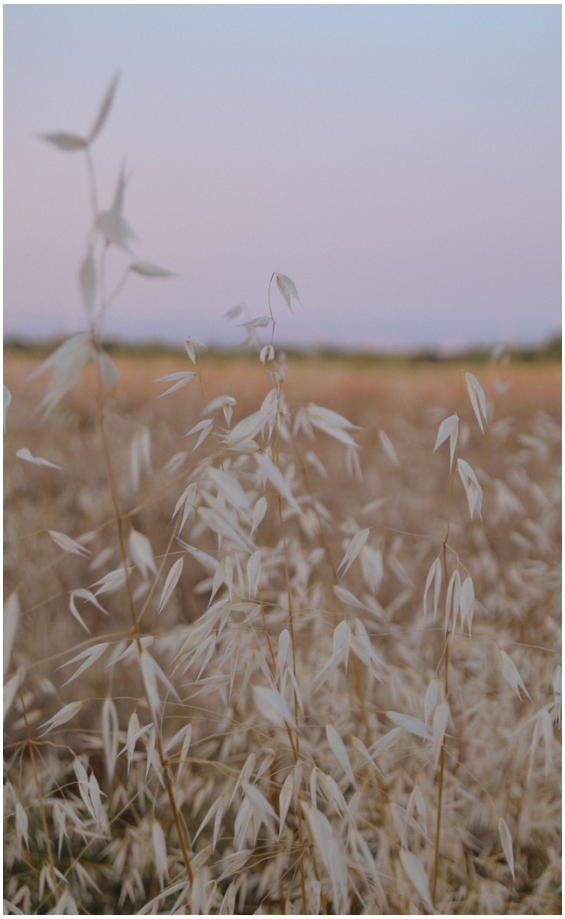
The inefficiency of livestock production is already contributing to global food insecurity by pushing prices for grains and other crops used as animal feed higher than they would be if the world ate fewer animal products, making it harder for the world's poorest people to afford staple foods and leaving more people hungry or malnourished. In the coming decades, it is projected these trends will get even worse. On our current trajectory, FAO forecasts that global meat consumption will grow by 70 to 100 percent by 2050, and with that increase will come massive additional feed crop and land needs. With the existing demand for animal products already driving deforestation in marginal growing areas like the Amazon rainforest, this trend will lead to heightened competition for a limited supply. The resulting upward pressure on prices will push staple crops out of financial reach of vulnerable populations, vastly increasing malnutrition and starvation.

Animal agriculture also contributes to food insecurity by increasing the vulnerability of our food system to shocks. As the impact of Covid-19 on the global supply chain has made abundantly clear, our food system is fragile and prone to disruption. That fragility is especially acute for animal production, which has a long, diffuse, and vulnerable supply chain: Crops must be grown and shipped to feed mills. Feed is then produced and shipped to industrial farms. The animals are then grown to slaughter weight and shipped to slaughterhouses. The slaughterhouses kill the animals, and the meat is shipped on refrigerated trucks to distribution centers. Each stage of this process can break down. In addition, the timeline from the first planting of feed crops to the final distribution to supermarkets is long and difficult to adjust mid-stream, making short-term adjustments difficult. For example, intensively confined and genetically similar animals are at heightened risk of communicable diseases. A disease outbreak, even contained to animal populations, can wipe out many millions of animals very quickly, jeopardizing supply and spiking prices. Even when the system is working as planned, animal production is a guessing game with very long lead times.

The third and final way in which animal agriculture exacerbates food insecurity is through its role as an important driver of climate change. As noted above, animal agriculture is responsible for a whopping 20 percent of annual global greenhouse gas emissions, more than any country in the world except for China. Climate change exacerbated the present food crisis by worsening drought in parts of Africa and the Middle East and making the heat waves that have killed dozens and reduced harvests in India 30 times more likely. Even if the world succeeds in reducing emissions to net-zero by mid-century, in line with the temperature goals agreed to in 2015 in Paris, global temperatures will continue to increase for some time yet, leading to more and more extreme droughts, hurricanes, floods, and other weather phenomena that imperil not just farmers and their crops but everyone who relies on them. To avoid even worse outcomes, emissions from livestock production must fall.

V. Alternative Proteins as a Food Security Solution

Alternative proteins are superior to animal protein on all these fronts: efficient use of feed crops, resilience to shocks, and reduced climate impact.



First, alternative proteins are far, far more resource-efficient than animal foods. Today's plant-based alternatives to conventional beef use 90 to 99 percent less land than their conventional counterparts, and a life-cycle assessment of cultivated beef found that it could require 93 percent fewer calories and 95 percent less land than conventional beef. These numbers can get even better over time with efficiency-focused research and development. As a result, a large-scale switch to alternative proteins would free up enough of the projected staple crop supply to lower crop prices by as much as 12 percent.[ii] This is in contrast to vastly increased food prices on our current trajectory. In addition, the supply chains for alternative proteins are simpler and less vulnerable to disruption than those for animal products, as well as easier to adjust in the event of unexpected changes. The time to produce alternative protein products is much shorter than that of conventional animal products. By not being constrained by animal reproductive capacities, alternative protein allows for more rapid adjustments to changes in the market and increases overall production. Further, in an advanced economy in which demand for some kinds of animal products may surge while others dwindle, alternative protein producers can meet demand without producing an entire animal along with unwanted byproducts. Alternative proteins concentrate production in one factory that does not have animals coming in and out—with no need for feed mills, hatcheries, industrial barns for raising animals, fleets of tractor trailers to haul livestock for slaughter, slaughterhouses, or post-slaughter processing. Because the supply chain for creating an alternative protein has so many fewer links, requiring less coordination, transportation, and perishable components, the system is more resilient to shocks.

Finally, alternative proteins produce just a fraction of emissions associated with the production of traditional animal protein. While increased consumption of animal products could raise annual livestock sector emissions by around 12 gigatons CO_2-eq by 2050,[iii] a transition to alternative proteins has the potential to deliver 14 to 20 percent of the emissions mitigation the world needs by 2050 to stay below 1.5° C.[iv] In part this is because alternative proteins require far less land and less fertilizer to produce, drastically reducing deforestation, nitrous oxide emissions, and aquatic eutrophication. Animal agriculture's land use requirements–nearly one-third of the land surface of the earth–make a shift to alternative proteins extremely compelling as a source of land for nature-based sequestration. Shifting from animal to plant-based agriculture would free up enough land for 26 GT of carbon sequestration, according to a paper in *Nature Sustainability* by New York University environmental scientists. In addition, because alternative protein production is concentrated in factories, alternative proteins can better take advantage of the emissions reductions enabled by renewable energy sources than can animal agriculture. In this sense, alternative proteins are the food & agriculture sector's way to "electrify everything."

Today, the primary obstacles to wider uptake of alternative proteins are taste and price. Accordingly, the key to scaling these innovative technologies is emphatically not government action to replace, restrict, or disincentivize animal products in the marketplace. Rather, the most effective course of action is a concerted and well-funded research effort aimed at making alternative proteins taste as good or better, cost the same or less, and be just as nutritious as traditional animal proteins. The limited amount of public research to date has been enormously effective at making progress toward these goals and provides encouragement that a government-supported research and development effort could accelerate progress on taste, price, and nutrition parity progress. Should that happen, a large-scale shift toward animal proteins could lower grain prices, make the food system more resilient, and mitigate climate change without requiring sacrifices by consumers or making protein too expensive for people in developing countries.

For all these reasons, alternative protein innovation is a key strategy both for increasing the security and resilience of the food system and mitigating the security threats associated with food crises.

VI. Alternative Proteins Are Profitable, Scalable, and Politically Viable

In addition to their potential food security benefits, alternative proteins face a markedly easier path to implementation than many other system transformations of similar scale and impact. Unlike proposals to limit consumption levels or reduce population or economic growth, a switch to alternative proteins promises to produce more food per person at greater profit to producers with far fewer consequences for food insecurity, climate, or public health. This creates an incentive for industry to support the protein transition and for governments to make early

investments in a lucrative new sector. All five of the world's largest meat companies have invested in or are developing alternative protein products, including both plant-based and cultivated products. Cargill's $100 million investment in a pea protein processing facility in rural Minnesota, replacing a dairy processing facility on the same site, is just one example of an established corporation taking part in the positive system transformation that alternative proteins promise.

Alternative proteins will also provide economic opportunities for farmers. On our current trajectory, many farmers face an uncertain future. The World Bank expects that the effects of climate change will cut crop yields significantly, especially in the world's most food-insecure regions. Meanwhile, climate change is projected to cost South America up to 21 percent of its arable land and Africa up to 18 percent of its arable land. The Bill & Melinda Gates Foundation is already funding research to develop alternative protein systems that can provide income and nutritional benefits to farmers in low- and middle- income countries, and similar initiatives could catalyze new opportunities for farmers who are facing the prospect of significant reductions in yields and arable land.

9.8m jobs

$1.1T

added gross value to the economy by 2050

The UK's Foreign, Commonwealth and Development office co-funded a report with ClimateWorks Foundation that was launched at COP26 in November 2021. That report posits that with modest government support of roughly $10.1 billion per year, alternative proteins could employ between 9.5 and 9.8 million people by 2050 with a gross value-add to the global economy of $1.1 trillion. Moreover, as U.S. Secretary of Agriculture Tom Vilsack has noted, research on alternative proteins could yield sizable economic benefits even in the short term: "Studies have shown that every dollar invested in agricultural research creates $20 in economic activity." With such a promising economic outlook, political leaders on both sides of the aisle can agree that investing in alternative protein production capabilities is in the best interest of their constituencies. This is why former DOD and NSC official Matt Spence called accelerating the development of alternative protein "a politically feasible and technologically possible major step to advance our national security."

Governments are well-positioned to benefit from alternative proteins. With the unprecedented flow of information across borders, the global community stands to gain from research and development conducted anywhere. However, the greatest benefits will go to the countries that make early investments in research and development and provide incentives for companies to enter the space and scale up production.

Governments in Israel, Japan, Germany, India, Singapore, Canada, and the Netherlands have invested in alternative protein R&D, recognizing the opportunity to lead in a burgeoning field, and China has been quietly allocating significant funding to help the sector scale up since at least 2020. China's 2022 five-year agricultural strategy, the country's five-year plan for the bioeconomy, and President Xi himself have all pointed toward a country that sees the promise of alternative proteins.

While the United States still leads the world in the number of alternative protein companies and capital investment in the industry, the center of gravity is quickly shifting. As former U.S. Secretary of Agriculture Sonny Perdue warned: "If [the United States doesn't] facilitate the invention of these ideas, we're going to see these technologies go to places around the world that are more conducive to their development, and frankly China may be one of those."

VII. Recommendations for U.S. Leadership

The global food security community has spent very little time or energy on the inefficiency of crop production for meat, perhaps seeing the issue as totally intractable. To date, no one in the global development community has seriously engaged with the fact that the global community is on track to produce 70 to 100 percent more meat by 2050, with dire consequences for the global poor.

The lack of policies addressing the diversion of crops toward feed stems from the outdated conclusion that the only solution is a reduction in meat consumption, the fair observation that consumers are unlikely to voluntarily eat less meat, and the belief that government policies to that end will be extremely unpopular and most likely impossible.

However, there is great promise in recent scientific advancements focused on making meat from plants and cultivating actual animal meat directly from animal cells. As noted above, the theory of "alternative proteins" is to create products that can compete on taste and price with conventional meat while requiring a fraction of the land and caloric inputs. This is a new solution to the myriad problems of current meat production that is analogous to renewable energy in that it creates the same experience for consumers without the climate costs. Plant-based and cultivated meat can be made to compete with current products by tasting the same or better and costing the same or less. Consumers need not change anything about how they make their purchasing decisions.

Substantial, concerted, and well-funded research and development efforts will be necessary to realize this attractive vision. The United States should seek to advance these efforts through the following policy measures:

Create Interagency Alternative Proteins Initiative and Protein Centers for Excellence

Alternative protein research and development will require strategic vision and coordination across different agencies and levels of government. To coordinate long-term strategy and minimize gaps or redundancies across agencies and funding programs, the United States should create an interagency initiative, modeled on the National Nanotechnology Initiative, which is coordinated under the auspices of the White House National Science and Technology Council.

Federal and state governments should also establish centers of excellence focused specifically on alternative protein research and development, which can integrate knowledge from many technical disciplines, including biochemistry and biomechanics, agricultural science, industrial engineering, materials science, and artificial intelligence research. In many cases, these centers can be created under agencies' existing authority. Legislators could explicitly authorize these centers and then fund them, or they could simply use the appropriations process to signal their intent to funding agencies. Universities or institutions with comparable research capabilities, such as national laboratories, will make excellent hosts for these centers.

Incentivize Research and Development

Federal investment in research and development will support economic growth, reduce costs for key technologies, and promote U.S. leadership on clean energy and climate. Funding public, open-access research that benefits the entire sector can address the industry's biggest technical challenges, inspire additional research, and create new opportunities for growth. Research can be funded by creating new initiatives or using existing programs relating to engineering, agricultural innovation, climate science, and economic development. One specific focus area should be incentivizing research regarding better ingredient processing and manufacturing equipment. The technologies being used today have largely been repurposed from their original uses and are sub-optimal with respect to scale, cost, and functionality.

Agencies could engage in this research directly or fund it through grantmaking programs, focusing specifically on issues that are critical to scaling alternative protein industry: protein and ingredient extraction methods that are low-cost, scalable, and gentle enough to preserve important functional and nutritional properties; extrusion and newer manufacturing technologies to improve plant-based meats' texture and taste while reducing energy inputs; and bioreactor and process design for cultivated meat to replace existing bioreactors which were designed for smaller-scale pharmaceutical applications.

Incentivize Manufacturing and Infrastructure Investment

Strategic incentives—investment tax credits, loan guarantees, demonstration projects, and other forms of financial support—have catalyzed explosive growth in the renewable energy sector and can stimulate similar progress for alternative protein infrastructure. As with renewable energy, the key challenge to systemic reform is the vast scale of production that will be required. Federal investment assistance will help alternative protein companies purchase or lease expensive processing equipment or manufacturing facilities, for a lower cost of capital than is available for private equity financing. By prioritizing capital investment in rural areas, the government can also ensure the smoothest possible transition from conventional to alternative protein farming, processing, and manufacturing. Governments should also provide additional support for crops that are typically used for alternative proteins, by expanding insurance programs for specialty crops like yellow peas.

Invest in Workforce Development

Policymakers must also prioritize training for the alternative protein technical workforce. For example, USDA programs could train existing agricultural and meat processing workers to transition from conventional to alternative protein manufacturing, while public-private partnerships could be used to create apprentice programs for alternative meat production facilities. The federal government already supports apprentice programs for advanced manufacturing industries through Manufacturing USA, which provides a clear framework for an alternative proteins-focused apprentice program.

Using the Cooperative Extension Service can support farmers while promoting awareness of the opportunities presented by the alternative protein sector. The Cooperative Extension Service should develop programs and expertise to inform farmers about opportunities to grow input crops for alternative protein production and to assist them in implementing best practices. Through public-facing educational programs and its many partnerships with universities and vocational schools, the federal government should also promote awareness of the alternative protein sector and development of relevant technical knowledge and skill. These programs should aim to expand support to include the public and land-grant universities, including the 1890 institutions, tribal colleges, and minority-serving institutions to diversify and improve the alternative protein workforce.

Pursue International Engagement

Finally, the United States should pursue bilateral or plurilateral research partnerships between and among leading countries that will advance global alternative protein science. Innovation and commercialization partnerships could focus on Brazil, Israel, Singapore and Europe, while partnerships to build awareness and capacity in major emerging nations might begin with India and China. In addition, the United States should seek to build a strong international alliance to promote food security, national security, and climate action through coordinated investments in alternative proteins, educating the international community, aligning global funding, and mainstreaming alternative proteins into policies and budgets related to sustainable development, climate change, and national security.

VIII. Conclusion

Food insecurity presents an unacceptable threat as the world grows, warms, and develops. With food systems already vulnerable to shocks to global trade that threaten reduced yields, hunger, and even famine around the world, and the pressure only rising as the population grows and the planet warms, the United States must act to prevent starvation and the ensuing social and political disorder. An alternative protein transition can ease the pressure by dramatically increasing the production efficiency of meat, allowing the food system to simultaneously reduce its land footprint, decrease its greenhouse gas emissions, and increase the quantity and quality of calories available to humans. Inevitable shocks to global supply, such as natural disasters or war, would have an accordingly less devastating effect on the vulnerable.

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[i] The 20% figure is derived from the linked article. The article states that the food system produces about 17.3 Gt of GHG emissions annually and that the production of animal-based food accounts for about 57% of those emissions. 57% of 17.3 Gt is 9.86Gt, which is about 20% of the roughly 50Gt of GHG the world emits annually.

[ii] This figure comes from p. 4 of the linked report and is derived from analysis that made use of the Model of Agricultural Production and its Impact on the Environment (MAgPIE). For additional detail, see here.

[iii] This figure was calculated by increasing 2012 emissions (7.1 gigatonnes CO2-eq) by 70 percent to estimate 12.07 gigatonnes CO2-eq in 2050. As noted earlier in the piece, demand for livestock products is expected to grow at least 70% by 2050. Both the 7.1 and 70% figures come from Gerber, P.J., et al., Tackling climate change through livestock: A global assessment of emissions and mitigation opportunities (Rome: Food and Agriculture Organization of the United Nations (FAO), 2013).

[iv] ClimateWorks original modeling based on Contribution of the land sector to a 1.5 °C world (Nature Climate Change 2019); Key determinants of global land-use projections (Nature Communications 2019); and Reducing food's environmental impacts through producers and consumers (Science 2018).

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ALTERNATIVE PROTEINS: A FOOD & NATIONAL SECURITY SOLUTION

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