Experiences with large-scale production of sugar cane and plantation wood for the export market in Brazil; impacts and lessons learned

Workshop on INTERNATIONAL BIO-ENERGY TRADE and DEVELOPMENT

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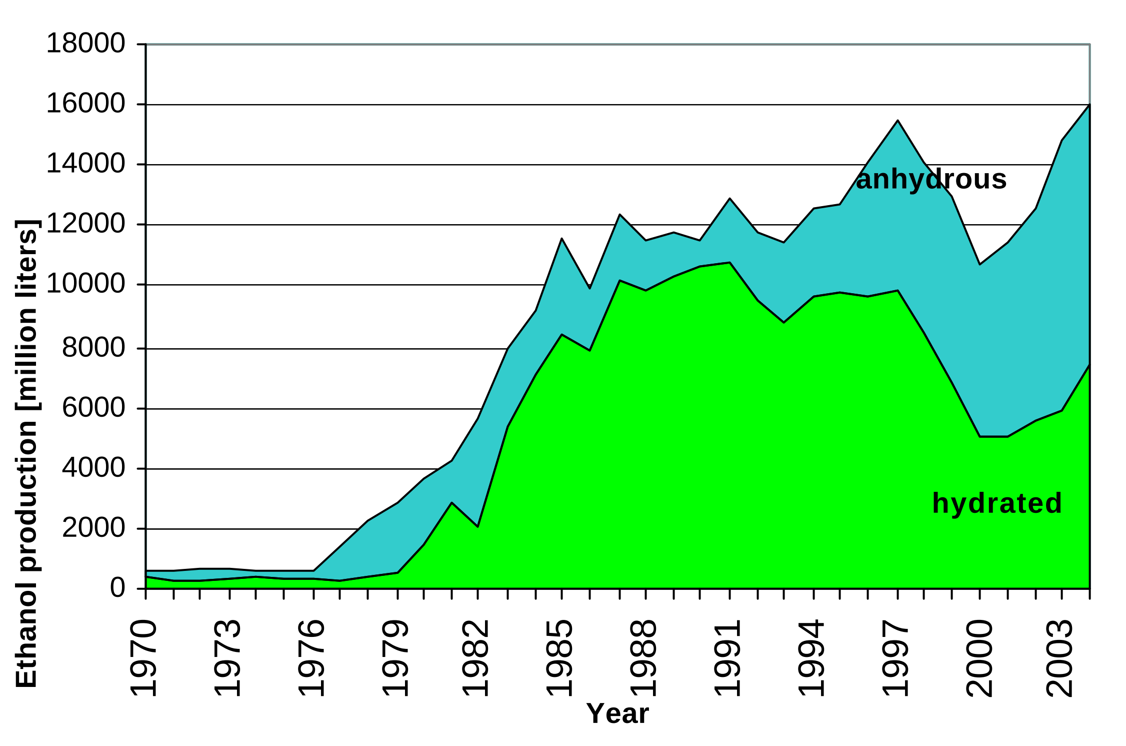
I. Ethanol - outline

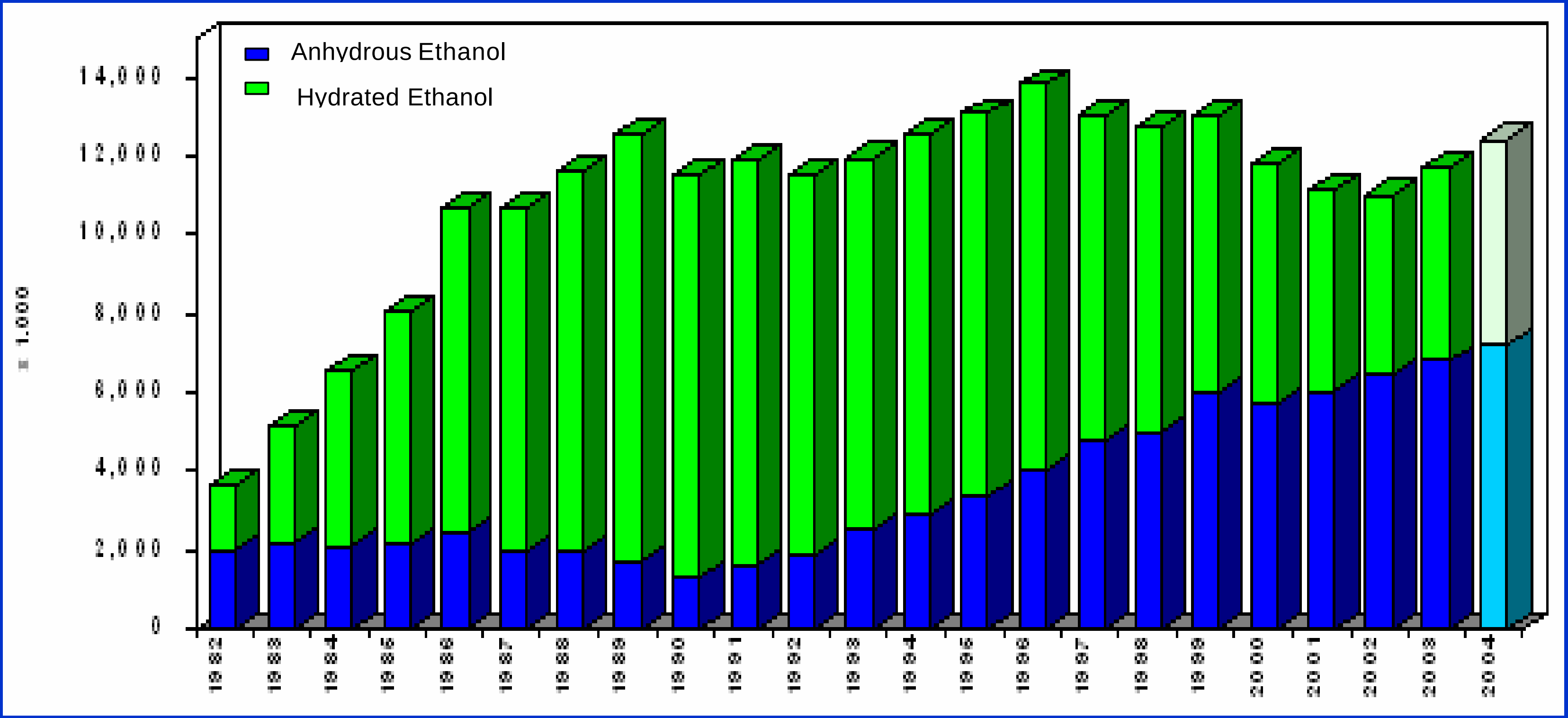
- Historic ethanol production and consumption in Brazil;
- What's going on in the ethanol industry, in Brazil;
- Market perspectives up to 2013: domestic and exports;
- Requirements up to 2013: land use, enlargement of capacity, investments, logistics;
- Sustainability aspects: main results achieved and problems to be addressed.

Ethanol production in Brazil



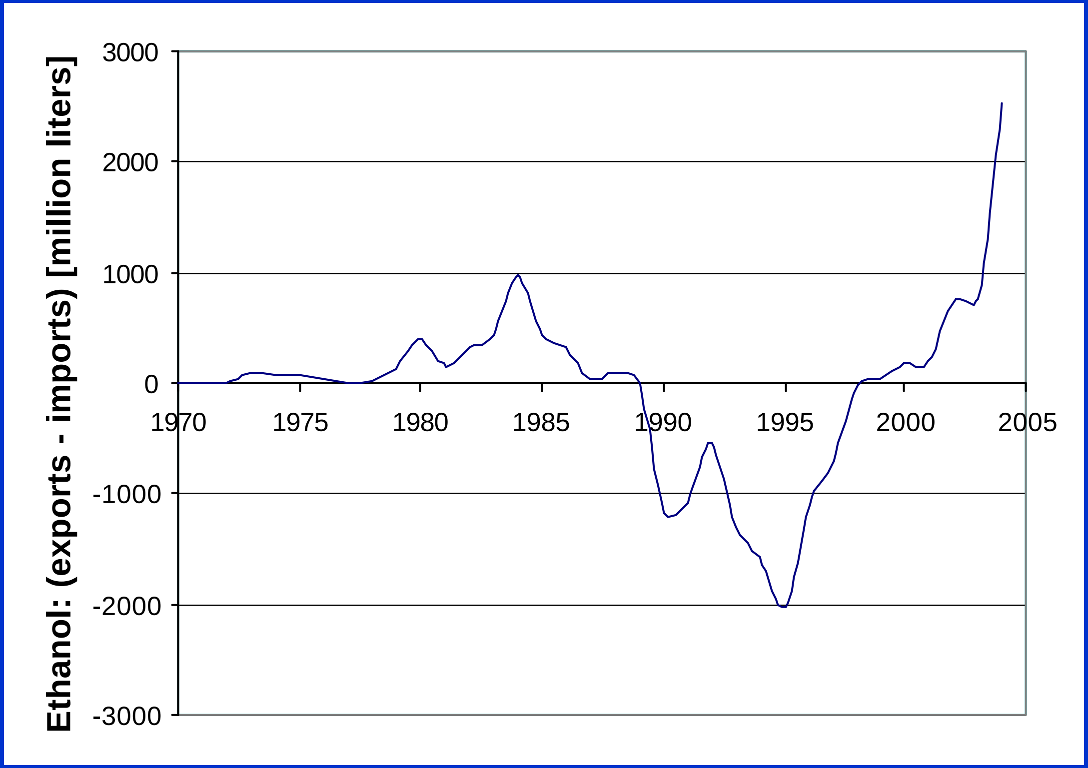
- Brazilian production in 2003: 37% of the world production.
- Ethanol production in 2004 is an estimate.
- Ethanol production is risen since 2000.
- Production includes other uses than automotive fuel and exports.

Ethanol consumption in Brazil



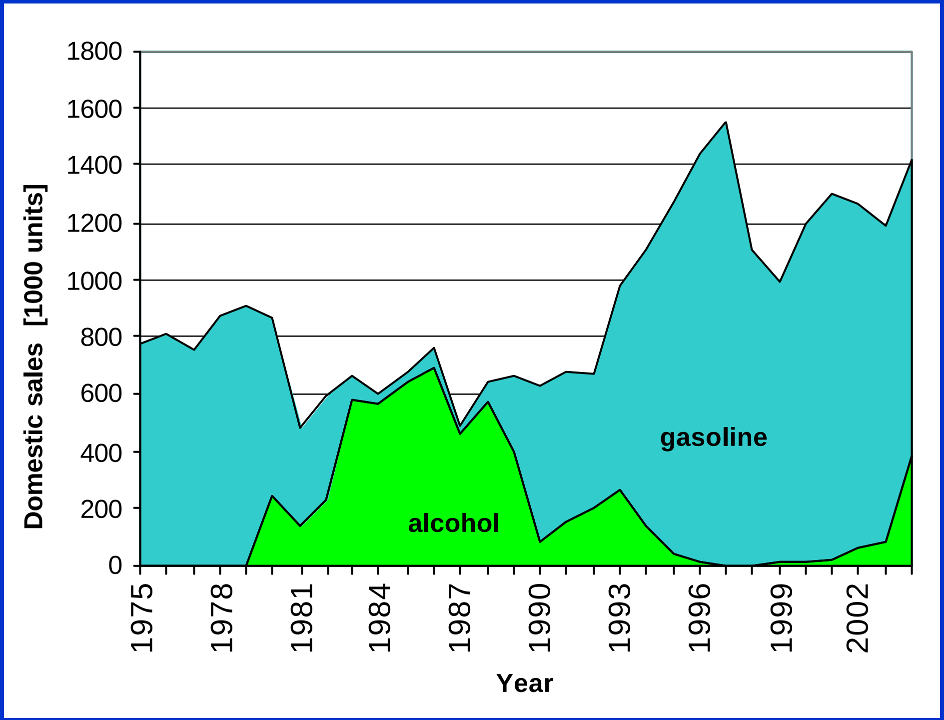
- Ethanol consumption as automotive fuel in 2004 is an estimate = 12.4 billion liters (2.5 billion for exports and 1 billion liters for other uses)

Ethanol (exports – imports)



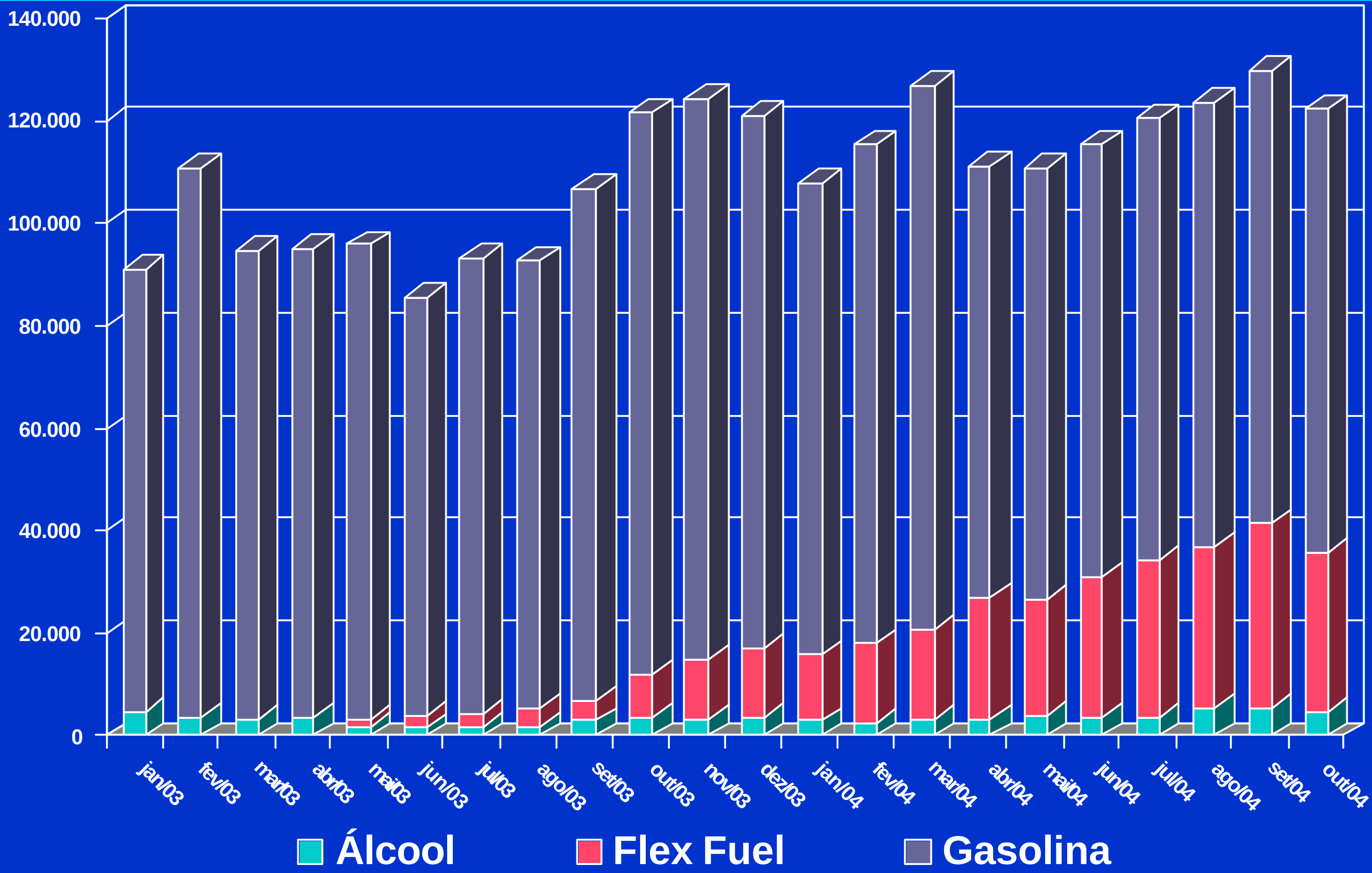
- In 2004 ethanol exports are estimated as 2.52 billion liters (average price in 2004: 0.21 US$/liter).
- Until October 2004, 1.95 billion liters were exported (India 23.1%, US 20.2%, South Korea 10.2%, Japan 9.2%, Sweden 8%, Jamaica 6.3%, The Netherlands 6.2%, Mexico 3.5%, Costa Rica 3.2%).

Flex-fuel vehicles



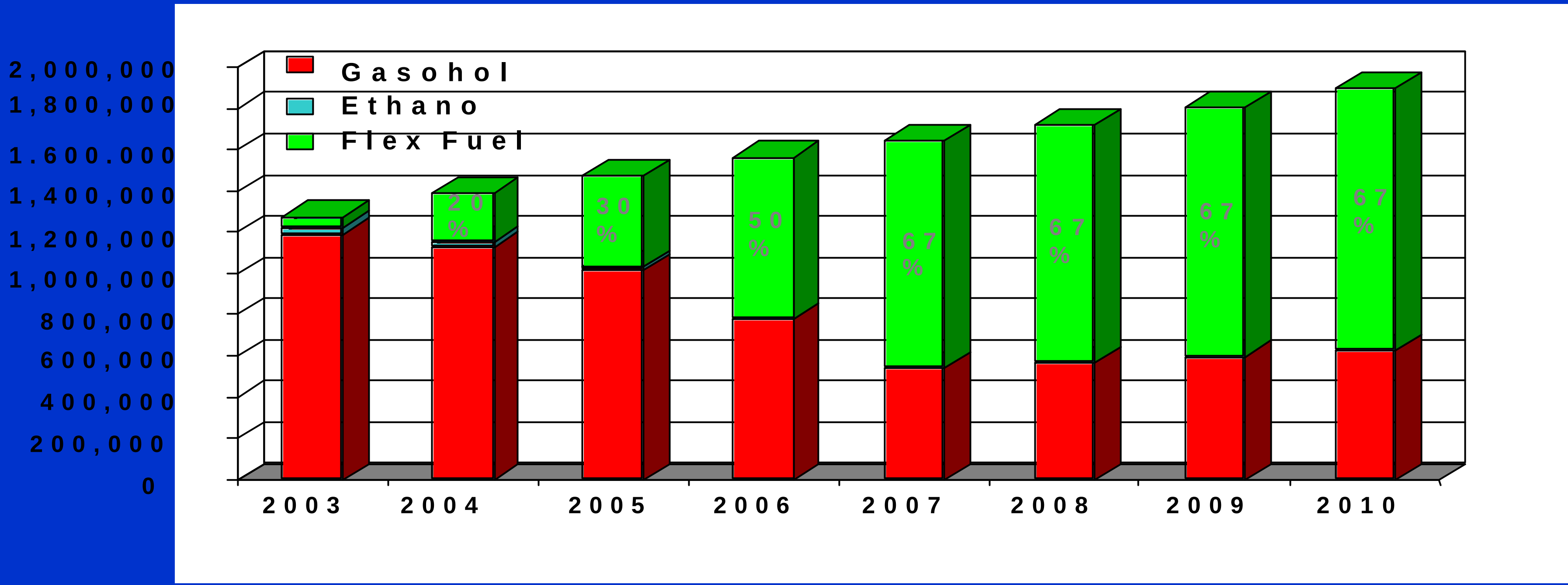
- Sales of flex-fuel vehicles have started in March 2003; since than sales have risen steadily.
- In 2004 sales of ethanol vehicles (most flex-fuel vehicles) represente 27% of the total sales.

Flex-fuel vehicles



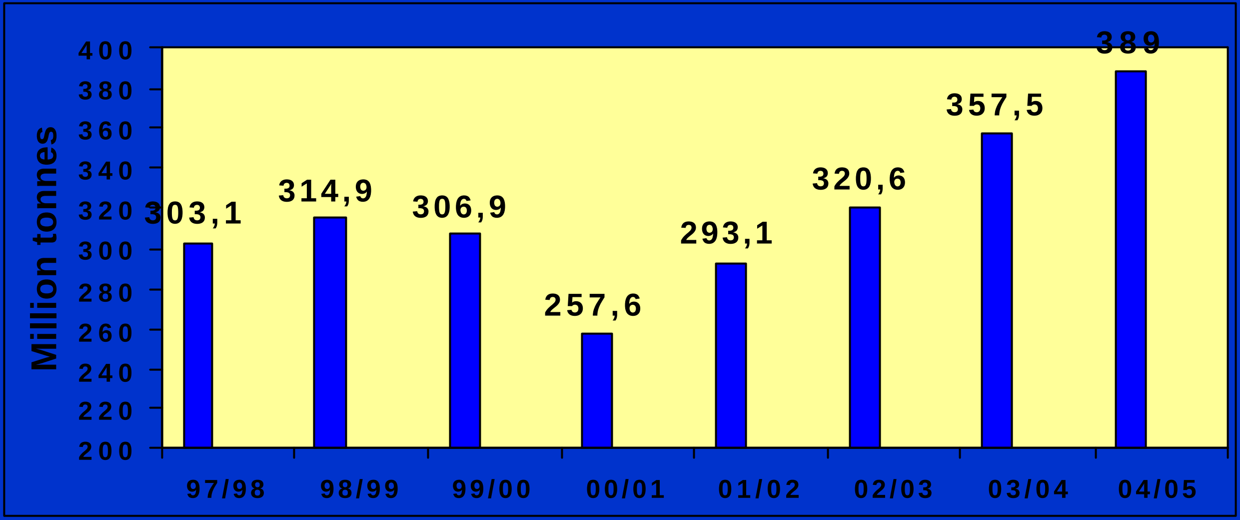
- Details of the vehicle sales from January 2003 to October 2004.

Flex-fuel vehicles



- Regarding flex-fuel vehicles, the result achieved in 2004 (27%) was better than expected.
- It is forecast that the share of flex-fuel vehicles will reach 67% in 2007.

Production and installed capacity



- Sugarcane production has risen 10.85% per year during the last 4 harvest seasons.
- Current ethanol production capacity is about 18 billion liters per year.
- 33 industrial units are under construction (22 in São Paulo State – where 60-65% of the production is concentrated) and will be in operation in 2005-2007.

Perspectives up to 2013

- “Conservative” estimates according to DATAGRO:
- Market for sugar: 32 to 35.6 million tons, being 12.8 million tons for the Brazilian market (internal consumption in 2004 estimated as 9.7 million tons), and 19.1 to 22.7 million tons for exports (14.3 million tons exported in 2004).
- Market for ethanol: 30.9 billion liters, being 25 billion liters for the Brazilian market (13.5 billion liters in 2004) and 5.9 billion liters for exports (2.5 billion liters in 2004).
- Consequently, the total sugarcane production should reach 607 to 633 million tons (56 to 63% larger than the production during the last harvest season).

Perspectives for ethanol exports

- US market can surpass 19.1 billion liters in 2011 in case the Energy Bill is approved (ethanol to be blended with gasoline). The US market is nowadays highly protected. The Caribbean Basin Initiative limits imports up to 7% of the US market.
- Europe: a directive obliges the use of certain amount of renewables in automotive fuels (2% in 2005 – 5.75% in 2010). The potential demand in 2010 (EU-25) is estimated as 13 billion liters. The demand can be accomplished by internal production, but production costs are almost 3 times higher than in Brazil.
- India: there is an E5 directive. The short term demand (up to 500 million liters in 2005) shall be accomplished by imports due to constraints of local production.

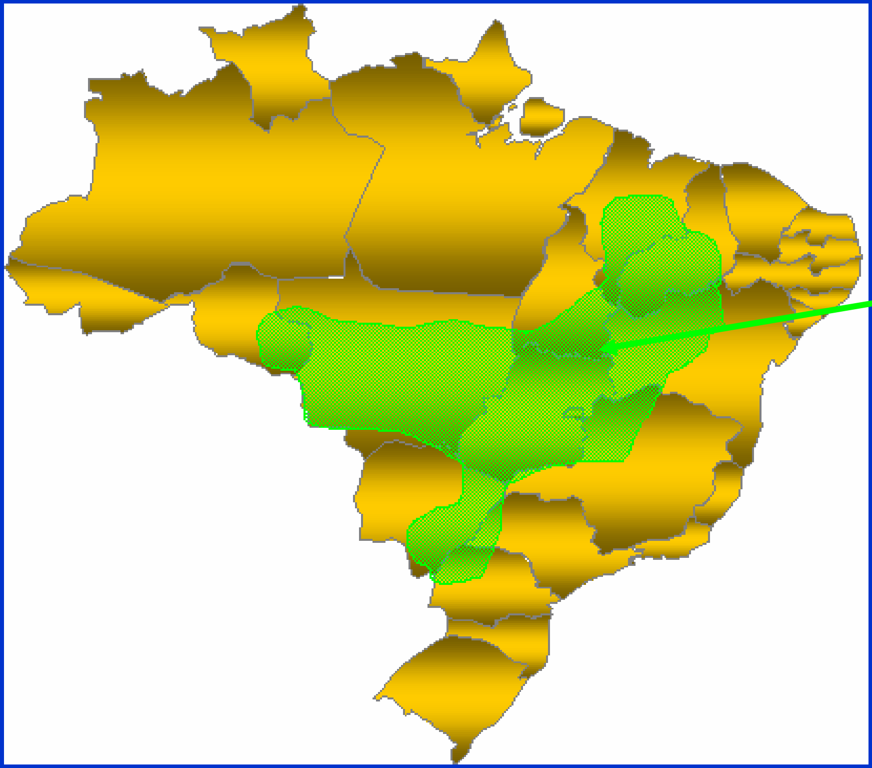
Perspectives for ethanol exports

- Japan – nowadays E3 is not mandatory. Considering the target of E10, the market is estimated as 10 billion liters is 2010. Japan can not be a ethanol producer.
- South Korea – the same Japanese position should be adopted. Considering the target of E10, the market is estimated as 1.9 billion liters.
- China – a blend of ethanol + gasoline should be used up to 2008. The market in 2010 is estimated as 4.8 billion liters, being the local production able to reach 2.5 billion liters.

Medium to long run requirements

- As previously mentioned, the total sugarcane production should reach 607 to 633 million tons, i.e., 218-244 million tons additional. Considering an average yield of 77 tons of sugarcane per hectare, the total land requirement would be 7.9 to 8.2 million hectares, i.e., 2.4-2.7 million hectares additional.
- The total arable area in Brazil is estimated as 376 million hectares (IBGE). The area available for the enlargement of the agriculture, without deforestation, is estimated as 110 million hectares. Thus, the required area would be about 2% of the land available.

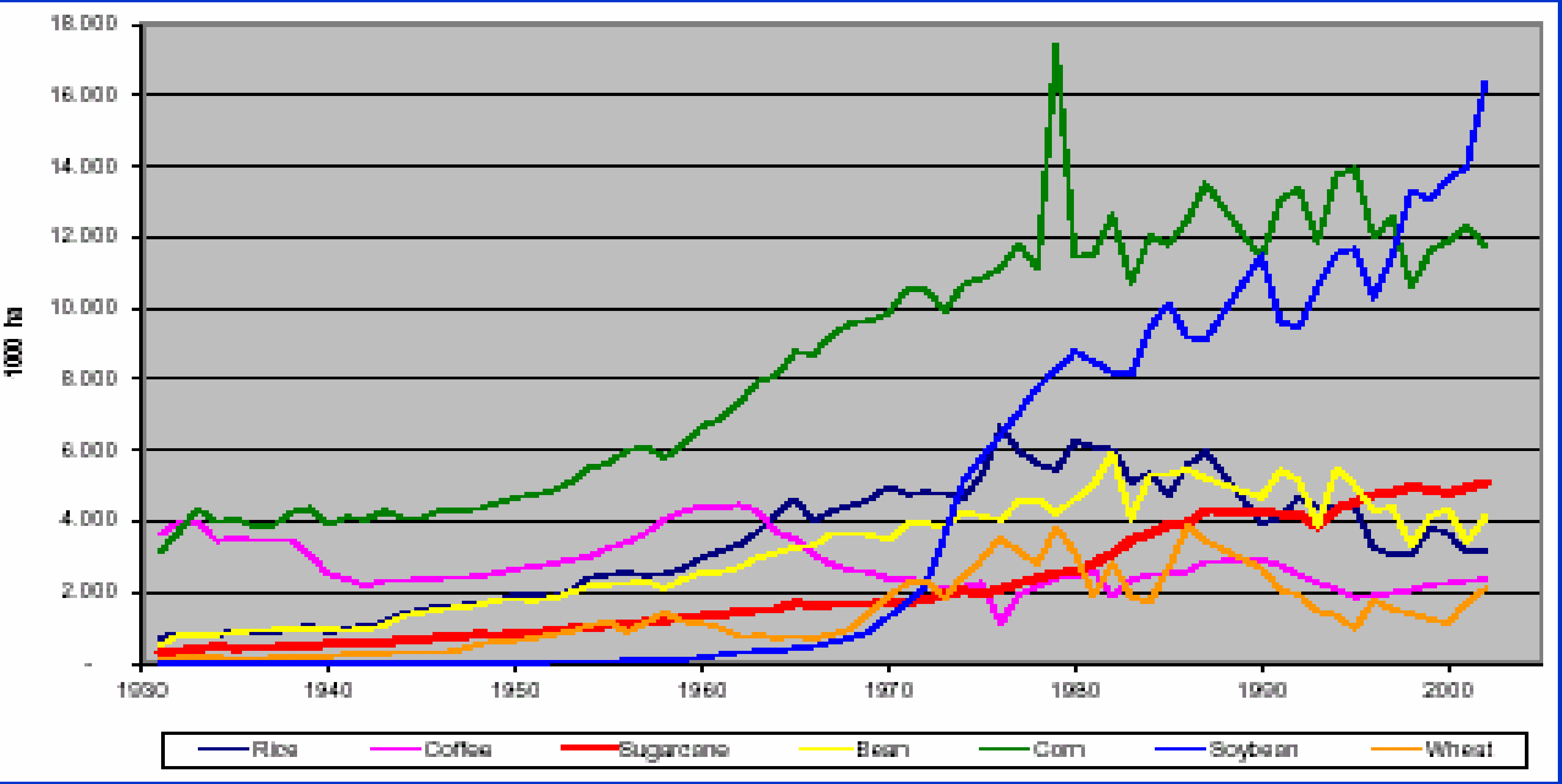
Medium to long run requirements



Areas available for the enlargement of sugarcane plantation

- "Cerrado": 90 million ha (controversial)
- Areas used for cattle: 20 million ha

Medium to long run requirements



◆**The harvested areas of corn and soybean crops have increased dramatically, while the area harvested for other cultures, including sugarcane, has remained almost identical for the past 35 years**.

Medium to long run requirements

- The estimated additional production capacity of ethanol in 2013 would be 30.9 – 18 = 12.9 billion liters.
- Considering an industrial unit able to produce 80 million liters of ethanol per year, 160 new industrial units should be built up to 2013.
- The associated investment in the agriculture is estimated as US$ 2.3 billion, while the industrial investment is estimated as US$ 6.3 billion, summing up US$ 8.6 billion.
- According to equipment producers, Brazilian industry is able to build 24 blend new mills per year, i.e., 1.92 billion liters per year.

Medium to long run requirements

- Regarding logistics, current capacity of terminals is estimated as 3.6 billion liters/year. PETROBRAS controls more than 50% of this capacity (2 billion liters/year in Rio de Janeiro).
- The capacity under construction sums up 5.7 billion liters, being 1 billion liters in Northeast.
- In the short run, PETROBRAS is able to enlarge its capacity to 6-7 billion liters (i.e., o add 4-5 billion liters).
- Thus, it is considered that logistics won’t be a serious constraint for ethanol exports.

Sustainability aspects – some results

- Regarding ethanol production, a very positive energy balance is observed (output/fossil input = 8.3 to 10.2).
- In 2003, in Brazil, the automotive use of ethanol represented avoided emissions equivalent to 27.5 M tCO_2 equivalent. Considering the consumption of 25 billion liters in 2013, avoided emissions would correspond to 50 M tCO_2 equivalent.
- In Brazil, it was possible to reduce lead additives by increasing the amount of alcohol in gasoline blend (lead were completely eliminated in 1991). Aromatic hydrocarbons (such as benzene), which are particularly toxic, were also eliminated and the sulfur content was reduced as well. In pure ethanol cars, sulfur emissions were completely eliminated. The addition of alcohol in commercial gasoline has reduced the total carbon monoxide, hydrocarbons and sulfur fleet emissions by significant proportions.

Sustainability aspects – some results

- In 2004, the Brazilian sugarcane sector was responsible for 700,000 jobs and around 3.5 million indirect jobs, corresponding to the production of 389 million tons of cane. Wage levels in the sugarcane sector are comparatively higher than those in other rural sectors. Experience in Brazil has shown that, in large-scale sugarcane plantations, informal working conditions were replaced by a well-organized sector where labor laws are enforced.
- The use of fertilizers in sugarcane fields is controlled, so that hazardous chemicals can be replaced with the by-products of industrial production (vinasse and filter cake). This reduces the use of chemicals and avoids pollution of ground water and rivers.

Sustainability aspects – some results

- In recent years, the genetic development of sugarcane species has advanced. These developments have resulted reduction in the use of pesticides and their environmental impacts, an increase of sugar content, the development of disease-resistant species, better adaptation to different soils, and the extension of the crushing season.
- A very substantial cost reduction was observed and ethanol is competitive vis-à-vis gasoline without subsidies. Cost of production is estimated as 17-19 cents U$/liter.

Sustainability aspects – problems

- Water use and its consumption – in Brazil, sugarcane plantations are not irrigated, but water consumption is very high at the industrial level (on average, 5 m^3/ton of sugar cane crushed, but can be as high as 20 m^3/ton). It's absolutely necessary to reduce water consumption.
- The long term effects of vinasse application on the soil are unknown so far.
- As mentioned, there is enough area available for the enlargement of the harvested area. However, the expansion of sugarcane in the "cerrado" area should be carefully considered.
- According to the environmental legislation, it is forbidden to engage in any type of deforestation. In addition, in São Paulo State, each agricultural producer must guarantee a preserved area (corresponding to 20 per cent of the total area planted with sugarcane as a natural reserve) to guarantee the local biodiversity. The same should be assured in other parts of the country.

Sustainability aspects – problems

- In São Paulo State sugarcane is no longer planted in areas of watershed protection, but the same should be assured in other parts of the country.
- Harvesting with previous field burning is responsible for expressive emissions of NOx and particulate matter. In São Paulo State, existing legislation foresees a gradual growth on mechanized harvesting (with no fuel burning), with full mechanization to be reached by 2021-2031, depending on the terrain conditions. Green cane harvesting will allow the recovery of sugarcane trash (leaves and the tops of the plant), and a deep increase on biomass availability for electricity production in industrial process. In most of the northeast region, green cane harvesting cannot be applied due to topographic conditions.
- In addition, green cane harvesting will imply a reduction on job creation.

II. Wood - outline

- Overview – 4 decades of plantations;
- National programs 2004/07;
- Ongoing initiatives – pellets/brickets and chips;
- Planted forests – main states;
- Present figures and perspectives;
- Sustainability aspects – technical / environmental, legal and social aspects;

Overview – 4 decades of plantation

- In 1965, the existence of just 0.5 M ha of plantations and a growing pace in deforestation led to a revision in the ongoing forestry legislation updating the Forestry Code.
- In 1967 it was created the IBDF- Brazilian Institute for Forestry Development, and a national program to foster forestation, named Brazilian Incentive Law. It ruled during 20 years and the approved projects should have covered an area of about 6.5 M ha, which in practice were not verified.
- In the 1990's there was a reduction in the forested area from more than 300 thousand ha/year to about 170 thousand ha/year. Reasons: the end of the program above, unstable economy, lack of financial resources and high interest rates.
- Pulp and Steel industries, during the 1990's, were responsible by most of those plantings. These industries, having enough financial resource and stable external market, were stimulated by the new local technologies, which provided increasing wood yields.

Overview – 4 decades of plantation …

- In 2000-2003 forested areas held about 250 thousand ha/year, an amount still lower than the harvested area.
- During recent years, environmental and social concerns started to be demanded in the forestry sector.
- Pulp and Steel industries have not facing problems with wood supply such as timber industry has (they have mature forests planted in the 1990’s). Some timber consumers are importing wood from MERCOSUL.
- Bio-energy from wood has its demand and supply estimated as about 70 M t for 2003. About 10% from that amount is regarded to be from sources of unknown sustainability.
- Field residues have been rarely used for energy production, remaining as an important alternative for both internal and external bio-energy trade.

National Programs 2004-07

- Several programs are being implemented aiming at supply all sector demands: Pronaf Florestal; Propflora; Profloresta; Proambiente.
- Pathways: increasing annual planted forests and incorporating native sustainable forests through certification process (e.g.: FSC).
- Targets for planted forests (4 years) – 0.8 M ha through small and medium farmers; 1.2 M ha through companies; 75 thousand ha to recover riparian forests and 125 thousand ha to rebuild legal farmland reserves (80% Amazon, 35% Amazonian cerrado and 20% for the rest).
- Targets for native forests (4 year / implementation) - 15 M ha of native certified and sustainably managed forests, in which 5 M ha must come from “Social Forests” managed in a community or familiar way.
- Energy target – 1.5 GW of electric energy generated on site, mainly from residues.
- GHG targets – it is estimated that the contribution would correspond to 50 M tCO_2 equivalent (avoided emissions and storage).

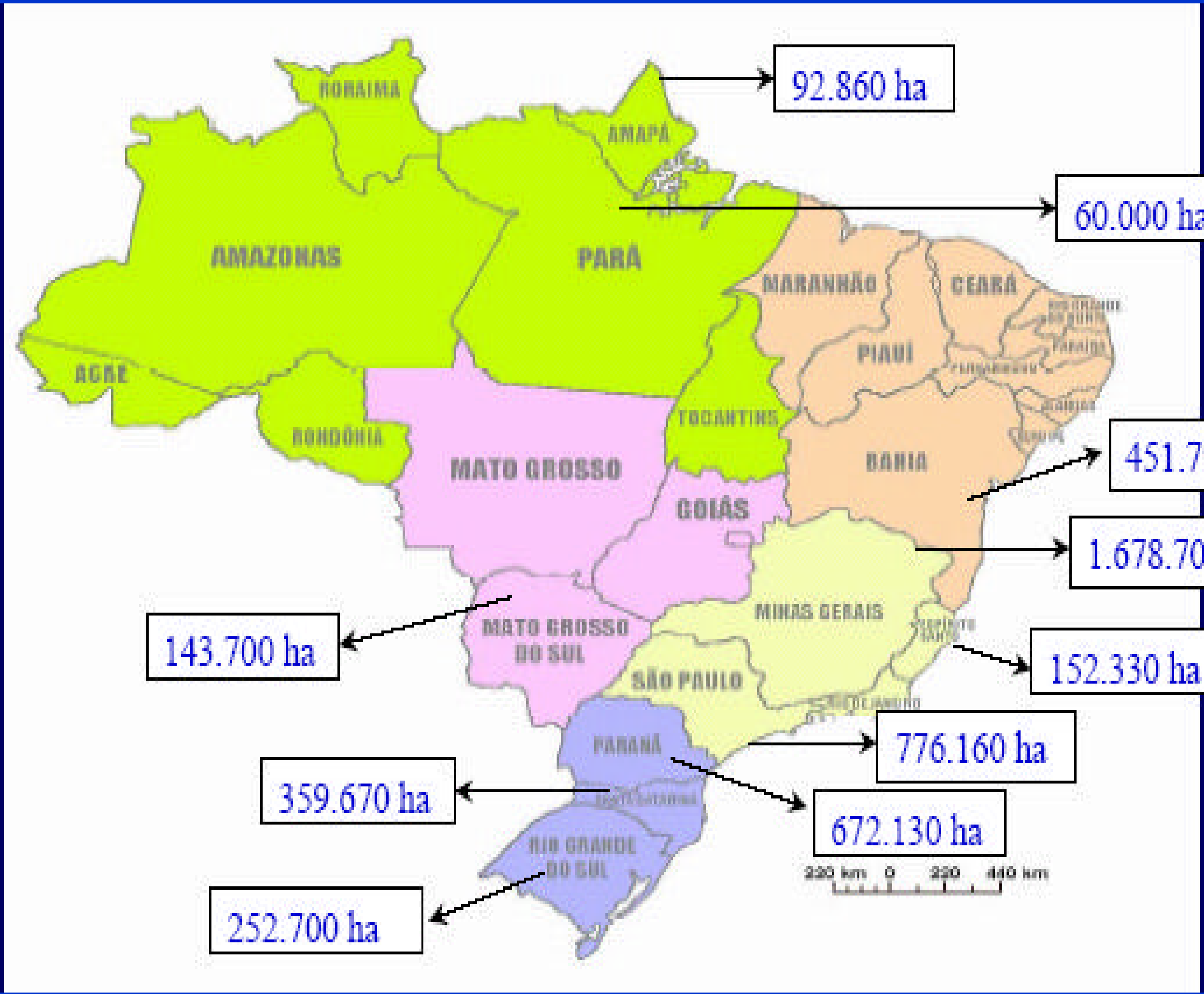
Ongoing initiatives – pellets/brickets

- Consumption in a starting phase.
- Substitute for firewood and charcoal.
- Advantages: denser in mass and energy; cleaner.
- Potential use of forest residues: 30 Mt – 250 PJ.
- Prices of residues: 0.7 U$/GJ (Amazon) to 1.7 U$/GJ (South and Southeast).
- Wood pellets/brickets: exportation in 2004 – 10 thousand t.
- Consumption in 2005: estimated as 30 thousand t.
- Current destination of exports: North America (Canada).
- Uses: packed for households, restaurants, bakeries.
- Pellets/brickets initial price: U$ 52/t FOB (packed) 2.7 U$/GJ.

Ongoing initiatives – chips

- Main destination of exports: pulp and paper industry (Asia, Europe, USA)
- Just one company is exporting chips from residues (barks) and acacia trees for energy purposes.
- Exportation in 2004: 250 thousand GMT – 3 PJ.
- Potential, considering forest residues: 30 Mt – 250 PJ .
- Current destination of energy chips: Europe.
- Uses: co-firing and biomass power and heating plants.
- Use of chip carriers up to 40,000 t.
- Average prices: 25 US$/t (1.2 US$/GJ) FOB; 42 US$/t (2.1 US$/GJ) CIF Europe.

Forest plantations – main states



In 2000

Present figures and perspectives

Indicators	Unit	2002	2005	2010	2015	2020
Planted Area	k ha/yr	200	500	500	500	500
Harvested Area	k ha/yr	(378)	(480)	(592)	(673)	(765)
Growing Stock (a)	k ha/yr	(178)	20	(92)	(173)	(265)
Supply	M t /yr	44	55	80	150	150
Demand	M t /yr	(70)	(85)	(125)	(150)	(175)
Surplus (b)	M t /yr	(26)	(30)	(45)	0	(25)
Residues (c)	M t /yr	75	95	115	135	156
Biomass surplus (d)	M t /yr	49	65	70	135	131
Bio-energy surplus (e)	E J /yr	0,41	0,55	0,59	1,13	1,10

(a) Although growing stocks appear to be positive in 2005, it reflects the industrial situation. Small timber consumers are facing problems to get mature softwood logs. In addition there is need for increasing plantings after 2005 in order to meet increasing demands.

(b) Negative surplus are due to low amount of plantings undertaken in the 1990s. Increasing in forested area observed after 2004, will just start to show results after 7 years for eucalypt and 12 years for pine wood.

(c) Industrial (saw mill) and field residues from planted forests.

(d) net biomass amount considering negative and positive surplus (- /+).

(e) net bio-energy amount considering negative and positive surplus (- /+).

Sustainability – technical and environmental aspects

- Average annual yield: 25-50 t/ha for eucalyptus (7 years) and 20-40 t/ha for pines (12 years).
- Up to 3 harvests per planting for eucalyptus.
- Charcoal - increasing efficiency leading from 330 to 450 kg / t of wood (+ 36%), together with the achievement of 100 % from planted forests for 2010.
- No-tillage or reduced tillage is the usual method of planting.
- Highly reduced input of chemicals.
- At licensing stage, it is required the adoption of general BMPs (e.g.: wildlife corridors, riparian vegetation, nutrient cycling and others). The Code of Best Practices for Planted Forests is still under construction.
- Land availability for new forests may be met inside the 10 M ha already forested, even considering rotation practices. Reasons: short-term rotation and increasing earnings obtained in productivity.
- Additionally, small farmers are foresting marginal lands, not appropriated for other purposes.
- There are 400 M ha of Native Forests for a estimated management of less than 7% for National Program and other initiatives.

Sustainability – legal aspects

- After Constitution of 1988 the Environment National Policy and the SISNAMA – Environment National System started, in fact, to be implemented. Environment Agencies at State level became responsible to issue licenses for activities both at running or initial phase.
- Some States have their EA still under structuring. In that places activities remain controlled by national agency which unfortunately does not have enough structure to it.
- EIA is required for all medium and large projects, even in Amazon where National Agency cares for it. This is another reason why many small projects remain deforesting and polluting.
- Legal framework established in 1998/99 set sanctions for environmental crimes enabling enforcement efficacy.

Sustainability – social aspects

- Forestry sector is responsible for 0.5 million direct jobs and 2.5 indirect ones. It is expected an increase of 10% up 2007, as a consequence of the National Programs and of the stable economy.
- The most important companies are now working under the “integrated system”, which consists of a partnership between industry and landowners, mainly small farmers. In this system industry provides clones (seedlings) and all other agricultural materials; farmers participate with land and work-force.
- A target from National Programs states, for this decade, that about 250 thousand rural families will be maintained by 5 M ha of “Social Native Forests” certified and managed sustainably (Brazil has about 50 M ha of National Forest Reserves).
- Attractive financial resources linked to National Programs are loaned by public banks. They require from any operation, the strict legal accordance all labor aspects.
- A charcoal producers association together with the State of Minas Gerais Government are implementing a certification process (Forestry Origin Stamp) for internal and external markets (named SOFEX and SOFIN). This certificate (stamp) assures that this charcoal was produced according to Brazilian labor and environmental laws.