THE ETHANOL PROGRAM IN BRAZIL

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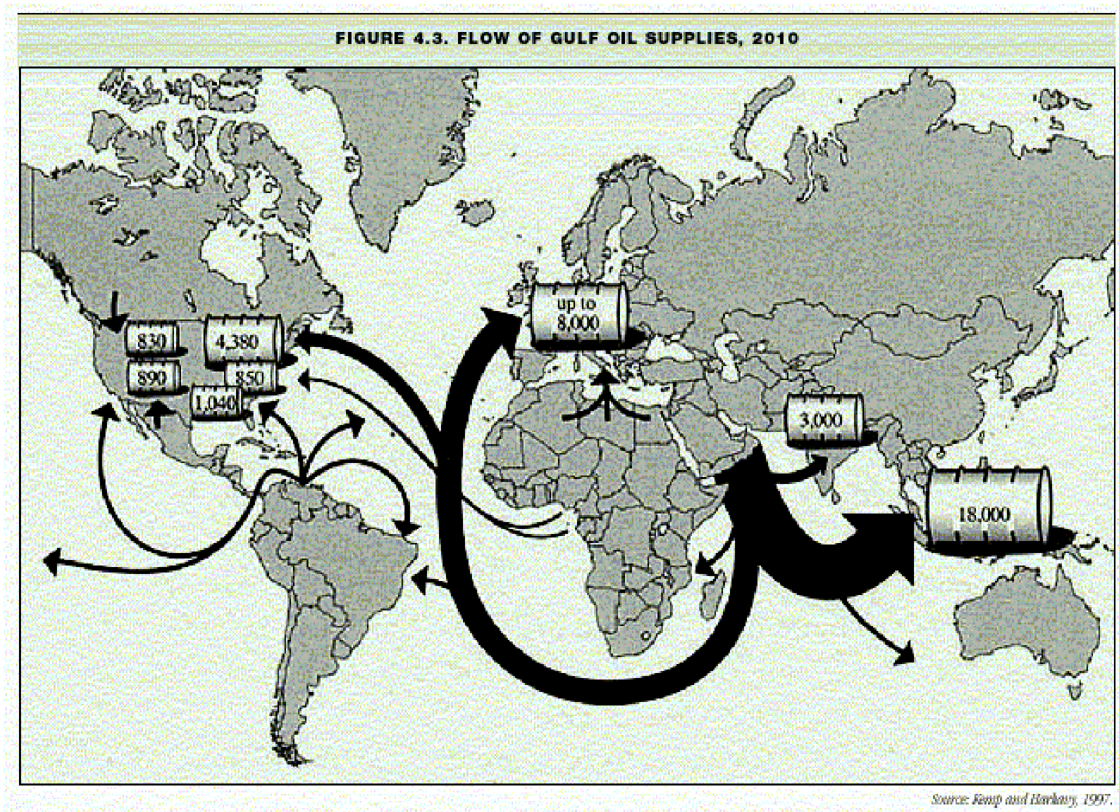
One of the most striking characteristics of the 20th century is the emergence of the automobile for personal transportation. There are today in the world 700 million of these vehicles in circulation, the great majority of them with Otto cycle engines running with gasoline. Automobiles are today an integral part of our way of living. They shaped the whole transportation system of mankind and represent a very significant fraction of the GDP of many countries. As developing countries grow and develop the number of automobiles in the world will grow. The number of such vehicles "per capita" is approaching one in industrialized countries but much smaller rate in today´s developing countries and thus likely to grow significantly. In China there are only 20 automobiles for 1000 people compared to 700 per 1000 people in the United States.

The gasoline necessary to feed these automobiles is roughly 20 million barrels of oil equivalent per day, one quarter of the world petroleum consumption from which it is produced and, unfortunately, petroleum is found in relatively few regions of the world. Exports and imports of this commodity are a most important item in international trade and many countries are critically dependent on petroleum imports. This is the case of the United States, as well as many developing countries. Figure 1 indicates the major fluxes of petroleum around the world.

Figure 1. Oil flows throughout the world (UNDP, UNDESA, WEC, 2002)



Brazil was in that category in the 1970's and was for that reason critically affected by the oil crisis of 1973. At that time, the cost of oil imports in hard currency represented approximately a full half of all exports (roughly 4 billion dollars at historical value, equivalent to US$ 12 billion in 2005). The increase of petroleum prices therefore did exert considerably strain in the Brazilian economy at that time.

To face that situation the Brazilian Government embarked in two programs:

1. a significant effort of prospecting petroleum mainly under the deep waters of the continental shelf which, successfully, has taken the country to self-sufficiency after 30 years.
2. an ambitious program to produce large quantities of ethanol from sugarcane (PROALCOHOL) as a substitute for gasoline.

Brazilian conditions are very favorable for the production of ethanol. Sugarcane has been an important crop since the 18th century and Brazil was the world´s third largest sugar producer (5 million tones of raw sugar equivalent) in 1975. During the 1970´s oil crisis, sugar was experiencing a long period of low prices in the international market, so the decision to divert some of the sugarcane to ethanol production was very reasonable, considering also that the technology needed has been available for decades.

The PROALCOHOL was launched by the Government in two variants:

i. Compulsorily using 10 percent anhydrous ethanol as an additive to gasoline not requiring changes in the motors
ii. Voluntarily using 100% hydrated ethanol (95% ethanol + 5% water) in modified Otto cycle motors

Multinational automobile industries based in Brazil have introduced all the necessary engine and vehicle modifications for ethanol use. Gasohol vehicles running with up to 10% ethanol (in volume basis) require almost no changes, but more modifications are required for a larger share of ethanol in the fuel blend. In Brazil, with minor adaptations developed by the car manufacturers, all gasoline vehicles run with blends ranging between 20% and 26% of ethanol. After 20 years, these manufacturers developed a flexible fuel technology, commercially available and predominant in car sales today at no additional cost.

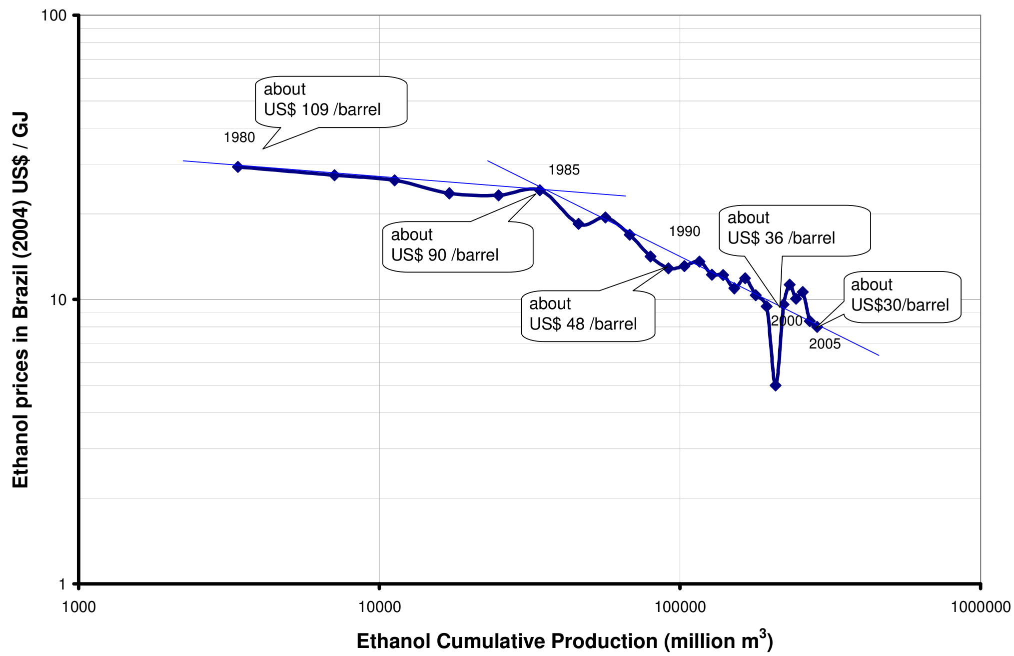
A remarkable characteristics of the Program is that all the automobiles manufacturers agreed to produce automobiles with converted motors. Essential for that was the availability of an infrastructure for ethanol pump in most of the service station around the country. At that time, gas stations were offering different pumps with “regular” and “super” gasoline (with higher octane and lead additives) . Tanks and pumps for “super” gasoline were easily replaced by pure ethanol.

Ethanol production costs were close to US$ 100 a barrel in the initial stages of the Alcohol Programme in 1980. Until 1985, as production increased, prices paid to producers reflected average costs of production (Goldemberg et. al., 2003). During this initial phase, prices fell slowly, only reflecting the gains in agro-industrial yield and economies of scale captured by producers, and these gains were transferred to consumers through a pricing regulation scheme.

In the past, the Brazilian Government subsidized this Program through a variety of mechanisms, particularly “soft” loans to the sugarcane growers, which built ethanol distilleries, and incentives to encourage people to purchase pure ethanol driven cars. Estimates of the total amount of investments in the agricultural and industrial sectors for automotive ethanol fuel between 1975-1989 reach a total of US$ 4.92 billion (2001 US$). Oil imports avoided meant savings amounting to US$ 52.1 billion (January 2003 US$) from 1975 to 2002.

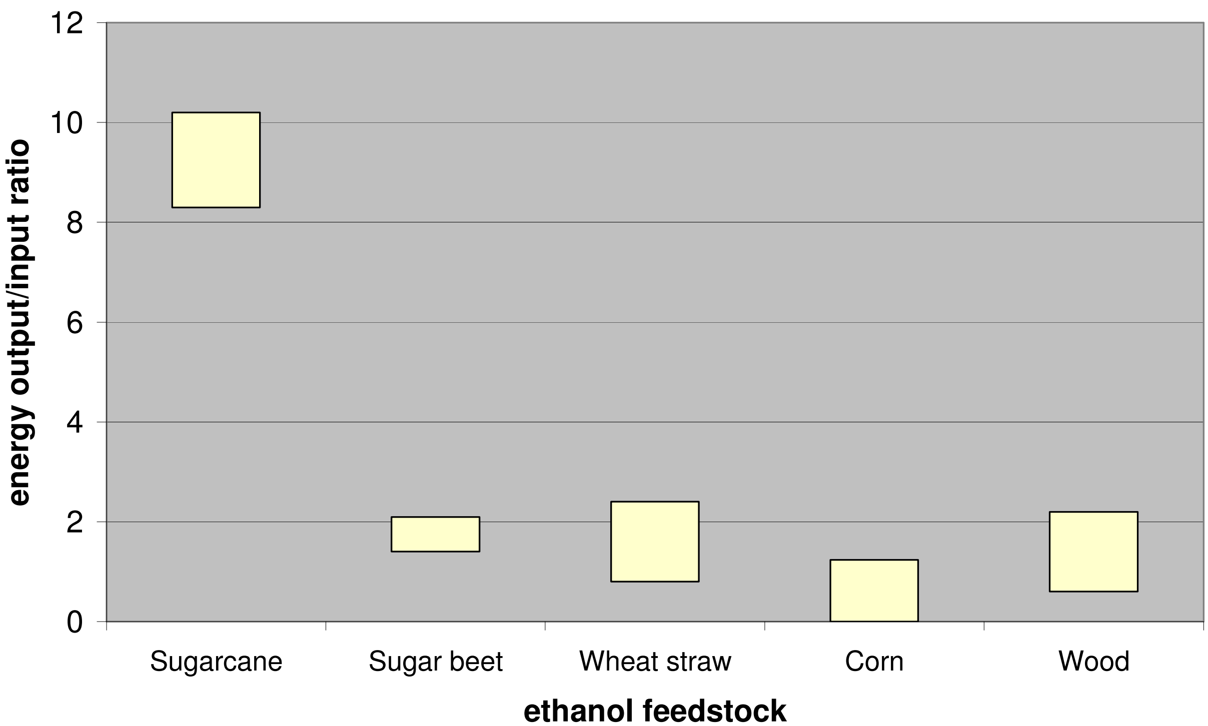
More recently, economies of scale and competition led to a reduction in production costs (Figure 2). They were due mainly to a significant increase in agricultural yield, which is a function of soil quality, weather conditions and agricultural practices, and is also strongly influenced by agricultural management. Productivity gains and cost reductions were also achieved as a result of the introduction of operation research techniques in agricultural management and the use of satellite images for species identification in cultivated areas. Similar decision-making tools have been applied in relation to harvesting, planting and application rates for herbicides and fertilisers.

Figure 2. Ethanol learning curve (Goldemberg et alii, 2003 updated)



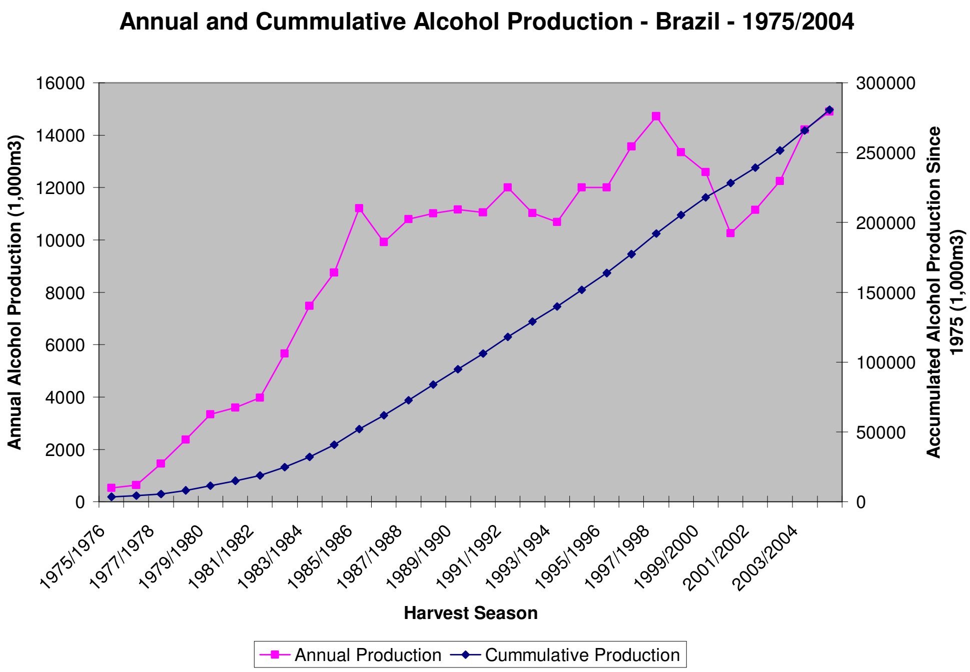
Also, this cost reduction was highly influenced by the use of sugarcane bagasse (a by-product of sugarcane crushing) for energy production, avoiding the use of any fossil fuel in the industrial project. That´s why the energy balance for sugarcane ethanol is the best in the world for biofuels: up to 10 output units for each input unit.

Figure 3. Energy balance of alcohol production from different feedstocks



Sources: (Macedo et alii, 2004; UK DTI, 2003 and USDA, 1995) The evolution of the Program can be gauged in the following Figure 4.

Figure 4. Evolution of Proalcohol



Source: Goldemberg et alii (2003) updated

A comparison of ethanol costs with gasoline in the international market is shown in Figure 5, a remarkable example of the "learning curve" effect for a renewable energy such as ethanol.

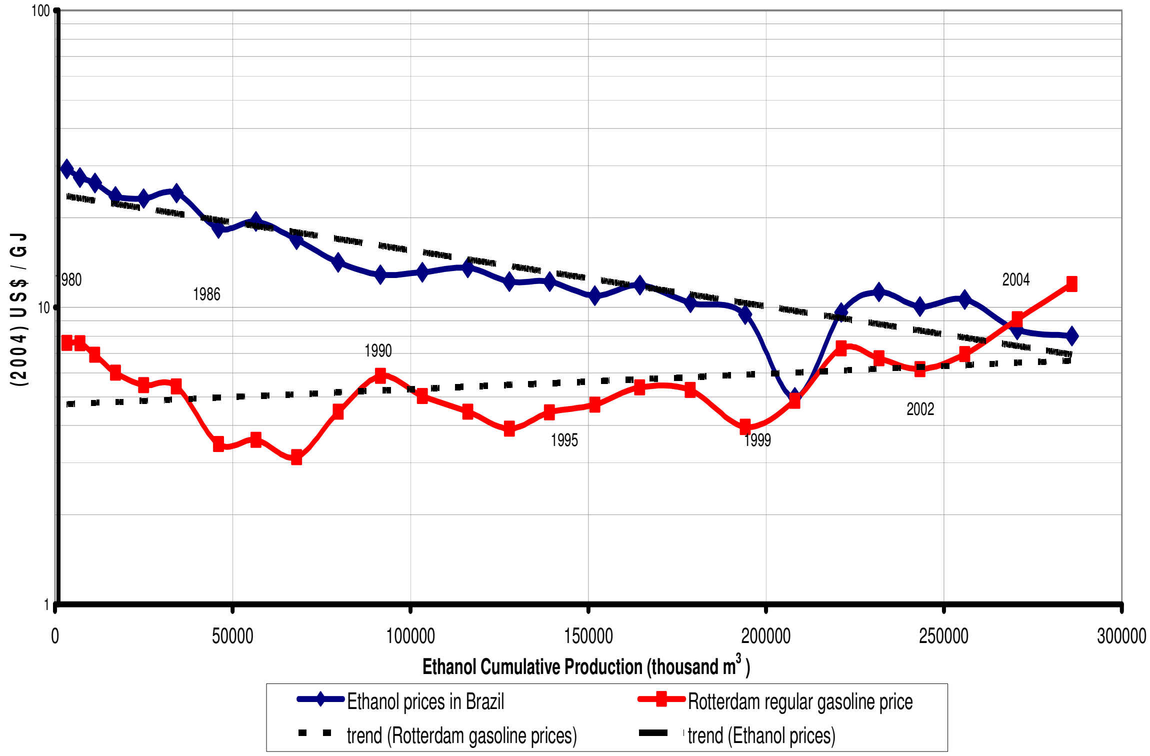


Figure 5. Brazilian sugarcane ethanol international competitiveness (Goldemberg et alii, 2003 updated)

The experience with ethanol in Brazil could be replicated in other developing countries, because many of these countries already have sugarcane plantations and could gradually start to produce alcohol fuel both for domestic supply and, later on, for export (despite the existing barriers in industrialized countries against the import of biofuels produced in developing nations).

Table I lists the main producers of sugarcane in the world, showing that this is a concrete possibility.

Table I – World sugarcane producers

	Sugarcane	2004	
		Production (million ton)	Area (thousand ha)
1	Brazil	416.26	5,634.55
2	India	236.18	4,000.00
3	China	90.98	1,392.10
4	Thailand	64.97	1,121.41
5	Pakistan	53.42	1,047.50
6	Mexico	45.13	639.06
7	Colombia	40.02	431.74
8	Australia	36.99	448.00
9	Philippines	32.50	395.00
10	United States of America*	26.32	379.68
11	Indonesia	25.60	360.00
12	Cuba	24.00	700.00
13	Argentina	19.30	350.00
14	South Africa	19.09	321.57
15	Guatemala	18.00	186.34
	World	**1,328**	**20,454**

Source: FAOSTAT (2005)1.

There is enough area available for an ambitious introduction of 10% of ethanol in world´s gasoline. It would be necessary nearly 30 million hectares of land, which is only 3% of the total area of harvested crops in the world (1042 million hectares in 2001).

If ethanol from sugar cane were to replace 10% of the gasoline consumed in the world (34.75 million TJ in 2000), carbon emissions would be reduced by 66 million tonnes (Ceq) per year. This is equivalent to approximately 1% of the world´s emissions, or one fifth of the Kyoto Protocol target.

1 According to another source, the sugarcane harvested area (in thousand hectares, year 2004) was 385 in the whole United States, of these 170 in Florida, 9 in the Hawaii, 188 in the Louisiana and 18 in Texas (USDA, 2005).

For that, more 30 million hectares of land are needed, corresponding to 50% more than the existing area.

Environmental aspects must be taken into account, but the production of biofuels (especially sugarcane ethanol) is a win-win perspective for both developing and developed countries.

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