Global Food System Transition is Necessary to Keep Warming Below 1.5°C

Opportunities for Alternative Proteins

CLIMATE ADVISERS

Good Food Institute

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Introduction

To meet the Paris Agreement's 1.5°C target and to protect forests and other critical ecosystems that serve as carbon sinks, a global food system transition is necessary. Even if fossil fuel emissions were immediately halted, global protein production alone would make meeting the Paris Agreement's 1.5°C target impossible.[i]

A protein transition has the potential to deliver **14 to 20 percent of the emissions mitigation** the world needs until 2050 to stay below **1.5° C**.[ii] This amounts to **10 to 14 gigatons of CO2-eq per year** of emissions mitigation compared to business as usual by 2050.[iii] Such a protein transition will also accelerate natural climate solutions by freeing hundreds of millions of hectares for conservation and climate-focused land management. This could be an area equal to one-quarter of the lower 48 U.S. states in size and would remove an additional five gigatons of carbon dioxide per year from the atmosphere.[iv] This protein transition includes increasing the greenhouse gas efficiency of existing protein production systems and making healthy and sustainable food options far easier to access, in part by accelerating the growth of alternative proteins.

Rationale for Alternative Proteins

THE PARIS AGREEMENT'S 1.5°C TARGET REQUIRES RAPID AND AMBITIOUS FOOD SYSTEM CHANGES

- **The global food system causes 34 percent of global greenhouse gas emissions, and half of this is attributable to today's system of protein production.**[v] This amount exceeds total U.S. emissions from all sectors. Food system emissions stem from deforestation for livestock and feed production, emissions from feed crops, and direct emissions, including methane and nitrous oxide.[vi, vii] About 30 percent of global methane emissions come from ruminant methane and manure.[viii]
- Historically, demand for meat has risen as a function of per capita GDP. Between 2020 and 2050, global demand for meat is forecast to increase 40 to 100 percent. The vast majority of this rise will occur in major economies, particularly middle income countries.[ix]
- If there were no change in meat production methods, such an increase would cause an additional 5 to 10 gigatons CO2-eq per year of emissions from livestock and related activities alone.[x]

> Today's systems of protein production cause roughly half of all food system emissions — an amount that exceeds total emissions in the U.S. from all sectors.

ALTERNATIVE PROTEINS ARE THE RARE LAND SECTOR MITIGATION SOLUTION THAT CAN SCALE TO MEET 1.5°C

- Led by the livestock sector, today's protein production systems are the single largest anthropogenic use of land and driver of deforestation.[xi] Protein systems, including grazing and feed crop production, use 70 percent of all agricultural land and 30 percent of the land surface of the planet.[xii]
- Alternative proteins can play a leading role in the global protein transition by significantly reducing food system emissions while freeing up considerable amounts of land for additional climate mitigation strategies, food security, and protection of biodiversity.
- Like solar panels, lithium-ion batteries, and electric vehicles, alternative proteins can supply enormous greenhouse gas reductions if widely used. Governments can catalyze innovations that enhance the quality of plant-based and cultivated meat and seafood while starting these products down the cost curve where costs fall as volumes rise.
- Plant-based and cultivated meat and seafood concentrate energy use in the manufacturing facility. In addition to eliminating meat's methane and nitrous oxide emissions from ruminant digestion and manure decomposition, alternative proteins are the land and agriculture sector's way to "electrify everything." As Bill Gates notes in his new book, "Cultivated meat has all the same fat, muscles, and tendons as any animal… All this can be done with little or no greenhouse gas emissions, aside from the electricity you need to power the [plants] where the process is done."
- Instead of using land to grow crops to feed animals and additional land to raise the animals, crops can be used directly to make plant-based meat and cells can be cultivated into meat in a production facility with minimal land footprint.
- Plant-based meat uses up to 99 percent less land than conventional beef and cultivated meat could use 95 percent less land than conventional beef.[xiii] In both cases, innovations will make alternative proteins even more efficient as they scale up.
- The land spared can reduce deforestation and free up land for regenerative agriculture and ranching practices, natural climate solutions, production of renewable energy, and protection for biodiversity.[xiv]
- Alternative proteins' scalability, enormous mitigation potential, capacity to reduce pressure on forests, and co-benefits for food security stem in large part from their massive land use efficiency advantages over conventional meat.



Photos courtesy of Beyond Meat

WHAT ARE ALTERNATIVE PROTEINS?

There are two primary types of alternative proteins: plant-based and cultivated.[xv] Just as the goal with renewable energy is to make it interchangeable with conventional energy, so too plant-based and cultivated meat are 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.[xvi]

- **Plant-based meat, seafood, eggs, and dairy** are made from plants and mimic the taste and texture of animal-based products. The products are focused on fully satisfying meat-eaters and are not designed for vegetarians or meat-reducers. Because their production is so much more efficient, as they scale, they should be able to compete on price.
- **Cultivated meat and seafood** is real animal meat cultivated directly from animal cells. The resulting meat is identical to conventional meat, and as with plant-based meat, scale-up should allow prices to come down such that it will compete in the marketplace with conventional meat.[xvii]

Alternative proteins are designed to replace conventional meat, seafood, eggs, and dairy 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 consumers in the near future.

ALTERNATIVE PROTEINS CAN PROTECT MARINE AND OTHER AQUATIC RESOURCES

- Many wild fisheries are already harvested at maximum capacity. The inability of aquaculture to produce some key species of fish and projections for a slowed rate of growth of the aquaculture industry in coming years combine to produce a severe gap between supply and demand.[xviii]

- The development and widespread commercialization of plant-based and cultivated seafood — including products that incorporate sea vegetables — can alleviate pressure on wild fisheries and even aquaculture systems.
- Thus, there is an urgent and sizable need for altogether new approaches to meet the increasing global demand for seafood. Public research to support advances in food technology and commercial innovation can drive market-based solutions in the form of alternative seafood, providing consumers with delicious, affordable, and nutritious seafood products without species depletion, environmental degradation, and habitat destruction.
- By reducing agricultural land use and inputs, alternative protein can limit water withdrawals, improve water quality, and reduce ocean pollution and degradation driven by agricultural runoff.[xix]

ALTERNATIVE PROTEINS ALSO OFFER CRUCIAL GLOBAL HEALTH BENEFITS

- Covid-19 caused the worst global recession since World War II, and nearly one-third of small businesses in the United States have closed since January 2020.[xx] The United Nations Environment Programme has found that one of the most likely causes of the next pandemic, potentially even more lethal than Covid-19, is animal protein production.[xxi] Plant-based and cultivated meat production have no chance of causing another pandemic, since they do not involve live animals.
- Over 70 percent of all antibiotics are used for conventional animal agriculture.[xxii] This widespread use of antibiotics is leading to more and more antibiotic-resistant superbugs that already kill between 500,000 and 700,000 people a year— and the rate of multidrug resistance is growing worse in low and middle income countries.[xxiii, xxiv] By 2050, it is estimated that these superbugs could kill 10 million people per year and cost the global economy more than $8 trillion per year.[xxv, xxvi] Alternative proteins require no antibiotics, so their risk of contributing to antibiotic resistance is also zero.
- By reducing the land footprint of food, alternative proteins can drive down the cost of achieving food and nutrition security.
- First generation alternative proteins often offer slight nutritional advantages over their conventional counterparts. Moving forward, alternative proteins have high potential to continue to improve their nutritional profile.

International Policy Agenda

Market reports predict a steady rise in plant-based and cultivated meat consumption in developed economies as they reach price and taste parity with conventional meat.[xxvii] However, until they reach price and taste parity, these products will stay niche.

There is a great deal to be done at the international level. The potential contribution of alternative protein to meet the goals of the Paris Agreement remains poorly understood. For example, no intergovernmental assessment of the mitigation potential of alternative proteins has occurred. Moreover, there is no agreed diplomatic forum where nations can have sustained discussions about innovations to accelerate alternative proteins, be they of a scientific, policy, or commercial nature. This is in sharp contrast to other climate-friendly technologies, such as batteries and renewables, which are discussed regularly in the Clean Energy Ministerial (CEM) , Mission Innovation partnership, and in other more traditional energy innovation platforms. The United States has not promoted bilateral or plurilateral programs on alternative proteins via diplomatic or foreign assistance channels. There are no agreed best-practice policies for alternative protein science, R&D, or commercialization.

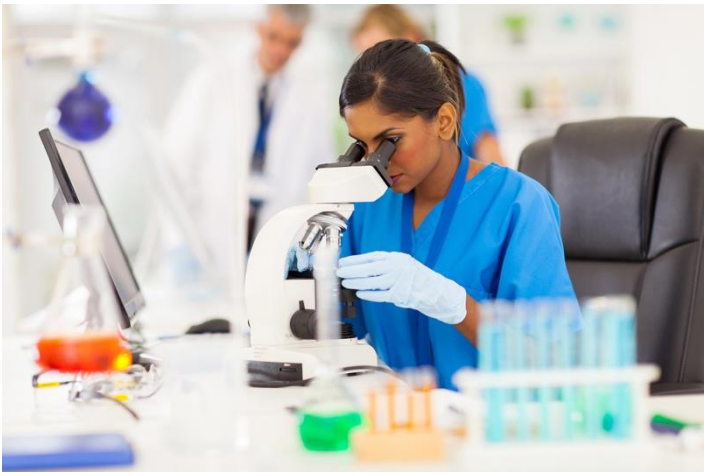
Breakthrough Energy suggests that the world's leaders must act now to (1) fund open-access science, (2) incentivize private sector R&D, and (3) support plant-based and cultivated meat infrastructure and manufacturing.[xxviii] We believe that these are the right international priorities. Enormous potential exists for collaboration with like-minded countries. A number of significant economies have expressed interest in exploring protein transition diplomacy. This includes reliable climate champions [such as **Norway, Germany,** and the **United Kingdom**, as well as **The Netherlands** and **Denmark**]. It also includes countries that are already major protein suppliers such as **Brazil**. Brazil sees becoming a global leader on alternative proteins as a business opportunity, a Paris Agreement implementation strategy, and a risk mitigation strategy as consumers shift away from animal protein. Several emerging nations concerned about food security (such as India and China) could also welcome international collaboration on alternative protein. **Israel** and **Singapore** are leaders in alternative protein technology. These nations would welcome international collaboration in this area for both environmental and commercial reasons.

> Between 2020 and 2050, global demand for meat is forecasted to increase 40 to 100 percent.

Three Steps the United States Can Take to Kickstart International Cooperation

1. COMMISSION SCIENTIFIC ASSESSMENTS

A multilateral scientific assessment of the protein transition should be conducted. This assessment could be done globally via the United Nations (UN) by integrating the global protein transition into ongoing climate science work. UN players that might be involved include: the UN Sustainable Development Solutions Network, UN Food and Agriculture Organization, the World Food Programme, the UN Environment Programme, the World Health Organization, the World Bank, and the Intergovernmental Panel on Climate Change. Alternatively, the Biden administration could ask the National Academies of Science to work with its international counterparts in the International Academies Partnership to develop a multi-country scientific assessment. The Biden administration could also ask the National Science Foundation and/or Department of Agriculture to undertake a study with science and agriculture agencies in Europe. Topics could include:



- Greenhouse gas mitigation potential as well as co- benefits such as conservation, food security, public health potential, and ocean health.
- Assessment of innovation needs: cost, taste, and nutrition innovation needs and how to meet them.
- Economic impacts: growth, job creation potential, value of innovation for 1.5° C, returns to public investment, socio-technical protein transition scenarios (what must be built, when, and what will it cost).[xxix]

2. INTEGRATE ALTERNATIVE PROTEINS INTO MISSION INNOVATION AND THE NEW AGRICULTURE MINISTERIAL, AGRICULTURE INNOVATION MISSION FOR CLIMATE (AIM for Climate)

The world needs a diplomatic forum to promote innovation and policy best practices among countries. This ministerial could be housed as a working group within Mission Innovation provided that partnership expands its scope beyond energy. Additionally, alternative proteins should be integrated within the newly created Agriculture Innovation Mission for Climate (AIM for Climate). Alternatively, the CEM could create a new working group on forests, food, and land. Under any of these approaches, the United States could be represented internationally either by the State Department or, for more technical discussions, by the Department of Agriculture and the National Science Foundation. Creating a new forum for international collaboration on climate-friendly forest, food, and land strategies would help increase climate ambition broadly in this vitally important but neglected sector, while also providing a home for international collaboration on alternative proteins specifically.

> Alternative proteins should be integrated within the newly created Agriculture Innovation Mission for Climate (AIM for Climate).

3. FUND AND FINANCE THE PROTEIN TRANSITION

- Increase funding for food and agriculture innovation by 50 percent and devote a portion of this funding to alternative proteins.
- Carve out 10 percent of forest finance for the protein transition.
- Make alternative proteins an integral part of the U.S. Agency for International Development (USAID) strategy.
- Set aside funding for alternative proteins in the Green Climate Fund.
- Leverage the protein transition to help achieve the U.S. International Development Finance Corporation's (DFC) climate goals.
- Carve out a portion of the American Jobs Plan, President Biden's infrastructure plan, to support innovation in the protein transition: Public investment in research will stimulate economic growth and create jobs.
- Launch research and development (R&D) partnerships: Bilateral or plurilateral R&D partnerships between and among leading countries that would advance global alternative protein science, innovation, and diffusion to ensure that alternative protein products can compete with animal sources. Innovation and commercialization partnerships could focus on Brazil, Israel, Singapore and Europe. Partnerships to build awareness and capacity in major emerging nations might begin with India and China.

In addition to spearheading these international collaborations, the United States should lead by example and take action at home, including doubling agriculture innovation spending and devoting some of this increased funding to alternative proteins, setting a food and agriculture target in the nationally determined contributions (NDCs), and as noted above, include protein transition research and innovation in the American Jobs Plan.

Conclusion

Governments that invest in alternative protein science, innovation, and commercialization will become global leaders in reducing agricultural emissions, improving human health, protecting biodiversity, and increasing food systems resilience. As the world's foremost leader in alternative protein innovation, the United States should become the global leader in promoting international cooperation in this area. Doing so would make an enormous contribution to meeting the long-term goals of the Paris Agreement while also advancing U.S. economic interests and global sustainable development.

FAQs

ARE ONLY HIGH-INCOME COUNTRIES LIKE THE UNITED STATES INTERESTED IN ALTERNATIVE PROTEINS?

No. Interest in alternative proteins is growing rapidly around the world, including in low and middle income countries. For instance, the world's first cultivated meat research center was created in Maharashtra, India; plant-based meat, egg, and dairy products are available in 800+ locations in Sub-Saharan Africa via Infinite Foods; and the Brazilian government and Amazonas State are collaborating with GFI-Brazil to connect indigenous crops with the rapidly growing alternative protein sector and spare the rainforest from further environmental harm.

WILL ALTERNATIVE PROTEINS PUSH PEOPLE IN LOW AND MIDDLE-INCOME COUNTRIES AWAY FROM TRADITIONAL VEGETARIAN DIETS INTO MORE GREENHOUSE-GAS INTENSIVE DIETS?

Highly unlikely. Consumers of traditional vegetarian diets are extremely unlikely to want to eat alternative proteins that taste like meat, egg, and dairy. There is very little risk of tempting this population to switch from traditional vegetarian foods to alternative proteins. However, for much of the world, increasing meat consumption is aspirational. As incomes rise, meat consumption also increases, and alternative proteins can help fill this gap with significantly less impact on the climate, forests, and oceans than conventional animal products. In order to increase global access to alternative proteins, infrastructure investments in low and middle income countries are needed, particularly cold-chain technology.

Of course, animal-sourced foods will remain an important component of diets in populations with significant burdens of undernutrition. As much as possible, and over time, producing those products using cultivation can lessen adverse climate impact.

WHAT U.S. FEDERAL AGENCIES ARE CURRENTLY INVOLVED IN ALTERNATIVES PROTEINS?

In 2020, both the National Science Foundation (NSF) and the U.S. Department of Agriculture (USDA) awarded alternative protein open-access research grants — $3.55 million to fund cultivated meat research and training at the University of California Davis and nearly $500,000 each to plant-based meat researchers at the University of Massachusetts Amherst and Purdue University. In addition, the Department of Energy has provided grant funding to at least one alternative protein company, and NASA has funded cultivated meat research.

Climate Advisers works to strengthen climate action in the United States and around the world through research, analysis, public policy advocacy and communications strategies. We partner with governments, non-profits, philanthropies, international organizations, financial institutions and companies to help deliver the clean economy. We develop and promote sensible, high-impact initiatives that improve lives, enhance international security and strengthen communities. Climate Advisers currently consists of several independent organizations collaborating to advance the same mission, including: Climate Advisers Trust, a U.S. non-profit, Climate Advisers United Kingdom, a U.K. non-profit, and Climate Advisers Incorporated, a global consultancy. Further information is available at climateadvisers.org

The Good Food Institute (GFI) is a 501(c)(3) nonprofit working internationally to make alternative proteins delicious, affordable, and accessible. GFI advances open-access research, mobilizes resources and talent, and empowers partners across the food system to create a sustainable, secure, and just protein supply. Further information is available at gfi.org.

[i] Clark, MA, et al. Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets (Science 2020).

[ii] 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).

[iii] This mitigation potential includes emissions reductions from reduced deforestation for livestock and feed production, reduced emissions from feed crops, and reduced direct emissions from the sector. It does not include carbon removals or sequestration. These measures would also facilitate enhanced removal at the rate of at least 5 Gt CO2 per year.

[iv] The carbon opportunity cost of animal-sourced food production on land (Nature Sustainability 2020).

[v] Crippa, M et al. Food systems are responsible for a third of global anthropogenic GHG emissions (Nature Food 2021).

[vi] P.J. Gerber et al., Tackling Climate Change Through Livestock: A Global Assessment of Emissions and Mitigation Opportunities, FAO (2013).

[vii] Inventory of U.S. Greenhouse Gas Emissions and Sinks, EPA.

[viii] Those who worry about CO2 should worry about methane, too (The Economist 2021).

[ix] World Livestock 2011: Livestock in food security, FAO (2011).

[x] This was calculated by increasing 2012 emissions (7.1 gigatonnes CO2-eq) by 52 percent to estimate 10.8 gigatonnes CO2-eq in 2050. P.J. Gerber et al.,Tackling Climate Change Through Livestock: A Global Assessment of Emissions and Mitigation Opportunities, FAO (2013).

[xi] Song, X. P. et al. "Global land change from 1982 to 2016". Nature vol. 560, 2018, pp. 639–644.

[xii] FAO, Livestock's Long Shadow, 2006. http://www.fao.org/3/a0701e/a0701e.pdf

[xiii] The Good Food Institute, Plant-based meat for a growing world & Cultivated meat LCA and TEA: Policy recommendations

[xiv] Benton, T. et al. Food System Impacts on Biodiversity Loss, Chatham House (2021).

[xv] Fermentation is another form of alternative protein production that is often associated with plant-based. 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.

[xvi] See, e.g., The Good Food Institute explanations: plant-based, cultivated, fermentation-derived.

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

[xviii] Cai, J. and PingSun Leung. Short-term projection of global fish demand and supply gaps, FAO (2017).

[xix] The Good Food Institute, An ocean of opportunity (2019).

[xx] Percent Change in Number of Small Businesses Open, Opportunity Insights Economic Tracker (2021).

[xxi] Preventing the next pandemic - Zoonotic diseases and how to break the chain of transmission, UN Environment Programme and International Livestock Research Institute (2020).

[xxii] Ritchie, H. How do we reduce antibiotic resistance from livestock?, Our World in Data (2017)

[xxiii] Jacobs, A. Denmark raises antibiotic-free pigs. Why can't the U.S.? (New York Times 2019).

[xxiv] Van Boeckel, T.P. and Ramanan Laxminarayan. Global trends in antimicrobial resistance in animals in low- and middle-income countries (CDDEP 2019).

[xxv] No time to wait: Securing the future from drug-resistant infections WHO (2019).

[xxvi] O'Neill, J. Antimicrobial resistance: Tackling a crisis for the health and wealth of nations (Review on Antimicrobial Resistance 2014).

[xxvii] Global plant-based and cultivated meat market projections include: BCG: 22% of market share by 2035 with supportive regulation and tech developments; Barclays: 10% of market share by 2029; Jeffries: 9% of market share by 2040; Kearney: 60% of market share by 2040.

[xxviii] Alternative Proteins - Research and Development, Breakthrough Energy (2021).

[xxix] Andlinger Center for Energy and the Environment, The Net-Zero America Project.