The race is on to cultivate a seaweed that slashes greenhouse emission from cows, other livestock

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Those concerned with climate change may soon feel less compunction about biting into a cheeseburger.

Researchers have recently discovered that feeding cattle and other livestock a specific type of seaweed—known as Asparagopsis taxiformis—can dramatically reduce the massive amount of planet-warming methane such farm animals burp and fart into the atmosphere.

Scientists from San Diego to Vietnam to Australia are now working overtime to figure out how to best cultivate the underwater plant—which a growing number of private aquaculture companies are seeing as a potential cash cow.

Whether motivated by profits or global warming, the race is on to patent recipes for growing the seaweed and then figuring out how to ramp up production. Global demand is expected to far outstrip the capacity to harvest the subtropical seaweed from the wild.

In California alone there are 1.8 million dairy cows, with farmers of the greenhouse-gas spewing animals facing a state mandate to slash their methane emissions 40% by 2030. Experts also expect that agricultural businesses may adopt the practice regardless of government pressure in order to market themselves as more environmentally friendly.

"Every time I talk about it, I get goosebumps," said Jennifer Smith, a marine biologist at UC San Diego's Scripps Institution of Oceanography, who said she can envision the university spinning off a local start-up to help meet local demand for the seaweed. But first, she has to dial in the recipe.

For several months, Smith has been experimenting in her lab with cultivating the seaweed to, among other things, maximize concentrations of bromoform—the compound that blocks the production of methane in cows, sheep, goats and other ruminant animals.

"This is the sporophyte," she said at her lab in La Jolla, holding one of a dozen flasks filled with the red algae, dancing in aerated seawater. "In this case, the bubbles are not as vigorous, allowing these puff balls to get bigger.

"By just manipulating nitrogen and phosphorous, we have already seen that we can double the concentrations of bromoform in just a week," she added.

The red-colored sporophyte is one of several phases of Asparagopsis. The subtropical seaweed also has a more fleshy stage with long stalks and branches.

Experts are currently debating in which stage to grow the seaweed. The practical considerations include not only the cost of cultivation but its carbon footprint. If growing the seaweed and shipping it to farms generates considerable amounts of greenhouse gas, the process could cancel out the benefits of reducing methane.

Growing Asparagopsis as a sporophyte, for example, would likely require doing so in tanks of sterilized seawater to prevent contamination of the clingy plant material. That means using some form of energy to

pump in air and nitrogen.

As a result, some businesses are focusing on growing the more fleshy form of the plant in the ocean.

"Some people are saying let's grow the sporophyte," Josh Goldman said from Southeast Asia. "That's not that hard to do, but the problem is it's going to be expensive. Our vision of this is the most scalable and lowest cost way is in the ocean, rather than in tanks or pods on land."

Goldman is leading a project dubbed Greener Grazing for Australis Aquaculture, which grows ocean-farmed barramundi sea bass in Vietnam. The company also already grows a seaweed known as Kappaphycus alvarezii, a red algae used as a food additive to thicken or stabilize almond and coconut milk.

Now it wants to cultivate Asparagopsis using nets of "seeded rope" that float several feet below the ocean surface. Goldman said the company hopes to have the process fully developed and in the patenting process by the end of the year. Then the company will not only start industrial-scale cultivation, but potentially sell the nets to other aquaculture businesses.

"We've built the first ever seed bank for the species," he said, "and we've made a number of first significant breakthroughs. When you look at what's this going to add to the cost for a gallon of milk, I think ocean cultivation is going to be the solution long term."

Still, that cost calculation doesn't necessarily take into account the greenhouse gas emissions from flying the seaweed halfway around the world. Growing the seaweed in close proximity to farming operations may require cultivation of the algae on land in tanks, especially because it only grows in subtropical waters.

There's another practical consideration: What if cows don't like eating the seaweed?

So far, all signs are positive. Ongoing research at UC Davis, following a study from the university published last year, has found feeding dairy cows just a small amount of the seaweed can cut methane from the animals by more than 50%. And an earlier trial from researchers in Australia has suggested that with the right levels of bromoform, methane emission from cattle and other livestock could essentially be wiped out.

This would be a major breakthrough since methane is a greenhouse gas many times more potent than carbon dioxide, and livestock account for about 14.5% of climate-warming emissions worldwide, according to the United Nations' Intergovernmental Panel on Climate Change.

However, scientists have said more research is needed before the seaweed can be widely used on farms.

"We're in week seven of a six-month trial," said Ermias Kebreab, an animal science professor at UC Davis. "Last time, we figured out that it works over a short period of time, but we didn't know how long it would last."

Specifically, Kebreab said his research is focused on determining whether the seaweed will have any harmful effects on the animals and if it will change the taste of milk or meat. There's also been some concern that the cows wouldn't like the flavor of the seaweed, but so far a little bit of molasses seems to do the trick.

"If it works it's going to be huge demand," he said. "Right now, we're talking with the dairy industry, but we have to show that it really works before we really engage."

All of this might not have happened without the efforts of Joan Salwen. After two decades as a business consultant for Fortune 500 companies, she took a fellowship in 2015 at Stanford University's Distinguished Careers Institute. Her grandfather raised cattle and sheep when she was growing up in eastern Iowa, and she was interested in exploring themes of sustainable agriculture.

Shortly after getting to Stanford she read a little-known paper on the impacts of Asparagopsis on methane production authored by researchers at James Cook University in Australia and the government's research arm the Commonwealth Scientific and Industrial Research Organization.

After enlisting experts to help her work through the technical aspects of the research, she was awestruck by the potential implications of the findings.

"I knew right away that we needed to know whether this thing was effective on the reduction of gas and safe for animals and humans," she said.

That's when she called up Kebreab at UC Davis. It turned out he was vaguely aware of the paper and interested in looking into the research.

"I asked him if we could help give this thing a ride," Salwen said. "He said I was going to have to support his research financially, which was fine. But the other thing was we were going to have to source the seaweed."

They eventually found a supplier in Australia that was willing to donate some wild harvested seaweed, and have since secured additional sources for roughly $100 a kilogram of dried seaweed.

To fund the effort, Salwen has to date raised close to $1 million from a

number of different organizations, including the Schmidt Family Foundation, the David and Lucile Packard Foundation and the Foundation for Food and Agriculture Research.

Salwen said that while there's some competition to develop cultivation techniques of Asparagopsis, people are largely working together to share information and best practices. She said that those involved see significant room for many different players in what could be a massive new industry.

"This will be like growing corn or soybeans," she said. "There will be a whole lot of people cultivating and building farms. It's not like anyone believes for a second that they could own the production market, so people are really collaborating."