# From nuts to kelp: The ‘carbon-negative’ foods that help reverse climate change

By Joseph Poore

3 January 2025

We all know that producing most foods creates greenhouse gas emissions, driving climate change. These emissions come from hundreds of different sources, including tractors burning fuel, manufacturing fertiliser and the bacteria in cow’s guts. Overall, food production contributes a quarter of human caused greenhouse gas emissions.  
  
However, there are some foods that remove more greenhouse gases than they emit, often referred to as “carbon negative” foods. These foods leave the climate better than they found it. Producing and eating more of these could help reduce the carbon impact of our food and, in some cases, restore ecosystems in the process.  
  
When plants grow, they take carbon dioxide (CO2) from the air, but when we (or animals) metabolise these plants, this CO2 usually gets released straight back into the air.  
  
Due to ongoing emissions, however, we need to permanently remove carbon from the atmosphere, storing it deep in the sea, rocks, soil or in trees. There are a few food products and production practices that do this. In fact, it’s already possible to make your entire diet carbon negative, although in today’s world, it would require substantial changes to how most people eat.  
  
Kelp  
  
As kelp and other macroalgae grow, they take in CO2. Parts of the kelp break off and move down to the deep ocean floor where some of that carbon gets stored. These removals are relatively small per kg of kelp, so for kelp-based foods to be carbon negative, the supply chain has to be very carbon efficient, with minimal transport, packaging and processing.  
  
Locally-sourced kelp therefore has the potential to be carbon negative (although this represents the minority of cases today). However, buying kelp may provide an incentive to restore the vast areas of kelp forests that have been destroyed; an environmental benefit that goes beyond mitigating climate change.  
  
Bacterial products  
  
Methane-oxidising bacteria are a group of bacteria found in several different environments which consume methane to get energy. This is very useful because methane is a potent greenhouse gas, with each kg causing 30 times more warming than CO2 over a 100-year timescale.  
  
If we eat these bacteria, we metabolise them, releasing CO2. Therefore, eating products containing these bacteria would convert a potent greenhouse gas (methane) into a far less potent one (CO2). The bacteria also require other nutrients, like nitrogen and phosphorus, but research shows these bacteria can use upcycled nutrient-rich waste streams, such as food waste or animal manure, as a nutrient source.  
  
Products from these bacteria – such as protein powders or meat-replacers – are highly likely to be carbon-negative, although there are none in the shops today. However, in 2023, Finnish Solar Foods launched an ice cream in Singapore which includes a protein made from a different type of bacteria, showing that a market for a bacterial food products could exist.  
  
Blueberries and celery  
  
In wetted peatlands, organic carbon can accumulate faster than it decomposes. A few products can be grown on wetted peatlands, including blueberries, cranberries and celery. Foods grown like this therefore have the potential to be carbon negative, if their supply chains are also made very carbon efficient.  
  
This is not normally the case for fresh blueberries, which are often packaged in plastic and flown around the world from countries like Peru, making them an extremely high-carbon food. While carbon negative peatland products exist, they are very rare and hard to identify in the shops at the moment, but this is another space to watch.  
  
Nuts, olives and citrus  
  
Planting trees on cropland stores carbon. Over the last 20 years the global area of tree nuts has doubled, and much of this expansion has occurred on croplands. Even accounting for the full supply chain, the typical nut product you will buy in the shops today removes around 1.3kg of CO2 per kg.  
  
These removals last until the trees reach maturity, usually at around 20 years. If the trees are used to make long-lasting wood products at the end of their life, this carbon can remain stored for much longer.  
  
Regeneratively farmed food  
  
Many regenerative practices, such as not tilling the soil or planting hedgerows, can increase the amount of carbon stored in soil or in vegetation. For example, British regenerative farming firm Wildfarmed reports removals of 1.5kg of CO2 for each kg of wheat produced by the growers it works with. Some companies with carbon-efficient supply chains already say they have turned their products carbon negative. Gipsy Hill Brewery in London, for example, claims to produce carbon-negative beer, and has done a ...  
  
However, for high emissions foods, such as beef, research has found that regenerative practices are unlikely to achieve carbon negativity. Further, some regenerative practices can increase emissions elsewhere in the food system. For example, an Argentinian farm, where the cattle graze at low intensity amongst shrubland, certified its beef as removing 0.3kg of CO2 per kg. To achieve this, it required 500 sq m (5,400 sq ft) of pasture and cropland per kg of beef. If every beef farm used so much land, we wo...  
  
The need for carbon labels  
  
Overall, it is very hard to identify carbon negative foods today. But this is being solved. Robust carbon monitoring and labelling schemes, that account for the full life-cycle of products, are being rolled out around the world. For example, in New Zealand, farms now need to quantify their greenhouse gas emissions, and in France, the government is planning a national rollout of carbon labelling. Once these schemes are fully in place and backed by regulation, it should be far easier for everyone to identi...  
  
Land-sparing foods  
  
For all the potential of carbon negative foods, they may always only make up a small part of our diets; there just aren’t enough products with carbon negative potential, and regenerative practices probably can’t offset high emissions foods. So, we need other strategies for carbon negativity too.  
  
If we stop farming land, it will likely revert back to forest or natural grassland. So if you can produce the same amount of food with less land, the land that is freed up will likely absorb carbon.  
  
One way to spare land is to increase yields: produce more on the same amount of land. However, yield increases tend to be a few percent per year at most, and nowhere near enough to spare enough land to make a product carbon negative. Something far more powerful is required.  
  
Some products use so much land compared to their alternatives, that swapping away from them can create negative emissions. This is because by sparing land, you are freeing up land for revegetation, which would then absorb carbon from the air. On average, for example, beef uses 100 sq m (1,100 sq ft) of land per 100g of protein, while plant-based foods like beans or tofu use around 5 sq m (50 sq ft) for the same amount of protein.  
  
Carbon Count  
  
The emissions from travel it took to report this story were 0kg CO2. The digital emissions from this story are an estimated 1.2g to 3.6g CO2 per page view. Find out more about how we calculated this figure here.  
  
An analysis using a leading climate model found that if we all stopped consuming animals and permanently swapped to plant-based food, we could return 3.1 billion hectares (seven billion acres) of farmland to forests and natural grasslands. This is an area the size of the US, China, the European Union and Australia combined.  
  
If you looked at our planet from space, it would be transformed. Eight billion tonnes of CO2 would be removed, each year, for around 100 years as vegetation regrew and carbon in the soils re-accumulated. This tremendous amount of carbon removal would offset all of food’s emissions and make our diets carbon negative. Per person, on average globally, our average food related emissions would go from around 2,000 kg of CO2 equivalent (CO2eq) per year to -160 kg CO2eq per year.  
  
While carbon labelling and new technologies are vital for our shift to carbon negativity, swapping from products that use lots of land (generally meat and dairy) to products that use little land (generally plant-based foods) is probably the most effective way to make our diets carbon negative.  
  
Joseph Poore is director of the Oxford Martin Programme on Food Sustainability. He researches the environmental impacts of global agriculture and how to reduce these impacts.

## Questions 14-17

Reading Passage: The article discusses carbon-negative foods and their role in reversing climate change.

Which paragraph contains the following information?

(Write the correct letter, A-H, in boxes 14-17 on your answer sheet.)

14. Reference to the role of agriculture in contributing to global greenhouse gas emissions.

15. Explanation of how kelp helps absorb carbon dioxide.

16. Mention of the need for carbon labelling on food products.

17. Discussion on the limitations of regenerative farming in reducing carbon emissions.

## Questions 18-22

Complete the sentences below.

Choose ONE WORD ONLY from the passage for each answer.

(Write your answers in boxes 18-22 on your answer sheet.)

18. The process of growing kelp results in the removal of \_\_\_\_\_\_\_\_ from the atmosphere.

19. Methane is a potent greenhouse gas that is much more harmful than \_\_\_\_\_\_\_\_.

20. Some food products, such as those derived from bacteria, have the potential to be \_\_\_\_\_\_\_\_.

21. The destruction of kelp forests contributes to the \_\_\_\_\_\_\_\_ of marine ecosystems.

22. The aim of land-sparing strategies is to use \_\_\_\_\_\_\_\_ to reduce carbon emissions.

## Questions 23-26

Look at the following statements (Questions 23-26) and the list of experts below.

Match each statement with the correct expert, A-D.

(Write the correct letter, A-D, in boxes 23-26 on your answer sheet.)

List of Experts

A. Dr. Joseph Poore

B. Climate change researcher at Oxford University

C. Environmental policy advisor

D. Sustainability expert from a global agriculture firm

23. Increasing yields is key to making land use more sustainable.

24. Carbon-negative foods require careful attention to their supply chain.

25. The restoration of kelp forests offers a chance to mitigate climate change.

26. Regenerative farming can be an important tool in reducing the agricultural carbon footprint.

## Questions 27-30

Choose the correct letter, A, B, C or D.

(Write your answers in boxes 27-30 on your answer sheet.)

27. What is the primary reason for the difficulty in identifying carbon-negative foods today?

28. According to the passage, what is the best way to make our diets carbon negative?

29. What does the article suggest about the global impact of a plant-based diet?

30. What is the purpose of carbon labelling on food products?