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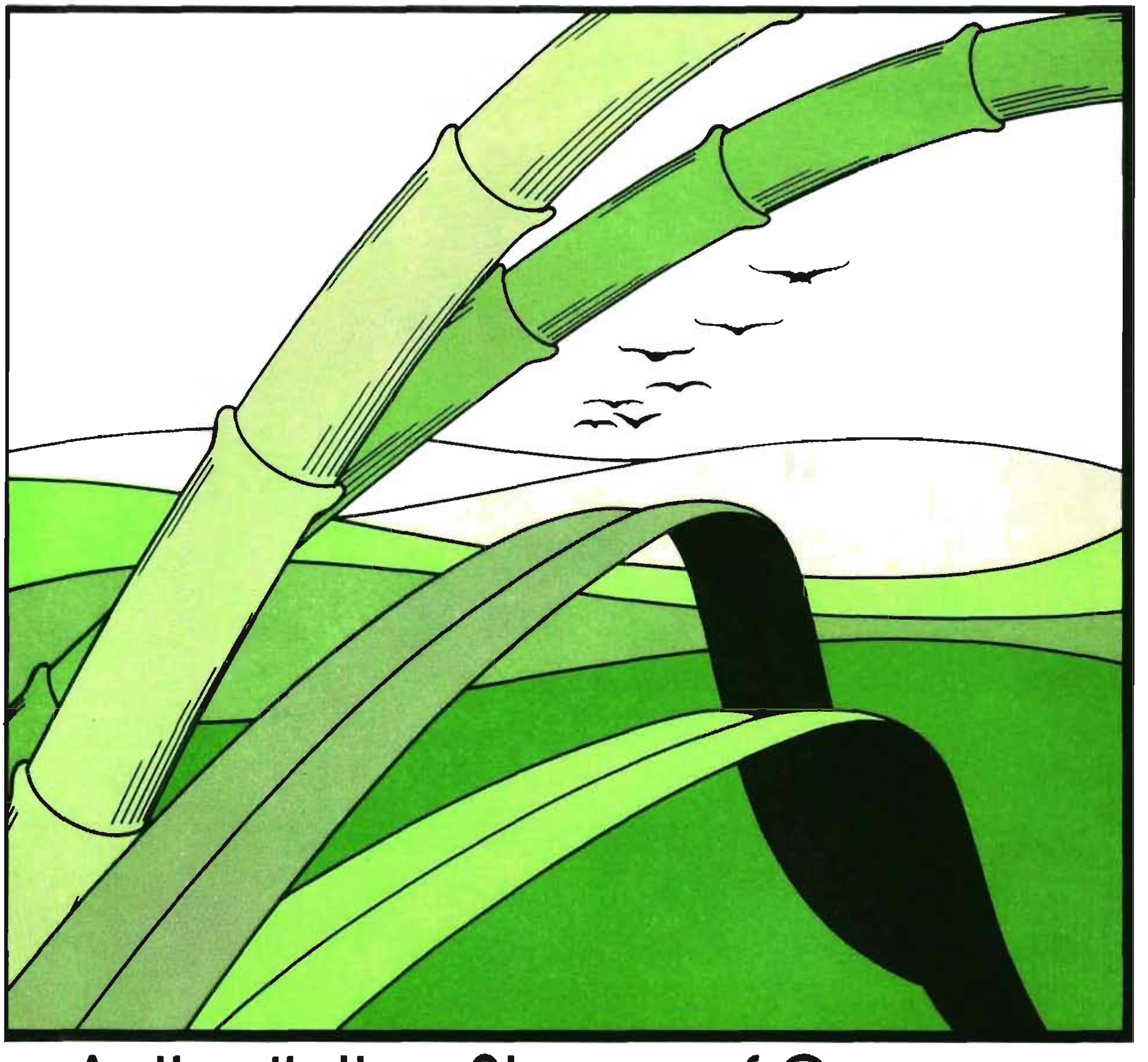

Antipollution Stance of Germany and Potential Market for Brazilian Alcohol in the European Community

• L. Yeganiantz • E. Contini • E. R. da Cruz • A. Brandini

Brasília, DF, Brazil
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FOREWORD

The global energy problem is so complex that no nation can attempt to solve it acting alone. For the necessary international cooperation to succeed, there must be a common basis for understanding the nature of the problem and its possible solutions. EMBRAPA's research work on economics of energy and related trade implications is in the initial stage. But it is hoped that with the creation of an international and interdisciplinary network of collaborating energy institutions and specialists who share the same interests, some advance will be made in the resolution of the major problems of energy, environment and economics.

A too rapid and worldwide expansion of hydrocarbon consumption implied an energy policy that was unable to moderate the rate of growth of internal fuel consumption in relation to its production. Biomass offers a viable alternative, with Brazil giving a good example.

Although economic analysis strives to be objective, this study like many others, reflects the character and background of its authors. As a result, the views and interpretations in this document are those of the authors and should not be attributed to EMBRAPA, to its affiliated organizations or to any individual acting in their behalf.

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ANTIPOLLUTION STANCE OF GERMANY AND POTENTIAL MARKET FOR BRAZILIAN ALCOHOL IN THE EUROPEAN COMMUNITY*

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ABSTRACT

West Germany is committed to a complete ban on leaded gasoline and to a massive use of a high-octane option. Replacement of the high-octane option, that requires 10 percent more crude oil, by blends of ethanol and low-octane gasoline, in addition to eliminating the need for lead and diminishing air pollution, can replace something like 190 million gal. of gasoline burned in the EEC, starting with 45 million in Germany every year. This could provide a market for surplus sugar, cull potatoes, and other agricultural wastes. It could also provide a market for Brazilian alcohol, particularly at the initial stage. Economic and engineering comparisons of gasohol blends and lead-free gasoline under Common Market conditions, based on Brazilian experience, show the relative advantage to be with alcohol blends.

INTRODUCTION

The economic development registered over the last two centuries was fundamentally based upon energy obtained from coal and oil, as well as on technology created and developed to use them in an expanding process of industrialization.

Availability of fossil fuels, together with appropriate technology for their use, afforded to a select number of countries the benefits of a prosperity that set them apart from the rest of the world. (Figure 1).

The quarter century proceeding the so-called "energy crisis" of 1973-74 was one of exceptional prosperity and economic growth among both developed and developing countries. The Average Gross National Product growth rates of 4-5 percent were achieved in the OECD through this period. The communist countries mostly attained or surpassed the high per capita income growth rates achieved in Western Europe and North America, but fell below the exceptionally high japanese growth rate.

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World output of goods and services tripled in real terms between 1950 and 1974. Population rose from 2.8 to 4.4 billion, and per capita income doubled.

In the period 1948-73 international trade grew at a rate of about 7 percent per annum more rapidly than the volume of world production. Another characteristic of this period was the relative stability of agricultural incomes and prices since the Korean War. Agricultural production and trade grew with economic development. Worldwide, agricultural output rose at 3.1 percent per year in the 1950s, 2.6 percent in the 1960s, and 2.2 percent in the 1970s. The growth was broadly shared among developed and developing countries, with the latter enjoying higher rates of growth than the former. By 1980, world agricultural production, excluding China's, had nearly doubled the levels of the early 1950s. World agricultural trade grew at 3 percent per year in the 1960s and 4.3 percent in the 1970s. Underlying that growth were forces of sustained economic development that expanded and altered the composition of demand, stimulated international trade, and induced structural changes in agriculture. Massive foreign investments improved the infrastructure of agricultural production systems and the development of natural resources, particularly water resources for irrigation. Human capital was enhanced through education. Real expenditures for agricultural research more than doubled, yielding myriad productivity-enhancing technologies.

Nevertheless intervention in the Agricultural sector and distortion of agricultural trade are widespread in the world. In fact, one could say that almost all governments intervene in the agricultural sector and distort agricultural trade. Countries in the advanced level of economic development tend to subsidize domestic producers and keep domestic prices at relatively higher levels. Any surpluses are usually dumped on the world market either at subsidized prices or through humanitarian bilateral or multilateral assistance programs. On the other hand, countries in the early or intermediate stage of development tend to keep food prices at a low level to subsidize urban consumers and to be able to compete in world markets to earn necessary foreign exchange.

Near self-sufficiency in food may be considered a politically desirable objective by many governments. Excessive reliance on imports of food may subject a government to external pressures. Also the fluctuations in the world market prices quit often cause fluctuations in domestic prices and/or government budgets unless sufficiently large stocks are held by the country. Fluctuations in food prices can have undesirable consequences. The poorest not only suffer more when food prices rise, but food price increases generate inflationary pressures and prices may not fully come down when food availability increases later. It is thus conceivable that the costs of attaining desired levels of food self-sufficiency may be smaller than the costs of substantial dependence on imports.

The rapid expansion of food production in Saudi Arabia provides an example of the value countries place on self-sufficiency in food. In less than a decade Saudi Arabia has almost turned into a food exporter. Its wheat production has risen from 3000 m.t. in 1975 to an expected output of 800,000 m.t. in 1983. This development has not been brought about cheaply; large investment outlays were made. For example, 21 billion dollars on agriculture and water development have been budgeted for the third five-year plan (1980-85). Such agricultural development may have been spurred by talk of trading "a bushel of grain for a barrel of oil" and by fears of a food embargo.

An objective of agricultural protection as practiced by the European Economic Community is often to ensure income parity between agriculture and non-agricultural sectors and between different regions of a country or different countries of the Economic Community. Income subsidy (through whatever means) for agriculture may be needed to ensure that a certain amount of agricultural production takes place and that agriculturists do not leave the sector, in which case it is really a subsidy on self-sufficiency. On the other hand it may also be needed for farmers who cannot be easily absorbed in other sectors if they leave agriculture, even when the government wanted to encourage them to do so. Subsidies may also be given to promote agricultural development in certain regions. These may be economically backward regions, or regions with poor agricultural resources where agricultural activities nonetheless are considered desirable for a variety of reasons such as settlement in border areas, preservation of environment, etc.

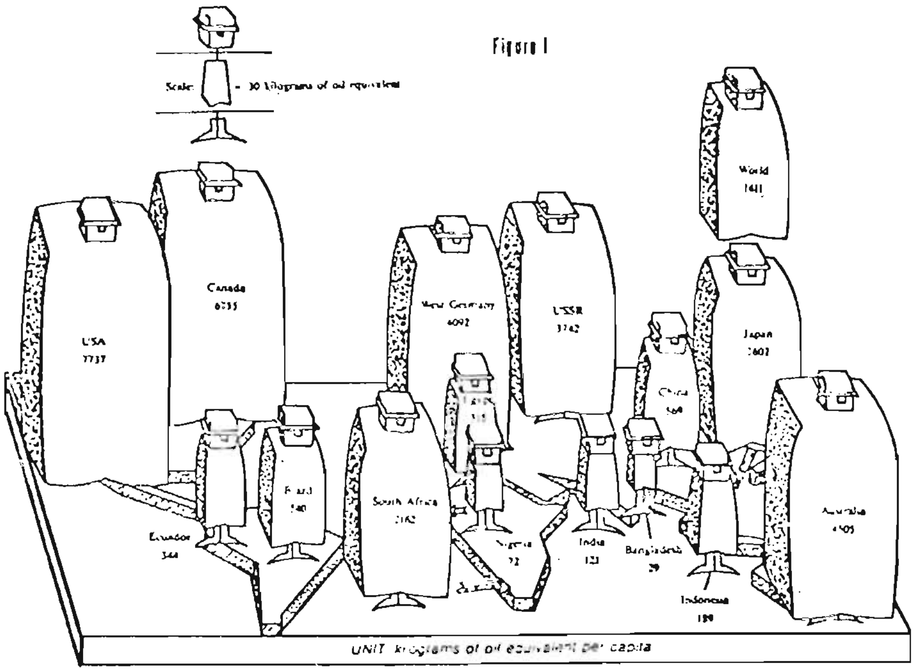
Whatever may be the motivation for protection or penalization of agriculture, the costs are not always born by the country. Other countries many times bear part of the costs, and of course some countries may benefit as well.

The arguments made for food apply even more to energy self-sufficiency, given the fact that non-renewable energy resources are more concentrated than food productions resources. Building agro-energy capacity that provides energy use for surplus food will protect a country against short term food or energy shortages on the world markets.

Addressing agriculture and energy issues together reflects a single, critical agenda of interdependent global issues which require the cooperation of all countries and of all sectors.

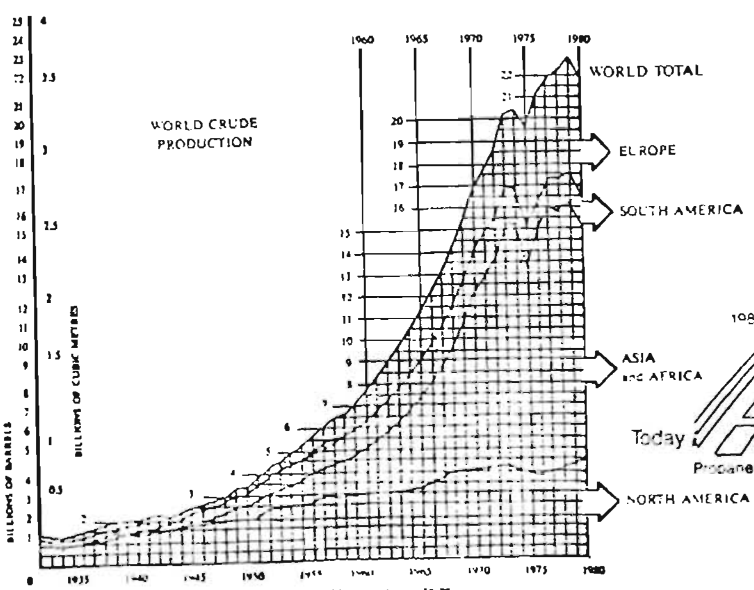
The major objective of this paper is to show that partial substitution of fossil fuels by alcohol and other bioenergy sources is of joint interest to Common Market's Agricultural producers and potential alcohol exporting countries like Brazil. The pr-sentation that follows will address major issues, in each case placing the anticipated benefits of trade and diversification of the use of traditional food products in the appropriate historic, economic and social perspectives. This paper was inspired by ideals of interdependence and global responsibility through "action" program stressing mutual self-interest and commercial reciprocity.

1978 per capita consumption of commercial** energy in 15 selected countries



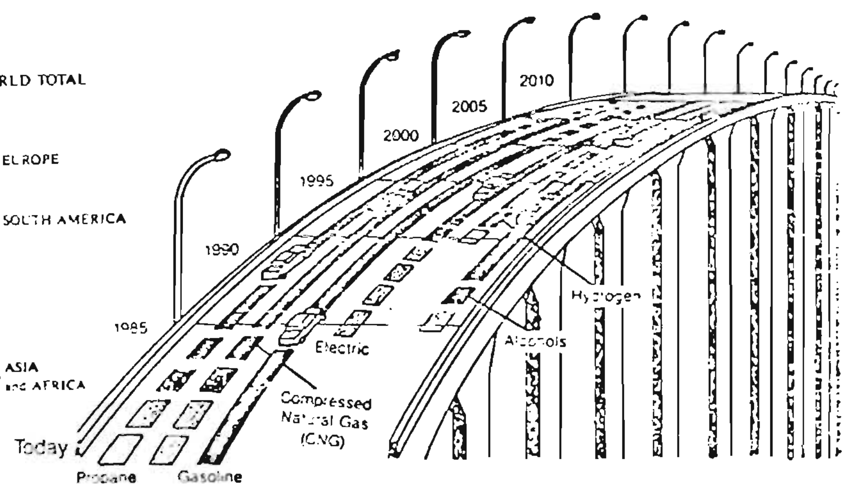
**Commercial energy refers to energy which enters into trade. Data on non-commercial energy use are scarce and imprecise.
Source: After United Nations, 1980

World crude oil production by region, 1930-1980



Source: De Golyer and MacNaughton, 1980, p. 4, and Auldridge, 1980, p. 78-79

PROPELLING OURSELVES INTO THE FUTURE



INTERNATIONAL INDEBTEDNESS

Worldwide Situation

International indebtedness is probably the most pressing problem on the world economic horizon. Many developing countries are facing severe difficulties in servicing their foreign debt, which in total has climbed to over US$ 750 billion, over half of it owed to commercial banks. Already more than 25 countries, between them with bank loans of around US$ 250 billion, have been forced into reschedulings.

This huge debt load stems from the large structural imbalances in countries, external payments which began to appear in the 1970s after the first oil crisis and which continue today. These imbalances were wrongly diagnosed as "cyclical disequilibria"; as a result, the current-account deficits of the non-oil developing countries were allowed to accumulate to frightening proportions.

The correct way to deal with the problem would have been under the collective responsibility of the world community, expressed either through the International Monetary Fund (probably with an adjusted mandate) or through some other international initiative. Instead, it was left to the commercial banks to finance the developing countries, deficits under their own credit responsibility. The banks saw in this an opportunity for profit. They rushed to intermediate between the savings, in the form of bank deposits, of the newly-surplus countries (mainly Opec oil exporters) and the demand for loans of the deficit countries. And they allowed themselves a comfortable spread.

The New York banks, acting as the main money-centre institutions of the world banking system, set out to secure the largest share of the so-called recycling.

It was much the same for a limited number of other international banks, such as the leading British banks, the four large German banks and the Japanese banks-big banks which had the credibility to act as primary depositories of surplus funds.

The table, reproduced here from the American Banker, shows that in Brazil, Mexico and Venezuela taken together, the 10 large American banks have outstanding loans which by far exceed their total equity.

Table 1 - Outstanding loans of 10 Amercan banks to Brazil, Mexico and Venezuela, 1983

Outstanding loans in US$ billion	Brazil	Mexico	Venezuela	Total of 3 countries	Total as % of bank's equity
Citicorp	4.4	3.3	1.1	8.7	180
Bank America	2.3	2.5	2.0	6.8	148
Chase Manhattan	2.4	1.7	1.0	5.1	183
Man. Hanover	2.0	1.7	1.1	4.8	174
Morgan Guaranty	1.7	1.1	0.5	3.3	122
Chemical	1.3	1.5	-	2.8	143
Bankers Trust	0.9	0.9	0.5	2.2	143
Cont. Illinois	0.5	0.7	0.5	1.6	96
First Interstate	0.5	0.7	-	1.2	64
Security Pacific	0.5	0.5	-	1.0	68

Source: The American Banker

Foreign Debt and German Reparations Problem

The foreign debt of developing countries like Brazil is similar to the German reparation problem of the late 1920s and the theoretical dispute as to the existence of the "transfer" problem. J. M. Keynes (1929) argued that a country making large payments abroad will in addition to constricting national consumption, investments and the problem of collecting revenues from its population, experience extra cost in the form of falling export.

prices and general deterioration of the balance of trade. The opposite view, held by Bertil Ohlin, denied the existence of this transfer burden. Ohlin (1928, 1924) argued that income shift across national borders will make it possible to transfer goods and services without any losses, the implicit assumption being that demand elasticities are very high or virtually infinite (Avramovic, 1984).

According to classical economic theory only when the rate of economic expansion begins to slow are commodities prices expected to drop. Current low commodity prices (in spite of world wide overall recovery and growth among developed countries) could be due to the fact that high interest rates and the strong dollar are forcing debt-ridden developing countries to export as much as they can-no matter how low the price - in order to service their debts.

As a result, the debt service may turn out to be very much a negative-sum game. Countries in debt will lose very much more than the countries that lent can gain. The present situation supports Keynes' thesis of the existence of a transfer problem due to falling prices of export commodities under a condition where the developing debtor countries have to make large payments by shipping goods virtually irrespective of demand conditions in the world market. This is in part due to austerity programs that the International Monetary Fund (IMF) has imposed on debtor countries.

Bretton Wood Conference

Later in 1944, Keynes, as chief British representative to the Bretton Wood Conference, provided the intellectual capital for the two new institutions created at Bretton Woods: the International Monetary Fund (IMF) and International Bank for Reconstruction and Development (World Bank). This conference and resulting agreements provided the institutional setting for the greatest economic boom in history. In Western industrial countries personal income grew substantially, creating consumer societies and resulting during the next 25 years in production of more steel, autos and consumer goods than had ever been manufactured previously. Europe and Japan would recover from wartime devastation to challenge U.S. industiral supremacy. Even some Third World Countries, such as Brazil would take advantage of the open world economy created at Bretton Woods to become newly industrial powers (Moffitt, 1983).

One of the things argued about during the Bretton Woods Conference was the potential intervention of the IMF in domestic economic policy decision of individual country. Keynes an ardent enemy of the gold standard (that forced countries to submit to foreign financial pressures), categorically rejected the notion of a supranational agency intervening in domestic policy decisions. His early fear was well grounded,as indicated by Moffitt (1983) who states that "In the postwar world, the IMF took the place of the gold standard".

Global Money Market

The global money market was established to enable Western banks to serve their corporate clients on a global scale. Despite the existence of the IMF, the business of lending to governments was taken over by the private banks, who established the global money market to serve their corporate clients on a global scale.

The first economic shock of the 1970's, was worldwide inflation. Although Third World exports initially profited from the upsurge in global inflation, the benefits were short-lived. By 1974 the profits of higher raw material prices were consumed by skyrocketing oil prices and the inflated costs of manufactured products imported from the West using borrowed money at a growing interest rate.

After the "First Oil Shock" in 1973 the banks worldwide were looking for borrowers to unload billions of OPEC petrodollars. Eurobanks took prime responsibility for the petrodollar recycling process. As a result the first energy crisis not only did wonders for the Arab oil exporters, it was also a boom for the banks. The syndicated loan market is the primary Euromarket lending mechanism. Instead of concentrating the whole risk, syndicated loans decentralize the risk among many participating financial institutions. Syndicated loans are prices at the going interest rate known as LIBOR (London Inter-Bank Offered Rate) plus a margin known as a spread which is inversely proportional to the perceived creditworthiness of the borrower (For years, Brazil borrowed at rate very close to LIBOR. As the Brazilian debt problem increased its spread quickly soared to over 2 percent).

Table 2 - Sindicated Bank Credits and Fixed-rate International Bonds for Developing and Developed Countries - 1971-1982 period.

Type of Credit by Recipient / Year	1971-1975	1975-1980	1980	1981	1982
Sindicated bank credits					
Non-oil developing countries	21.4	109.9	24.0	33.4	28.3
OPEC	8.0	45.1	11.0	11.9	12.5
All developing countries	29.4	155.0	35.1	45.2	40.8
Developed Countries	53.8	144.6	42.3	88.1	43.4
World total	83.2	299.6	77.4	133.3	84.2
Developing Countries as % World total	35.3	51.7	45.3	33.9	48.5
Fixed-rate international bonds					
Non-oil developing countries	1.9	11.5	1.9	4.3	3.9
OPEC	1.3	3.5	0.5	0.4	1.0
All developing countries	3.2	15.0	2.5	4.8	4.9
Developed Countries	47.1	166.9	39.4	48.2	70.9
World total	50.3	181.9	41.9	53.0	75.8
Developing Countries as % World total	6.4	8.2	6.0	9.1	6.5

Source: Morgan Guaranty Trust Company, World Financial Markets.

Official and Private Loans

Before the first oil shock of 1973-74, the official and private loans had tended to be complements rather than substitutes. Thus, while private capital is largely untied, of relatively short maturity and mostly given at floating interest rates, official loans are often tied to special program and projects, have longer maturity and are offered at fixed sometimes concessional interest rates. The official loans were supposed in be used in building infrastructure and other long-lived projects. These projects had high social returns and increased the economic feasibility for various other private sectors investors who were supposed to make private loans at higher rates and due to higher returns be able to repay these loans. In 1970 with growing international liquidity among private financial institutions the private foreign capital increasingly substituted for official capital in infrastructure and social services. Table shows when developed countries were and are able to get credit in the form of fixed-rate international bond developing countries are given syndicate bank credit based floating interest rate.

The 1970s witnessed a very rapid build-up of the external debt of developing countries, accompanied by a pronounced shift away from official bilateral and multilateral borrowing towards private capital, mainly from the commercial banks. A shift in the source of foreign borrowing resulted in a hardening of the average terms for foreign debt.

The worldwide recession of the early 1980s and resulting impact on foreign borrowers brought the debt problem of the countries like Brazil to the front pages.

The global debt crisis was basically due to what Moffitt (1983) calls "a marriage of convenience between the global banks and poor Third World countries". Basically, the global banks had money to lend and Third World countries needed it satisfy the revolution of rising expectation of their population or in most cases needed it just to survive in an increasing hostile world economic climate.

The concern over the stability of the financial intermediaries-especially the commercial banks deflected attention from the growth of individual countries and over all economic condition of indebted countries as a group. The "success" in recycling of debt has come to be viewed as maintaining the stability of the system of financial intermediation, and this stability therefore has become viewed as an end in itself rather than the means by which global economic activity can be maintained at high levels (Hope, 1981) (emphasis added).

Repayment Problem

In 1970, after amortization and interest payments, 42 percent of total disbursements made to developing countries was available for purchasing goods and services from abroad and for reserve accumulation. The ratio of set transfers to disbursements rose to nearly 50 percent in 1975-76. Due to refinancing debt in 1977-78 this ratio fell to 40 percent by 1978. In 1979 the slowing of disbursements, combined with the surge in interest payments as interest rates caught and passed inflation rates had the result that only 28% of disbursement was left after previous financial obligations were met. The year 1979 marked the move back to positive real interest rates effectively eliminating the inflation-induced transfer from lender to borrower (Hope, 1981). In 1980-82 period, real interest rates rose sharply and the positive gap between nominal rates in the capital markets and the low rates of inflation in developed countries, particularly the United States and Europe, has widened to the all time high.

The proportion of exports absorbed by interest payments, for Latin America as a whole in 1983 was estimated at 42 percent (Table 3). Without counting the repayment of short-term debt, based on refinancing arranged or under discussion principal repayments on medium - and long-term debt were estimated at another 20 percent of export earning. This makes for a total debt service ratio of 62 percent (Kuczynski, 1983). This is much worse than in the Great Depression of 1930's when the average of both interest and repayments for a group of eight Latin American Countries reached 40 percent of exports (Abramovic, 1982).

In six major debtor countries - Brazil, Mexico, Argentina, Republic of Korea, Venezuela and the Philippines - annual interest payments abroad now account for 5-7 percent of GNP, representing perhaps one-quarter to one-third of gross domestically generated savings, a formidable proportion on any reckoning (Avramovic, 1984).

On top of interest, an enormous bulge of principal repayments looms ahead: those owed by 25 largest developing country debtors, many of them Latin American, are scheduled to increase from US$ 25 billion in 1984 to US$ 85 billion in 1987.

Table 3 - Estimated interest burden of some developing countries

	Estimated 1983 Merchandise exports ($ billion, f.o.b.)	Estimated interest due in 1983 (% of exports)
Argentina	9	50
Brazil	22	46
Chile	4	50
Mexico	22	46
Venezuela	14	29
Total Latin America[a/]	96	42
Algeria	12	14
Indonesia	19	21
Republic of Korea	24	18
Philippines	5	48
Nigeria	12	11
Total other developing countries	330	12

Source: Kuczynski, 1983.

a/ Including Caribbean and other countries not listed.

BRAZIL GENERAL BACKGROUND

Brazil has generally been referred to as a country with an immense territory (the fifth largest in the world, having 8 1/2 million square kilometers) with a surprisingly large amount of it still unused. Its rapidly growing population of 120 million is the world's eighth largest, with an enormous potential for development. All together, Brazil is today internationally viewed as one of the most modern and sophisticated industrial economies of the developing world.

Brazilian Economic Policy and Economic Growth, 1947-1982

Brazil, during the postwar period, has undergone all the possible development and growth experiences starting from import substitution industrialization to outward looking export expansion and diressification from rapid economic growth to balance of payment disequilibrium accumated debt and stagnation.

A wide variety of strategies and instruments have been employed for economic development with varying degrees of success and distortions as well as a changing scenario of political institutions. The rapidly growing interest in the Brazilian economic "miracle", and the equally strong controversy surrounding Brazil's experiment with foreign debt accumulation, suggests that a review of the country's general development experience is in order before moving into a specific discussion of energy policies in the succeeding chapter since the former has obviously conditioned the latter.

The postwar era can be divided roughly into two historical periods. The first (from 1947 to 1963) can be called the inward looking import-substitution period. This period marked the first deliberate strategy to industrialize through stimulation of domestic production of previously imported finished manufactured goods and later capital goods. Associated with this effort was a style of sectoral target planning, non-market allocation of resources (i.e.licenses, subsidies), increased participation of foreign investment, a growing discrimination against agriculture and exports, increased income inequality, rising inflation and eventually a rising constraint on the capacity to import in the early 1960's.

Through foreign exchange controls, import restrictions, low interest rates, indirect taxation, and factor and product price controls, Brazil attempted to accelerate industrial growth. Only enough stimulus was given to agriculture to maintain low food prices, generate some surplus for export, and create a market for domestically produced tractors, fertilizer and other inputs. With its large resource base, broad domestic markets and favorable economic policies, industrialization proceeded quite rapidly so that by the mid-1950's a large proportion of consumer durables were produced domestically, and some progress toward capital goods production was evident. Agriculture, however, remained relatively backward, and food and fiber supplies barely kept pace with demand. (Alves, 1984).

Brazil's pattern of economic development began with import-substitution industrialization in the 1930s and the early postwar period up to the mid 1960's. Following a long period of Brazilian export stagnation, economic policy measures were undertaken which were more conductive to improved export performance. Among these measures one can site a policy of relaxing import restrictions, providing greater exchange rate realism, and instituting specific export incentives and others. As indicated by aggregate data Brazilian export sector responded favorably and throughout the late 1960's and early 1970's the rate of export growth were reasonably high and quit satisfactory, serving to reverse the declining Brazilian share in total world exports. According to Tyler (1983) the annual compounded rate of growth for total Brazilian exports in constant U.S. dollars for the period 1964-1974 was 12.6 percent. This represented 8.2 percent growth for primary products and 24.8 percent for industrialized product.

This export-oriented growth phase was in large measure the result of deliberate policy changes in 1968. The Brazilian government shifted to a crawling peg exchange rate, and established an elaborate system of export subsidies, tax exemptions and export credits designed to promote exports. These met with great success, and the 1968-1973 period is now known as the "boom" period in Brazilian economic development. The "boom" slowed in 1973 as productive capacity became fully utilized, and as the oil crisis imposed greater constraints on Brazil due to its dependence on foreign sources for 85 percent of oil requirements. These effects dampened Brazil's export drive and economic growth. There has been substantial recovery, although not all the way back to prior growth rates, till a second oil shock in 1979 increase in interest rate and accumulated foreign debt further demaged Brazil's economic situation.

With the events accompanying the first petroleum price increase, the international recession, and subsequent economic policy measures of the mid-1970's, Brazilian export performance was adversely affected. The real rate of total export growth for the 1974-1978 period declined to 5 percent annually. Brazilian primary product export earnings, inspite of significant increase in quantity exported, did not increase, due to low commodity prices. The industrial export grew at 11.8 percent in constant U.S. dollar annually.

The most common and popular explanation for the decline in export growth performance have to do with international demand conditions. First, it is argued that the international recession of 1974/75 and its aftermath reduced the demand growth for Brazilian exports. Second, increased protectionism on the part of the developed countries, particularly the United States and the European Common Market has adversely affected the growth of Brazilian exports.

Some western economist like Tyler (1983) do not accept demand-side arguments to explain all of the decline in Brazilian export growth. They seek explanation in terms of domestic export supply situation.

They emphasize that the "petroleum-price-related terms-of-trade loss and the accompanying balance-of-payment difficulties were not dealt with through macroeconomic absorption reducing policies and real exchange rate depreciation" (Tyler, 1983). Instead, increased international indebtedness and incerases in import restrictions were pursued in stead of the more conventional policy measures. The increases in import restrictions had the effect of angmenting an already existing anti-export bias and therefore making export activity less economically attractive than import substitution for domestic producers.

Due to abrupt slowdown in international lending to all developing countries in the second half of 1982, Brazil faced serious financial problem similar to these of other Latin American Countries.

In December, 1982 Brazil declared "unilaterally" its inability to service and repay its loans. The banks had no choice but to concede to its requests by a certain date (March 31st), otherwise the country would declare itself insolvent. Brazil's action gave a different perspective to the whole problem of outstanding world indebtedness. Bank loans became frozen assets (The Economists,April 30, 1983).

At the end of 1982 Brazil's foreign debt had reached US$ 90 billion with the sharpest increase in short-term debt. As a result Brazilian government signed and agreement with the International Monetary Fund (IMF).

Under IMF agreement, Brazil was committed to an auterity program featuring large cuts in government spending including that of the state enterprises. Cuts in credit subsidies are also included.

The cost in terms of living standards was high,unemployment is reckoned to have shot up among the industrial labour force from around 11% in the mid-1970s to around 20% now (about 1m of Sao Paulo's 4m workforce are without jobs). Underemployment is around 30-35%. There are no social security payments to the jobless. Fearing labour trouble, the Brazilian government has been protecting the purchasing power of the lowest paid while cutting back on salaries for skilled workers and the middle classes.

The end of voluntary credit flows by foreign banks and the inflationary up-surge, in 1982 pushed Brazil to a record level of 235% inflation. This imposed on the Brazilian economy the adoption of dramatic measures in order to change the structure of production and to fight inflation by reforming the financial monetary and fiscal systems. The first measure was maxi-devaluation of the cruzeiro followed by its full pegging in indexation to the General Price Index (IGP) in February 1983. As a result the Brazilian export coefficient has been rising considerably. Domestic consumption and particularly energy consumption was controlled with success. Brazilian trade balance showed large positive surplus. There is no doubt that US$ 9 billion target will be exceeded and may reach 12 billions at the end of 1984. Domestic oil production also has been rising. The average national oil production reached, at the end of June (1984) 500 thousand barrels/day that together with proalcool allowed Brazil to diminish its oil imports to an estimated value of 6.8 billion dollars as compared to nearly 11 billions in 1980. Thus Brazil was able to follow the policy prescribed IMF of reducing imports and increasing the export to generate foreign exchange to make payments on debt.

Outward Looking Development Based on Trade as an Engine of Growth

The Brazilian government has been strongly committed to building a market society which explicitly emphasizes protective action towards economic growth through industrialization and urbanization. The industrialization process in a "backward economy" and the strategy of catching up to the "developed" countries requires a high level of investment. As a result the urban-industrial process has been imposing a range of debts on the rest of Brazilian society. First, it is in debt to foreign creditors. Second, it is in debt to internal creditors, mainly from agriculture. Third, it is in debt to the mass of consumers who bear the real financial burden of two petroleum shocks and high rate of interest that has to be paid on accumulated debt. But clearly the boom period showed that Brazil has the capacity for dynamic manufactured export growth, and brought Brazil strongly into a leading position among the newly industrializing countries.

The increase in sales to the developed world, brought on mainly by the U.S. economic recovery, has helped Brazil achieve excellent results in its foreign trade sector. Its US$ 6.3 million trade surplus goal for 1983 was easily achieved - a goal that at the beginning of that year seemed almost impossible to reach, since traditional markets, such as Latin America, had to restrict their imports, because of the world recession. Brazil, however, thanks to the recovery of international prices for some raw materials, was able to overcome the problem, exporting to the United States, the Common Market (its biggest trading partner) and Asia.

If the trend in the first-half of the year of 1984 holds, Latin American exports this year to the U.S. could increase by as much as US$ 13 billion, reaching a total of 55 billions. If one assumes an average interest rate increase of 2% on Latin America's debt of US$ 336 billion, with about a half of which is owed to the U.S. banks, with three quarter of that half being rate sensitive, the increase in payments to U.S. banking institutions is less than US$ 3,5 billion. The rate of increase in exports earning to increase in interest expense is about 4 to 1. This shows that even with significant increases in interest rates of countries with large debts when given a chance to export they can avoid the tendency and need to dealave a moratorium that could be catastrophic for banking institutions. Liberal foreign trade policy on the part of European Community could further help with increasing exports and debt payments.

Europe's anti-inflation success in the face of rising commodity prices can be explained, in part, simply by the way the numbers are kept. Oil prices, for instance, receive much less weight in European consumer price indexes than they do in the U.S. because oil consumption per capita in Europe is much lower. And raw materials in general amount to only a quarter of total imports.

The main reason behind Europe's success in combating inflation in the face of rising commodity prices lies in a combination of restrictive economic policies in the public sector and a dramatic improvement in corporate productivity. These changes include:

- Reducing budget deficits dramatically, especially in West Germany, which last year came in US$ 3.5 billion below its prejected US$ 14.5 billion federal deficit.
- Keeping tight reins on monetary growth within the major European countries - even in Italy, which has had run away inflation.
- Lowering unit labor costs through lay-offs and greater work-rule flexibility.
- Raising the efficiency of corporate Europe by lowering breakeven points.
- Importing goods more cheaply from Third World countries.

On July 1984 the U.S. dollar reached a ten year high against the German mark at 2.86 and set a record against the French frane at 8.77. The British pound fell to an all-time low of US$ 1.30 (Business week, July 23, 1984). The strong U.S. currency cuts worldwide demand because the rest of the world must pay more in local currencies for nearly all internationally traded commodities, which are priced in dollars. West Germany, for example, in July of 1984 had to pay about 4% more German marks for oil than it did in January of the same year. This may depress oil demand and increase the likelihood of an oil-price drop.

According to economic theory: Capital flows to the highest rate of return. Never this was better illustrated than in the United States where the current combination of stimulative fiscal policy and restrictive monetary policy that has created an environment of strong growth, rising employment, high interest rates, and low inflation. The result is that dollar is replacing gold as the ultimate refuge of frightened investors.

The growth rate for the 10 member countries of the European Community has been less than half that of the U.S. and Japan, while unemployment has continued to rise even during the recovery. The one area in which the Europeans have had success has been in reducing double-digit inflation. And that has been all the more remarkable coming in the face of bloated commodity prices for European buyers cause by the sharp decline of their currencies against the dollar.

But the tremendous surge in the cost of key imported commodities has not generated imported inflation. Paradoxically, European economies are anticipating their best consumer price levels for years. Germany is confidently set to end this year with a consumer price index increase of around 2.5%, the lowest since the 2.7% recorded in 1978.

In addition, the same strong dollar that is sending commodity prices higher in Europe is also generating an export boom for European products. A growing proportion of the profits of many European auto, chemical, and machinery manufacturers are coming from exports to the U.S. These profits, in turn, permit European corporate managers to absorb higher imports. Even though Europeans have been hit it terms of commodity prices, they are getting a benefit from their exports.

Europe is also benefiting from the intense export drives of many Third Word countries that desperately need foreign exchange to pay their debts. To achieve these goals they have also allowed their currencies to depreciate against the dollar - giving European importers a break.

Having coped so far with the threat of rising prices, the question ahead of Europe is whether it can duplicate America's tandem success of low inflation and high economic growth.

Since 1973, OECD economic growth has averaged only half as much as it did in the preceding decade, inflation has doubled, and unemployment as a percent of the labor force has doubled.

The shock to oil importers is seen clearly in the events of 1979-80 and their aftermath. Initially the increase in oil prices over the two years meant a transfer of resources of US$ 240 billion a year in nominal terms from importers to exporters (US$ 200 billion from industrial countries, US$ 40 billion from developing countries). These income losses by importers had their counterpart in income gains by exporters. This is a characteristic phenomenon of a commodity boom; the element that is unique is the size and speed of the transfer, which in fact led to the ominous ramifications described earlier.

The response of the non-oil-producing Latin American countries was to borrow to cover their growing trade deficits. The response of the oil-producing nations was to borrow because the money was there for the asking and, what the hell, they had oil, the best of securities, to borrow against.

In addition. importers suffered huge income losses for which there were no corresponding gains by exporters. OECD estimates indicate that the economic disruption costs of the oil price shocks will reduce OECD output by some US$ 400 - US$ 500 billion (1981 dollars) below what it otherwise would have been (Fried, 1982).

A startling fact emerges from the data appearing in the 1982 World Development Report. The average rate of economic growth of oil-exporting countries as a group in the past ten years is lower than it was in the period 1960-73. If draws further credence from the extraordinary difficulties now confronting a number of oil-exporting countries, such as Mexico, Nigeria, and Venezuela.

A decrease in oil prices should result in greater economic growth in the industrialized countries, which in turn will create stronger demand for developing countries' exports. For indebted developing countries a fall in oil prices would be a mixed blessing. For Brazil, every dollar decrease will result in a change of US$ 250 million in current balance of payment accounts. Major oil exporters such as Mexico and Venezuela, however, would suffer a significant revenue loss, making it much more difficult to repay their debt.

Agricultural Development

The forced-draft industrialization policies have been financed at the expense of the agricultural and rural sectors.

The low rate of growth of agricultural production in Brazil after World War II was the result of a combination of factors. Among them were: lack of an agricultural research tradition and institutions, limited extension services, lack of an infrastructure to serve agriculture and price and tax policies designed to fall most heavily on agriculture, thus acting as a disincentive to production of agricultural products. In addition, import substitution industrialization was adopted as a growth and development strategy by the government, resulting in continuous transfer of resources from agricultural to industrial and service sectors. This neglect of agriculture also caused some domestic supply problems. It gradually became clear that unless there was adequate production to supply growing domestic demand for food, general stagnation would occur.

In addition, Brazil until the middle 1970's did not participate in the growing trade in agricultural products that has characterized the post-World War II period. As a result, the demand for agricultural export was kept relatively low. This problem was further complicated by the fact that export quotas were placed on agricultural products from time to time under the guise of controlling domestic inflation. This further dampened the demand for agricultural products and reduced the incentives to output expansion.

In the mid-sixties, economic policy underwent a change of emphasis from autarchic industrial import substitution to agressive export expansion in which agricultural and agro-industrial products played a major role. Overall performance of the economy also improved, resulting in a growth rate in the G.N.P. of 11% in the 1966-73 period.

As a result of this policy change, Brazil became an often quoted example of a country that had managed to achieve a significant agricultural development in the seventies. In the early eighties it also became the second largest exporter of agricultural products, superceded only by the United States.

As a result, Brazil is rapidly becoming an agricultural world power.

In the last decade, Brazil's total agricultural production has tripled, and not all of the growth has come in the output of crops traditionally associated with tropical farming. For example, when the United States at one point curbed soybean exports to Japan, the Japanese turned to Brazil. Soybean output jumped from 2.2 million tons in 1974 to an estimated 16 million tons in 1984, overtaking coffee as the country's number one export crop.

Until the mid-seventies, the principal factor responsible for the growth of agricultural output in Brazil had been expansion of cultivated areas along with some increase in yield which was mainly true with export crops. The scientific frontier in terms of increased productivity of land, labor and various modern inputs was little explored.

The Brazilian agricultural policy initially emphasized building extension institutions. However, at an early stage it became obvious that for successful operation of extension services, a strong research system had to be built to provide new knowledge and technology to be used in giving technical assistance to farmers. As a result one of the strongest agricultural research systems coordinated by the Brazilian Agricultural Research Corporation EMBRAPA, created in 1973, was build in the 1973-84 period.

Brazil regards the application of science and technology to agriculture as a major means of achieving economic and social progress. It is believed that the future of Brazilian agriculture depends on becoming predominantly knowledge-intensive and that agricultural and related research has to be given special emphasis so as to achieve substantial growth in production. In the 11 years since the reorganization of the national agricultural research system, marked by the founding of EMBRAPA (Brazilian Agricultural Research Corporation), agricultural science has become a poerful, productive force in Brazilian society. According to Eliseu Alves (1984): EMBRAPA proposes to change the focus of the relationship between advanced and developing countries from "technology transfer to science transfer".

Improved and new methods of agricultural and industrial production in the industrialized countries will displace more traditional products of developing countries. A good existing illustration of the kind of Third World product displacement that is likely to occur through the development and application of biotechnology in the years ahead is that of sugar, for which fructose made from corn or maize grown in the industrialized countries is emerging as an economically viable and more and more widely used substitute. The price of sugar has been falling since 1980 as shown in table 4.

Table 4

BRAZILIAN SUGAR EXPORTS - 1980-84

Year	Crystal Sugar			Raw Sugar			Refined Sugar		
	Value $ 1000 FOB	Quantity (t)	Price $/T	Value $ 1000 FOB	Quantity (t)	Price $/T	Value $ 1000 FOB	Quantity (t)	Price $/T
1980	317,398	568,922	557.89	624.500	1,391,530	448.79	346,356	611,884	566.05
1981	86,884	221,689	391.92	578,928	1,563,519	370.27	395,926	915,635	432.41
1982	76,911	397,665	193.41	259,441	1,222,178	212.28	243,655	1,089,841	221.74
1983	25,990	145,820	178.23	319,619	1,523,427	209.80	169,420	791,454	214.06
1984*	6,180	35,364	174.75	134,856	683,976	197.16	68,772	355,746	193.32

Source= CACEX

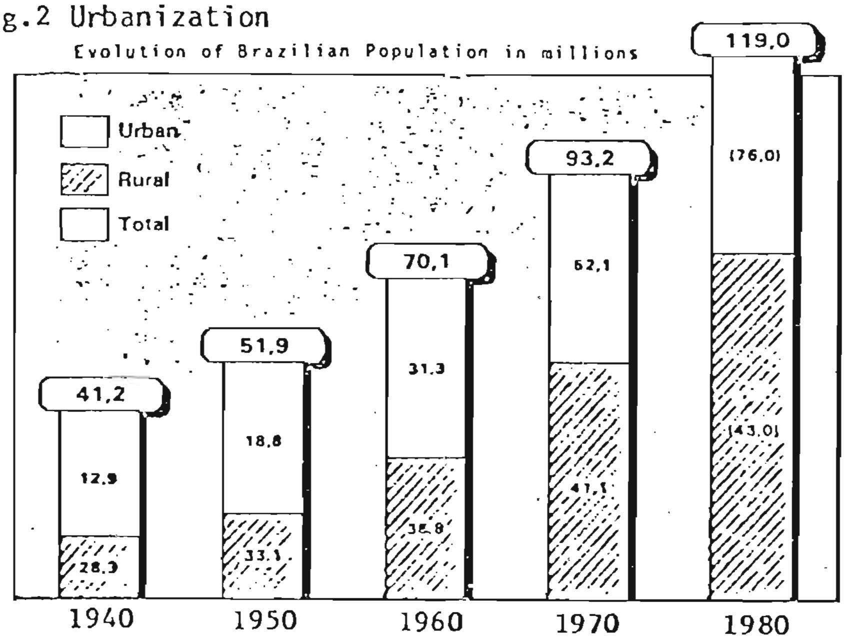
* January/May.

Table 5 - PERSONS SUPPLIED BY BRAZILIAN FARM WORKER

Year	Population		Economically Active	Person Supplied Per Farm Workers		
	Urban	Rural	Rural Population	Urban Resident	Rural Resident	Total
1940	12.880	28.356	9.723	1,3	2,9	4,2
1950	18.783	33.161	10.253	1,8	3,2	5,0
1960	32.004	38.987	12.277	2,6	3,2	5,8
1970	52.905	41.607	13.087	4,0	3,2	7,2
1980	82.013	39.137	13.109	6,3	2,9	9,2

Source: IBGE

Fig.2 Urbanization



Source: IBGE: estimativa de Brasil em Exame para população urbana 1980

BRAZIL'S BIO-ENERGY PROGRAM

The Challenge

The sharp increase in petroleum price in 1973 and steadily rising cost of this commodity ever since have resulted in partial and possibly temporary redistribution of wealth in favor of a rather limited number of countries with petroleum deposits. At the same time, non-industrial countries without petroleum deposits were harder hit, since they had to pay high prices both for industrial and petroleum products.

Toynbee's observation that civilization is the story of challenge and response has seldom been better exemplified than by reaction to the effect on the world economy of the Energy Crisis.

The government of Brazil, for example, has involved itself in large-scale production of alcohol, totaling millions of gallons a year. The adaption of a national alcohol fuels programa "PROALCOOL" was a positive expression of Brazilian determination and resolve to remedy its debilitating energy problems. As the cost of oil skyrocketed, the Brazilian government became increasingly determined to reduce its dependence on oil imports.

Thus, through all the confusion and contradictions of the energy crisis, one significant fact is beginning to emerge: Brazil has a good chance to free itself of heavy dependence on foreign oil. A related fact is that in the act of meeting their energy problems the Brazilians may be starting a new industrial revolution, the most significant and exciting feature of which could be a less centralized, more cooperative, and more creative way of life.

The energetic cycle emerging in Brazil is a process that conciliates scientific creativity with intensive manual labor, combining technological development with creation of employment opportunities to the benefits of a growing population.

Alcohol fuels, at least in the case of countries with agricultural exports, can help to reconcile the differences between the rich and the poor, the industrial and the developing nations, and between mankind and nature. In this new and emerging field there is room for the many, regardless of who they are or where they come from. In capturing this important opportunity there is no room for exploitation, no room for economic and political greed. There is plenty of room for cooperation and technology sharing for large and small-scale plants, for the revitalization of rural communities and for scientific and technical advancement of alcohol fuels in the developing nations. With the knowledge that there is plenty of room for all, we can then get on with the critically important tasks of reconciling the differences between those of us who perhaps have too much and those of us who certainly have too little.

Early Development

The use of alcohol as a vehicle fuel in Brazil dates back to the 1920s. The first government resolution establishing compulsory alcohol addition to gasoline at a five percent level dates back to 1931. During that year two commissions were created: the Alcohol Motor Study Commission and the Commission to Support Sugar Prices. These two commissions were reorganized and combined in 1933, becoming the Sugar and Alcohol Institute (IAA).

The sugar policy that followed the creation of the Sugar and Alcohol Institute was influenced by the policy experience in coffee, which at the time was the major foreign exchange earner. Coffee policies in Brazil have been oriented towards the objective of achieving high prices abroad through control of supply. One of the most drastic measures undertaken to control supply occurred in the 1930s and during the Second World War when the government decided to burn about 78 million bags of coffee to maintain prices in the international market at a satisfactory level.

Along similar lines, the Sugar and Alcohol Institute was created to face the continued crises of overproduction and low prices that had been disturbing the sugar market for many years. It attempted to achieve a balance between output and consumption through the absorption each year of a certain quantity of sugar-cane in the production of alcohol (Miller Paiva, p. 167). In other words, the basic mission of the IAA has been to achieve balance in the production, consumption, and export of Brazil's sugar and alcohol. The IAA pursues these multiple objectives by establishing yearly production goals, milling and distillery quotas, and export targets. In addition, IAA has traditionally helped in financing the building of new alcohol distileries linked to or adjoining existing sugar mills.

PROÁLCOOL

In 1975 the government took a great leap forward and mandated the eventual complete replacement of gasoline with ethanol.

Owing to Brazil's relatively lengthy experience with cane-derived ethanol, short-term needs have to date been derived from this source.

PROALCOOL, the major program of alternative energy sources using agricultural biomass in the world. It is based on the following economic and social policy objectives:

- Improving balance of payments through the substitution of alternative energy sources for imported fossil fuel and the exportation of alcohol.
- Increasing demand for domestic industrial products through the expansion, modernization and construction of alcohol distilleries.
- Avoiding additional individual income concentration.
- Avoiding additional inequities of regional income distribution.

To attain these goals, PROALCOOL is supposed to utilize a variety of feedstocks other than sugarcane and molasses, including manioc, babassu, sorghum, sweet potatoes, other starches, wood, and cellulosic materials. The use of different feedstock are considered as a means of expanding the productive land base, increasing the security of supplies through diversification and involving new-regions in the socio-economic benefits which may accrue from the endeavor.

Of the alternative crops, manioc is now widely grown in Brazil, typically in poorer and small-farm agricultural areas. The Northeast and South are the major producing areas. Manioc can be harvested year-round in some areas or chapped, dried, and stored for off-season processing. It can be grown under a wide range of soil and moisture conditions. For making alcohol it requires a separate heat source which varies by region (coal, surplus bagasse, wood, etc.). Since manioc is grown principally as a subsistence crop on small plots and with little improved technology, the potential productivity under commercial conditions is not clear. Experimental work in Brazil and elsewhere, however, suggests that substantial increases over current Brazilian productivity levels are possible. One pilot plant operated with relative success.

Manioc appears to be well suited to the cerrado region, though its adaptability is not limited to that area. The cultural energy balance and volume of the crop needed to operate an alcohol plant suggest that it should be grown in close proximity to the processing facility, and that, to be economically viable, the yields must be increased. This may mean large plantings and certainly a higher level of management and technology than manioc now receives.

Another alternative crop, sweet sorghum (Sorghum bicolor L. Moench) is a high yielding biomass crop producing fermentable sugars (and cellulose) for conversion into ethyl alcohol. Unlike sugarcane, sweet sorghum can be an attractive alcohol feedstock in the United States and Europe. Its high drought tolerance and low nutriente requirements make sweet sorghum a prime candidate for agriculturally-derived alcohol fuels.

The feasibility of expanded use of alcohol as a chemical feedstock are also being studied. New distilleries, production incentives, and low world sugar prices combined to raise alcohol production more than fifteen fold since 1976. (Table 6).

Table-6- Alcohol Production, 1970/1 to 1979/85
(Thousands of liters)

Crop Year	Production	Crop Year	Production
1970/71	637,238	1978/79	2,451,576
1971/72	613,038	1979/80	3,800,000
1972/73	680,972	1980/81	
1973/74	665,979	1981/82	
1974/75	624,985	1982/83	
1975/76	555,627	1983/84	
1976/77	643,158	1984/85	9,100,000
1977/78	1,470,404		

The major technological problem is diminishing the cost of building of distilleries. At present the investment may reach US$ 12 million for a plant with a capacity of 500 barrels per day.

The technology for the manufacture of ethanol also has been criticized by several experts as having negative net energy production efficiencies. Careful analysis of these claims often reveals serious technical flaws. For example, some of those who see negative net energy production efficiencies in ethanol plants are referring only to the use of a small portion of the biomass feed such as the grain; the remainder of the feed is ignored. Others often give no energy credits for the by-products produced along with alcohol; and still others consider only the manufacture of pure alcohol, which is not necessary or perhaps even desirable when producing alcohol for fuel (Purschwitz, 1981). In other words, the present costs of producing alcohol may be decreased by simplification of production methods, since present processes, particularly in developed countries, are based on the production of a grade of alcohol which is of specific taste, color, and odor. Since these are of no concern in motor fuel, simplification in the process, equipment, and quality of raw materials are possible. As a result, labor and capital costs could be reduced. Also, lower grades of raw material could be utilized in producing a cheap grade of alcohol.

Ethanol costs are influenced by the capital investment in and the financing of the distillery, operating costs, and the by-product credits. The cost of an ethanol distillery for starch and sugar feedstocks is about US$ 1.00 - US$ 2.00 for each gallon per year of capacity. Distilleries that rely upon sugar feedstocks are more expensive than those using starch, due to the equipment needed to handle the feedstock and to concentrate the sugar solution to a syrup for storage.

In order to achieve the goal of 10.7 billion liters by 1985, Brazil was supposed in-est US$ 6 billion in PROALCOOL between 1981-1985.

The Brazilian government remained the largest supplier of capital for PROALCOOL providing both credit and technological assistance. Concessional financing was very attractive for establishing distilleries and expanding crop production. This financing is currently split between the industrial and agricultural sector.

Industrial sector financing included the financing of 80 percent of the total cost of establishing distilleries or the modernization of old ones which use sugarcane as the raw material. Financing of 90 percent was available for distilleries using alternative feedstocks (i.e. manioc). The interest rates varied according to region and feedstock. Distilleries linked to sugar mills could have been financed at 4 percent in the North and Northeast, but at 6 percent in the Center or South. An autonomous distillery using sugarcane was financed at 3 percent and 5% in the respective regions. Interest rates of 2 percent were available for distilleries using raw materials other than sugarcane. Financing for all distillery projects was spread over a maximum of 12 years, with an initial 3 year grace period and 40 percent annual monetary readjustment based on National Treasury Indexed Bonds (ORTN).

Concessional financing for the agricultural sector was split between financing investment costs (establishing sugarcane plantations or renewing old ones) and financing production costs. In both cases, financing of 100 percent of the cost of the project was available. In the case of financing investment costs, interest rates of 15, 21, and 26 percent, respectively, were set for small, medium and large farmers (located in the North/Northeast).

Other Bio-Energy Possibilities

Brazil is engaged in the research and production of other types of agri-fuels as well. Oil supply problems and ever-rising prices have stimulated research into the use of alternative fuels to extend or substitute for diesel fuel used in agricultural tractors. Vegetable oils obtained from seed crops show promise when used in diesel engines. However, observers foresee two major problems with this technology: (1) difficulties in storing production, because heat and humidity combined with bacteria can denature the oil, thereby making it inappropriate for fuel purposes; (2) vegetable oils now and for the foreseeable future are high priced and can probably be more profitably sold as edible oils.

The possibility of being able to produce fuel from organic wastes is an attractive proposition and has stimulated considerable international interest from time to time over the past 30 years. The anaerobic digestion of manures and many other biomass materials produces a gas known as biogas consisting of approximately 60 percent methane, 40 percent carbon dioxide (containing small amounts of hydrogen sulfide); stabilized solids, consisting of vegetable proteins and humus, potentially valuable as a feed additive or as a fertilizer and soil conditioner; and nutrients dissolved in the spent process water, suitable for growing algae for use as a fertilizer.

In countries where sewage disposal systems are not adequate, anaerobic digestion of night soil and other sewage greatly reduces the presence of pathogenic organisms in the open environment.

Hence, anaerobic digestion not only offers energy, feed, and fertilizer products but it prevents environmental degradation of various kinds. Anaerobic digestion should therefore be viewed in the light of all its benefits, not just the energy obtained. In recent years, Brazil has made large investments in the development of biogas technology. Due to these efforts and some assistance from other countries, these technologies are considered ready for national diffusion.

In short, there are numerous factors that must be considered as we advance into integrated food, feed, fiber, fuel, chemical feedstock, and fertilizer systems. We are also beginning to recognize that our liquid fuel problem is so severe that it may well be in our best national interests to embark on the production of non-petroleum liquid fuels even if they are more expensive.

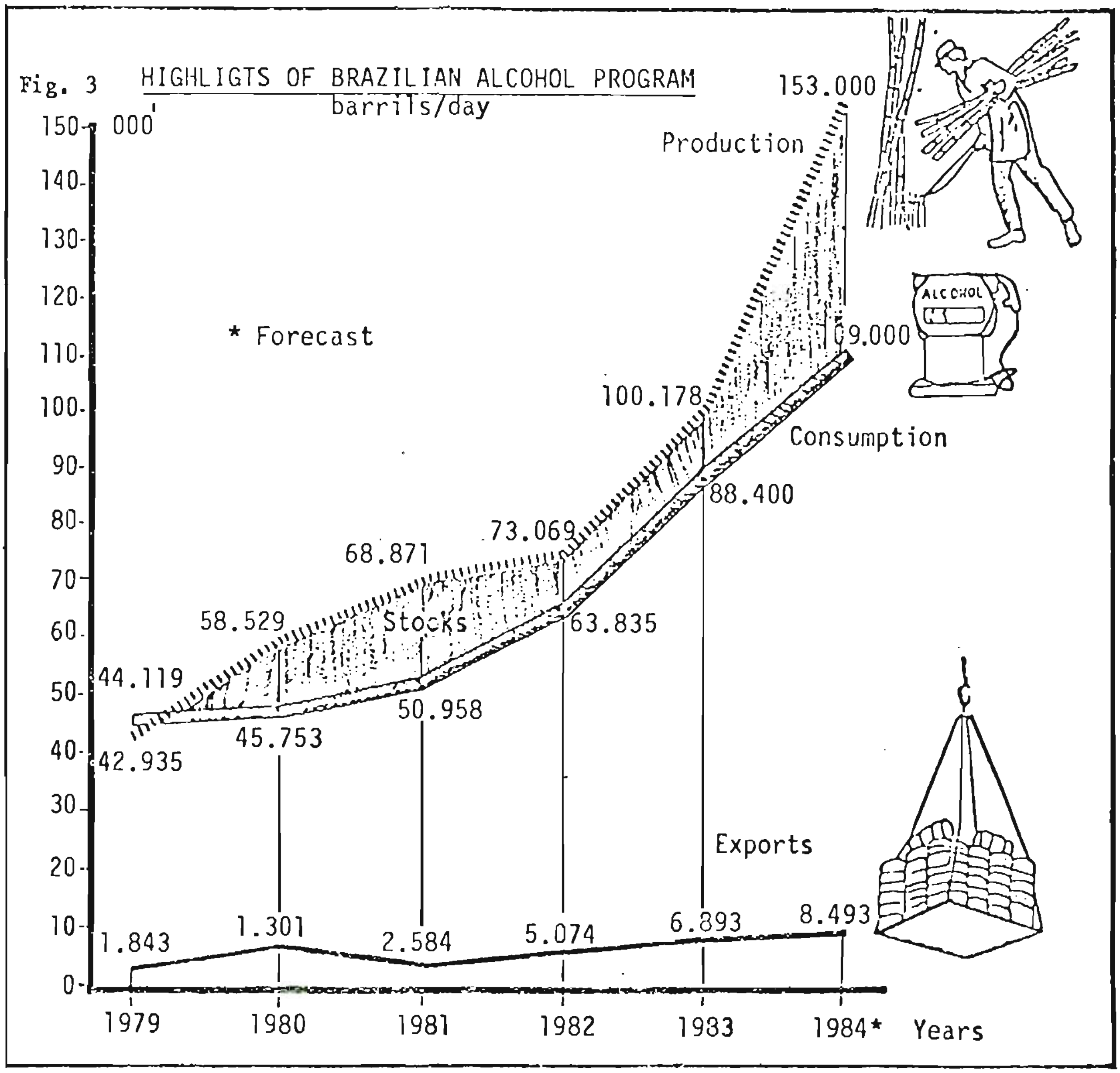


Table 7 PROALCOOL HIGHLIGHTS

PETROLEUM IMPORTS

Year	1973	1979	1980	1981	1982	1983
US$ billions	0,7	6,5	9,4	9,7	8,6	6,8
Bar./day	649	997	876	777	734	644

Source: Ministério das Minas e Energia

PERCENT COMPOSITION OF PETROLEUM REFINERY OUTPUT

REFINERY OUTPUT	1973	1979	1983
LPG	4,0	4,3	5,6
Gasoline	27,8	20,0	16,5
Naphtha	3,2	5,0	9,1
Diesel fuel	23,7	28,5	33,4
Kerosene	4,6	5,0	5,9
Fuel Oil	31,9	29,4	22,8
Others	4,8	7,8	6,7

Source: Ministério de Minas e Energia, Auto Suficiência Energética, Um Cenário de Estensão do Modelo Energético Brasileiro, Brasília, julho, 1984, p. 98.

DEPENDENCE ON FOREIGN SUPPLY OF ENERGY

Years	1973	1979	1983
%	34,2	37,5	22,2

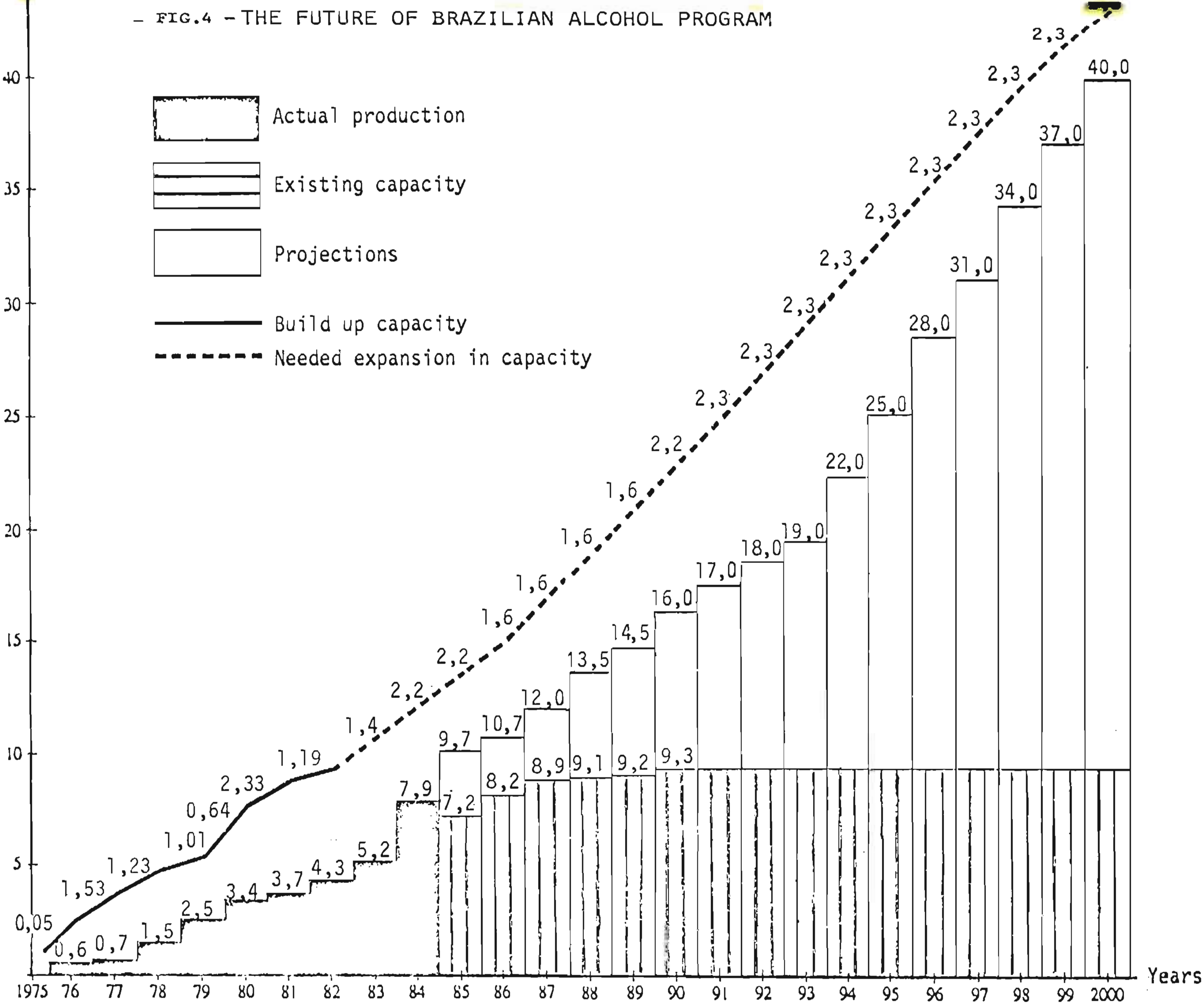
Source: Ministério das Minas e Energia

Table 7 - Evolution of liquid fuel consumption in high way transportation in 000' TEP and percentage - Brazil 1973-1983

YEAR	DIESEL OIL	GASOLINE	ETHYL ALCOHOL	TOTAL
1973	5.290	10.269	233	15.792
	33.5	65.0	1.5	100.0
1974	5.692	10.656	143	16.491
	34.5	64.6	0.9	100.0
1975	6.516	10.901	122	17.539
	37.2	62.1	0.7	100.0
1976	7.577	10.783	128	18.488
	41.0	58.3	0.7	100.0
1977	8.215	9.977	474	18.666
	44.0	53.5	2.5	100.0
1978	8.864	10.183	1.116	20.163
	44.0	50.5	5.5	100.0
1979	9.447	9.949	1.654	21.050
	44.9	47.2	7.9	100.0
1980	10.274	8.613	1.955	20.842
	49.3	41.3	9.4	100.0
1981	10.045	8.196	1.727	19.968
	50.3	41.1	8.6	100.0
1982	10.557	7.807	2.562	20.926
	50.5	37.3	12.2	100.0
1983	10.575	6.668	3.570	20.813
	50.8	32.0	17.2	100.0

Source: Ministério das Minas e Energia, Balanço Energético Nacional, Brasília, 1984.

- FIG.4 - THE FUTURE OF BRAZILIAN ALCOHOL PROGRAM



Source: SOPRAL, Produção e Demanda de Álcool 1982.

Table 8

REVENUE, EXPENDITURE AND PROFIT OF AN AGRO-INDUSTRIAL PROJECT FOR PRODUCTION OF 29 BILLION LITERS A YEAR OF SUGARCANE ALCOHOL FOR EXPORT. (US$/barrel)

Year	Petroleum Price (FOB)	Price of gasoline: (1)	Manufacturing expenses (2)	Freight, warehousing and customs duties (3)	Total expenses, except interest	Unit profit	Production of alcohol (10 billion)	Total profit (US$ 10^6)
1985	35.0	49.2	24.6	2.6	27.2	22.0	-	-
1986	36.3	50.7	24.6	2.6	27.2	23.5	-	-
1987	37.6	52.2	24.6	2.6	27.2	25.0	91.2	2.3
1988	39.0	53.9	24.6	2.6	27.2	26.7	127.7	3.4
1989	40.5	55.6	24.6	2.6	27.2	28.4	164.2	4.7
1990	42,0	57.4	24.6	2.6	27.2	30.2	182.4	5.5
1991	43.0	58.5	24.6	2.6	27.2	31.3	182.4	5.7
1992	43.9	59.6	24.6	2.6	27.2	32.4	182.4	5.9
1993	44.9	60.7	24.6	2.6	27.2	33.5	182.4	6.1
1994	46.0	61.9	24.6	2.6	27.2	34.7	182.4	6.3
1995	47.0	63.1	24.6	2.6	27.2	35.9	182.4	6.5

Prices as of August, 1983

(1) Price representing value of alcohol for mixing with gasoline;

(2) Does not include remuneration of capital, since the amount referring to interest (see other Table) already indicates the cost of this factor;

(3) Despite the meagre information available on the amount of these charges, it is felt that about 2.6 dollars per barrel will be sufficient;

(4) The prices adopted for the petroleum and the gasoline may vary, but the sum indicated is likely to be close to reality.

Table 9

CASH FLOW DURING THE PERIOD OF RECOVERE OF THE INVESTIMENT IN THE PROJECT FOR PRODUCING OF 29 MILLION LITERS OF SUGARCANE ALCOHOL

(US$ 10^9)

YEAR	INITIAL DEBIT BALANCE	INTEREST IN PERIOD (1)	INVESTIMENT IN PERIOD	PROFIT IN PERIOD	FINAL DEBIT BALANCE
1985	-	-	3.0	-	3.0
1986	3.0	0.3	6.0	-	9.3
1987	9.3	0.9	6.0	2.3	13.9
1988	13.9	1.4	3.0	3.4	14.9
1989	14.9	1.5	1.0	4.7	12.7
1990	12.7	1.3	1.0	5.5	9.5
1991	9.5	1.0	-	5.7	4.8
1992	4.8	0.5	-	5.9	(0.6)

N.B.: (1) 10% on initial debit balance

BRAZILIAN AUTOMOBILE INDUSTRY AND PROALCOOL

At present, alcohol is used by a fleet of 1.2 million cars (8% of the total) especially manufactured to run on alcohol, whose consumption is 60,000 barrels of alcohol/day (48,000 bep/day). In addition, the consumption of anhydrous alcohol as an extender of regular gasoline (in a proportion of 21.4% in 1983) is estimated at 50 barrels of alcohol/day (41.2 bep/day). At a rate of US$ 30/barrel of petroleum, more than US$ 1 billion of total imports will be substituted. This constitutes 17% of total petroleum imports.

At present, alcohol mostly substitutes gasoline. Since Brazil his shifted to the import of heavy oil, at the refinery level the production of diesel oil has been increased from 23-34% of imported oil, resulting in a 30% increase in diesel availability due to alcohol substitution of gasoline. Still, a certain gasoline surplus and diesel oil deficit is expected. The agricultural sector directly uses about 18% of total diesel oil and the transportation of agricultural inputs and outputs is based on diesel trucks.

Supplement 1 illustrates how alcohol is beygining substituting diesed in production of alcohol. Chart shows the development growth of Brazilian automobile production. It shows a decrease of regular gasoline driven cars and an increase in alcohol driven models. Eventhough about 90% of new cars sold in Brazil are alcohol-using models some 240,000 gasoline-models are to be exported in 1984.

One of Brazil's major foreign trade items, the automobile sector has kept up its production pace and is one of the areas benefiting most from exports. More active in the European market, especially since 1981 (with the launching of the Fiat Diesel), the export programs are being continuously evaluated in order to achieve greater results.

In the last three years, the Brazilian automobile industry invested US$ 2 billion in its production lines in order to introduce new products. And the great stars of these investments were the so-called world cars, aimed mainly at transforming Brazil into a great export center, competing with Japanese cars. General Motors spent US$ 500 million in the manufacturing of its Monza, while Ford spent US$ 400 million for its Escort. And Fiat is ready to invest US$ 300 million on its Uno world car, to be introduced in 1985. GM, which seems unwilling to stop, has announced new investments for this year and next: US$ 250 million for product development and technical research, aimed at the Brazilian market and the foreign one as well.

Businessmen in the sector see Brazil as one of the few countries in the world able to assemble cars and be competitive with the Japanese. Volkswagen will launch its Santana world car this year exactly to make use of the advantages of producing in Brazil: cheap labor (half that of Japan's), excellent quality, local source of raw materials for the automobile industry and the Befiex (fiscal benefits for exporters) program. According to the figures provided by the National Association of Motor Vehicle Manufacturers (ANFAVEA) the automobile industry grew 5% in 1983 over 1982, thanks to the general world economic recovery and to the popularity of the alcohol-fueled automobile with the Brazilian public, which has received strong fiscal incentives from the federal government. The businessmen's optimism doesn't stop there: they hope to increase by 5% in 1984 the 900 thousand units built in 1983. This increase could reach 10%, depending on government economic policy.

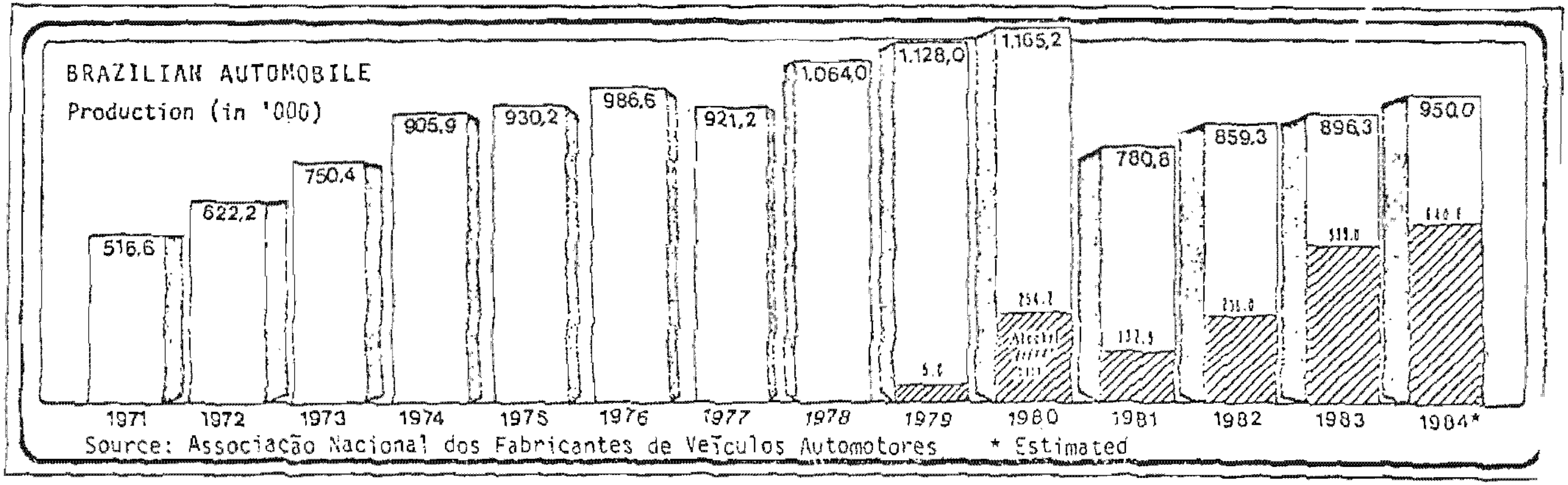
Heavy investments were also made in the bus industry, mainly for those buses destined for mass transit in the great urban centers.

Table 10- Production of Vehicles, Brazil, 1970-1983

Year	Total Vehicles	Automobiles	Trucks	Tractors
1970	413.202	343.480	38.388	16.607
1971	516.067	437.776	38.869	25.448
1972	609.470	509.303	50.150	34.549
1973	729.386	600.030	64.844	44.211
1974	905.103	750.237	76.631	52.741
1975	929.807	722.465	78.665	65.666
1976	985.469	827.260	83.895	71.713
1977	919.864	771.609	101.338	59.719
1978	1.063.217	920.897	86.319	55.874
1979	1.128.325	960.363	93.168	64.511
1980	1.165.217	977.695	102.056	69.993
1981	780.852	621.885	76.414	47.022
1982	859.295	715.743	46.698	37.566
1983	896.274	772.125	35.268	26.560

Source: Ministério da Indústria e do Comércio

Fig. 5


BRAZILIAN AUTOMOBILE
Production (in '000)
516,6
622,2
750,4
905,9
930,2
986,6
921,2
1.064,0
1.128,0
1.165,2
780,8
859,3
896,3
950,0
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984*
Source: Associação Nacional dos Fabricantes de Veículos Automotores
* Estimated

LEAD-FREE GASOLINE AND ALCOHOL

The Dispute Over Lead-Free Gasoline in Europe

While European auto makers have long built engines to lead-free specifications for export models, auto pollution only recently surfaced as an important environmental issue at home. In mid-July, 1983, The West German Interior Minister pushed a proposal through the Bonn cabinet to require catalytic converters and lead-free gasoline in all new cars sold in Germany beginning in 1986. The plan could mean huge extra costs for consumers and auto makers and could split the European auto market down the middle between lead-free and leaded standards.

Germans were startled by the conservative government's antipollution stance, although public pressure has been mounting over the problem of acid rain affecting Germany's forests.

Acid rain is a political, economic and environmental issue on both the continents of North America and Europe. To reduce sulfur dioxide emissions and thus minimize acid rain, legislative actions were taken in the early 1970's and later modified in the U.S. and more recently in certain European countries. These actions mandated installation of air pollution control equipment, primarily flue gas desulfurization (FGD) systems, to remove most of the fly ash and sulfur dioxide (SO_2) from exhaust gases before they could be released into the environment.

At the last European Community meeting, it was understood that the Germans were moving along the same track as the United States reducing lead emissions to 0.15 parts per million. When the German proposal becomes law, Germans will be able to travel outside Germany only if the rest of European are kind enough to supply them with lead-free gas.

Germany, as Europe's premier auto market, has the clout to circumvent the slow-turning wheels of EC diplomacy. Some 21% of the cars sold in Europe end up on German autobahns, and the prospective requirement means that other European carmakers may have to convert big portions of their production to lead-free specifications (Businessweek, August 8, 1983).

A Europe split into lead-free and leaded market segments would make a shambles of market planning and exacerbate the bitter cross fire over EC trade barriers. If a divided market results, German manufacturers - who sell US$ 3 billion worth of cars to France and Italy annually - could be the big losers.

On the lead-free side are the British, who were shocked last spring by a blue-ribbon-panel report on lead pollution that said the average blood-lead concentration among Britons was extremely high. Lining up with Britain are the Scandinavians, Swiss, and Greeks, who are anxious to protect the soon-to be refurbished Parthenon in Athens. Ranged against them in EC discussions to set a timetable for conversion to lead-free standards are France and Italy, who are determined to protect domestic industries geared to high lead use. And Belgium is in the middle.

The French government has invested heavily in research by Renault and Peugeot on a highly efficient, leaded-fuel motor, which could begin production around the time Germany's lead-free rules go into effect. According to a French government spokesman: It will be up to the consumer to decide which he prefers, an efficient car that consumers three liters of gasoline per 100 km or one that burns 10 liters of lead-free gasoline to go the same distance. (Businessweek, August 8, 1983).

Still, the Germans are confident that the EC Commission will give at least tacit support to a preemptive conversion. Their optimism appears to be well-founded. With seven out of 10 EC members in favor of lead-free, "economic pressures" will force the others into line.

Even if the Europeans manage to agree on a common schedule for lead-free standards, the problems for the European auto industry loom large. Conversion would entail significant price increases, particularly for cars in the compact-to-mini range, and may give a competitive boost to large cars. "For them the extra cost is a throwaway", says one discouraged small-car sales executive. But Volkswagenwerk predicts a 10% rise in its average US$ 4,400 sales price in Germany. Renault and Fiat may be hit even harder, as will U.S. makers such as Ford and GM. Their subsidiaries in Europe have moved aggressively into the small-car market. Opel launched GM's first mini ever in Europe last fall (Economist, October 1, 1983).

The actual result will be considerably higher car prices, an increase in gasoline bills of as much as 10%, and new maintenance cost which might add US$ 2.4 billion annually to the expenses of German motorists. These increases could also put an end to the recovery of the domestic German car market. And the timing of the conversion rules could wreak havoc. If, as some auto makers fear, pre-1986 cars are allowed to phase out over a 10-year period, sales of still-legal leaded-fuel cars will skyrocket in 1985, while 1986 sales of lead-free cars will be low.

Vehicle fuel consumption can be reduced by increasing engine compression ratio but this requires, to ensure knock-free operation, motor gasoline of higher octane number, which however requires more energy in its manufacture since gasoline antiknock performance is measured by the octane number of fuel. Until recently, tetra ethyl lead (TEL) was used as a gasoline additive or antiknock booster. Preocupation with lead poisoning and the introduction of catalyst emissions control systems on vehicles resulted in prohibition of using TEL or other antiknock boosters, since these additives poison the catalyst units, making them ineffective as emissions control devices. Also, the recent trend of increasing engine compression ratios to improve fuel economy has resulted in an increased tendency of new automobile engines to knock with the available unleaded gasoline fuels. Introduction of alcohol methanol and ethanol, into gasoline blends would be expected to increase the optimum octane numbers, since alcohol have a high octane number. Optimum octane number of alcohol gasoline blends and relevant percentage of alcohol needed to achieve minimum crude oil usage in the system refinery-engine in Europe has been studied by Spencer and Brandberg (1982). The value of alcohol as a blend component in terms of crude oil saved is about one to one.

At present the United States Environmental Protection Agency EPA wants to reduce the amount of lead in gasoline by 91% till the end 1986. The proposed rule would tighten the current standard of 1.1 gram per gal to 0.1 gram in 1986 and ban all lead in gasoline by 1995 EPA estimated that the proposal would cost refiners about 578 million but would produce benefits of about US$ 1,8 billion in reduced medical and vehicle main tenance costs (Businessweek, August 13, 1984).

In addition to substituting lead and associated environmental impact the addition of ethanol to gasoline will

1) Somewhat decrease hydrocarbon emission
2) Significantly decrease carbon monoxide emissions
3) Slightly increase nitrogen oxides emissons and
4) Significantly increase evaporative hydrocarbon emission.

In addition, massive use of ethanol will provide for partial energy self-sufficiency based on the use of local sugar and agricultural wastelive cull potato. It can also diversify the foreign sources of energy from oil producer to agricultural products exporters like Brazil.

As noted, gasohol, generally speaking, is less polluting than other fuels. This is particularly the case in Brazil where blends may have a higher alcohol content than elsewhere and where cars may run on pure alcohol rather than gasoline.

Table shows some test results found in Brazil. The percentage of carbon monoxide in exhaust gases from 20% ethanol gasoline blend is 4.2% as opposed to 6.8% for pure gasoline.

One should observe the current controversy over the use of lead anti-knock agents in the petroleum-based First World countries. Clear indications of its effects are now beyond dispute. Not only would gasohol help to overcome this problem but a total ethanol basis is Brazil would prevent the repetition of past pollution problems encountered in cities like Los Angeles and Duisburg it their agravation with the rush to buy new car using leaded gasoline in 1975-76 or imported vehicle lateron.

Table 11 Percentage of carbon monoxide (CO) in exhaust gases according to alcohol-gasoline blendings and air/combustible relationship

Relat. *Air/Combust.*	*Percentage of CO*		
	Gasoline	*10% Alcohol*	*20% Alcohol*
15.1	0	0	0
14.4	1.1	0	0
14.0	2.1	0.8	0
13.5	3.2	1.7	0.99
12.5	5.4	3.9	3.0
12.0	6.8	5.1	4.2

Source: Àlcool Etilico, Avaliaçao Tecnologica, December 1978, Cat. CNPg-Table VIII-3, p. 326.

Note: Data based on tests taken in a Chevrolet six-cylinder engine. It shows that 20% of alcohol blend to gasoline, and a relation Combustible/air between 15.1 and 14.3 provokes a substantial reduction in hydrocarbons (HC) and (CO) but a considerable increase in NOx.

FINAL OBSERVATIONS

It is now abundantly clear to everyone the degree of importance which energy has assumed on the international agenda. Oil imports account for roughly seventy five per cent of the energy needs of Japan, sixty per cent for Western Europe, and twenty per cent for the United States. The 1973 embargo by the major oil-producing countries in the Middle East resulted in major upheavals in industrialized countries, upheavals that demonstrated their vulnerability, added enormously to world-wide inflation, and disrupted the international monetary system.

The dependence on oil of the newly industrializing countries like Brazil, and in fact of all countries, is a product of an industrialization based on the availability of cheap and abundant energy. It is a contentious issue as to how much oil is still in the ground, but it is clear that a major part of known supplie resides under the control of a very small number of countries. It is also clear that existing oil dependence relations cannot be substantially or quickly altered; rather the focus has to be on how future energy demands will be met.

Modifying the longer-term relationship is a technology-intensive problem that requires present action. Alternative energy technologies, especially bio-energy, more intensive oil exploitation and exploitation techniques, technology for deeper ocean drilling, environmentally safe coal mining techniques, improved and safer transport technology, more efficient technologies for energy consumption, are all relevant objectives that require R & D investments well in advance of their realization. More difficult than the problems themselves is the analysis of the wisest R & D resource allocation among these objectives, since they cannot all be given the same priority. Such analysis necessarily requires broad studies that involve the interaction of scientific and technological with political and economic factors.

World population of 4 billion at present, 7 billion projected for the year 2000 and 16 billion projected for the year 2135 give some idea of the challenge that face mankind to feed a rapidly growing population. Food production increases commensurate with the expected population increases will be required to maintain the present less-than adequate nutritional levels. Resources including energy to produce this food are limited.

To produce food for the world's increasing human population will require many more agricultural energy inputs than are now required. It is unknown and difficult to predict, however, whether per capita energy requirements for food production will increase or decrease in the future (Fluck & Baird, 1980).

The energy crisis is an opportunity for farmers and agricultural research workers to turn their creativity to shaping energy alternatives suitable to farm needs. It is suggested that lower energy input and higher output characteristics be considered in breeding and selection of the new varieties. Research orientation formulated during the next few years will affect what people throughout the world will eat and use as energy in the year 2 000.

Most serious analyses point out that the long-term trends for energy demand and energy supply indicate that a serious energy shortage is expected, especially for oil. This is likely to give rising energy prices.

The energy crisis, brought about by diminishing oil reserves and escalating prices, is inevitably making itself felt both in developing and developed oil importing countries. These countries rely on oil for transport, as well as for agricultural and industrial processes. Alternative fossil fuels, such as coal, are not available in many of these countries; and destruction of forests for fuel is evident in many areas of the Third World. The production of fuels from waste agricultural materials, or from energy crops, makes considerable sense on economical as well as social grounds, in situations where no replacement for petroleum or diesel-oil are otherwise available.

Furthermore, once ambitious development programs are completed, the oil supplies from the traditional oil-exporting countries could be gradually reduced because of more conservationist preferences (Al-Chalabi, 1979). Finally, the oil supplies from the Middle East could be at least partially disrupted because of political events and possible superpower competition (Noreng, 1981). The prospect of these developments is central to the objective relationship between partial use of a bioenergy alternative and full dependence on imported oil in Europe. Growing energy crops is sometimes considered as competitive with producing food. Even though in the short-term, certain substitution may occur (Mello, 1982), given development of new scientific frontiers, particularly bio-technology and genetic engineering, bio-energy alternative for food-feed crops will provide additional initiative for agricultural development and can be used as a buffer or hedging mechanism against frequent fall in commodity prices through integrated food-feed-bio-energy production systems. These systems in addition to partial or full energy self-sufficiency of agricultural production units could shift from bio-energy fuel to food and feed production (Agide, Yeganiantz, 1982).

Brazil is poorly endowed with organic fuels, either coal or petroleum; consequently, in the early seventies it imported more than 80 percent of its petroleum needs. The rapid growth of its automobile and truck fleets as well as the rapid economic growth of the country and the rise in world petroleum prices have caused petroleum to become a major component of its total import bill, increasing from 10% in 1972 to more than 50% of its export earnings in 1980. This has also resulted in accumulated growth of foreign debt that totaled 100 billion dollars in 1984.

Brazilian agriculture has been called upon to make a major contribution through the expansion of crops with energy-producing biomass capacity to reduce Brazil's heavy dependence on imported petroleum.

At the present time in Brazil there are many processes and concepts which are being developed and studied for producing alcohol fuel from several types of biomass feedstocks. Massive investments aimed at reducing dependence on imported oil have been made, notably through the conversion of sugarcane to alcohol.

After a relative success of the Brazilian experience, various proposals have been made in which a major portion of a country's petroleum needs would be supplied by cultivating specific crops. Can Germany and other Common Market countries use the same approach as Brazil? The German Federal Republic and other European countries cannot afford to use farmland for fuel as Brasil does, but they still have some possibilities of producing fuel from biomass.

Approximately one quarter of the food produced throughout the world never reaches the consumer because the food is damaged before consumption. Typical examples include cull potatoes, that increase the percentage of seed potato used in developing countries and constitute the major portion of potato used as feed in developed countries.

As a result, countries like Germany can use agricultural waste like cull potatoes and eventually most of it sugar beet for alcohol production. This is due to the fact that sugar as a food product is expected to drastically decrease in the future as has been described earlier in this paper. They can also provide market for potential alcohol exporting countries like Brasil.

The global energy problem is so difficult that no nation acting alone can solve it. Yet for the necessary international cooperation to succeed, there must be individual country efforts that could be used as a base of shared understanding of the nature of the problem and its possible solutions. The Brazilian Alcohol Programa (PROALCOOL) has aspired to contribute to the development of a possible solution at least for some countries.

The lean burn and soot free performance of alcohol fuel show that alcohol fuel has an advantage over gasoline or diesel fuel for exhaust emissions control as a result.

The use of alcohol helps to solve the greatest environmental problem facing nations: carbon monoxide emissions form combustion engines. Among the most susceptable groups are undernourished children, taxi drivers, traffic policeman and many others.

In spite of clear-air programs in many cities, a general tendency for smog to increase in urban and industrial areas can be observed directly in most parts of the World.

Investigation and analysis of the environmental constraints on the development of alternative resources for the generation of energy in Brazil includes environmental control technology for chemical effluents and characterization and evaluation of chemical effluents like aldehyde. Definition of the needs for environmental controls and evaluation of alternative environmental control technologies constitutes a major preocupation of Brazilian technicians and responsible authorities. Until now, all indications are that alcohol fuels significantly diminish air pollution. This justifies local production and some imports of alcohol instead of petroleum as socially and economically desirable policies.

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SUPPLEMENT 1

ENERGY SELF-RELIANCE OF BRAZILIAN ALCOHOL PROGRAM*

by:

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MAY - 1984

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ENERGY SELF-RELIANCE OF BRAZILIAN ALCOHOL PROGRAM

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ABSTRACT

The Brazilian alcohol Program, in 1983 produced alcohol for more than one million cars (8% of total), especially manufactured to run on alcohol. In addition, the consumption of anhydrous alcohol, as an extender of regular gasoline, reached 21.4% in the same year. A new policy of marking alcohol production in Brazil energy-self-sufficient and independent of imported petroleum has been initiated. Some of the 33,000 trucks that originally used diesel fuel have been converted to alcohol. Of some 34,000 tractors used on farms for alcohol production, 500 of them have already been shifted to alcohol use. It is estimated that some 90% of the tractors can be converted to alcohol at a total cost of US$ 7.5 million. This will result in savings of about 4% of the total oil imports in 1983, or the equivalent of some 350 million dollars of foreign exchange at 1983 prices. The alcohol consumption needed for this conversion is about 10% of the 1983 production level. Some 18% percent of alcohol production could theoretically provide energy self-sufficiency for fuel alcohol production in Brazil.

INTRODUCTION

The Brazilian Alcohol Program, established in 1975, was designed to reduce petroleum imports initially through the addition of anhydrous ethanol into regular gasolines, and later through the utilization of straight ethanol, 94-96° GL, in especially manufactured internal combustion engine powered cars and light trucks.

During the first period of the program, from 1976 until 1979, anhydrous alcohol was added to the regular gasolines up to 20% by volume while pure ethanol was only consumed by controlled fleet under running tests. By 1979 the alcohol production of Brazil was about 2.492×10^6 m^3 while the consumption was about 2.56×10^6 m^3. This fact was responsible for reducing gasoline consumption by 2.0×10^6 m^3.

In 1980 the Brazilian automotive industries manufactured and sold over 150,000 ethanol powered cars. Besides this, about 50,000 cars were converted to run on straight ethanol. By the end of 1983 from a total fleet of about 12 million cars, over one million were running on straight ethanol. The consumption of anhydrous alcohol as an extender for regular gasolines (gasohol) during the same year reached the 21.4% level.

Figure 1 shows the production, export, consumption as fuel, and industrial use of ethanol in Brazil.

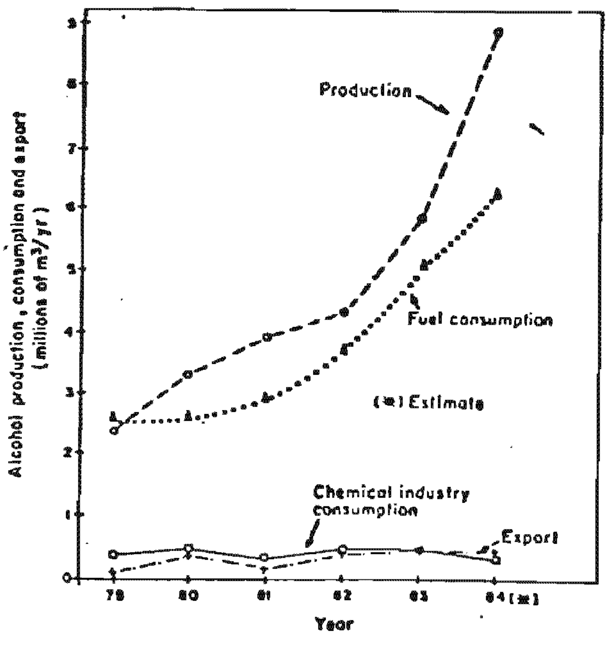

Figure 1. Evolution of alcohol production, consumption and export in Brazil.

In spite of the great success of the alcohol program for cars and light trucks, little effort had been put into direct diesel fuel substitution until the end for 1979. However, diminished demand for gasoline resulted in a lower percentage of gasoline being produced during refining and catalytic cracking, increasing the amount of other derivatives, particularly diesel fuel. The actual refining process today is yielding about 34% diesel fuel while before 1980 only 26% of the output from the petroleum refining process was diesel fuel. This large increase in diesel fuel yield has helped to reduce petroleum importation as well as permitted an increase in total diesel fuel consumption.

Figure 2 shows recent trends in Brazilian fuel consumption patterns. It will be noted that diesel usage accelerated at a faster pace than alcohol in the late 1970's, while gasoline usage declined in the same period.

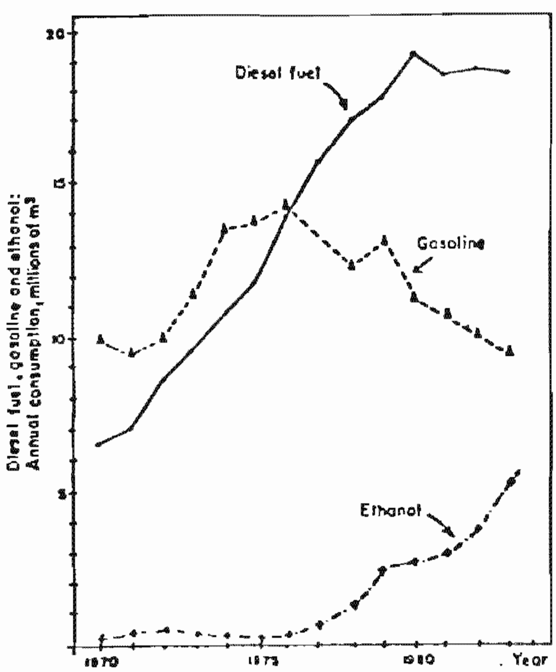

Figure 2. Trends in Brazilian fuel consumption

Increasing dependence on foreign petroleum imports exposes all sectors of the national economy to unpredictable but extremely damaging interruptions in the normal availability of these fuels. Such interruptions can be especially disastrous in the case of agriculture and the food industry where liquid fuel needs are seasonal and cannot be postponed without the risk of loosing entire crops.

POTENTIAL IMPACT OF THE SELF-RELIANCE PROGRAM

At present, nearly 18% of the diesel fuel in Brazil is consumed on farms and in related activities. If we consider the potential for alcohol powered tractors to achieve a significant fraction of the 500,000 tractors in the total Brazilian fleet, savings in diesel consumption will be worthwhile. Also, trucks used for transporting sugarcane number about 33,000 and account for a part of rural diesel demand.

But more importantly, future expansion of alcohol production capacity should be accomplished on the basis of the program's self-reliance on alcohol, not petroleum. An analysis of energy and costs, including machinery investments, involved in the production of alcohol to meet 1985 PROALCOOL objectives is presented in outline form:

A. PROALCOOL GOAL (1985): 9.9×10^9 LITERS

Sugar cane yield: 70 t/ha.year
Alcohol yield: 70 ℓ/ha. year.
Area necessary: 2,020,000 ha (for ethanol)
production - does not include cane for sugar)

B. INDUSTRIAL INSTALLATIONS

- Distilleries with 120 m^3/day: 550 units
- Weight of each distillery: 2,500 t
- Total weight of distilleries: 1,375,000 t
- Investment in industrial installations unit cost (Turn key): US$ 4 million
  Total cost: US$ 2,200 millions.

C. AGRICULTURAL MACHINERY

Agricultural machinery	Number	Unit weight (t)	Total weight (t)
.plows	23,000	1.2	227,000
.discs	23,000	0.8	18,400
.cultivarors	11,000	0.3	3,300
.planters	11,000	0.8	8,800
.sprayers	8,000	0.3	24,000
.cane loaders	10,000	7.0	70,000
.wagons	11,000	2.0	22,000
.trucks	15,000	6.0	90,000
.tractors	23,000	5.7	132,000
Total machinery weight:			370,000

Investment in agricultural equipment:

Machine	Average price per unit US$/kg	Total cost US$ million
Tractors	5.50	726
Implements	3.00	444
Trucks	6.00	540
Total costs		1,710

D. BUILT IN ENERGY

The built-in energy estimated to manufacture agricultural machinery, including tractors, implements and trucks, is based on costs of US$ 47.70/MG (Pimentel, 1973; Moreira, 1980), and 14.65 MG/kg as the average energy necessary to produce all the distillery equipment and installation. Therefore 14 million barrels of petroleum is the equivalent energy to produce the 370,000 t. of agricultural equipment, while only 3.61 million barrels of petroleum is the equivalent energy to build and install the 550 distilleries. Considering that alcohol produced in a single year has energy equivalent to 37 million barrels of petroleum, one can conclude that the built-in energy for all equipment accounts for less than 5% of the alcohol energy output. It is important to note that most of the built-in energy for the mentioned equipment comes from coke, charcoal, and hydroelectricity. Only a small percent comes from petroleum derivatives, that should be replaced by ethanol.

E. ENERGY CONSUMPTION AND COSTS IN BIOMASSA PRODUCTION

Alcohol production in Brazil is heavily based on sugar cane plantations. An estimate of energy inputs and costs is based on current agronomic practices. Three cuttings every four years represents an acceptable average for the brazilian alcohol program. Table 1 shows energy consumption and costs per hectare of sugar cane.

Cost of cane at the distillery (unloaded) US$ 9.34, based on petroleum at US$ 30.00/ barrel).

If the price of petroleum increase to US$ 43.00/barrel, the cost of sugar cane at the unloading dock would rise to US$ 11.02/t.

Considering that the average sugar cane yield is 70 t/ha.year, and current technology permits alcohol yields of 70 ℓ/t, then 4,900 liters of ethanol is obtained per hectare per year. Based on Table 1, cost of alcohol at distilleries is about US$ 0.19/ℓ or US$ 30.31/barrel. This figure is based on US$ 654.00 to produce sugar cane per hectare per year, producing 4,900 liters of alcohol. The industrial cost or processing cost is estimated as 30% of the total cost. Sugar cane stalks delivered to the distilleries represent about 70% of the alcohol cost.

Table 1 - Energy consumption and costs per hectare of sugar cane (3 cuttings in 4 years)

Inputs	Average Consumption per hectare	Total Cost/ha (US$/ha)	Energy Equivalent per hectare (Mcal/ha.year)
Labor	286 man	90	286
Tractor	27 h	55	224
Implements	27 h	9	100
Truck	20	65	180
Fuel (diesel):			
.Tractors	100 ℓ	27	920
.Trucks	105 ℓ	28	966
Fertilizers			
N	72 kg	60	1,029
P_2O_5	60 kg	45	138
K_2O	72 kg	35	151
Lime	0.75 t	12	90
Chemicals			
.Herbicides	4.90 kg	40	362
.Insecticides	0.70 kg A.I.	9	56
.Seed cane	2.5 t	26	248
Sub Total		501	4,752
Interests + Taxes + Profit		153	
Total		654	

Average cane yield: 70 ℓ/ha year
Alcohol yield: 4,900 ℓ/ha year

It is also assumed that within the self-reliance program, all 15,000 new or adapted trucks and 23,000 new or adapted tractors could be alcohol powered, representing 205 liters of diesel fuel per hectare per year. For the 2,020,000 ha planted with sugar cane, 2,604,400 barrels of diesel, could be saved. The 205 liters of diesel fuel per hectare can be replaced by 348 liters of ethanol, at a rate of 1.7 liters of ethanol per liter of displaced diesel fuel (Finch et al., 1982). This represents only 7.1% of the total alcohol output per hectare, or about 4.4 million barrels of alcohol per year. Clearly only a small increase (7.64%) in land planted to sugar cane is needed to sustain the self-reliance program in terms of direct fuel requirement while keeping the PROALCOOL target at its projected level.

On an overall energy basis, the analysis shows a positive balance, giving the overall output to input ratio equal to 5.5. This means that 18.2% of the ethanol produced would be sufficient to provide the total equivalent energy input for sugar cane production.

No extra energy source is needed in the industrial processing plant (distillery), since the sugar cane bagasse provides all the energy required within the plant, through direct burning in special furnaces for steam production.

F. RELIABILLTY OF ALCOHOL TRACTORS

Reliability and long life are assured by using existing Diesel cycle alcohol compatible components in conjunction with an essentially diesel block base. This provides an end product designed for the same ruggedness needed for the agricultural environment as the diesel engine it replaces. With proper selection, the desired reliability is maintained regardless of whether the alcohol engine be "factory" made or transformed from a conventional diesel engine using either the Otto or Diesel cycle.

Brazilian experience includes: 1) Commercially produced tractors such as: MASSEY FERGUSON, using an Otto cycle based on diesel block; VALMET, using a MWM Diesel cycle employing a pilot injection diesel, with 10 to 20% diesel fuel, and a second injection sytem to inject 80 to 90% of the complementary energy as alcohol; CBT, with one model using the Otto cycle from vehicular application and another model using an Otto cycle based on diesel block; and FORD, using an Otto cycle on diesel block; 2) Tractor test fleet, based on ten prototypes, produced by FORD and operated by EMBRAPA for almost five years. Untill now, their performance gives reason to believe that engine life of alcohol tractors will be as good as the diesel equivalent when designed to diesel ruggedness.

G. ALCOHOL TRACTOR COSTS

In terms of conversion cost, the price of new alcohol powered machinery is comparable to traditional diesel powered units. It has also been estimated that, at present, the cost of converting a four cylinder engine tractor from diesel fuel to carburated alcohol (Otto cycle) is on the order of US$ 350.00. It is estimated that about 21,000 tractors can be converted to alcohol at a total cost of US$ 7,5 millions. This will result in savings of about 4% of the total oil imports in 1985, or the equivalent of some 350 million dollars in foreign exchange at 1983 prices, without considering foreign exchange earnings that could be generated by exporting surplus gasoline and other petroleum based products.

FURTHER POSSIBILITY OF ENERGY SELF-SUFICIENCY OF AGRICULTURAL PRODUCTION UNITS

Motivated by the relative success of the alcohol program, Brazilian scientists are working hard on the unsolved problems of producing and conserving energy in agriculture and on ways of supplying an important part of energy needs on the farm. Figures 3 and 4 represents simplified self-explanatory flow charts of Integrated Food-Feed-Bio-Energy Production Systems (Cabral et al., 1982). It is not expected that all components presented in the flow chart will be included in the

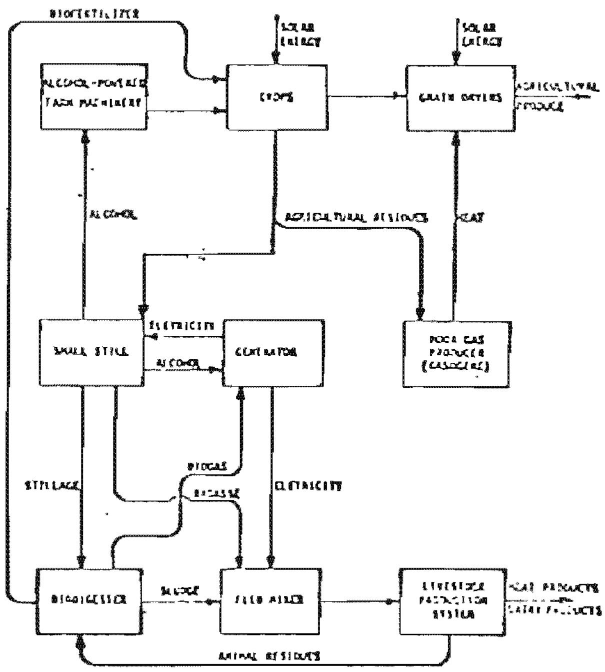

Figure 3. Material & Energy Flow of an On-Farm Energy System Option

same production unit. EMBRAPA - Brazilian Agricultural Research Organization - has several systems implanted in various research centers designed to provide energy self-sufficiency for the centers, based on specific biomasses regionally selected. These systems, in addition to generating part of the fuel needed by the experiment stations, provide detailed operational data and are used for demonstration purposes.

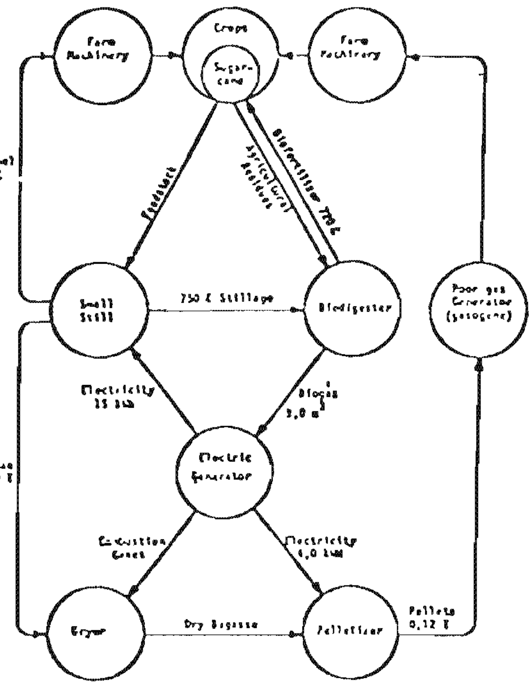

Figure 4. Integrated Food-Feed-Bio-Energy Production Systems

CONCLUDING REMARKS

Agriculture is the process of coverting the energy of the sun into products for human use. This gives agriculture a dual personality with respect to energy-it both uses it and produces it. In addition, most crop production is energy-efficient; i.e., even with modern energy-intensive cropping methods, agricultural activities generally yield more energy than they use. As a result, agricultural activities can be largely self-sufficient in terms of energy. This paper shows how the production of fuel alcohol can be made nearly independent in relation to fossil fuels. It also gives some ideas on how agricultural production units can become self-sufficient in term of energy inputs.

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SUPPLEMENT 2

THE ENVIRONMENTAL IMPACT OF THE BRAZILIAN BIO-ENERGY PROGRAM*

by:

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THE ENVIRONMENTAL IMPACT OF THE BRAZILIAN BIO-ENERGY PROGRAM

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Introduction

While urbanization is an important dimension of economic and social progress, the rapid growth of major urban concentrations in the developing countries is creating enormous demands for shelter, health care and transportation. Rising construction and maintenance costs are pushing the costs of adequate housing beyond the reach of low-income families. Housing costs are forcing land-use patterns which seperate employee's place of residence from their job location. The need to commute over long distances and the expense involved tend to reduce employment opportunities for the least mobile. In addition, air pollution in the cities, resulting from industrialization and from a growing number of cars, necessitates low-cost solutions which permit more resources to be allocated to other basic needs. Since capital resources are likely to remain scarce in many countries, basic needs will have to be met through the use of innovative technologies. These include measures to reduce air pollution caused by the large number of motor vehicles in urban areas.

Ridker (1980) estimated that in 1975, demage costs from major pollutants was $ 37 billion and control costs were $ 9.1 billion. The same author estimated that a decrease in damage costs of these pollutants from $ 37 billion to $ 27 billion between the years 1975 and 2025 will result in a rise of $ 68.3 billion in control costs in the United States.

L. Barrett and N. Waddel in 1972 estimated that the direct cost of air pollution in the United States is $ 16.1 billion per year, or more than $ 80.00 per person. This figure does not include indirect costs or the substantial effects on human and other organisms.

The pollution level in Japan is between 10 and 40 times greater than in other industrial states. The result has been the proliferation of bizarre, pollution-related diseases: Minameta disease (mercury poisoning), Tai-tai (Cadmium poisoning), PCB (Polychlorinated biphenyl poisoning), and Yokkaichi (asthma) (Stunkel, 1981).

These diseases, which have killed or disabled thousands, are the direct consequence of economic growth and the resulting industrial activities which produce millions of tons of industrial wastes per year.

As a country gets richer and pollutes more, its standards of pollution control rise. More and more must be spent to protect the environment, and higher levels of pollution abatement are necessary.

Although it is reasonably certain that high air pollution affects the death rate, it would be difficult to prove that this pollution decreases the average life expectancy by more than a year or two, as a national average. At the same time, we know that excess poverty may reduce life expectancy by as much as thirty years. Therefore, most people would have no difficulty in making a choice; they prefer the increased wealth and affluence of industrialization even at the cost of polluted air and water.

As a result, Brazilian industries including the world's ninth largest automotive complex, in attempting to maintain a competitive advantage in the export market, according to Erickson (1981) "have externalized the social and health costs of polluted air and water upon nearby populations".

Rather than undertaking time consuming, costly studies of the effects of pollution on health, Brazil can utilize the results of other countries which have carried out scientific investigations into the health and welfare effects of air pollutants resulting from motor vehicles.

It is the aim of this paper to provide some rough and aggregate measures of the economic costs to Brazilian society of urban air pollution from cars and to project the decrease that may result from the increased use of alcohol in place of gasoline while recognizing that costs vary with many local factors which have not been taken into account in this paper.

In estimating total pollution cost and the impact of the alcohol program, the overall (sometimes simplified) methodology as developed by Small (1977) was applied. However, due to missing data and the unpublished nature of some statistics as well as the problem of limited space, the results have been presented as assumptions used to calculate the parameters needed.

An Example of how to Estimate the Cost of Air Pollution in Brazil

Two categories of air pollution damage costs have been estimated for the year 1985: health-sanitation cost and property damage cost.

1. The health - sanitation cost was estimated by using the household expenditure survey for 1974 and giving it a growth rate proportional to its income elasticity for various parts of the country. The final value for 1985 was US$ 95,00 per urban resident. The health-sanitation expenditure due to air pollution was assumed to account for 4% of this cost

   Health Sanitation Cost = $68 \times 10^6 \times 95 \times 0.4$ = US$ $258{,}4 \times 10^6$

2. Property damage cost from air pollution, allowing for depreciation and increased maintenance costs due to pollution, was estimated at a yearly rate of 0.5% of total residential housing value. This value was computed by using a weighted average of the construction cost of residential housing, estimated at US$ 180,00 per square meter, allowing 8 m^2 for each urban resident. Total urban population (cities of 100,000 or more inhabitants) was estimated to reach 68 million by 1985.

   Property Damage Cost = $68 \times 10^6 \times 8 \times 180 \times 0.005$ = US$ $489{,}6 \times 10^6$

The air pollution damage costs from these two categories is estimated at US$ 748 million or US$ 11.00 per urban resident. This estimate does not include morbidity and mortality costs, damage to public, commercial and historic buildings, urban vegetation, agricultural production and other damages.

Automobile Emissions in Brazil

Detailed data on automotive pollutant levels in Brazil's major cities are not available. Occasional data from specific projects on air quality measurement for São Paulo and Rio de Janeiro are available however. There is little doubt that air pollution is severe is many Brazilian cities and that automobiles make a significant contribution to this pollution.

The following items contribute to the high level of car pollutants:

1. Brazil is an urbanized country and at present 52% of the population lives in cities with a population greater than 100,000. The majority of this population is heavily dependent on motor vehicles for transportation.

2. Due to their tropical location, Brazilian cities experience much sunshine, with the result that the potential for the formation of photochemical oxidants from unburned hydrocarbons and oxides of nitrogen is high.

3. Approximately 36% of the Brazilian urban population of 68 million will be below 12 years of age in 1985 and thus more susceptible to the effects of air pollution.

Table 1 - Emission Effects of Ethanol Usage in Brazil

Type of Vehicle	Fuel	Percent Difference in Emissions Compared to Gasoline					gm/m Aldehyde
		CO	HC	NOx	Aldeh.	Evap.	
Brazilian Opala, No Emission Controls 1/	Brazilian Gas vs. 20% Braz. Ethanol	-33%	-33%	+38%	+114%	NR	.07 gm/m
Brazilian 1976 1.4L sedan** w/production calibration 2/	20% Braz. Ethanol	-39%	-15%	NR	0	NR	.06 gm/m
Brazilian 2.3L Truck** with Production Calibration 2/	20% Braz. Ethanol	-33%	-15%	+11%	-75%	NR	.23 gm/m
Brazilian Opala, No Emission Controls 1/	Brazilian gas vs. 10% Braz. Ethanol	-15%	-16%	+27%	+71%	+2.5%	.12 gm/m
Brazilian 1976 1.4L sedan** recalibrated 2/	100% Ethanol	-64%	-17%	NR	+325%	NR	.26 gm/m
Brazilian 2.3L Truck** recallibrated for max. economy 2/	100% Ethanol	-84%	-32%	+5%	+107%	NR	1.8 gm/m
Brazilian 2.3L Truck** recallibrated for max. power 2/	100% Ethanol	-6%	-34%	-42%	+16%	NR	1.01 gm/m

** Hot CVX
* Baseline aldehyde on gasoline was reported at 0.87 gm/m, which is far higher than for other vehicles in the report.

Source: 1/ R. Furey & M. Jackson, Exhaust and Evaporative Emissions from a Brazilian Chevrolet Fueled with Ethanol-Gasoline Blends, GM Research Labs, Warren. MI, Report GMR-2403, June 1977 and 2/ G. K. Chui et alii, Brazilian Vehicle Calibration for Ethanol Fuels, Ford Engineering and Research Staff, U.S.A. and F. Pinto, Ford of Brazil. (Undated - used 1976 and 1978 vehicles).

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4. There is a significant incidence of poverty and malnutrition in Brazil's urban areas, resulting in people being more susceptible to pollution effects.
5. There are about 12 million motor vehicles in Brazil (mid-1982) and more than 50% of these vehicles are found in urban areas.

Table 2 - Various Emissions in gr./Km

Vehicle	Emission	CO_2	CO	HC	NO_x	Aldehydes
MA1	Ethanol	185,87	5,21	0,99	1,25	0,136
MA2	Ethanol	183,07	9,88	0,52	1,78	0,162
MA3	Gasoline	165,57	53,06	3,03	0,83	0,019
MA4	Gasoline	167,53	27,24	2,53	1,43	0,032
MB1	Ethanol	152,64	25,87	2,97	1,04	0,197
MB2	Gasoline	114,82	59,01	5,19	0,93	0,037
MB3	Gasoline	149,23	65,72	8,33	0,97	0,037
MC1	Ethanol	157,27	17,31	2,24	1,12	0,130
MC2	Ethanol	161,97	19,63	0,75	1,04	0,161
MC3	Ethanol	168,01	12,43	0,54	0,89	0,135
MD1	Gasoline	186,94	24,10	1,98	1,27	0,018
MD2	Gasoline	168,71	21,02	2,37	1,40	0,033
ME1	Ethanol	171,79	15,58	1,42	1,66	0,223
MF1	Ethanol	166,75	9,12	0,41	1,55	0,113

Note: MA, MB, MC, MD, ME, MF = Different models used

SOURCE: Nelson Nefussi, João Vicente de Assunção, Manoel Paulo de Toledo, Alfredo Silvio Castelli, Comparação entre Emissões de Poluentes de Veículos a Álcool e a Gasolina, XI Congresso Brasileiro de Engenharia Sanitária e Ambiental, Fortaleza, 20-25 de Setembro de 1981, mimeog. p. 9.

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6. High levels of industrialization and concentration of industries within urban limits, together with weak or non-existent pollution controls had already created high levels of pollution even without cars.

7. Variation in percentage of ethanol added to gasoline and the resulting poor engine adjustment in terms of optimum air-fuel mixture contributes to emission related problems.

The Impact on Air Pollution of the Brazilian Alcohol Program-Proalcool

Proalcool plans to allocate the 10.7 billion-liter 1985 production target in the following manner:

1. 6.1 billion liters of hydrous alcohol to fuel vehicles adapted to run on pure alcohol.

2. 3.1 billion liters of anhydrous alcohol to blend with gasoline in 20.80 mix and

3. 1.5 billion liters of alcohol(not considered here) to be used in the petrochemical industry.

Table 3 - Change in Emissions in Urban Areas Resulting From Implementation of Brazilian Alcohol Program (Compared to unblended gasoline)

	Hydrous Alcohol	80% Gasoline (12.4 bil. ℓ) plus Anhydrous Alcohol (3.1 bil. ℓ)
VOLUME	6.1 bil. ℓ	15.5 bil. ℓ
MILEAGE		
Km/ℓ	8.8 km	10.1 km
TOTAL TRAVEL		
(per year)	53.68 bil./km	156.55 bil./km
URBAN TRAVEL		
(70% of Hyd. Al. and 38% Gas-Al. Mixture)	37.58 bil./km	59.49 bil./km
CHANGE IN EMISSION		
CO		
Tons/bil. km	-27,310.00	-15,008.4
Total - tons	-1,026,309.8	-892,849.7
HC		
Tons/bil. km	-1,680.0	-938.8
Total - tons	-100,714.4	-55,849.7
NO_x		
Tons/bil. km	+150.0	+280.0
Total - tons	+5,637.0	+16,657.2
ALDEHYDES		
Tons/bil. km	+128	+33.0
Total - tons	+4,810.2	+1,966.7

SOURCE: Tables: 1 and 2.

Average percentage change of engine and vehicle emission data (according to latest studies published) presented in tables 1 and 2 can be summarized as follows:

	CO	HC	NO_x		Aldehyde
Pure Ethanol	-65%	-69%	+13%	(difference due to	+441%
20% mixture	-36%	-24%	+24%	engine calibration)	

These percentages applied to the absolute values of Table 2 result in the following changes in gr/km:

	CO	HC	NO_x	Aldehydes
Pure Ethanol	-27,31	-2,68	+0,15	+0,128
20% mixture	-15,01	-0,94	+0,28	+0,033

TABLE 4 - Air Pollution Cost due to Implementation of the Brazilian Alcohol Program: Change in Quantity and US$ Value of this Change.

Type of Pollution	Cost/ton US$ 1/	Change in Quantity Tons/year 3/	Total Value of Change US$ 6/
CO	11.20	- 1.919,159.5	- 21,494,585
HC	172.80	- 156,564.1	- 27,054,276
NO_x	570.60	+ 22,294.2	+ 3,652,462
Aldehyde	NA	+ 6,401.1	NA
Sub Total			- 44,896,400
Potential pollution cost of *refining* Gasoline to be substituted	- 7.82 (billion liters-gasoline equivalent 2/	- 5.3 (US$ million per billion liters) 4/	- 41,446,000
Potential pollution cost of lead in gasoline *substituted* by alcohol	- 7.82 (billion liters gasoline equivalent) 2/	- 6.0 (US$ million per billion liters) 5/	- 46,920,000
Total			- 133,262,400

1/ Small, 1977; 2/ Only 9.2 billion liters of alcohol considered; 3/ Data *from table 3;* 4/ *Based on* data from National Academy of Science, 1974; 5/ Stork (1961); 6/ The part of hydrous alcohol was US$ 25,681,646 and the mixture (blend) US$ 19,214,754. This amounts to 0.6 Cent per liter for hy-*drous alcohol and 1.6 Cents per liter for blended portion.*

Using estimates selected by Small (1977) and corrected for U.S. dollar inflation (Figure 4) the benefit resulting *from the change in emis-sions* due to the use of alcohol can be estimated. This, however, does not take into consideration changes in aldehydes as indicated in table 4.

To estimate the decrease of pollution costs resulting from not re fining gasoline for automotive use, the following assumptions are made: (1) *The 9.2 billion liters of* alcohol are equivalent to 7.8 billion liters of ga soline (2) Pollution cost of refining gasoline is US Cents 0.53 per liter of gasoline or US$ 5.3 million per billion liters. This assumes that all refi neries s*upplying urban transport systems are located within* the *urban areas* and operate without any of the newer pollution controls.

The potential savings from decreased lead pollution due to the elimination of leaded gasoline from urban areas was *estimated at US Cents 0.6* per liter. (Stork, 1981, Hepple, 1972).

After reviewing data for various countries, it seems reasonable to expect pollution costs per unit of emission to vary by a factor of at least four between big, concentrated cities like São Paulo and smaller cities *having 100-500 thousand population.* (Small, 1977).

Thus cost decrease due to alcohol use in São Paulo, (if decreased refining and lead elimination are considered) would be (0.6 + 0.5 + 0.6) X 4 = US Cents 6.8/liter in the case of hydrous alcohol and (1.6 + 0.5 + 0.6) X 4 = 10.8 Cents/liter in the case of mixed alcohol.

Based on this estimates, a car using 1,800 liters of alcohol per year will save about US$ 122.40 in potential air pollution damage. (assuming average U.S. prices apply and aldehydes are controlled at no cost). In the case of a taxi using alcohol and driven 150,000 kilometers per year, (7.5 km/ℓ), this value goes up to US$ 1,360.00 per year.

This indicates that installation of pollution control devices costing US$ 150-250 per unit on public transport could be justified.

Final Observations

Despite the claims for and indications of major air quality benefits from the use of ethanol as fuel, a comprehensive review of the available literature indicates the existence of contradictions and discrepancies in reported data. However, it still appears that the alcohol program would be ecologically benign for urban areas since compustion of ethanol generates fewer atmospheric hazards than gasoline combustion.

While recent studies made in São Paulo indicated some decrease in CO, the amount is still far from what is allowed in other countries. It is worth mentioning that not only air quality will be improved with a decrease in CO, but it is expected that car engine performance will also become more efficient.

The use of alcohol avoids all pollution due to lead and aromatic carcinogens. Unburned fuel in emissions can be only slightly above that for gasoline. However aldehyde levels reach four times those of gasoline. There are two types of aldehydes emitted from burning ethanol: formaldehydes and acetalhydes. Formaldehydes are supposedly more toxic and cause cancer in laboratory animals even though their effect on the human body is not known. Acetaldehydes which constitutes the major portion of ethanol aldehyde emissions, irritate the eyes causes respiratory problems, but are believed to be less toxic than formaldehydes and acording to some authors these pollutants can be controlled by catalytic converters.

Evaporative emissions of ethanol, including fuel vapors from the gas tank when the engine is idling, and from gas station pomps should be measured and evaluated. There is some indication from Characterization Report of EPA (1978) that these increase even with gasohol.

In order not to decrease emissions at the cost of increased fuel consumption, the air-fuel mixture and fuel-air equivalance ratios must be both energy efficient and environmentally benign.

Any successful program for reduction of vehicle exhaust emissions must include an effective engine inspection and maintenance program. From the standpoint of trained personnel and the necessary facilities and instrumentation, this may constitute a major problem in Brazil.

For congested urban areas, pollution costs while not justifying a large reduction in automobile travel, do justify expenditures on catalysts to control air pollution. Air pollution problems that can be solved by alcohol substitution of gasoline will be of particular benefit to specific population groups like children living or attending school in highly congested and polluted areas, traffic policemen, taxi and bus drivers who smoke, people with pulmonary and other diseases.

The Brazilian alcohol program in addition to having the potential of substituting pollutants like CO and HC for NO_n and aldehydes, may result in decreasing urban air pollution at the expense of increasing rural water pollution.

Agricultural activities resulting in air pollution include insecticide and pesticide dusting and spraying, and burning of vegetation.

Increased use of fertilizers might result in water pollution. In addition, the major impact of alcohol distilleries-the potential degradation of water quality by stillage-can be prevented by product recovery or waste treatment producing all potassium and one fourth of nitrogen needs of sugarcane.

An environmental data base for energy-biomass which will serve to structure an assessment of the probable environmental consequences of production and commercialization of ethanol should be developed.

Because of the highly distributed pattern of biomass-energy sources, many of the environmental impacts are site-specific which makes it necessary to identify, evaluate, and integrate the environmental impacts for various local conditions.

The challenge facing research workers dealing with alternative sources of energy is to recognize the potential for collaboration among various institutions that enables each specialist, including ecologists and social scientists, to use their skills to solve the great unanswered economic, technological and ecological problems of energy supply. For these professionals, dependence on imported fossil fuel is not a threat but a challenge to develop technologies that remove economic vulnerability and diminish indirect costs such as pollution of traditional energy sources.

Much important data were not available to the authors at the time of manuscript preparation and interested readers are urged to inquire further. The ideas presented in this paper are the opinions of the authors and do not represent the official stand of any institution.

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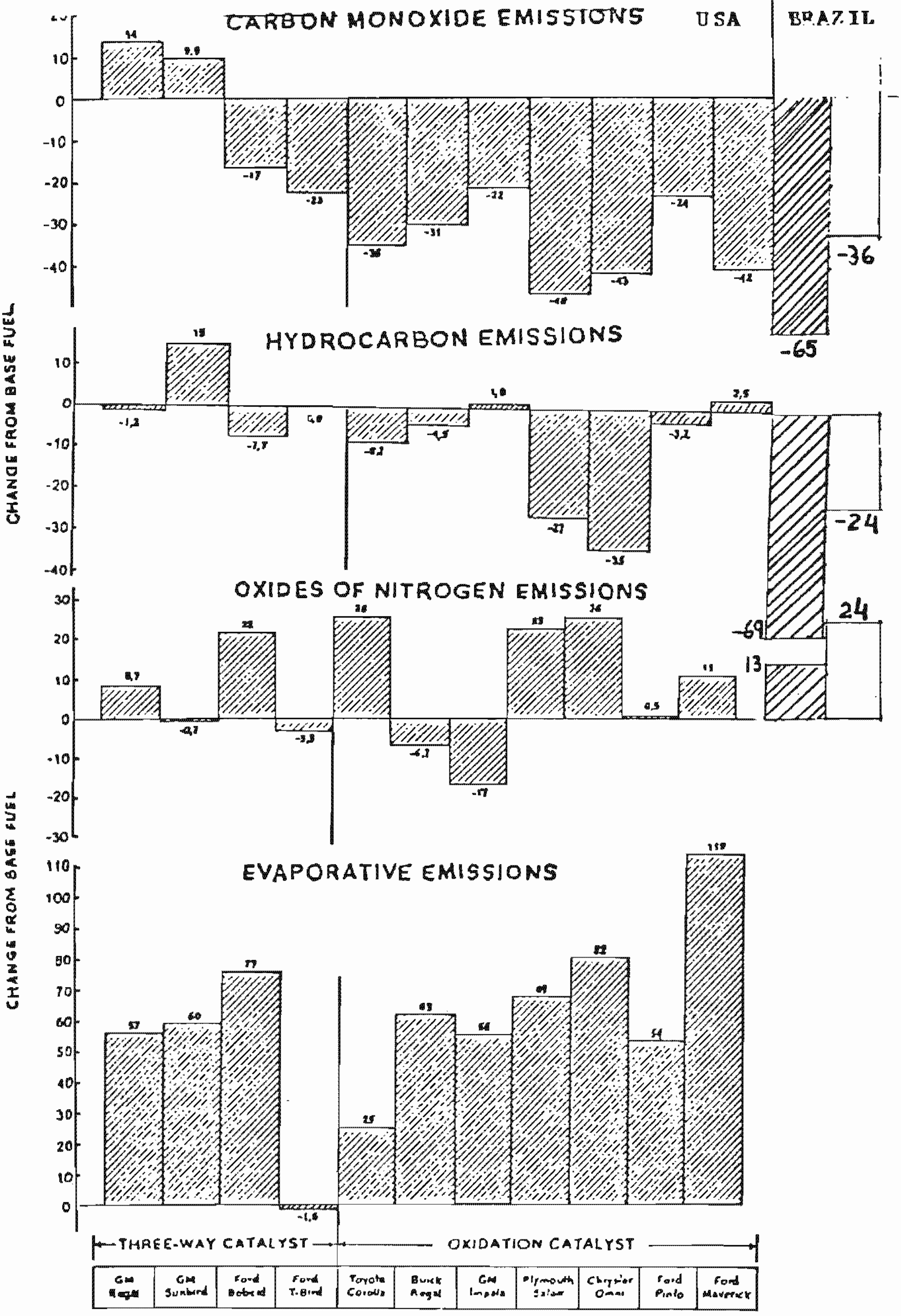

Fig. 1/ Percent Charage of Emissions compared to Base Fuel for 90% Gasoline, 10% Ethanol Fuel U.S. Environmental Protection Agency 1979.

Pure EThanol
20% MixTure