Energy farming: A prospective plan of energy substitute

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Abstract

The moral issue of competition between food crops and energy crops always emerges in the discussion of energy farms. These are legitimate concerns that we may be in the future short of food or that we may have obligation to sell or give foodstuffs to other nations. It is also apparent that the concept of a single-purpose, dedicated energy farm must be modified by economic considerations which suggest that food, fiber and other valuable co-products are essential to the feasibility of the production of energy from biomass. The key consideration in biomass energy farming is the choice of plant type and species to be cultivated. . Energy farm will produce the fuels required to produce and process the co-products plus surplus. If co-products credits could equal the current disposal credits, then energy crops might be competitive today.

Keywords: Biomass, food stuffs, Energy farming, economics, photosynthesis.

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Through the process of photosynthesis, plants are able to convert solar energy into biomass which can be used as a source of fuel. Recently, in more industrialized nations, human activity has taken advantage of photosynthesis only for the production of food and fiber. However, the majority of the world's people, the poor in the underdeveloped countries, still provide most of their space heating and cooking energy from biomass materials, mainly wood and dung. As a result of projections of energy shortages in the years to come, interest in alternative fuel sources has increased considerably. Biomass is one of those energy sources being considered. The specific production of biomass for fuel could occur on energy farms. Here, in world no one is considering the presently available waste and residue biomass resources, a very important and sizable source.

There are basically three types of energy crop systems: annual energy crops (grains and grasses), silviculture energy farms (trees), and aquatic energy farms (both land based and open ocean). The three major factors that influence the amount of energy the nation can derive from energy farms are land/water availability, productivity and economics. These factors differ for each type of biomass system. They are dependent on the location, the level of technical development, and or the assumptions and extrapolations used. According to the MITRE Corporation, production of one quad (1×10^{18} Joule or 10^{15} Btu) of energy in the form of

biomass would probably require 2 to 5 million hectares of land, assuming a productivity of 11,000 to 28,000 kg/hectare.

The moral issue of competition between food crops and energy crops always emerges in the discussion of energy farms. These are legitimate concerns that we may be in the future short of food or that we may have obligation to sell or give foodstuffs to other nations. It is also apparent that the concept of a single-purpose, dedicated energy farm must be modified by economic considerations which suggest that food, fiber and other valuable co-products are essential to the feasibility of the production of energy from biomass. As mentioned above, a key uncertainty that influences the energy potential derived from energy farms is productivity, the sustained biomass yield. Yields can be affected favorable by careful selection of species and sites, and optimization of cultural practices and weather. Since these sub factors, except weather, can be controlled or modified to some extent by human activity, the factor of productivity is one that, within the limits of biological photosynthesis, can be manipulated. The economics of energy farming are dependent basically on two factors: productivity and cultural practices.

Plants proposed for energy farming

The key consideration in biomass energy farming is the choice of plant type and species to be cultivated. There is little difference in the energy content per unit weight (Table 1). The choice of the

species will depend on locations, soils, water quality and a host of other factors.

The environmental problems need to be addressed, particularly the effect on the atmospheric level of carbon dioxide caused by its release from deep ocean waters by artificial upwelling. The coastal-based cultivation of smaller seaweed is presently being investigated (Cotner *et al.*, 1977). The very large theoretical energy potential and the high value of co-products (agars, chemicals, mariculture, etc.) make these plants particularly interesting for biomass energy farming.

Economics of energy farming

The Eucalyptus farms operated in Australia and Argentina are commercially successful because they produce a valuable fuel product, charcoal, and they produce co-products. For most applications (regardless of the plant species chosen or the harvesting and cultivation techniques employed), it is almost an economic certainty that any successful energy farm will depend largely on co-products. There must be a mix of chemicals, wood, pulp, fiber, and food as co-products to fuel. Energy farm will produce the fuels required to produce and process the co-products plus surplus energy. Even though they are a net producer of energy, for the most part, this will not be the major source of revenue. Therefore, calling them energy farms is possibly a misnomer.

Economics of the Farming Operation

It is to compare the projected economics of energy farms. Energy farming costs are generally higher than conventional farming. This is true even though the equipment would be used year round and, therefore, amortized over a continuous period as opposed to the seasonal use in conventional food and fiber farming. The major difference in costs of energy farming as opposed to conventional farming is the fact that the energy farm needs to maximize, as much as possible, the supply of biomass. As a result they must operate year round with maximum inputs of

fertilizer and water, which tend to be the more expensive items in farm operations.

There is also important in considering the viability of energy farms is the net energy efficiency, that is, the amount of energy produced divided by the amount of energy input to the system. It is interesting to compare this to the energy efficiencies of the solid fuel product of energy farms compares well with natural gas and coal in terms of simple production at the site as shown in Table 2.

There are significant costs for biomass transportation. Biomass, because of low density and low energy content per unit weight, does bear a significant higher cost in transportation than natural gas or coal. Consequently, it would be unreasonable to expect to grow an energy crop and transport it a great distance to be converted into an end-use energy form. Instead, the biomass produced would be converted on site into electricity, synthetic natural gas, a pyrolytic car, or oil which is more energy dense and more economical to transport. Also, on-site utilization of biomass energy would allow co-generation from waste heat, maximizing overall efficiency.

A most attractive concept is the location of biomass-fueled industries next to the energy farm. In this manner there are minimal costs involved in transportation for the end user, and the fuel can be used in a more efficient end-use form.

Economics of Conversion

One process now in commercial operation by which the products of energy farms can be converted into various energy forms is combustion. This produces steam both for process use and for electricity. The exact economics of the combustion of the combustion of wood for steam production varies at the many saw mills, paper mills, and various other industries that utilize this technology. If co-products credits could equal the current disposal credits, then energy crops might be competitive today.

Table 1: Energy Contents for Various Plant Biomass

Plant	Part harvested	MJ/kg (0% Moisture)
Sorghum	Above-ground biomass	16.9
Kenaf	Above-ground biomass	17
Sugarcane	Bagasse	18.6
Sugarcane	Above-ground biomass	17.7
Sudan grass	Above-ground biomass	15.1
Sunflower	Above-ground biomass	

Table 2: Efficiency of energy extraction processes

Process	Natural gas, %	Energy farms, %	Surface-mined coal, %	Deep-mined coal, %
Extraction/production				
resource recovery	73	100	80	57
Energy input	0.5	5.6	0.8	0.8
Net available	72	94	79	56

(Source: Calvin, 1977)

Conclusion

Energy farms are a potential viable, economical (Strong, 1977) means of producing considerable amounts of energy in an environmentally acceptable way, and in a wide variety of forms beginning in 5 to 7 years. The exact amount of energy available from energy farms depends on the scenarios and assumptions one is willing to make. In any case, one can see that the potential for energy production is quit considerable. Furthermore, and very importantly, one should also consider that this does not include biomass *waste* materials, that is, municipal solid waste, agricultural and forestry residues, of which there are very large quantities available. More important they exist today, are a disposal problem, and are economical to convert to energy with existing technology. The subject of residues is extremely important to the future of

energy farms. The uses of wastes will provide a toehold in the energy market for biomass fuels. Energy farms are then is a natural follow-on to supplement the biomass fuel supply from wastes. Without this toehold provided by the use of wastes, energy farms may never be competitive.

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