An Extension Guide to Alternative Proteins

NC STATE EXTENSION

What are alternative proteins?

Our bodies need protein to stay healthy. Protein helps build muscles, heal injuries, protect from illness, and keep our bodies working properly. "Alternative proteins" are made to look and taste like conventional animal protein products, such as burger patties, chicken nuggets, dairy products, and even fish and eggs. They are used in traditional main course foods like conventional meat and seafood, or consumed like dairy. What makes these proteins “alternative” is that they are not made from farmed or wild-caught animals or fish. Instead, they come from:

- Farm-grown crops, such as beans or peas
- Fermentation processes using microbes and ingredients from plants
- Animal cells that are cultivated in food production facilities

Among the three main types of alternative proteins, plant-based and fermentation-made products are already available on the market (e.g., plant-based burgers made from pea protein). Cell-cultivated products (e.g., cell-cultivated salmon) are still emerging and only available in a select number of restaurants in the U.S. Overall, the products available in stores today can complement other conventional proteins on our plates to diversify our diets.

Alternative Protein Sources

- **Plants**: Plant-based proteins are derived from plant sources. There are different types of plant-based proteins: those considered more "traditional" plant-based proteins (like beans, lentils, tofu, and tempeh), and the more novel "alternative" proteins that are extracted from crops like soybeans, yellow peas, wheat, and lentils, but mimic the look and taste of conventional protein products.
- **Microorganisms**: Fermentation-based proteins are produced using microorganisms, such as fungi (e.g., yeast) or bacteria, that are food-safe. Among the various types of fermentation processes, “precision fermentation” is one that utilizes microorganisms engineered to produce a specific ingredient found in plants or animal products, such as milk proteins like whey. Precision fermentation is not a novel technology; it has been used for decades to produce, for example, rennet for making cheese, vitamin B12 used in supplements, and insulin used as a drug for people with diabetes.
- **Animal cells**: Cell-cultivated (or cell-cultured) protein products are made from real animal cells grown in a controlled environment in U.S. Food and Drug Administration (FDA) and U.S. Department of Agriculture (USDA)-regulated food production facilities. These facilities use similar equipment to that used for producing other foods and beverages, such as brewing beer.

Conventional agriculture is an important source of raw materials, as the nutrient broth used to grow cells uses plant-based ingredients. Furthermore, crops such as soy, pea, corn, or wheat are typically used as ingredients in cell-cultivated meat to enhance texture, maximize nutrition, and improve taste and affordability.

Agricultural stakeholder

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How can alternative proteins diversify food choices?

Our world now has more than 8 billion people and is continuing to grow in size (United Nations, 2024 *[https://www.un.org/development/desa/pd/world-population-prospects-2024]*). We need to make sure that our food systems can supply enough affordable, nutritious food to feed a growing population. Conventional agricultural practices are facing increased challenges to meet growing demands for meat and seafood due to limited land, water, and nutrient resources, among other constraints (Cole et al., 2018 *[https://www.nature.com/articles/s41538-018-0021-9]*). Thus, additional sources of protein can be an important part of a more diversified global food system in addressing growing food and nutritional security concerns.

Additionally, many people want food choices that can help protect the environment. Plant-based, fermentation-made, and cell-cultivated proteins may offer an option to reduce land use, water consumption, agricultural fertilizers consumption (including phosphorus and nitrogen), and greenhouse gas emissions (Sinke et al., 2023 *[https://link.springer.com/article/10.1007/s11367-022-02128-8?utm_source=getftr&utm_medium=getftr&utm_campaign=getftr_pilot&getft_integrator=sciencedirect_*

contenthosting]; Rubio et al., 2020 *[https://pmc.ncbi.nlm.nih.gov/articles/PMC7722853/]*; Eastham & Leman, 2024 *[https://www.sciencedirect.com/science/article/pii/S2214799324000729]*; Hilgendorf et al., 2024 *[https://www.sciencedirect.com/science/article/pii/S095816692400020X]*).

From a dietary perspective, non-animal proteins can support health. Plant-based proteins often have nutrient-dense or healthful characteristics, such as containing fiber, being cholesterol-free, and having less saturated fat than meat (Physicians Association for Nutrition & Good Food Institute [GFI], 2025 *[https://pan-int.org/news/blog-post-title-one-h42r8-4z5ks-txgfj-4k9db-pxn4x-cnrwj-ze6ad-e2dzh-kfspk-r47b3]*). Some people - like vegetarians and vegans - avoid meat or other animal products completely and/or prefer more animal welfare-oriented protein options. Others (such as flexitarians) may want to incorporate more plant-based meals into their diet without giving up meat entirely. Alternative proteins are another option to help these individuals meet their protein needs while aligning with their personal beliefs and preferences.

Cell-cultivated burger by Mosa Meat

Attribution: Photo provided by Tim van de Rijdt from GFI's Cultivated Meat Image Library

Cell-cultivated salmon by Wildtype

Attribution: Photo provided by Arye Elfenbein from GFI's Cultivated Meat Image Library

Are alternative proteins regulated for safety?

Yes, all foods sold in the U.S., including alternative proteins, must meet safety standards (FDA, 2024 *[https://www.fda.gov/food/food-additives-and-gras-ingredients-information-consumers/understanding-how-fda-regulates-food-additives-and-gras-ingredients]*). Plant-based and fermentation-derived proteins are overseen by the FDA and must be labeled as such. This is particularly important if they contain allergens like soy or wheat. Cell-cultivated proteins go through a rigorous regulatory process with the USDA and/or FDA to ensure safety, accurate labeling, and consumer transparency (USDA, 2023 *[https://www.fsis.usda.gov/policy/fsis-directives/7800.1]*).

Plant-based meat

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How can alternative proteins contribute to the resiliency of national food supplies?

A more diverse food supply increases U.S. resilience to disruptions—whether from climate events, trade disruptions, or geopolitical tensions. The U.S. is a global leader in developing alternative proteins, as evidenced by substantial private investments and a range of companies (including many start-ups) working in this space (GFI, 2025a *[https://gfi.org/wp-content/uploads/2025/04/2024-State-of-the-Industry-Cultivated-meat-seafood-and-ingredients-GFI.pdf?_gl=1%2Ant0r5d%2A_up%2AMQ..%2A_ga%2ANjM3NDEzODU3LjE3NTIwMDEwOTc.%2A_ga_TT1WCK8ETL%2AczE3NTIwMDEwOTUkbzEkZzEkdDE3NTIwMDExOTMkajU3JGwwJGgw]*). This sector has the potential to enhance U.S. economic competitiveness and food resiliency by fostering innovation and creating jobs. The bipartisan National Security Commission on Emerging Biotechnology (NSCEB) warned that the U.S. risks falling behind without a strong national strategy in biotechnology, which overlaps with the development of alternative proteins (NSCEB, 2025) *[https://www.biotech.senate.gov/final-report/chapters/]*. Advancing alternative proteins alongside conventional agriculture can help build a stronger, more resilient food system.

What should consumers know?

Consumers should be aware of the potential benefits and uncertainties associated with alternative proteins. As mentioned earlier, alternative proteins offer several benefits related to nutrition, environmental sustainability, and consumer preferences. Many safe and nutritious alternative protein products are already available in supermarkets.

At the same time, research and policy around alternative proteins continue to advance, and ongoing studies will help deepen our understanding of long-term nutritional impacts. Some people have expressed concerns about the degree to which alternative proteins are processed or whether they are considered “ultra-processed” foods - foods that typically contain high amounts of salt, fat, or added sugar and food additives. Like conventional meat, cell-cultivated meat can be used as an ingredient in ultra-processed foods. Some plant-based protein products undergo extensive processing and may contain high amounts of sodium or additives. However, they also typically provide fiber, contain no cholesterol, and have lower saturated fat levels compared to conventional meat and foods that have typically been labeled as ultra-processed (Physicians Association for Nutrition & GFI, 2025 *[https://pan-int.org/news/blog-post-title-one-h42r8-4z5ks-txgfj-4k9db-pxn4x-cnrwj-ze6ad-e2dzh-kfspk-r47b3]*).

Additionally, while there is already a firm indication of the environmental benefits of alternative proteins, more studies are still needed to confirm the impacts of some of these products, many of which are still in early stages of development. Also, while growing meat from cells is still relatively expensive, ongoing innovations in manufacturing technology are steadily paving the way toward more affordable products.

What should farmers know?

Farmers play a crucial role in this food ecosystem, including the development and production of alternative protein products. Many raw materials for alternative proteins come from agriculture. Both conventional and alternative protein sources may contribute to strengthening national and global food security and economic development. At the same time, further investigations are still needed to understand the full range of impacts on agricultural communities.

Rather than replacing conventional livestock production, alternative proteins can serve as a complementary approach that expands the scope of protein availability and market opportunities, as alternative protein processes utilize U.S.-grown agricultural inputs, such as corn and soybeans. Additionally, these technologies may offer new opportunities for utilizing agricultural side streams like straw, leading to new revenue streams (Charteris & le Coutre, 2025 *[https://doi.org/10.1016/j.fufo.2025.100726]*; Zhang et al., 2024 *[https://onlinelibrary.wiley.com/doi/pdf/10.1111/gcbb.13120]*). Open and ongoing dialogues between policymakers, farmers, and industry will be essential to creating a food system that respects agricultural heritage while embracing innovation.

Will alternative proteins replace traditional livestock products in the food supply?

No, alternative proteins are not expected to replace traditional livestock products in the food supply. Rather, they may expand the number and type of food proteins available for consumers. Further, global meat consumption is expected to continue to increase in the coming years and decades (Food and Agriculture Organization of the United Nations, 2018 *[https://www.fao.org/global-perspectives-studies/food-agriculture-projections-to-2050/en]*). Alternative proteins can supplement the supply chain and help meet the growing demand for protein. Livestock production will continue to be vital to the food supply, and alternative protein production is expected to lead to new jobs being created in the U.S. to build, operate, manage, and grow this industry.

Currently, alternative proteins hold a small market share compared to conventional animal protein products. For plant-based protein, the retail market was estimated to account for 1.7% of total retail packaged meat dollar sales in the U.S. in 2024 (GFI, 2025b *[https://gfi.org/wp-content/uploads/2025/06/State-of-the-Industry-Plant-based-meat-seafood-eggs-dairy-and-ingredients-GFI.pdf]*). About 80% of total protein consumption comes from animal and dairy sources, according to a 2022 food forum organized by the National Academies of Sciences, Engineering, and Medicine (2022 *[https://doi.org/10.17226/26923]*). Approximately 20% of consumers have purchased plant-based alternative meat, with 12% buying it multiple times (Neuhofer et al, 2022 *[https://www.nature.com/articles/s41598-022-16996-5]*). Furthermore, cell-cultivated meat is still in the early days of development. Some estimates suggest that by 2030, cell-cultivated meat could supply 0.5% of the world's meat (McKinsey, 2021 *[https://www.mckinsey.com/industries/agriculture/our-insights/cultivated-meat-out-of-the-lab-into-the-frying-pan]*), and others suggest a considerably lower proportion (Dullaghan & Linch, 2022 *[https://forum.effectivealtruism.org/posts/2b9HCjTiFnWM8jkRM/forecasts-estimate-limited-cultured-meat-production-through]*; European Parliament: Directorate-General for Parliamentary Research Services, 2024 *[https://www.europarl.europa.eu/RegData/etudes/STUD/2024/757806/EPRS_STU(2024)757806_EN.pdf]*). Looking forward, as global demand for protein continues to rise, both traditional livestock production and alternative proteins will play important complementary roles in our food system.

Farmer and agronomist

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Where can I learn more?

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Publication date: Oct. 9, 2025

This publication printed on: Oct. 14, 2025
URL of this page *[http://content.ces.ncsu.edu/an-extension-guide-to-alternative-proteins]*