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Algae and Energy

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The extent to which algae contribute to human welfare is often forgotten, ignored or unappreciated. Many types of algae serve as bases in commercially prepared foods and condiments. Algal products are used in cosmetics, textiles, pharmaceuticals and paints. In Asia, algae are often mixed and served with rice and fish to supplement the human diet. In coastal areas of the world, kelps are often chopped as food for livestock. The alga *Poryphyra* is cultivated in Japan to supply a 65 million pound annual market (8).

Although algae contribute significantly to contemporary human welfare in many subtle ways, their roles in future human societies are potentially more significant. In comparison to other photosynthesizers, algae rank high in the conversion of light energy into chemical energy stored in organic molecules. A world-wide, average, organic conversion efficiency of 0.05 per cent is attained with conventional agricultural technology. Animal protein is produced with less than a one per cent conversion efficiency; field crops have a conversion efficiency between one and two per cent; and algae have a conversion efficiency ranging from four to five per cent (2).

At least part of this efficiency is due to the fact that algae grow fairly continuously throughout the growing season, whereas higher plants usually produce the bulk of their organic matter during very brief intervals in their seasonal cycles (17).

Comparative data for the production of several different sources of protein are shown in Table 1.

Table 1. (11)

Comparative Protein Yields in Pounds Per Acre

Algae (*Chlorella*)	55,000
Soybeans	880
Peanuts	420
Beans	370
Peas	353
Oats	253
Milk	90
Meat	54

It has been advocated that algae should be cultivated for the production of organic compounds (3,9). In the United States, 389 million acres of land are devoted to protein production. Assuming current population trends, consumption rates, and food preferences, conventional protein production methods will require 533 million acres of land by the year 2000 (15). Studies indicate that six million acres of algae farms could replace 200 million acres of agricultural land and meet one-half of the protein requirements of the livestock industry (6).

Burlew has proposed that *Chlorella* has a potential dry-weight yield of 17.5 tons per acre (1), with 50 per cent of this yield being marketable protein. Current agricultural technology would require 22 acres of soybeans to produce an equivalent amount of protein (13).

In addition to producing substantial yields of protein, the culture of some algae can improve water quality. Removal of waste products from water supplies is becoming a serious problem in a civilization that consumes 270 million gallons of water per day and will require 600 billion gallons daily by the year 1980 (4). Developing processes to remove and recover nitrogen and phosphorous from water supplies is essential (16). It appears that algae may be able to extract these minerals economically.

Estimates of the cost of production of algal protein range from 25 cents to one dollar per dry-weight pound (10,12,4). However, production costs are difficult to assess (5). In Israel, where climatic variables such as light and temperature are equable, production costs would be minimal in comparison to other geographical areas less suited to algal growth. Production costs depend upon the total, useful, dietary energy available. This also depends upon the type of protein produced by the algae that is cultivated. Cost analyses on small experimental plots may not be applicable to production costs in large-scale, commercial operations.

Currently it costs approximately 14 cents a pound, before processing, to produce a pound of protein from soybeans (13) and energy costs are rising rapidly. Some studies indicate that algae cultured on wastes would require 1/50 of the land area, 1/10 of the water, 2/3 of the energy, 1/5 of the capital and 1/50 of the human resources required of the contemporary agricultural technology needed to produce an equal quantity of organic material (7).

What is now considered an unconventional source of protein, may, because of increased protein demand and increased energy costs, become an alternative source of livestock feed in the future. As a result, "algaculture" could play an increasingly significant role in the future of agriculture.

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MIT to Study Nonconventional Protein Resources

A major study of the world's nonconventional protein resources has been started by the Massachusetts Institute of Technology under a $185,000 grant from the National Science Foundation.

The study is intended to produce an agenda for high priority research on nonconventional protein sources that can make a significant contribution to enhancing the world food resources.