THE OFFICE SUMMARIES

THE PARLIAMENTARY OFFICE FOR SCIENTIFIC AND TECHNOLOGICAL ASSESSMENT

June 2025

Proteins: paving the way for the food transition

© Adobe Stock

Proteins, along with fats and carbohydrates, are essential macromolecules required by both humans and animals for a healthy diet.

They play a central role in a wide range of issues, spanning health, environment, technology and society.

Some of these concerns overlap: How can we ensure an adequate protein supply to feed the global population in coming decades? What are the most effective diets for maintaining the right nutritional balance for human health? Animal protein accounts for two-thirds of the human food intake in developed countries. Is this level of production sustainable in an era when greater action is needed to combat greenhouse gas (GHG) emissions? Could synthetic proteins or alternative sources such as insects and algae offer viable solutions? Is it possible to feed livestock with fewer imported protein sources, reducing dependency on these products? Can we shift our consumption habits change and if so, how quickly?

Exploring the characteristics of different protein sources is, in fact, part of a broader debate on food and food production in general. The OPECST report offers a comprehensive overview of the various issues surrounding protein in food and examines potential pathways towards a more sustainable food transition.

Philippe Bolo, Member of the National Assembly

Arnaud Bazin, Senator

What are the quality and quantity requirements for protein in a healthy diet?

The **daily protein requirement for human beings is 0.83 grams per kilogram of body weight**, or 60 grams for someone weighing 72 kg. The daily requirement for babies, children, teenagers, pregnant women and the elderly is slightly higher. Physical activity can also require a higher protein intake.

This **recommendation is easily met in France** where the average daily protein consumption is 1.4 g/kg of body weight. Of this, two-thirds comes from animal sources (meat, milk, eggs, fish and seafood) and one-third comes from plant sources (cereals, legumes, fruit), even though international guidelines recommend a 50/50 plant and animal protein ratio.

The **protein content of different foods varies significantly,** for example, 100 grams of beef provides 24 grams of protein, 100 grams of soy offers 34 grams, 100 grams of durum wheat contains 8 grams, and 100 grams of rice contains 3 grams.

In addition to varying protein content, **the quality of protein also differs depending on the source.** The proteins we consume contain the amino acids required for the body to produce various useful proteins, including enzymes, hormones, transport proteins, and structural proteins. **The body needs 20 amino acids for protein synthesis, 9 of which are classified as 'essential amino acids'** because the body cannot produce them on its own.

However, **not all foods provide the same quantities of amino acids**, and the latter are not always distributed in the same way.

In general, animal proteins contain enough essential amino acids to fulfil the body's needs. On the other hand, **cereals tend to be low in lysine and legumes often lack sufficient amounts of sulphur-containing amino acids** like methionine and cysteine.

Plant proteins therefore typically have lower PDCAAS and DIAAS quality scores compared to animal proteins. This is due to an imbalance compared to a reference protein, as well as their lower digestibility.

Substances such as tannins, phytates and trypsin inhibitors can hinder bioavailability after digestion.

Assessing the quality of food based on protein quality should be done with greater nuance.

First of all, the body's amino acid requirements can be met through **several sources of protein**, by combining cereals and legumes for example.

Next, **individuals do not consume proteins alone, they combine them with other food items that provide other nutrients** such as fats, carbohydrates, minerals, trace elements and vitamins. Milk for example is not only a good source of protein, but also provides vitamins A and B, calcium, potassium and phosphorus. Red meat is rich in haem iron. Fish, seafood, algae and shellfish are more notable for their omega-3 and omega-6 polyunsaturated fatty acids content than for protein.

The excessive consumption of certain nutrients can however have negative effects on health. For example, over-consumption of red meat has been linked to colorectal cancer and cardiovascular disease.

Health is therefore dependent on the overall **food matrix**, combining quantity, quality and variety in the diet, not just focusing on individual protein sources.

Increasing the proportion of plant proteins in the diet is consistent with the goal of staying healthy. A **completely plant-based diet** can provide sufficient quantity and quality of proteins as long as individuals opting for this diet are fully aware of the risks of potential micronutrient deficiencies and take the appropriate vitamin B12, calcium, iron, zinc and sometimes iodine supplements.

Is the environmental impact of protein production sustainable?

Food production is having to satisfy the **needs of a growing population**, exceeding 7.9 billion people in 2022, and expected to surpass 8.6 billion by 2032 and 9 billion by 2050. As living standards rise, there is an increased appetite for animal protein, which further drives demand.

However, livestock farming, the primary source of animal protein, has a significant impact on the environment. It **accounts for 12% of global GHG emissions** due to ***methane (CH_4) emissions*** from ruminant digestion (over a century, methane has a global warming potential that is 28 times higher than CO_2) and ***nitrous oxide (N_2O) emissions*** from liquid manure.

To produce animal protein, the farm animals also need to be fed, requiring farmland. **70 to 75% of the world's farmland** is dedicated to producing animal feed. **On average, it takes 4.9 kg of plant protein to produce 1 kg of animal protein.**

When considering only proteins that can be consumed by humans, **the food conversion ratio of plant protein to animal protein is significantly reduced.** Livestock primarily consumes grass and plant-based by-products such as cattle cake, which are unsuitable for human consumption (85 to 90% of ruminant feed cannot be consumed by people).

Nevertheless, a portion of crops must still be used for animal feed, which reduces the amount of land available for human food production, in a context of stagnating agricultural yields.

The use of additional agricultural land only poses a problem however, when it leads to deforestation or the conversion of natural grasslands into crop fields, which releases carbon into the atmosphere.

The net environmental impact of livestock farming, in terms of GHG emissions, is partially offset by **carbon sequestration in grassland soils.** On average, these soils can store around 760 kg of carbon per hectare per year, which mitigates gross GHG emissions from ruminants by around 30% (3 tonnes of CO_2eq per year for a dairy cow).

Additionally, **adapting livestock feed can reduce enteric emissions from ruminants** by up to 25% according to the French Livestock Institute. **Genetic selection** of herds can also contribute to lowering emissions.

Animal protein generally has a greater environmental footprint than plant protein derived from protein-rich plant products such as soy or nuts.

As a result, **incorporating more legumes** (soy, lentils, chickpeas, beans, broad beans) into diets is an interesting avenue to explore in improving the environmental impact of protein. Legumes are not only rich in protein, but they also offer agronomic benefits because they have the ability to fix nitrogen from the air into the soil, reducing the need for organic or mineral-based nitrogen fertilisers.

Reducing food waste, which accounts for up to a third of all food produced, could also play a crucial role in lowering the impact of food consumption on the environment.

Studies examining the introduction of more plant-based products into the French diet show that rebalancing the ratio of animal to plant proteins, without necessarily adopting a vegetarian or vegan diet, but by reducing the amount of animal protein consumed, is **likely to significantly reduce GHG emissions from food production.**

How do alternative proteins fit into this?

The development of alternative proteins through the use of technology is drawing attention in the world of research, sparking a wave of start-up initiatives.

- **Precision fermentation**

- This is **a well-established technology in laboratories** (for producing casein for example, the main protein in milk).

- The advantages of proteins produced using this method include **faster production**, the ability to **synthesise only the desired protein** (without all the components of a traditional animal product), and a **lower environmental impact** compared to conventional animal farming. However, this needs to be confirmed by more comprehensive life cycle assessments (LCAs) than those currently available.

- **Scaling up this technology to industrial levels remains a challenge**, particularly due to the need for large fermenters and the widespread availability of culture media.

● **Cell culture** (sometimes mistakenly referred to as 'synthetic meat')

- This **technology is still in development**, but has already overcome certain limitations, such as the elimination of foetal bovine serum as a culture medium. It is being explored to replicate products such as duck foie gras, chicken and beef, but reproducing the same textures and tastes of traditional meat products remains a challenge.

- An advantage of using cell culture is that **animals do not have to be slaughtered for food.** It may offer **environmental benefits**, but these still need to be confirmed through detailed LCAs.

- The **production process is complex and can be costly** as it involves creating entire food products rather than just individual ingredients. Scaling up to industrial levels remains a challenge.

- **Marketing authorisations** have been granted in a few countries (Singapore, United States), but widespread commercial use is still far from reality.

● **Insects**

- **Insects are rich in protein and micronutrients**, and have long been consumed by humans in Africa and Asia, although they may also contain antinutrients.

- **Insect production is fast**, relatively **environmentally friendly** and can use the heat from industrial waste and **agricultural waste** as feed for the insects.

- Several insect species are already authorised for human and animal consumption in the European Union.

- Consumer reluctance to eat insects means that they are primarily used for **animal feed**. Insect meal competes with other feed sources, making it less competitive, and contributing to the difficulties faced by start-ups in the sector.

● **Algae**

- It is important to differentiate between **macroalgae**, which are harvested at sea or on the shore (99% of algae production), and **microalgae** (e.g. spirulina), grown on land in ponds for use in food supplements.

- Algae is **rich in protein and micronutrients** and boasts a **notably low carbon footprint**.

- However, algae production remains **underdeveloped and faces challenges** in terms of the availability of algae cultivation areas (coastal farms) and the lack of a processing industry.

While the market for alternative proteins is expected to grow, algae products are currently **more of a supplement than a replacement for traditional proteins.**

Regulatory obstacles need to be overcome before algae can be fully launched on the market. In Europe, producers of novel food must seek marketing authorisation from the European Commission, following evaluation by the European Food Safety Authority (EFSA) as outlined in EU novel food regulations.

Uncertainty about consumer demand is hindering industrial development, which, beyond the research and development phase of a start-up, requires significant resources (public and private funding).

How can we win the battle to change eating habits?

Meat and dairy products are often seen by consumers as noble food products. However, meat consumption in France fell from 90 to 83 kg per person per year between the early 2000s and the early 2020s. Red meat (beef, lamb, mutton) is on the decline, unlike poultry, which continues to rise, and pork consumption is stagnating. Dairy consumption remains high, though there has been a decline in fresh milk, offset by an increase in cheese and ultra-fresh dairy products.

Animal protein therefore continues to play a central role in our diet, despite stagnating food budgets, which have remained at 14% of household expenditure for at least the last decade, compared with 35% in the early 1960s.

The shift towards plant-based diets is progressing, but slowly. Only 2.4% of French people follow a meat-free diet (vegetarians) and only 0.3% do not consume any animal products (vegans). However, flexitarians, who only eat meat occasionally, now represent nearly a quarter of the population. Vegetarianism and veganism are more prevalent among younger generations, suggesting that their proportion of the total population is likely to increase.

The acceptability of changing eating habits is influenced by many factors, including price (which gives plant-based products an advantage), product availability in stores (which still focus on animal products), ease of use (which disadvantages legumes) and taste (meat remains the preferred choice).

Familiarising consumers with new practices, for example by introducing **vegetarian meals** in school canteens, and **promoting the different protein sources** through campaigns as part of the French National Nutrition and Health Programme (PNNS) are among the initiatives to encourage a shift towards a more plant-based diet.

Another challenge is achieving **national self-sufficiency in animal protein** from farm animals, if not in France, then at least on a European scale.

Ruminant farms are only 75% self-sufficient in protein, and livestock farms as a whole are less than 50% self-sufficient. French farms therefore rely on imports of soy, rapeseed and sunflower meal.

Successive 'protein plans' have failed to significantly reduce this dependence. A range of solutions must therefore be called upon, such as maximising coupled aid under the CAP, encouraging the use of fodder legumes and developing varietal research.

The Office's Recommendations

1. Improve knowledge of the full environmental impact of the food we consume

There are existing tools but they need to be fine-tuned. LCAs for alternative proteins will need to be conducted with great precision so that they can be evaluated against traditional protein sources.

2. Set a target for protein self-sufficiency in livestock farming

Achieving this self-sufficiency should be a priority at European level. Lessons can be learned from the shortcomings of past 'protein plans'. Involving Parliament in assessing the strengths and weaknesses of these plans will provide a foundation for more effective and efficient strategies moving forward.

3. Encourage legume production

Legumes have potential for both human and animal nutrition. Research into different varieties is essential, as seed companies have not devoted the same efforts to legumes as they have cereals.

4. Promote the alternative protein ecosystem

These technologies do not pose a threat to our agricultural landscapes or to our culinary traditions. They should be explored, as they represent an expansion of this culture, offering promising prospects in niche and international markets. France should position itself in these markets in order to see a return on the investments made in numerous emerging start-ups.

5. Increase awareness of precision fermentation

This technology is nearing maturity, but it needs to be explained and clear health assessments should be readily available so that the products derived from this process are seen as mainstream ingredients, easily combined with conventional food products.

6. Continue research into cell culture

Although still in development, this technology should not be overlooked, and the public, as future consumers, must have access to detailed and objective information.

7. Safeguard expertise in insect production

Insect production is currently devoted mainly to animal feed, but it remains a sector worth exploring, despite its still very fragile economic model. The expertise developed by pioneering start-ups should be preserved.

8. Improve communication on different protein sources

Food choices are shaped by a multitude of individual decisions. There is still a lack of knowledge about different types of protein, and misconceptions persist. With the release of the next PNNS, public authorities will need to communicate on the importance of consuming a variety of protein sources and the risks of overconsumption.

9. Support protein diversity in foods

To diversify protein sources in the diet, consumers need access to reasonable alternatives that encourage gradual changes. From this perspective, we need to support and continue experimenting with vegetarian meals in school canteens.

10. Avoid demonising meat consumption

Meat consumption should not be demonised because it has its benefits, particularly in terms of protein and micronutrient intake, and remains an integral part of culinary traditions.

National Assembly Report no. 1531 (XVII legislature) – Senate no. 708 (2024-2025)
To view the report:
www.senat.fr/opecst
https://www.assemblee-nationale.fr/dyn/17/organes/delegations-comites-offices/opecst

National Assembly - 101 rue de l'Université - 75355 Paris 07 SP – Tel: 01 40 63 26 81 – Email: secretariat-opecst@assemblee-nationale.fr
Senate - 15 rue de Vaugirard - 75291 Paris Cedex 06 – Tel: 01 42 34 27 20 – Email: opecst-secretariat@senat.fr