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Responsible Seafood ADVOCATE

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Seaweed farming offers avenue toward greater food security

Responsible Seafood Advocate logo

1 September 2011 Dr. John Forster

Careful site selection, policy and investment are required

Seaweed can be a key part of self-sustaining marine culture systems that produce food, feed and biofuel. Photo courtesy of Paul Dobbins, Ocean Approved.

Even though aquaculture is known as "the world's fastest-growing food-producing sector," its current annual production of about 60 million metric tons (MT) is not even 1 percent of the world's total current food supply.

If aquaculture is ever to contribute more significantly, it must evolve to become an integrated marine agronomy producing macroalgae (seaweeds) as its primary crop. It would then be more like terrestrial agriculture and have the potential to be self-sustaining – growing feed for its own aquatic livestock – and to contribute to future needs for human food by reaching into the vast and under-utilized expanses of the oceans.

Not new

Seaweed-based marine agronomy is not a new idea. In Asia, seaweed farming for food has been developed in several countries over the past 50 years. In China, over 10 million MT of seaweed is now farmed yearly. About half serves as food for the Chinese people, and much of the rest is processed for the extraction of marine colloids. Japan and South Korea are also major growers of seaweed. Japan pioneered the farming of *Porphyra* species, better known as "nori" in Japanese cuisine.

Today, with this experience in Asia and the growing realization that future human needs for both food and energy may exceed our capacity to produce them, people in the West are thinking again about seaweeds as a possible source of both.

How to get there?

Kelp can grow to be known as an “ocean vegetable.” Photo courtesy of Paul Dobbins, Ocean Approved.

But the vision leaves open the question of how we get from here to there. The challenges are formidable and will need policy accommodation and sustained development effort to overcome. From a policy point of view, the idea needs deeper scrutiny as part of the broader food and energy security debate.

Given the likely environmental impacts of agricultural expansion, does the potential for large-scale ocean farming as an alternative merit the effort needed to make it happen? And, if the answer is yes, will people accept that this is a wise and necessary use of some of our ocean space? That is a big question, at least in many Western countries where aquaculture (especially fish farms) in coastal waters has often been contentious. Would the idea of seaweed farms be any less so? No matter that these might be located in areas well offshore eventually, development of the know how will initially need to be done in near-shore locations.

Nor will development be easy. There are big hurdles to overcome to farm in more exposed, deeper waters, yet this is where farms must eventually be if they are to produce on a scale that would add materially to global food production.

There are also challenges related to the supply of carbon dioxide and nutrients to seaweed farms if the plants are to grow optimally. Although there is an overabundance of carbon dioxide in the oceans and also of nutrients in some areas, the rate at which growing plants consume them must be matched by the rate at which they are made available in the water that flows past them. For big plantations, this can be problematic and will call for careful site selection and/or adaptive farm design.

Then there are matters of cost and how to process the raw seaweed to extract maximum value from it. Agriculture has had thousands of years to achieve its present levels of cost efficiency. Farming of seaweeds is new. Advances in farm design and operation, harvesting and processing, and the selection of seaweed strains for optimal performance all lay ahead.

We must be realistic about what might be possible today, but remain farsighted about what may be possible in the future. Activity in three areas suggests that these questions are now beginning to receive the attention they need.

Biofuels

First, there is resurgent interest in biofuel, with seaweed being promoted as a possible biomass source. The U.S. company Bio Architecture Lab, for example, is developing enzymes that will improve the efficiency of converting seaweed biomass into biofuel and has partnerships to commercialize the technology with Statoil in Norway, Empresa Nacional del Petróleo in Chile and DuPont in the United States. As discussed in a recent U.S. Department of Energy report (www.pnl.gov/publications/abstracts.asp?report=308267), this requires seaweed production on a large scale at low cost and, necessarily, the funding and momentum that such partnerships will generate will serve to advance the field in general.

In particular, development may well lead to an emphasis on the recovery of co-products as a means of increasing the value derived from the raw biomass. The most obvious co-product is food, or at least ingredients for animal feed. This is especially the case for co-production of biofuel and aquaculture feeds, because aquatic animal livestock do not need carbohydrate in their feed in the same way that terrestrial livestock do.

Integrated multitrophic aquaculture

A second activity driving development is integrated multitrophic aquaculture (IMTA). Its premise is that nutrients released by farmed fish can be recovered by seaweeds and invertebrates farmed alongside them. In this way, the potential for eutrophication is mitigated, and the productive capacity of near-shore aquaculture areas can be increased.

However, the system relies on external inputs of nutrients in feed. A future marine agronomy would internalize this dependence by growing its own feed ingredients and thereby be self-sustaining. IMTA development is a step toward this – an important one, because its focus on seaweeds will advance our knowledge of how to farm them and how to make best use of them once they are harvested.

As global food demands rise, seaweeds can help meet the need. Photo courtesy of Paul Dobbins, Ocean Approved.

Ocean vegetables

The third development that promises to move this concept forward is the startup of new farms in Western countries to produce seaweeds as “ocean vegetables” for human consumption. This has the advantage that it can be done profitably on a small scale and the merit that it coincides with trends in society toward consumption of less meat and more vegetables.

An example of a company pursuing this idea is Ocean Approved in Maine, USA. With the tagline “Kelp, the Virtuous Vegetable,” it has been selling kelp noodles, kelp slaw and other products to Whole Foods and other specialty stores in the northeastern U.S. for three years.

Starting with seaweed harvested from natural beds off the coast of Maine, it seeded its first farm ropes in 2010. This year it harvested its first farmed product and will shift to all farmed production. It is a small start, but as the first coastal seaweed farm in the United States, it will demonstrate the opportunity and develop the know-how on which a bigger industry can be built.

Increasing human demand

It is worth remembering that 39 years from now, as the United Nations Food and Agriculture Organization projects (www.fao.org/news/story/en/item/35571), we will need to grow 70 percent more food to meet increasing human demand. That is 5 billion MT annually with the use of all the land, freshwater and fertilizer that this implies.

The idea that food might be grown at sea without these inputs is surely something to consider in planning for our future food security. The advances described above are helping to keep that option open. But policy innovations are needed, too, and that calls for a long-term vision of what these early efforts might, one day, be able to achieve.

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