THE BRAZILIAN BIOMASS ENERGY PROGRAMME: AN ENERGY-FOOD INTERFACE EXPERIMENT

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Brazil is making a national commitment to produce a significant share of its liquid fuel needs in the form of alcohol derived from agricultural biomass. Other biomass sources such as coal, oil, wood, and biogas are planned and will become important inputs to the energy systems. This is the first major commerical experiment to use agriculturally produced biomass as a primary energy feedstock. The success of this experiment has enormous implications for a world short of both fuel and food.

Agriculture occupies a unique position relative to projected world energy shortages. It is, at the same time, both a critical user and a potential supplier of energy. In recent years, agriculture as an energy user has responded to abundant and inexpensive supplies of commerical energy by incorporating energy as a major input in the production process. Thus, inexpensive energy has become an essential ingredient in directing the focus of production technology (mechanization, nitrogen fertilizer use, irrigation, etc.) that is mainly responsible for the large increases in agricultural productivity. These increases in productivity in turn have allowed the world to keep pace with food needs of a rapidly expanding population.

Impending energy shortages, especially of petroleum, however, raise important questions concerning these trends in technology use and production. Energy prices have already increased substantially, and are expected to increase further in the coming years, resulting in higher costs and creating energy shortages. This will require a reassessment of the role of some modern forms of agricultural technology, especially in low income, petroleum deficient countries. In this context, the continuing debate over labour intensive versus capital (energy) intensive technological systems takes on added significance. Even if greater marginal productivity of energy inputs is apparent in developing countries, most still face the problem of generating the foreign exchange necessary to pay for energy imports, and are particularly vulnerable to energy price changes. Increased attention is also being given to keeping rural people employed in agriculture by means of a more selective use of energy intensive technology.

Many of these countries must thus follow a combined path of development, including a less energy intensive form of technology and a more even distribution of the scarce available energy sources, while developing alternative and, hopefully, renewable sources of energy. Agriculture, through its biological process of transforming solar energy, is one source of renewable energy. This is especially true in many tropical areas, where year-round growth and abundant solar energy and water are availabile. However, use of agricultural land for energy production may come into direct conflict with food production goals, since many of these low income countries are also food deficient. The prospect of substantial energy price increases thus holds the possibility of opening new markets for agricultural production, but is also a serious threat to world food supplies both through the increased cost of production inputs (energy) and competition from energy uses. This is the emerging energy-food interface.

The purpose of this paper is to analyze some emerging aspects of the Brazilian energy-food issue. Energy supply and use aspects are considered first. Policy decisions are an important issue and have short and long run effects. Allocation aspects and price impacts are considered. And finally, some findings and potential implications for Brazil, as well as other countries with similar energy needs and resource situations, are proposed.

The Brazilian Energy Problem

Brazilian development strategies were until 1973/1974 based on inexpensive fossil energy. Central to them was an ambitious industrialization programme. Emphasis was given to the car industry, the transport industry, highway systems, and areas of highly mechanized agriculture. The development path was followed by an increasing reliance on imported petroleum, accounting for about 80 percent of consumption, with small chances for successful drilling within the country.

Petroleum import costs rose about 16 times from 1972 to 1974. Simultaneously, prices of other imports increased, about doubling their total cost within the same period, while export revenue remained at the same level. This caused crucial balance of payments deficits. Immediate policy measures were taken to control fossil energy consumption and reduce import expansion by first increasing retail prices (and consequently stimulating energy conservation) and second by searching for petrol substitutes. In 1975, the Alcohol Programme was established. Technology and experience were available to expand the production sector to pay for imported petroleum and to create alternative labour demand to substitute gradually for the emphasis on the car industry (this sector could not be disrupted in a short time). Agricultural production became highly subsidized through negative credit rates, just as diesel and fuel oil were subsidized to stimulate production and to reduce the cost of both production and transport, and therefore to avoid a strong impact on inflation.

A short balance of payments equilibrium was obtained in 1977/1978. Agriculture had a significant contribution--exports about doubled from 1975-1980, and alcohol production increased from 600 million litres in 1975 to 4 billion[2] in 1980.

The new petroleum price increase in 1979/1980 changed the whole scenario. Petroleum import costs more than doubled, representing about half of the trade balance, causing increased deficits. Production efforts were not enough, and diesel and fuel oil subsidies caused an immediate expansion of their demand, while the petrol overpricing policy caused excess supply.

To meet the new situation, the government emphasized: (1) export crop production, (2) alcohol goals of 10.7 billion[2] litres by 1985, (3) continued expansion of hydroelectricity, (4) increased oil drilling, (5) new and alternative energy source research and production (coal, shale, nuclear, solar, etc.), (6) increased oil crop production to substitute for diesel, and (7) increased forestry production to subtitute for fuel oil. This entire programme is expected to reduce petroleum imports by 1985 to about half of the 1980 level.

The Brazilian Biomass Programme

As mentioned above, the Brazilian government created the Alcohol Programme in 1975. The success of this programme through 1979 was partly the result of the substitution of alcohol for sugar production. Further new expansion, however, has to come from autonomous alcohol production plants. Sugarcane is still the most important source. Cassava and other products are still being tested as potential sources.

In spite of the emphasis on developing alternative energy sources, alcohol and other biomass energy sources are still not competitive with petroleum at US$32/barrel. Only special subsidies to produce biomass and taxes on petrol (all energy markets are government controlled) make alcohol competitive. Alcohol costs, in petroleum equivalents, remain above petrol costs, but possibly below the costs of alternative liquid fuel from coal and shale oil. This is significant as a long run policy in the petroleum substitution process, especially for Brazil, with enough land but a lack of fossil energy sources.

Brazil has wide frontiers to explore. Only about 50 million hectares are used as cropland, and 170 million hectares as pasture for livestock. Most of this land, however, lies within already developed states in the south and southeast of the country, where more than 80 percent of energy consumption also occurs. This implies a need to expand to new frontiers. Between 1968 and 1977 the expansion to new frontiers occurred at a rate of 3.6 percent a year (Mello). No major productivity gains were made, however. The need to meet government biomass production goals and the export and internal food demand will require a yearly expansion of about 8 percent for the period 1978-1985. Those new frontiers have to be found in the far west and the northern parts of the country. Conquering them, however, is very expensive and demands large investments, and it changes the costs of food and biomass energy within the consumption centres. Consequently, a resource price increase occurs in the consumption centres proportional to the transport cost increase which relies on liquid energy prices.

There is therefore an allocation tradeoff between producing food or fuel at the distant new frontiers. The decision relies on the opportunity cost of transport for either product. Biomass energy may become competitive with fossil fuels at the frontier. This gains in importance because at present alcohol is produced on prime land, substituting for food and other commercial crops. Finally, transport costs weigh heavily on the energy output/input ratio, creating inefficiencies in the system.

Technical advances are possible at both the industrial and the agricultural levels. Costs can be reduced, making biomass more competitive. Alternative crops may reduce risk and increase output per hectare.

The labour-energy tradeoff made necessary by higher energy prices requires more research, especially on intermediate technology affecting production scale and alternative input use. In spite of the fact that most energy crops are more labour intensive than other crops, some have become increasingly mechanized, especially in labour deficient areas where high labour costs have made mechanization viable.

Finally, discussions are going on about production scale. Apparently there are economies of scale on larger alcohol plants. However, studies have shown the advantages of smaller plants--better use of wastes causing less pollution, maintenance of diversified farming, use of crop residues, better land conservation, and lower cost of transport. These, however, can only be achieved through a complete integrated analytical system, evaluating the opportunity cost of alcohol production.

Alcohol Production Systems

Current alcohol production systems in Brazil are establishing a monocultural structure, locally concentrated in São Paulo, subject to high agricultural production risk. Labour and income distribution problems have also been pointed out. Food production substitution has been identified, affecting food prices and consumption.

This whole scenario suggests the need for studies on regionally decentralized production structures and integrated energy-food production systems where biomass for energy is produced in parallel with food. On-farm small agroindustrial units have been successfully tested, achieving self-sufficiency of energy for food production along with a marketable surplus. Those systems also make better use of agricultural and agroindustrial residues.

The system has to be adapted for typical farms and for each region and for each biomass source. Rotation with food products is recommended, and combination with cattle, pig, and chicken production is useful so as to have a complete cycle for the biomass production system. Biomass production can also be integrated with solar, wind, and small hydropower stations. An alternative production scale is needed, and must be adapted to each farm size as well as to each product and energy demand.

Farm machinery has to be designed for the produced energy source, preferably capable of using more than one energy source to reduce risk of nonavailability of a specific source. Alternative sources may be alcohol, methane, coal, wood, etc. Providing appropriate technology engineering for these alternative sources is one of the main problems to be overcome. Finally, the principle of simplicity (ease of management) has to be the basic objective to be followed in order to make the system feasible at the farm level where costly specialized labour cannot be hired. Basic advantages of the system are not only energy self-sufficiency and risk reduction, but also higher income for agriculture, increased benefit and development for farmers, decentralized agroindustry, and keeping farmers on their land.

Three levels of integrated food-energy production and consumption systems are being studied:

1. A farm level integrated system with alternative farmers' goals, different farm sizes, and integrated combinations of crop and animal production is being tested. On-farm energy production may become a major policy instrument for rural development. Farmers are moving in that direction. However, technology availability still limits adoption. Most farmers are unable, due to their level of education, to manage complicated systems. This implies a need for technology development and education.

2. A system that integrates a group of farmers for the same objective is being studied. These groups are mainly intended for small farmers and are organized under any associative form, such as a cooperative. Many goals may gather these people together; for example, marketing, silage, energy supply, credit, extension services, etc. Alternative energy sources can be used--wind, solar, waterfall (small), and biomass. Benefit-cost analysis is being developed to study the best alternative as well as the best material flow system.

3. Locally integrated rural-urban self-sufficiency systems in small communities are being studied. Benefit-cost studies are being developed. Tradeoffs between alternative energy sources and alternative uses are being evaluated. Different consumption levels and minimums of acceptable energy consumption are being identified. Energy self-sufficiency is important but food production must not be neglected. Minimizing transport costs may be an important goal for future development policies as energy prices go up.

These systems may supply farmers, small communities, and even small cities. Large cities and long distance transport must find alternative means of supply. Biomass can still be a source. However, production will be on a different scale, with allocation and food-energy tradeoffs to be considered.

A national model of production, distribution, and consumption of biomass energy was built to analyze: (1) competition between biomass energy and other agricultural products within each region; (2) the optimal allocation at the regional level of agricultural resources between energy and nonenergy crops; (3) the competition within and among regions which produce biomass and other crops; (4) crop and resource prices; and (5) choice in each region of the best alternative sources of biomass. The model includes centrally located areas and frontiers, highly mechanized and labour intensive production, sugarcane and substitute products, prime versus lower quality land, biomass energy and food crops, supply-demand-trade, alternative transport systems, and the opportunity cost for resource use.

Results and Implications

Biomass energy production has two dimensions: first, to be integrated, local, and complementary to food production on an energy self-sufficiency basis; second, it has the overall objective of supplying national energy deficits. Energy self-sufficiency is not only viable at the farm level, but may also become a stimulus for rural development, especially in developing countries. Integrated local production systems may make better use of residues, reduce waste, and consequently increase output while reducing inputs, especially fertilizer. A cooperative system can provide advantages in scale and distribution of results in integrated farming systems. What is not viable on one farm may be useful in a group system.

The farmer's first objective relies on the economic results. Changes in energy prices change the production function. Agricultural policies may be needed to create conditions to stimulate farmers to change.

As energy prices increase, transport costs become a crucial parameter. Local food and energy self-sufficiency systems should therefore provide a solution to overcome possible future crises.

Energy self-sufficiency programmes are recommended for most countries, contributing to a better use of agricultural production. A more ambitious programme to substitute imported petroleum on a larger scale may be viable only for a few nations with large areas of unexplored land. Land is becoming scarce in many countries and the food-energy tradeoff limits major efforts on biomass energy production.

Not only must the supply side be studied; but demand conservation efforts could also reduce liquid energy deficits.

Notes

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[2]Billion as used here equals 1,000,000,000 [eds.].

Reference

Mello, F. H. de, "Agricultura nos Años 80--Perspectivas e Conflictos entre Objetivos é Politicas," 17th Congress of SOBER, Brazil, 1980.