IV

Impacts of production on commercial actions

The search for external sustainability determines that agricultural production should not impose any adverse economic impacts on the external environment; the externalization of costs to be paid by other sectors of society is evidence of an unsustainable production. As much as this concept seems strict, considering the present situation of agriculture around the world and the high subsidies that are currently in use, it is appropriate to use it as a way of showing and, to some extent, quantifying the inadequacy of many practices in the current system. The remarks on sustainability and international trade in the Rio Declaration go in the same direction: "*States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation*".

Actually the relation between more liberal standards of international trade and sustainable development has been marked by controversies and disputes between civil entities and governments; alleged (or real) environmental problems have been used to justify trade barriers, for example. It is also noticeable that some "liberalizing" initiatives focused on immediate results, which are sustained by some richer countries, have contributed in the opposite way: polarizing the disputes between rich and poor. Subsidies for agriculture (with their whole broad range of variations) have been setting a terrible example for perpetuating environmental problems. A report recently prepared by the WWF[1] indicates that the level of sugar subsidies and protection in the European Union, the United States and Japan have been inducing agricultural practices that are extremely damaging to the environment (especially related to the use of water for irrigation) in these regions, while keeping prices very low in other regions, thereby preventing them from using cleaner production systems too. Ideally, these issues would be resolved with more information and a gradual convergence to sustainability ideals.

1 "Sugar and the Environment", WWF, Nov 2004

For the most part, the promotion of specific economic interests has been the main consideration of international trade policies in most countries, instead of a broader sustainable development policy. Another problem is the position of some developed countries, who view trade policies as substitutes for international "financial aid," without considering the conditions to be attained so that the flow of funds may lead to sustainable development: for example, the payment of debts of developing countries.

The sugar cane products from the Center-South region of Brazil do not have any price support mechanism under governmental policies; there are no subsidies to sugar production or trade today, as they were eliminated years ago as part of the deregulation processes. The need for subsidies has disappeared in face of the great advances in competitiveness for the two products. The economic competitiveness of any activity is essential to its sustainability; Brazil's sugar cane industry has advanced greatly in this respect with its two main products. The competitiveness of the Brazilian sugar is now unquestionable (its cost is the lowest in the world), and ethanol can now be competitive with gasoline (international prices), while being the world's first renewable liquid fuel to accomplish this. The present situation and the prospects for next few years are analyzed below.

Chapter 11:
Competitiveness of Brazil's sugar cane agribusiness

Brazilian sugar cane products do not rely on any price support mechanisms under governmental policies. There are no subsidies to sugar production or trade, and the sugar production costs in Brazil are the lowest in the world. Ethanol production costs in efficient mills is competitive with the international gasoline cost, at oil prices significantly lower than the current prices. There are good possibilities for increasing this competitiveness in the next years, and clearly the Brazilian production is sustainable in this respect.

11.1 Introduction

In the following two items, the two main products of Brazil's sugar cane industry are analyzed as to their competitiveness, using production costs, and considerations regarding transportation and export costs, as well as an examination of opportunity costs for other land uses.

Ethanol is covered by **item 11.2** in more detail because the competitiveness of the Brazilian sugar has been extensively analyzed in the specialized media over the past few years. Still concerning ethanol, the history of the industry's technological breakthroughs, which have partly led to the increase in competitiveness over the past few years, is briefly reported, and the conditions for maintaining advances over the next few years are described; this analysis obviously refers to sugar production as well.

11.2 Ethanol production: costs and competitiveness

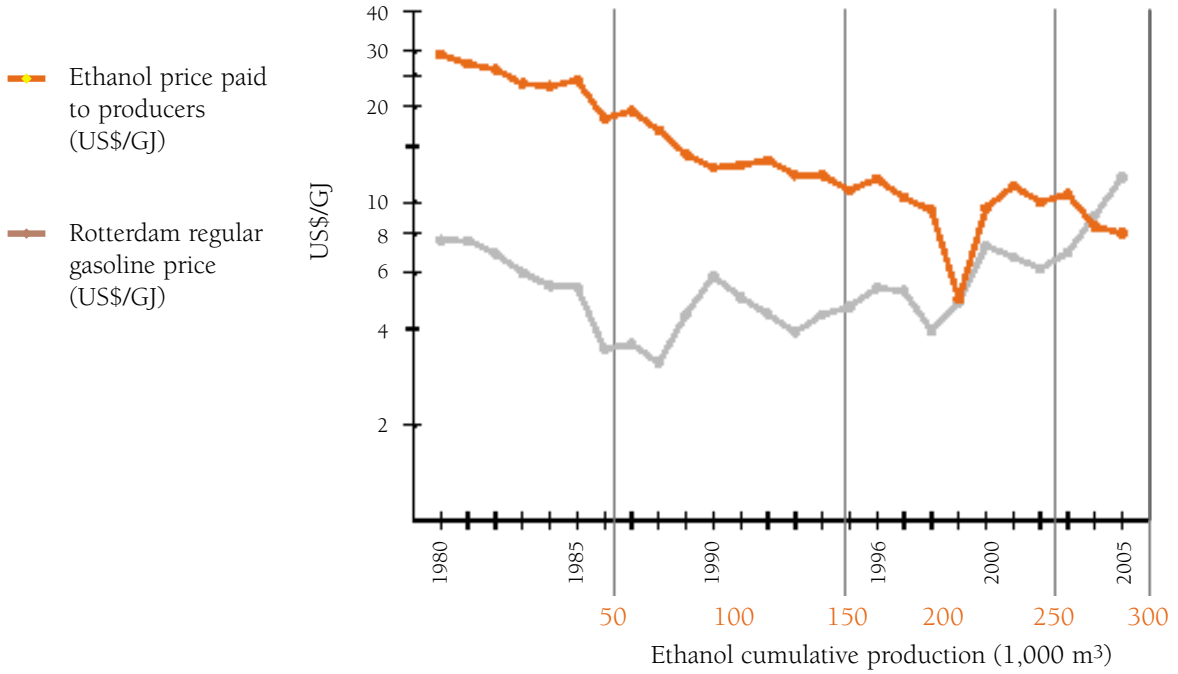
Competitiveness can be assessed based on the cost ($ / m^3) of the ethanol delivered to the consumer reliably and according to the specifications. It is influenced by local conditions (*production:* weather and soil, availability and cost of land, land structure, labor, local logistic support; and *governmental action:* interventions, taxes and subsidies, foreign exchange rates, environmental restrictions). It is also influenced by external factors, such as trade barriers, exchange rates, etc. Ethanol producers in Brazil have been taking action to improve their competitiveness, either adapting for or changing these conditioning factors, especially through investments, implementation of technologies, and political action.

The results can be summed up by the evolution of the price paid for ethanol to the producers (as a higher estimate of the production cost),[1] as shown in **Figure 1**. A comparison is shown with the international costs of gasoline production in the corresponding years. Because they refer to prices (rather than costs), the data reflect the market variations; the effect of the

1 GOLDEMBERG, J.; COELHO, S.T.; NASTARI, P.M.; LUCON, O.: "Ethanol learning curve – the Brazilian experience", Biomass and Bioenergy, vol. 26/3, London, Pergamon Press-Elsevier, 2003, pp. 301-304
Updated for reprint in 2005

oversupply of ethanol on the market (1999) and the recovery in the following years are shown.

Figure 1: Price paid to ethanol producers and gasoline cost



Source: Note **1** (see p. 189)

Given the large number of producers and diversity of situations (soil, land cost, commercial arrangements for purchased sugar cane, technological levels), it is difficult to get accurate values for production costs. Some approximations have been made based on appropriate samples.

An evaluation of the economically sustainable production cost in Brazil's Center-South region[2] used values for the *average of more efficient mills*, with the technology in use today. Mills with different capacities, management characteristics, location and land quality were considered. Also considered were the data provided by FGV – Getulio Vargas Foundation (historic series, until 1997/98), as updates for checking the consistency, and the differences arising out of the several cost concepts (economic, accounting, cash base), agricultural productivity variations, and prices of production factors.

Those economically sustainable production costs *for more efficient mills in Brazil's Center-South region* were brought up to date for January 2003 to R$ 520 / m³; if updated for December 2004, the amount would be US$ 0.20 / l (US$ 1 = R$ 2.8). Besides being computed for the more efficient sugar

2 BORGES, J.M.M.: "Alternativas para o desenvolvimento do setor sucroalcooleiro", FIPE – MB Associados, UNICA, vol. 2, São Paulo, 2001

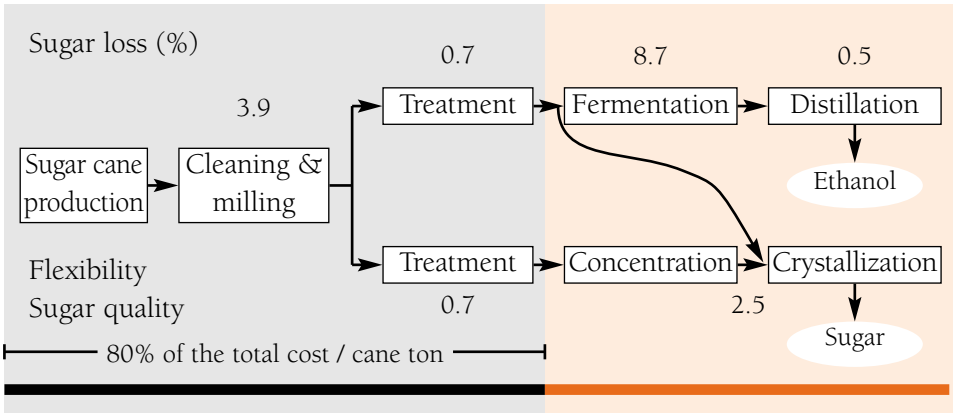
mills, this cost does not consider temporary fluctuations (for instance, the rise in land costs in times of rapid production growth, as in 2006; or peaks in some input costs, such as steel). Note that the prices paid to cane producers in the most important producing regions are indexed to the final sales value for sugar and ethanol (and the land rental cost is linked to the cane prices); this leads to a strong feed-back from international gasioline and sugar prices over sugar cane prices. A cost evaluation at the end of the season 2005/06[3] indicated R$ 35.7 / t cane, leading to R$ 647 / m^3 ethanol. The international cost of gasoline (with no additives, Rotterdam) was US$ 0.22-0.31 / l, with oil at US$ 25-35 / barrel. Over the past months it has seemed clear that the oil costs will be substantially above that level, which confirms the very competitive position of ethanol.

Ethanol production costs in Brazil should also be compared to the evaluated costs of corn ethanol in the United States (~US$ 0.33 / l), or wheat or beet ethanol in Europe (~US$ 0.48 and 0.52, respectively).[4]

The major cost reductions since the implementation of the ethanol program in Brazil have occurred in a context of broad discussions of political and economic conditions (initial governmental support followed by deregulation; policies for liquid fuels; building of an important set of legislations/regulations on environmental and social issues). The advances in competitiveness were supported by investments (production, logistics) and a significant development and implementation of technologies. In order to evaluate future possibilities of improvements, it is important to examine the evolution over the past few years.

Figure 2 shows the current mean values of sugar cane losses in the ethanol and sugar production processes in a typical mill in the Center-South region of Brazil.

Figure 2 Sugar conversion in the current processes[5]



3 Souza, I. C. : Impacto das perdas industriais no lucro da agro-indústria sucroalcooleira; 27ª. Reunião Anual da FERMENTEC, São Pedro, March 2003

4 Henniges, O.; Zeddies, J.: "Fuel ethanol production in the USA and Germany – a cost comparison", F. O. Licht's World ethanol and biofuels Report, vol. 1, no. Feb. 11 2003

5 Macedo, I. C.: "Fatores para a competitividade internacional", IV Conferência DATAGRO sobre Açúcar e Álcool, São Paulo, 2004

Such conversion efficiencies, greater flexibility in operation with the two products, and quality improvements were attained on the back of a strong process integration. The main technological advances were as follows:

1980-1990: Introduction of new sugar cane varieties developed in Brazil; new grinding systems; fermentation with much larger capacities; use of vinasse as a fertilizer; biological control of sugar cane beetle; optimization of agricultural operations; energy independence.

1990-2000: Introduction of excess energy sales; better technical, agricultural and industrial management; new sugar cane harvesting and transportation systems; industrial automation advances.

The following are some of the overall results for the São Paulo area:

+ 33% tons of sugar cane / ha; + 8% sugar cane sugar
+ 14% sugar conversion for ethanol sugar cane
+ 130% fermentation productivity (m^3 of ethanol / m^3 of reactor·day)

Technology will be of the essence in the years to come in order to strengthen the competitive position; actions shall include a solid dissemination of already commercially available technologies, innovation in ethanol production processes, and product diversification (from sucrose and lignocellulosic sugar cane residue).

In 2000, it was estimated that the additional implementation of commercially available technologies could result in cost reductions of up to 13 percent in the Center-South region's production[6]; the most important aspects were better use of sugar cane varieties, optimization of sugar cane transportation, better agronomic controls, fermentation and grinding, technical management of industrial production, and maintenance.

6 Internal report, 36 mills sample, São Paulo, 700.000 ha; CTC, May 2001

New processes include "precision agriculture", integrated sugar cane and trash harvesting and transportation systems, a much higher level of industrial automation, and new separation processes (juice and downstream processing). The genetic modification of sugar cane is advancing very quickly in Brazil (experimental scale, including field tests); the sugar cane genome was mapped in 2001 in São Paulo, and a few dozen projects (applications: functional genome) are in the pipeline in both public and private institutions.

Product diversification is being sought in two lines of activities:

Sucrose products: the low cost of sucrose in Brazil has been leading to the introduction of new industries, whether or not as additions to the mills; L-lysine, MSG, yeast extracts, citric acid and sorbitol are already in

commercial production, and other products are being considered. Brazil had an important alcohol-chemical industry in the 1980's (see **item 2.3**).

Sugar cane biomass energy: the use of sugar cane biomass to produce "clean energy" may take different paths. Excluding sucrose, the energy contained in one metric ton of sugar cane (including the straw) is equivalent to ⅔ of the energy contained in one oil barrel. That biomass can be recovered for ~US$ 1. / GJ; today, less than half of it is used (see **item 1.4**). Available technologies can generate additional electricity (from the bagasse and 50 percent of the straw) corresponding to an additional 30 percent of the sale value of sugar and ethanol. The development of an efficient system for biomass conversion into ethanol (expected to occur within the next ten years) could lead to the same additional sale value.

The development and implementation of technologies have a significant potential for increase in competitiveness. However, as the case was in the past, important results can be obtained with investments and policies to improve the infrastructure (logistics: ethanol and sugar transportation/storage/shipment).

11.3 Competitiveness of sugar

All production factors (technology, investment, political action) that influence ethanol production costs are equally present in the case of sugar. Therefore, production costs are expected to be maintained and possibly reduced, notwithstanding the increase in production in new areas (with some additional transportation cost, on average). Here, however, competitiveness should be measured in comparison with the production of sugar in other countries around the world (similar to international gasoline compared to ethanol).

In a competitiveness analysis, having relatively low production costs is a factor that must be complemented with other data: transportation costs (FOB price, for international trade); and, in some cases, considerations regarding opportunity costs for agricultural production (net gain for a possible use of land for another crop). These factors, for the group of countries concerned in sugar trade, are essential to determining the possibilities of sustainability (and possible growth) of individual productions. Also important are considerations as to the capacity to expand production and the several forms of subsidies used in international trade, particularly to this product.

In short, we can say that Brazil (Center-South) has maintained the world's lowest sugar production costs for many years, and is strongly inserted in international trade as an exporter (in fact, it accounts for 40% of the sugar

trade in the "free market"). The transportation and loading (shipment) costs are relatively high in Brazil, but that has not prevented it from taking a prominent position as an exporter. In the leading production area (São Paulo), crop replacements due to market prices took place (in specific cases and in a very limited way), for example, between citrus and sugar cane in the past few decades, but sugar cane production has always resumed its growth. At the moment, a strong expansion of sugar cane production is taking place, which indicates that the opportunity cost of land use (translated to the gross margin of alternative crops) does not change the competitive position of sugar.

Production costs *for more efficient mills in the Center-South region* (based on production factors), using the same database (and considerations) as that used for ethanol (see **item 11.2)**, are US$ 125 / ton of sugar (1 USD = R$ 2.8). Estimations made by LMC[7] in September 2004 also attribute these costs to the production in Brazil's Center-South region (and around US$ 220 / ton for the Northeast). More recent estimates,[8] considering the cost increases as discussed for ethanol, indicate R$ 414. / ton sugar (end of the 2005/2006 season). A comparison with other producers shows that, on a cumulative basis, for up to 20 Mt, the cost in the world is US$ 120 / ton (Center-South of Brazil); for 20 to 65 Mt, the cost rises rapidly to US$ 200 to 250 / ton, and for 65 to 100 Mt, it reaches US$ 400 / ton. Therefore, the ex-factory production cost in the Center-South is the lowest in the world.

7 TODD, M. (LMC International): "Factors that enable industries to be internationally competitive", Conferência Internacional DATAGRO sobre Açúcar e Álcool, São Paulo, 2004

8 SOUZA, I. C. : Impacto das perdas industriais no lucro da agro-indústria sucroalcooleira; 27ª. Reunião Anual da FERMENTEC, São Pedro, Março 2003

Concerning competitiveness in foreign trade, considering the mean costs

Table 1: Sugar production and exportation costs compared to the mean costs of other leading exporters

	Center-South	Northeast
Sugar cane production costs (%)	55	85
Processing cost (%)	60	105
Transportation and loading cost (%)	185	45
Total cost (%)	65	90

for the leading exporters (excluding Brazil) to be 100 percent, the situation in the Center-South and Northeast of Brazil according to the same study is as follows:

Exportation costs (transportation and port fees) are clearly points that need improvement in the Brazilian production. Transportation and loading costs in Brazil are estimated at US$ 24 / t in the Center-South, and US$ 8 / t

in the Northeast, compared to US$ 9 / t in Australia, for example.

Another fact to be considered in the context of international trade in sugar is that there is practically no governmental policy-supported price in Brazil, which is a factor that reinforces the country's competitiveness in a trade liberalization scenario (as expected). The availability of suitable land for expansion in Brazil is also much higher than in any other region in the world (see **item 6.4**).

11.4 The markets for the next few years

An evaluation of production sustainability in Brazil depends on the additional production volumes considered, notwithstanding the enormous availability of land for expansion. Many studies have focused on the future world demand for ethanol and sugar; the future is much clearer for sugar than for ethanol. The following results sum up the current knowledge.

For the domestic sugar market, a recent analysis performed by DATAGRO[9] considering the population and per capita consumption evolution points to 11.4 Mt / year; including 1.4 Mt / year of sucrose for sucrose derived products, the domestic demand for sugar is estimated at 12.8 Mt / year for 2013.

For the international sugar market, an analysis has been presented for a ten-year horizon covering ten regions around the world[10] and anticipating for 2014 an increase in exports from 45 to 71 Mt per year; Brazil would account for 40 percent of the world market (28 Mt / year). A more conservative position was presented at the same time by DATAGRO a smaller expansion of the world market would take Brazilian exports up to 20.9 Mt in 2013. The estimation by LMC is more conservative as well (world demand of 170 Mt, 2014).

For Brazil's domestic market in ethanol, the most significant new fact is the dramatic increase in demand that begins to take shape as result of the new bi-fuel cars coming into the market. The simulations conducted by DATAGRO using a model developed by the Commission for Reexamination of the Energy Base indicate that the demand for ethanol in 2013 (domestic market) would amount to 22.04 Mm^3, 9.4 Mm^3 of which being of anhydrous ethanol, 11.54 Mm^3 of hydrous ethanol, and 1.10 Mm^3 for other purposes. An evaluation made by the Sectoral Chamber of the Sugar and Ethanol Supply Chain[11] points to a domestic demand of 16.9 Mm^3 (2010) and 26.3 Mm^3 (2015). More recent analyses[12] confirm a higher demand: production would reach 35.7 Mm^3 ethanol in the 2012/13 season, with 27.5 as fuel for the internal market. Cane supply would be 680 Mton, based on projects being implanted or in expansions of existing units (2006).

Fuel ethanol is expected to strongly expand its presence in many new regions of the world.[13] As early as 2003, 13 countries in the five continents used ethanol as fuel component. Ethanol is used worldwide as a fuel, as an industri-

9 NASTARI, P.: "Projeções de demanda de açúcar e álcool no Brasil no médio e longo prazos", III Conferência Internacional DATAGRO sobre Açúcar e Álcool, São Paulo, 2003

10 DRAKE, J. (Cargill Sugar): "The future of trade flows in the World Sugar Trade", III Conferência Internacional DATAGRO sobre Açúcar e Álcool, São Paulo, 2003

11 Communication by Luiz C. Correia Carvalho, Min. Agricultura, 2004

12 CARVALHO, E. P.; Formulação de uma estratégia para garantir o aumento da produção (UNICA); Seminário "Uma estratégia para o etanol brasileiro", Rio de Janeiro, Nov 2006 ulton, L.; Hodges, A.: *Biofuels for transport: an international perspective*, IEA / EET, 2004

13 BERG, C.: "World Fuel Ethanol Analysis and Outlook", F. O. Licht, 2004

al consumable good, and in the beverage industry. It is produced either by fermentation (93%, in 2003) or chemical synthesis. Estimations for the 2000-2002[14] period indicate that the world production of ethanol for the various purposes was 33 Mm^3 / year, 19 Mm^3 of which as a fuel, 9 Mm^3 as an industrial consumable good, and 4.5 Mm^3 for beverages. In that period, the leading producers were Brazil (13.5 Mm^3, 2003) and the United States (6.5 Mm^3, 2001).

Estimation by UNICA for 2010, presented in 2003,[15] points to the following ethanol demand values:

USA	18 -20 Mm^3
Japan	6 -12 Mm^3
EU	9 -14 Mm^3
Eastern Europe	1 - 2 Mm^3
Canada	1 - 2 Mm^3

An evaluation recently performed by IEA[16] confirms those expectations: considering the targets that have already been set by the programs in UE and US/Canada, together with the expectations of Brazil, the evaluation points to a demand of 66 Mm^3 of ethanol in 2010, starting from the 33 Mm^3 of 2003. However, the estimations of Brazilian exports have been very cautious, particularly because of the high degree of trade barriers underlying many bio-ethanol programs around the world; values like 4.5 Mm^3 have been used as a reference for exports in 2010.

11.5 Future evolution of sugar cane production in Brazil

Meeting the domestic and international demand for ethanol and sugar, as quantified in **item 11.3**, would require a sugar cane production of 570 Mt of sugar cane/year within ten years (an increase of 2/3 in the current production). A recent revision of the ethanol demand (domestic and export markets)[17] estimates the demand for sugar cane at 560 Mt in 2010/11. These growth rates have been reached in the recent past.

Evaluating the possibility to accomplish that growth in a sustainable manner is one of the main purposes of this study.

To finish, we should remember that ethanol and sugar originate from the same crop, and the markets will interact in the event of such a strong presence of Brazil in foreign trade. A consideration that has been made is that equilibrium prices for sugar may be between US$ 0.08 and 0.09 / lb in the future if the expansion of both markets can be supported also by the Brazilian

14 SAKA, S.: "Current situation of Bio-ethanol in Japan", Workshop: Current State of Fuel Ethanol Commercialization, IEA Bioenergy Task 39, Denmark, 2003

15 CARVALHO, E.P.: "Demanda externa de etanol", Seminário BNDES – Álcool: Gerador de divisas e emprego, Rio de Janeiro, 2003

16 FULTON, L.; HODGES, A.: *Biofuels for transport: an international perspective*, IEA / EET, 2004

17 "Álcool: um cenário para 2010/11", Copersucar internal report, Apr. 2005

production. A final consideration refers to the subsidies to ethanol outside of Brazil: subsidies and high import taxes cannot coexist with the formation of a market in sustainable conditions.

11.6 Summary and conclusions

• The sugar cane products from the Center-South of Brazil do not rely on any price support mechanisms under governmental policies; there are no subsidies to sugar production or trade today.
• Ethanol production cost (without taxes) in the Center-South mills was estimated at R$ 647 / m^3, which is highly competitive with international gasoline costs. Ethanol production costs in Brazil are also lower than the costs for corn ethanol in the US or wheat and beet ethanol in Europe.
• The ethanol cost reductions in Brazil since the program was introduced have occurred on the back of advances in technology and management and investments in infrastructure. A broader implementation of commercial technologies may further reduce costs in the Center-South, but the best prospects relate to new technologies being developed. These include precision agriculture, new sugar cane and trash transportation systems, and genetic modifications of sugar cane.
• In addition, the production diversification will contribute to the rise in competitiveness, as it did upon introduction of ethanol. Such diversification (in progress) includes the increase in the use of sucrose and ethanol for new products, and the production of excess energy from sugar cane biomass in several ways (also in progress).
• The sugar from the Center-South has had the world's lowest production cost for many years now, amounting to R$ 410 / t. The world production cost is currently evaluated at US$ 120 / t, for up to 20 Mt (the production of Brazil's Center-South region); for 20 Mt to 65 Mt, the cost goes up to US$ 200-250 / t; and for 65 Mt to 100 Mt, it rises to US$ 400 / t. The total sugar production and export cost in the Center-South represents 65 percent of the mean cost of other exporters.
• The high availability of adequate land for expansion and the absence of governmental policy-supported prices in Brazil would allow even more competitiveness in a trade liberalization scenario (as expected).
• Analyses of the ethanol and sugar markets point to a demand of 580 Mt of sugar cane / year in Brazil for 2010 and 680 M tons for 2012/13.