Science Societies

Plant-based proteins: Good for you and the planet

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Plant-based proteins like pulses and legumes offer major health and environmental benefits, but the industry relies on too few crop species and needs greater investment and diversification to meet growing global demand

> sustainably. Advances in breeding, genetics, and food processing are unlocking opportunities to improve protein quality, reduce anti-nutritional factors, and create better-tasting, affordable products for a more resilient food system.

The plant-based protein industry is growing quickly, thanks to the health benefits, affordability, and environmental perks of crops such as soybeans, chickpeas, lentils, beans, and peas.

The problem is, most commercially available sources of plant-based protein come from just a handful of plant species, about 2% of the 150 plant species that support our global food supply. Diversifying this food supply with more sources of plant-based proteins (with higher disease resistance, insect resistance, protein quality, and yields) will be the key to giving people across the globe nutritious and sustainable foods.

A review in the journal *Crop Science* analyzed consumer perception of plant-based proteins along with manufacturing techniques and breeding strategies being used to meet plant-based protein's growing demand.

An ancient food

Plant-based sources of protein have been in our diets for quite some time. One source of plant protein, "pulse crops," are the dry and edible seeds harvested from legumes (like dry beans, peas, and lentils). These crops have been essential parts of our diet

since the Neanderthals ate them 70,000 years ago. Even today, many cultures across the globe include them in their diets along with oilseeds (like soybeans) and other plant-based sources of protein, especially in South Asia and Africa.

Despite this, meat is the primary source of protein for most people in the western world, and as such, people advocating for more plant-focused diets in the West face some opposition. There is evidence of success, though, such as the way tofu products rose in popularity during the 1970s and how soy milk and almond milk are now widespread in grocery stores.

A mindset shift

There are a few reasons why western consumers are switching to plant-based foods. They are great sources of protein, especially when combined with cereals. They can also improve cardiovascular health, metabolism, and overall gut health while helping prevent obesity, cancer, and diabetes. Consumers with allergies might also be drawn to plant-based products: Lactose-intolerant individuals might choose to drink plant-based milk as an alternative to dairy milk, and people might need to eat plant-based baked goods if they are allergic to eggs.

There are a few reasons why western consumers are switching to plant-based foods. For example, lactose-intolerant individuals might choose to drink plant-based milk as an alternative to dairy milk. Photo courtesy of Adobe Stock/Kristina Blokhin.

In addition to personal health choices, concerns about the meat industry's effect on the environment and animal welfare have prompted a higher demand for plant-based

sources of protein in Europe and the United States. As global populations rise and as climate change exacerbates stress on farms, it is more important than ever to produce sustainable crops. Currently, the meat industry produces more carbon emissions than the entire transportation sector and uses more than 50% of our freshwater resources. Switching to plant-based sources of protein could reduce carbon emissions and water waste. In addition, it's been suggested that shifting away from animal-based foods and towards plant-based foods could increase the global food supply by up to 49% without the need for more croplands.

Pulse crops and legumes can also reduce the amount of pesticides and fertilizers that a farmer needs. Integrating plant-based protein crops onto farms can protect other crops from diseases and pests by increasing biodiversity in fields, which makes it harder for pests and diseases that specialize in killing one kind of crop to spread. Pulse crops can also take nitrogen, an important plant nutrient, out of the atmosphere and into the soil, which further reduces production costs and increases farm income.

The environmental benefits of plant-based diets are especially well-regarded by younger generations. According to the European Institute of Innovation and Technology, 70% of Gen Z consumers think plant-based products will help us achieve global food sustainability.

An industry gap

While we are seeing an increased, worldwide demand for plant-based proteins, the public and private sectors still need to invest more in pulse crops: In a 2021 book, authors compared cereals, oilseeds, pulses, and root and tuber crop production worldwide from 1964 to 2014. They found that the total production area had increased 182% for cereals and 622% for oilseeds but only 68% for pulse crops and 76% for root and tuber crops. In addition, the specific cropping area under pulses only increased by

13.5% during those 50 years. Pulses, despite their potential, seem to be neglected compared with other crops. Historically, private seed companies have not invested in pulse development, and this gap calls for industries and public research teams to invest more in these crops. Pulse crops have great potential, and more research into them will serve stakeholders by further increasing their levels of protein, stress resilience, and environmentally sustainability while decreasing their production cost.

Better breeds

Legumes are already a good source of proteins, fibers, vitamins, and minerals. But there are aspects of their nutritional value that can be improved. For example, the protein quality of most pulses is considered worse than many animal sources of protein because they are an “incomplete” protein—they do not provide enough of the “essential” amino acids that out bodies cannot make alone. Scientists use protein assessments that are scored based on how many amino acids are in the food and how well humans can digest the protein. Higher digestibility means the source of protein is higher quality, and protein quality is another trait that breeders aim to improve in plant-based sources of protein.

"Anti-nutritional factors" found in pulses can be mostly removed by cooking the food thoroughly. Photo courtesy of Adobe

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In addition, plant-based sources of protein have so-called “anti-nutritional factors” that can cause serious damage to your metabolism and gut function. These are compounds naturally found in soybeans and pulses because they defend the plants against insects and diseases, but there needs to be a balance. While these toxins can be mostly removed by cooking the food thoroughly, there are breeding efforts aiming to minimize anti-nutritional factors in plant-based proteins.

All plant traits are influenced by what’s in their DNA. Breeding plants to create crops with desirable traits (like higher yields or higher amounts of protein) is a process that conventionally takes years and lots of resources because you typically need to grow plants in order to see what traits they have. Conventional breeding is also difficult because some traits are controlled by multiple different genes or interactions between a plant’s genes and the environment. Researchers are attempting to understand the genetic map of different pulse crops in order to leverage plant DNA to predict plant traits without the need to physically grow plants first. There are other ways plant breeders are using genetics to advance plant breeding. For example, genetic engineering can transfer beneficial genes into new crop lines. There are a handful of studies attempting these techniques in pulse crops, but there’s a need to try these advancements out with more species and varieties of pulses.

To actually measure protein concentration is another developing scientific field. Researchers are attempting to develop novel, better, and more accurate ways to estimate protein concentration in plants and plant-based products. Conventional methods indirectly measure protein and are limited in sample size. Technology can now aid researchers. Drones, satellites, and light wavelengths can be used to non-destructively sample thousands of plants to observe traits. These methods are used

more and more today to analyze the traits of wheat, rice, and soy crops but should also be adapted for use in more pulse crop breeds.

Plant products

After crops are harvested, they're processed in some way. In addition to plant-based meats, there are many food products you can make out of legumes like pastas, milks, snack foods, baby food, and baked goods. When making plant-based milks or plant-based meats, manufacturers need to extract the plant's protein without compromising its other qualities. Food scientists need to keep in mind the physical and chemical properties of these products that affect consumer perception. This is a continuously evolving process, and scientists are always troubleshooting plant-based products. Elements like color (which affects visual preference), the ability to absorb water and fat (which affects storage and texture), and gelation (which also affects texture) are especially important. The ability of proteins to dissolve, emulsify, and foam also affect how the isolated protein can be used. For example, mung bean protein is very promising because of its high yields and high nutritional value, but limited solubility in water (which can lead to poor mouthfeel and appearance) prevents food scientists from using mung bean to its full potential. Researchers are working through how to best extract mung bean protein so it can be used in more food products.

More opportunities for plant proteins

There are lots of research areas to improve the quality, taste, and digestibility of plant proteins while removing anti-nutrients. These crops are already rich in protein and other essential nutrients, making them promising across the globe. If their full potential is unlocked, that will help many people and the environment. Investing in plant-based proteins is an investment in affordable, great-tasting, healthy food. With the amount of opportunities for research, the outlook for plant-based proteins is promising.

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