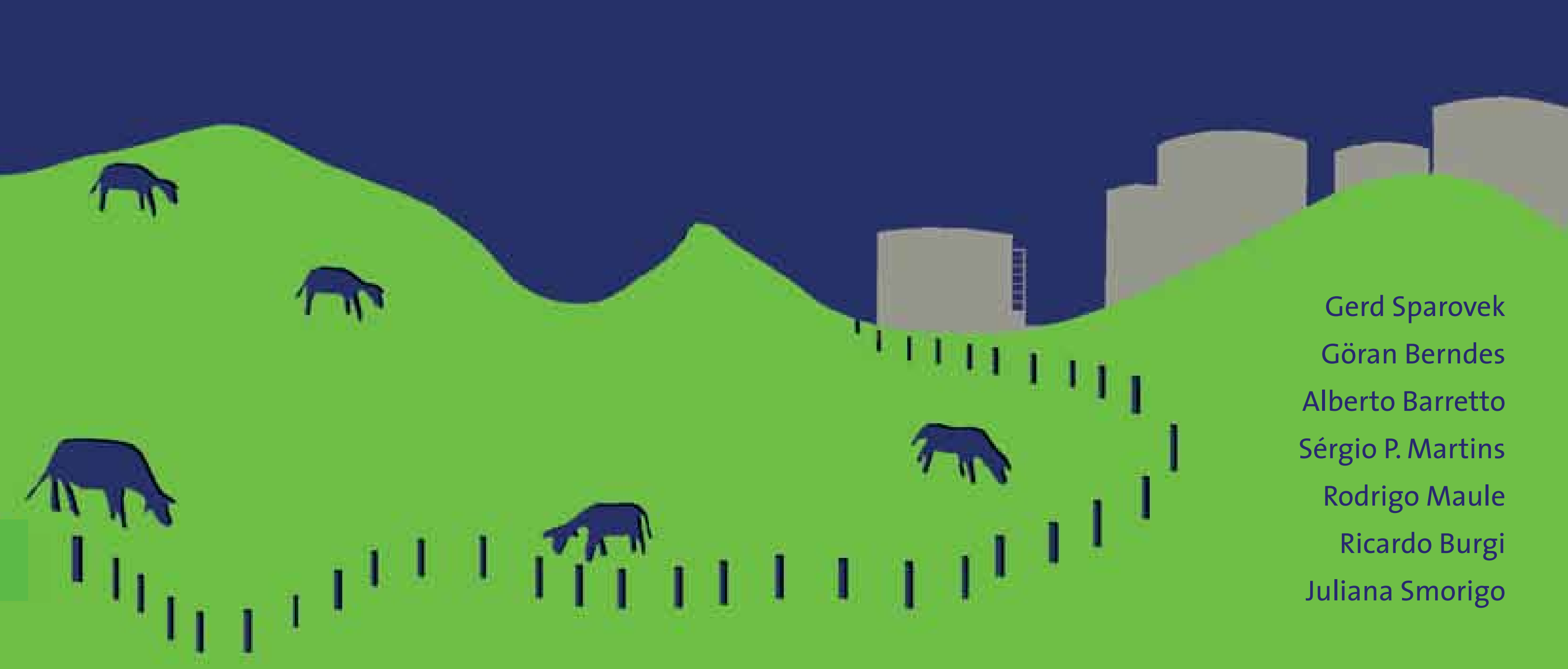

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Bioenergy and food production for local development in Brazil: inputs for policy-making

Bioenergy and food production for local development in Brazil: Inputs for policy making

Piracicaba, 2010

Bioenergy and food production for local development in Brazil: Inputs for policy-making.

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Introduction

Many studies have highlighted the environmental and socioeconomic concerns associated with bioenergy over the past few years. They stress both the negative effects on current agricultural and forestry production (e.g., loss of biodiversity, eutrophication and soil degradation) and new ones specific to bioenergy, such as the spread of alien invasive species, as well as rising food commodity prices due to competition for land use. The use of biomass for bioenergy – and especially the use of conventional food/feed crops to produce biofuels for transport – has consequently come under serious criticism.

Governments are now emphasizing the importance of ensuring sufficient climate change mitigation and avoiding the unacceptable negative effects of bioenergy, which is reflected in the development of regulating instruments. European examples include the requirement in the Directive on Renewable Energy in the EU (Directive 2009/28/EC) that biofuels used for compliance with targets – and benefiting from national support schemes – must fulfil sustainability criteria, with the parallel development of sustainability criteria in different member states (e.g., Germany, the Netherlands, UK) and by various NGOs and private entrepreneurs. Many international organizations are also involved with the development of sustainability frameworks, including IEA Bioenergy, the Roundtable on Sustainable Biofuels (RSB), the G8 +5 Global Bioenergy Partnership (GBEP), the International Bioenergy Platform at FAO (IBEP), the OECD Roundtable on Sustainable Development, and standardization organizations such as the European Committee for Standardization (CEN) and the International Organization for Standardization (ISO).

The negative environmental and socioeconomic effects of increasing biomass production for bioenergy should be avoided as much as possible. However, as a complement to the implementation of instruments hedging against undesirable developments, the promotion of desirable developments is an equally important task: one may find different ways of producing biomass while at the same time obtaining additional socioeconomic and environmental benefits based on general and local feedback and integration between technical, social and ecological systems.

The University of São Paulo in Brazil and Chalmers University of Technology in Sweden have been conducting joint research since 2005 in response to the challenge of identifying and developing attractive land use systems for food and bioenergy. The overall objective of the research is to support governments, farming communities, businesses and civil society organizations to develop water and land resources in sustainable ways. The following outcomes are envisaged:

• Demonstrate synergies and trade-offs of bioenergy and food production from a water and land resources perspective, including opportunities for enhanced supply chain efficiency;
• Demonstrate opportunities of integrating bioenergy production systems into the agricultural landscapes, to create land use systems that provide both food and bioenergy, and that are attractive from both socioeconomic and environmental perspectives;
• Develop tools to promote informed decision making for food and bioenergy production and investments, acknowledging the multiple interests of different users;
• Develop policy instruments to stimulate the improved management of land and water resources to increase sustainable biomass production.

This report presents results from research dedicated to the development and evaluation of a model for integrating sugarcane ethanol and livestock production in Brazil. The model aims to improve land use productivity and increase the level of revenue from livestock production, while making room for the establishment of sugarcane plantations on pastures not required for livestock production.

The report was commissioned by the Ministry for Agrarian Development in Brazil. It was produced within the framework of the Memorandum of Understanding on Bioenergy Cooperation, Including Biofuels, between Sweden and Brazil, and Task 30 in the Implementing Agreement on Bioenergy, which is part of an international energy technology collaboration programme implemented under the auspices of the International Energy Agency.

Göran Berndes
International Task Leader for IEA Bioenergy Task 30 – Short Rotation Crops for Bioenergy Systems

Table of Content

Executive Summary

There is presently intensive public debate as well as substantial scientific activity related to the sustainability of bioenergy, and of liquid biofuels for transport in particular. The debate concerns both environmental and socioeconomic aspects, and it involves a wide set of issues and many contrasting viewpoints.

One key concern relates to how the expanding bioenergy sector influences land use around the world; bioenergy can exacerbate negative impacts already associated with conventional agriculture and forestry systems, including: soil and vegetation degradation arising from overexploitation of forests and too intensive crop residue removal, water overexploitation, food commodity price volatility, and displacement of farmers lacking legal land ownership. But bioenergy can also lead to positive effects such as the environmental benefits that can be derived from integrating different perennial grasses and woody crops into agricultural landscapes, including enhanced biodiversity, soil carbon increase and improved soil productivity.

This report concerns sugarcane ethanol production in Brazil. A brief historic overview of Brazilian ethanol development is provided, followed by an account of the development during the period 1996-2006 and lessons learned from this period of sugarcane ethanol expansion. Among the many aspects, the issue of indirect land use change (iLUC) is discussed.

It is concluded that possibly iLUC emissions can be large enough to significantly reduce the climate benefit of sugarcane ethanol, but uncertainties and lack of science based information presently restrict an objective discussion and risk leading to uninformed decision-making. This uncertainty can open for radical propositions, either on behalf of the protection of natural resources, social development issues, or for the protection of markets and sector regulation. A more well-informed debate is needed and public institutions have an important role to play in promoting and disseminating relevant information.

A model for future sugarcane ethanol development is presented that addresses some of the environmental and socioeconomic concerns that have been raised in relation to Brazilian sugarcane ethanol. The key feature of the presented model – designated Community Hubs for Energy and Food (CHEF) – is that it integrates sugarcane ethanol production with cattle production. By integrating, the CHEF model mitigates some possible negative effects of conventional sugarcane ethanol production; economic growth is more evenly distributed and the local socioeconomic development improves, and there

is reduced risk that displaced land users migrate to other areas and convert native vegetation into new agriculture land.

Thus, besides providing an option for positive local socio-economic development the CHEF model presents an option for addressing concerns about iLUC causing negative biodiversity impacts and – potentially large – greenhouse gas emissions.

The report describes how CHEF could function within varying Brazilian contexts and also presents views of different stakeholders on sugarcane ethanol in general and on the CHEF model in particular. Stakeholders involved with or affected by sugarcane ethanol expansion (rural workers, land owners, cattle ranchers, farmers, mill owners) appear to have rather limited and narrow views on the possibilities for cooperation and integration. But the conventional sugarcane ethanol system may face challenges in relation to the growing organizational complexity, new environmental challenges, and the desire for a more fair and equitable society.

The report concludes by discussing roles of policies and governments in enabling the expansion of integrated biofuel and food production, which contributes positively to environmental and socio-economic development. Ensuring sustainable, inclusive, and socially fair expansion of sugarcane ethanol in Brazil, with its complex and rapidly developing agriculture and biofuel sectors, will likely require several complementary actions. This report presents one promising approach and a conceptual framework upon which agreements may be built, involving several stakeholder groups and engaging their capacity to contribute to attractive development. The Ministry of Agrarian Development in Brazil could have a key role as an agent capable of changing how biofuel expansion is perceived in Brazil.

chapter 1

chapter 1

Introduction: International biofuel development

High oil prices, air pollution, energy security concerns, and the impact of fossil fuel use on the global climate have led governments to promote the production and use of alternative fuels, primarily biofuels. The production and use of biofuels are consequently growing in many parts of the world. The production is based on so-called first generation technologies where conventional agricultural crops such as sugarcane, sugar beet, corn, wheat, soybeans and palm oil are converted to mainly ethanol and biodiesel.

In the United States, the expansion of the ethanol market began in the 1990s with the Clean Air Act Amendment, which established, under other measurements related to MTBE (methyl tertiary butyl ether), Daylight Saving Time and the blend of gasoline with other oxygenates; that gasoline should be mixed with ethanol, especially in more polluted regions. The law also encouraged tax reductions, as well as special credit schemes for agricultural producers[1].

A key factor in the expansion of ethanol is its use for boosting octane levels, in addition to its function as oxygenate, replacing MTBE (methyl tertiary butyl ether). MTBE is soluble in water and is a potential human carcinogen: in the case of an underground tank leak, subterranean water resources could be contaminated. In early 2000, 20 American states undertook actions to either

1 (PIACENTE, 2006)

prohibit or reduce the use of MTBE in gasoline, pressing for an increase in the demand for US ethanol[2].

The new Renewable Fuel Standard of the Energy Policy Act of 2005 set the goal of 28.4 billion liters of renewable fuels per year by 2012, which represents about 5% of the gasoline consumption projected for 2012. The Energy Independence and Security Act – EISA – of 2007 raised the vehicle fuel economy standards for automobiles and light trucks, in addition to stimulating major increases in biofuel production. It also envisages suspending the use of MTBE in gasoline after December 31st, 2014[3]. EISA established a deadline for increasing the use of renewable energy to 136 billion liters of ethanol per year by 2022, 56 billion liters of which should be obtained from corn and 80 billion liters from "advanced biofuels," defined as non-corn-based fuels with lifecycle greenhouse gas emissions at half those of gasoline or diesel at most.

Between 2002 and 2006, production in the United States grew an average of 23% per year, while consumption grew 27% per year. The blending of ethanol with gasoline increased from 1.5% (by volume) in 2002 to 3.8% in 2006, representing a consumption of 20.4 billion liters of ethanol.

In the European Union (EU), biofuels and bioenergy are among the key sectors addressed by the Strategic Energy Technology Plan (SET Plan), the technology pillar of the EU's energy and climate policy. In 1997, the EU proposed that the goal of each member country should be to use 12% of renewable energy by the year 2010. In May 2003, the European Parliament approved Directive 2003/30/EC, which allows member countries to enact laws that ensure that biofuels meet a minimum level of 2% of the transportation fuel supply by 2005 (corresponding to roughly 4 billion liters per year) and 5.75% by December 2010. The percentage targets are not mandatory, but the Directive asks EU member countries to present reports on how the goals are being achieved. Few countries reached the 2% level and biofuel adoption rates have up to now been slow in several member states. Yet, it was decided to introduce a 10% target for the year 2020 and higher longer term goals are envisaged, such as a minimum share of 25% renewable energy, primarily biofuels, in the transportation sector by 2030[4].

Other producer and consumer countries are emerging as well. Table 1 summarizes biofuel programs in a selection of countries, illustrating the potential for demand growth within a relatively short time frame. Most of the programs are driven by multiple objectives, including creating employment opportunities, reducing greenhouse gas emissions and oil import dependency – which can place a big burden on the national economies, especially in developing countries.

2 (WORLDWATCH INSTITUTE, 2006)

3 (PIACENTE, 2006)

4 EC, 2008a; Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. (COM (2008) 19 final. Brussels, Belgium

[Table 1] Targets and programs for transport fuels in major countries and regions

Country	Program
Argentina	Goal of using 5% of ethanol mixed with gasoline by 2010
Australia	At least 350 million liters of biofuels by 2010
Bolivia	Currently uses 10% ethanol in gasoline. Requires increasing the mixture to 25% over the next 5 years
Brazil	Adds 20 to 25% (E20 – 25) of anhydrous ethanol to all gasoline consumed in the country. Extensive fleet of flex-fuel cars that can use any mixture of pure hydrated ethanol (E100) and regular gasoline (E20-25)
Canada	5% renewable content in gasoline by 2010
China	2 million tons ethanol by 2010 increasing to 10 million tons by 2020; 0.2 million tons biodiesel by 2010 increasing to 2 million tons by 2020
Colombia	Uses 10% ethanol in gasoline in cities with population > 500,000
European Union	Targets 5.75% biofuels by 2010 and 10% by 2020
India	5% ethanol blending in gasoline in 2008, 10% as of 2009; indicative target of 20% ethanol blending in gasoline and 20% biodiesel blending by 2017
Indonesia	2% biofuels in energy mix by 2010, 3% by 2015, and 5% by 2020
Japan	0.6% of auto fuel by 2010; a goal to reduce fossil oil dependence of transport sector from 98% to 80% by 2030
South Africa	2% of biofuels by 2013
The Philippines	Requires that 5% of ethanol be added to gasoline since 2008. Requests an increase to 10% in 2010
Thailand	2% biodiesel blend by 2008, 10% biodiesel blend by 2012; 10% ethanol blend by 2012
United States	12 billion gallons by 2010, rising to 20.5 billion gallons by 2015 and to 36 billion gallons by 2022 (with 16 billion gallons from advanced cellulosic ethanol)
Venezuela, Puerto Rico, Mexico, and Peru	Target: 10% ethanol

Source: RFA, 2008; ANP, 2007; Elobio 2010

The rapid increase in the demand for biofuels has resulted in a heated debate over possible negative consequences. Rapidly increasing use of food crops for the production of biofuels may increase food prices, with devastating consequences for the low-income populations mainly found in the world's less developed regions. Expanding agricultural frontiers may also increase the pressure on natural resources (e.g. forests, rivers, and native species). With very few exceptions – Brazil being one of these – the current global production of biofuels relies on subsidies and protected markets, which puts pressure on public budgets and reduces opportunities for investments in other strategic areas.

The production and use of first generation biofuels is commonly considered a transition phase in biofuel development. The industry is expected to shift to using lignocellulose-based raw materials (e.g., forest wood, sugarcane bagasse, agricultural waste, herbaceous and woody plants) for the production of so-called *second generation biofuels*. This shift may:

• Reduce competition for food commodity crops, although competition for land, water and other resources may still arise when demand for lignocellulosic crops increases;

• Possibility of expansion to marginal areas that are not suitable for conventional agricultural crop production, thus avoiding direct competition with food production and also increasing the potential cultivation area ;

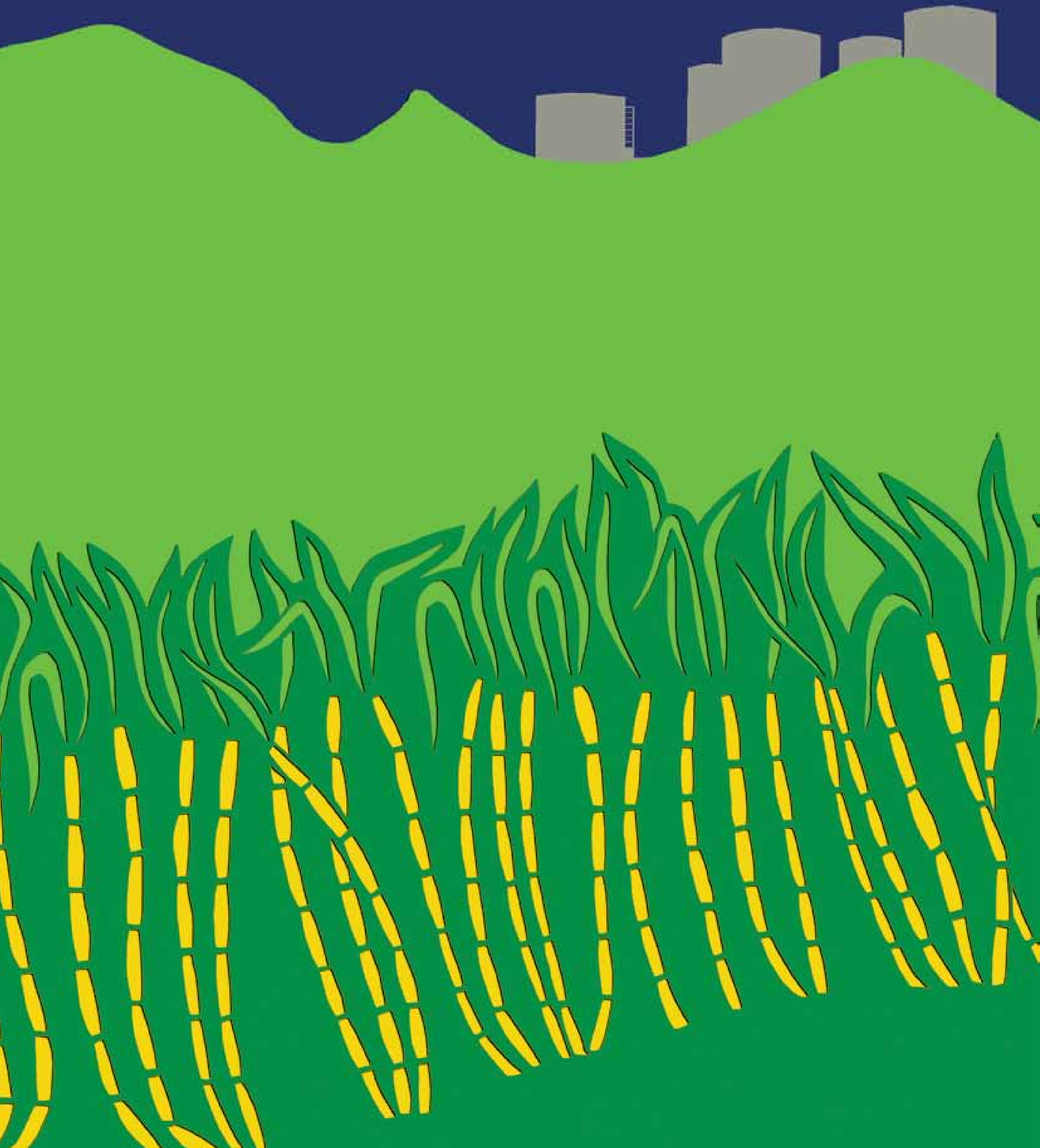
• Reduce environmental impact through the reduced use of chemical fertilizers, pesticides, and irrigation to produce lignocellulosic raw materials, compared to when conventional crops are produced;

• Allow the use of the large forest reserves in the Northern hemisphere

There is currently no competitive commercial production of cellulosic biofuels but substantial investments have been made in R&D, and the technology is developing. Current initiatives operate at the pilot or demonstration level. It is difficult to estimate when these technologies will be commercially available, but industrial-scale operations may begin at some point over the next ten years. Increased levels of private investment in research and technology development (R&D) might take place over the next few decades, based on the consolidation of the biofuels market. First generation biofuels prepares the market for the sector and some might prevail as competitive alternatives, with Brazilian sugarcane ethanol being the prime example of this.

chapter 2

chapter 2



Ethanol development in Brazil

2.1 Historic development

2.1.1 Before Proalcool

Sugarcane was first introduced in Brazil in 1532 and quickly established its strategic economic importance. The first phase of sugarcane cultivation took place in the 16th and 17th centuries, when it was the Portuguese colony's first and only commercial crop. With the departure of the Dutch from Northeastern Brazil in the mid-1600s, the Caribbean secured the dominant role in sugarcane production[5].

The start of sugar beet production in Europe in the 19th century negatively affected the situation for Brazilian sugarcane production[6]. The stagnation that turned sugarcane into a secondary product among Brazilian exports persisted until the New York stock market crash of 1929. After the 1930 revolution in Brazil, the government started investing in the sector and regulated the market by influencing the demand/supply ration by stocking large amounts of sugar, known as *regulatory stock*. At that time, the expanding domestic market – a consequence of industrialization – began to replace the international market. In 1933, the Vargas administration established the Sugar and Alcohol Institute (Instituto do Açúcar e do Álcool – IAA). The IAA remained active until 1990 when

5 (FURTADO; SCANDIFFIO, 2007)

6 (PIACENTE, 2006)

it was closed under the Collor administration[7].

The period from 1930 to 1988 was marked by the government regulating and financing the sector. Ethanol became a fuel option, stimulated by the government's concern over the non-industrialized sugarcane surplus and the sugar that was produced but not exported due to the global side-effects of the stock market crash[8]. At that time, biofuel initiatives did not focus on replacing fossil fuels, but on developing alternatives for the sugar industry by creating a new government-supported market.

With the support of an industrial park for production equipment, the majority of sugarcane production was then—and still is—concentrated in the State of São Paulo. Since World War II, production in the Northeast has been maintained thanks to the federal government's efforts, through subsidies, production quotas, and the establishment of specific markets for each region. With the government's assistance, the recovery of the international sugar market accelerated modernization, starting in 1960. In 1971, the government implemented the National Program for Sugarcane Improvement (Plano Nacional de Melhoramento da Cana-de-Açúcar – Planalsucar).

Between January 1973 and January 1974, the price of the 42-gallon oil barrel went from US$ 2.59 to US$ 10.95. Because of the huge impact of the oil crisis on the national economy, the federal government launched several programs during that decade: the National Plant Oil Program – Pro-Óleo, aimed at producing biodiesel for diesel engines; the National Charcoal Program – Procarvão; and the National Ethanol Program – Proalcool. Of these, only Proalcool, established in 1975, was effectively implemented and developed[9].

2.1.2 Proalcool

The first phase of Proalcool both expanded and consolidated the production of anhydrous ethanol in distilleries in autonomous sugar mills as a gasoline additive substitute for tetraethyl lead. The main steps were financing distillery construction, creating a market by a mandatory regulation through the increased use of the anhydrous ethanol–gasoline blend (institutional market), and by persuading the automobile industry to develop light vehicles running on hydrated ethanol (the ethanol car).

In 1979, after the second oil crisis, and motivated by the reactions of OPEC countries to the Iran-Iraq war, oil prices – which were around US$ 14 a barrel – climbed to around US$ 30. Due to the success of Proalcool thus far, the Brazilian government accelerated and redirected the program. The goal was to triple internal production by 1985, a target that was in fact surpassed. Technical

7 (FURTADO; SCANDIFFIO, 2007;

8 (CALABI et al., 1983)

9 (FURTADO; SCANDIFFIO, 2007; MAGALHÃES et al. 1991)

problems faced by engines that run exclusively on hydrated ethanol were solved, and the automobile industry began large-scale engine production.

These developments helped solidify agreements between the government and the automobile industry, supported by confidence and acceptance among consumers, who enjoyed a number of advantages: hydrated ethanol cost 30% less than gasoline, and tax reductions and exemptions were approved for the Industrialized Products Tax (IPI), the Highway Tax (TRU), and the value-added tax (ICMS) for cars that run on hydrated ethanol. The official advertising campaign used the slogan: *"This you can use; it will never end"*. Such factors increased the production of ethanol cars to 30% of all cars manufactured in 1981, 88% in 1984, and 96% in 1986. The period was also marked by the expansion of sugarcane to other regions (Northwest and West of São Paulo State, Southern Minas Gerais, and Northwestern Paraná), in addition to intensified cultivation in the traditional regions.

By the mid-1980s, the structural weaknesses of Proalcool became evident, as it had been running on major government subsidies. The deepening global economic crisis and the oil counter-shock lead to a drop in the prices of commodity products on the international market. Linked to the price of gasoline, the cost of hydrated ethanol plummeted as well. Public investments in the sector were cut, stabilizing domestic production. The explosive demand for hydrated ethanol due to the subsidy-based policy for ethanol cars, combined with the stagnation of the growth of ethanol production, led to insufficient supply capacity, and a subsequent need to import ethanol. The period from 1986-1990 was marked by the deceleration of Proalcool. In 1990, the supply crisis and the dismantling of the Institute for Sugar and Ethanol – IAA – signaled the end of Proalcool[10].

2.1.3 Deconstructing regulation

The 1990s were marked by a reduction and the quasi-elimination of the production of ethanol cars in Brazil. In 1990, the sale of ethanol cars was 11% (a very low figure compared to the 96% claimed in 1986). Sales were less than 1% in 1996 and almost zero in 1997. At that time, the growth of the ethanol sector had been due to the popularity of the 1,000cc gasoline cars with lower prices, made possible by reduced taxes. The lower price increased the overall fleet, demanding more gasoline, which at that time was blended with 25% of anhydrous ethanol (E25). In addition, sugar exports increased, demanding more sugarcane and mill capacity.

10 (FURTADO; SCANDIFFIO, 2007; PIACENTE, 2006)

Brazil quintupled sugar exports between 1992 and 1999. This period was also marked by a reduction in government intervention in the sector's regulation, control, and financing, and the end of the market guaranteed by government regulations (institutional market). During the Proalcool stage, growth was based on:

• Agricultural and industrial production centered around the production mills and, consequently, mill owners;

• Highly heterogeneous production efficiency;

• Negligible use of by-products and residues;

• Competitiveness mostly based on low salaries and the extensive expansion of production[11].

After breaking with the support structures that had ensured its development, the sector was divided with regard to the advantages or disadvantages of regulation and reduced government involvement. The deregulation process may be understood as a sequence of events beginning in 1988 with the end of the sugar export monopoly and internal quotas for marketing, followed by the demise of production quotas in 1991. In 1998, the federal government – by means of an administrative rule issued by the Ministry of Finance – authorized the free trade of fuel ethanol, and in 1999, after three successive delays, deregulated prices for all sugarcane-based industrial products: sugar, anhydrous ethanol, standard crystal sugar, and hydrated ethanol[12].

The growth and survival of the sugar and ethanol sector increasingly depended on adjusting to the new reality, which now required diversified and differentiated production. Solutions included new sugar brands, electricity cogeneration, and confinement of beef cattle in feed plots close to mills for the use of bagasse as feed, and industrial ethanol. The mills required ever more efficient uses for residues and by-products such as vinasse, filter cakes for the fertilization of sugarcane plantations, and bagasse for energy generation. From a management point of view, the motto changed to reflect an increase in production efficiency for feedstock and the overall industrial processes. Mergers and acquisitions started to take place at the corporate level.

The most important and persistent government regulation was the percentage of anhydrous ethanol to be mixed with gasoline. This still-current policy measure mandates that an Inter-ministerial Council for Sugar and Ethanol defines the blend between 20 and 25%. The percentage is fine-tuned to balance or influence the ratio between product supply and demand, and is also a way to influence the price of off-season hydrated ethanol.

11 (BELIK; VIAN, 2002)

12 (PIACENTE, 2006)

2.1.4 The successful innovation: flex-fuel vehicles

Launched in 2003, the flex-fuel vehicle program introduced models that run simultaneously on gasoline (E20-25) and ethanol (E100). This stimulated renewed confidence in the use of hydrated ethanol as fuel, eliminating the fear that haunted consumers who had been hit by the supply shortage of the early 1990s. The possibility of choosing the fuel with the best price, quality, performance, or greatest availability attracted consumers and triggered an immediate response from the industry. The technology was developed in the late 1980s in the United States, Europe, and Japan, and was based on the automatic recognition of the ethanol content in the gasoline blend, and through the simultaneous adjustment of the engine to the most favorable operating conditions. In 1992, General Motors introduced flex-fuel engines on the North American market.

Volkswagen's Gol Total Flex was the first flex-fuel vehicle to reach the Brazilian market in March 2003. Arguments in favor of the new technology covered all sectors. From the consumer side, it scared away the supply shortage ghost once and for all. By regaining confidence in hydrated ethanol, the automobile industry would no longer have to develop duplicate and parallel projects for hydrated ethanol and gasoline cars. Moreover, the sugar and ethanol sector would have greater flexibility in meeting the demand without having to commit to fixed ethanol production quotas, thus being able to better balance variations in the price of sugar.

Flex-fuel vehicles were reclassified with regard to the Industrialized Products Tax (IPI), so as to match exclusive hydrated ethanol cars. This allowed for an immediate price reduction. Sales of ethanol-based fuel cars went from 0.07% in 1997 to 6.4% in 2003 (the sum of both flex-fuel and exclusive hydrated ethanol cars). Starting in 2005, sales of flex-fuel vehicles surpassed gasoline-powered cars, with a 73% market share. After 2004, the price of hydrated ethanol was less than 70% of the price of gasoline in Brazil's main consumer regions (South, Southeast and Midwest), a percentage that is usually the point of balance between the two fuels. In the Northeast, ethanol hovered around 70%, and in the North the price of the fuel remained almost constantly above 70% of the price of gasoline.

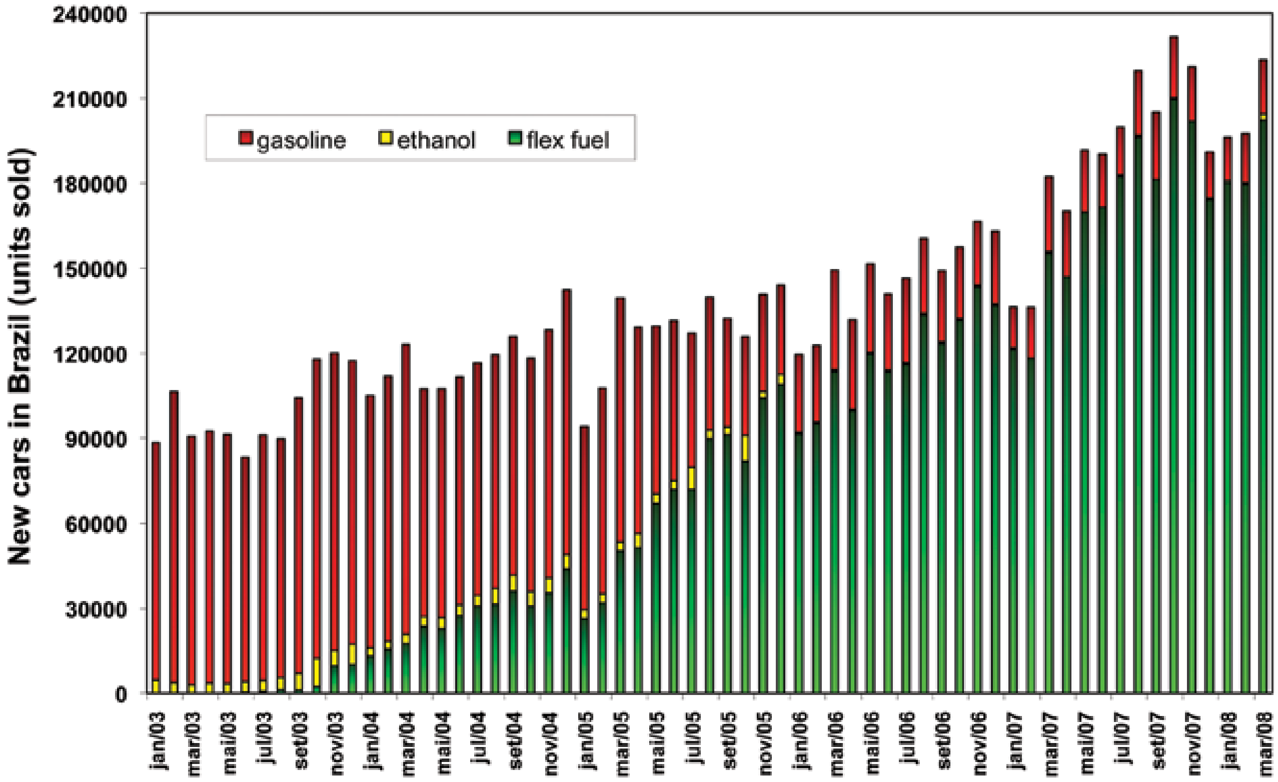
Growth projections for vehicle sales estimate that in 2010 about 30% of the Brazilian fleet of light vehicles will be flex-fuel[13]. Figure 1 shows the evolution of flex-fuel vehicle sales in Brazil between January 2003 and March 2008, compared to the sales of gasoline and hydrated ethanol vehicles. Figure 2 shows the evolution of sugarcane cultivation in Brazil between 1948 and 2007, making

13 (CARVALHO, 2005)

reference to the main historical events that impacted the Brazilian sugar and ethanol industry. Figure 3, which shows the variation in the Total Recoverable Sugar ratio (TRS) by product also sheds light on the sector's evolution[14].

14 (BRASIL, 2007)

Figure 1 Evolution of the sales of flex-fuel vehicles in Brazil.



Source: Anfavea (2008)

Figure 2 Evolution of sugarcane in Brazil and main historical events (between 1948 and 2007)

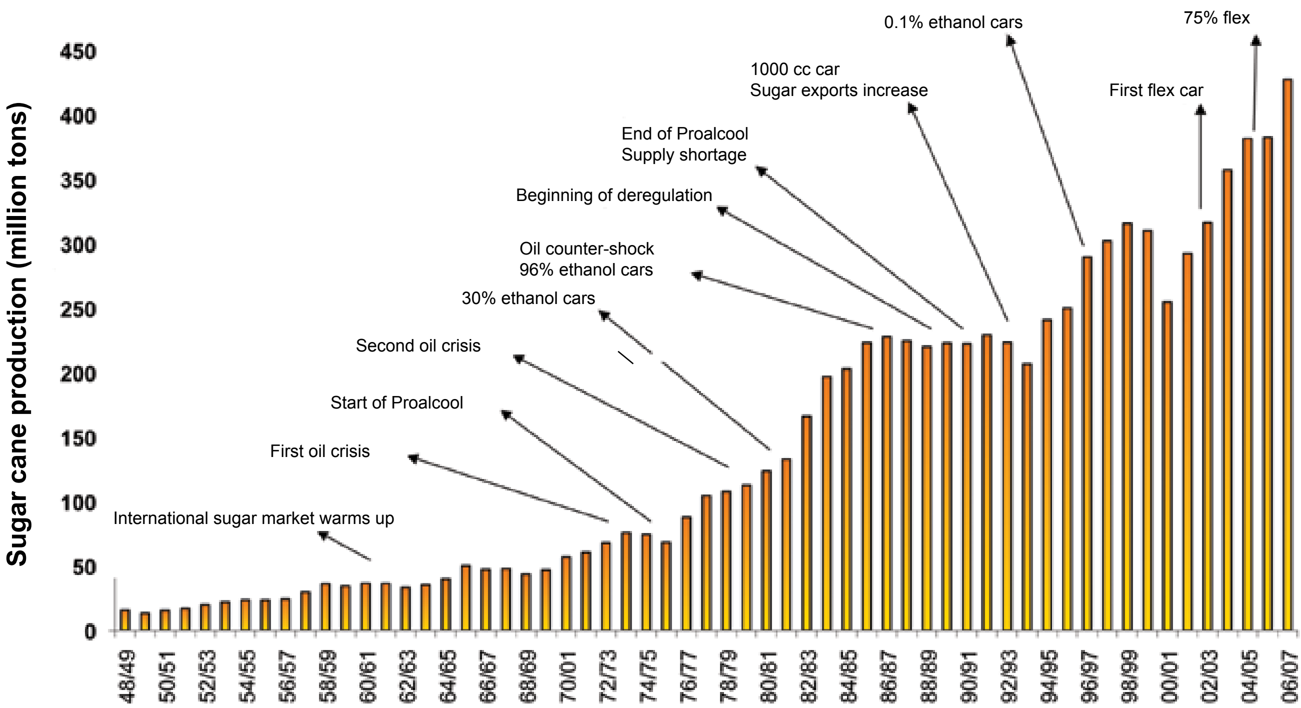
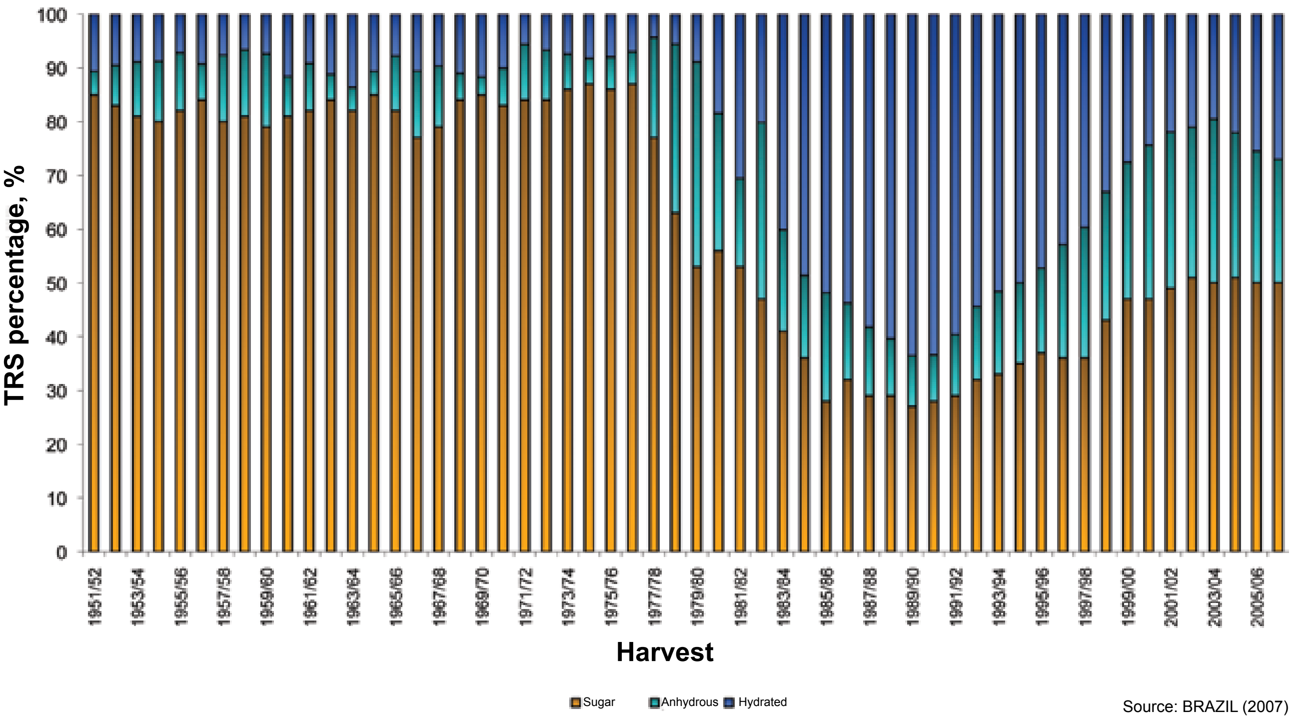


Figure 3 Evolution of the Total Recoverable Sugar – TRS per product between 1951 and 2007



Source: BRAZIL (2007)

2.2 Current situation and outlook for Brazilian sugarcane ethanol

Brazil is the world's largest sugarcane producer (Figure 4) In 2008/09 harvest, Brazil produced about 564 million tons of sugarcane, 60% of which was used to produce ethanol (anhydrous, hydrated, and industrial ethanol). In the early days of Proalcool (1975), productivity was 47 tons per hectare. In 2008, the average was 77.5 tons per hectare. In the 2008/09 harvest, the North and Northeast contributed 11% of total production; the remaining 89% came from the Central-Southern part of Brazil, with 61% from the State of São Paulo alone. The total sugarcane area harvested in Brazil in 2008/09 for ethanol and sugar production was 7.1[15] million hectares, 27.6 billion liters of ethanol produced. About 17% of the total (4.7 billion liters) was exported. Of the overall sugar production (31.0 million tons), 21 million tons (67%) were sold on the foreign market[16]. The GDP from the sugar and ethanol sector was US$ 28.1 billion, representing 2% of the Brazilian National GDP, if is considered all financial movement of the sugarcane chain the total gross revenue was about US$ 86.8 billion[17].

Data on the 2009/10 harvest indicates significant increases in the production of sugarcane (from 564 million tons in the 2008/09 harvest to 603 million tons in the 2009/10 harvest[18]). Brazil has thus assumed the leadership both in terms of overall production and productivity of sugarcane. Figure 4 shows the global production for this crop in 2008[19].

15The total sugarcane harvested area in 2008/09 was 8.1 Mha, including sugarcane for animal supplementation.

16(MAPA/ACS, 2009)

17 (NEVES M.F. *et al.* 2010)

18 (MAPA, 2010) Avaiable at http://www.agricultura.gov.br

19 (Brazil, 2007)

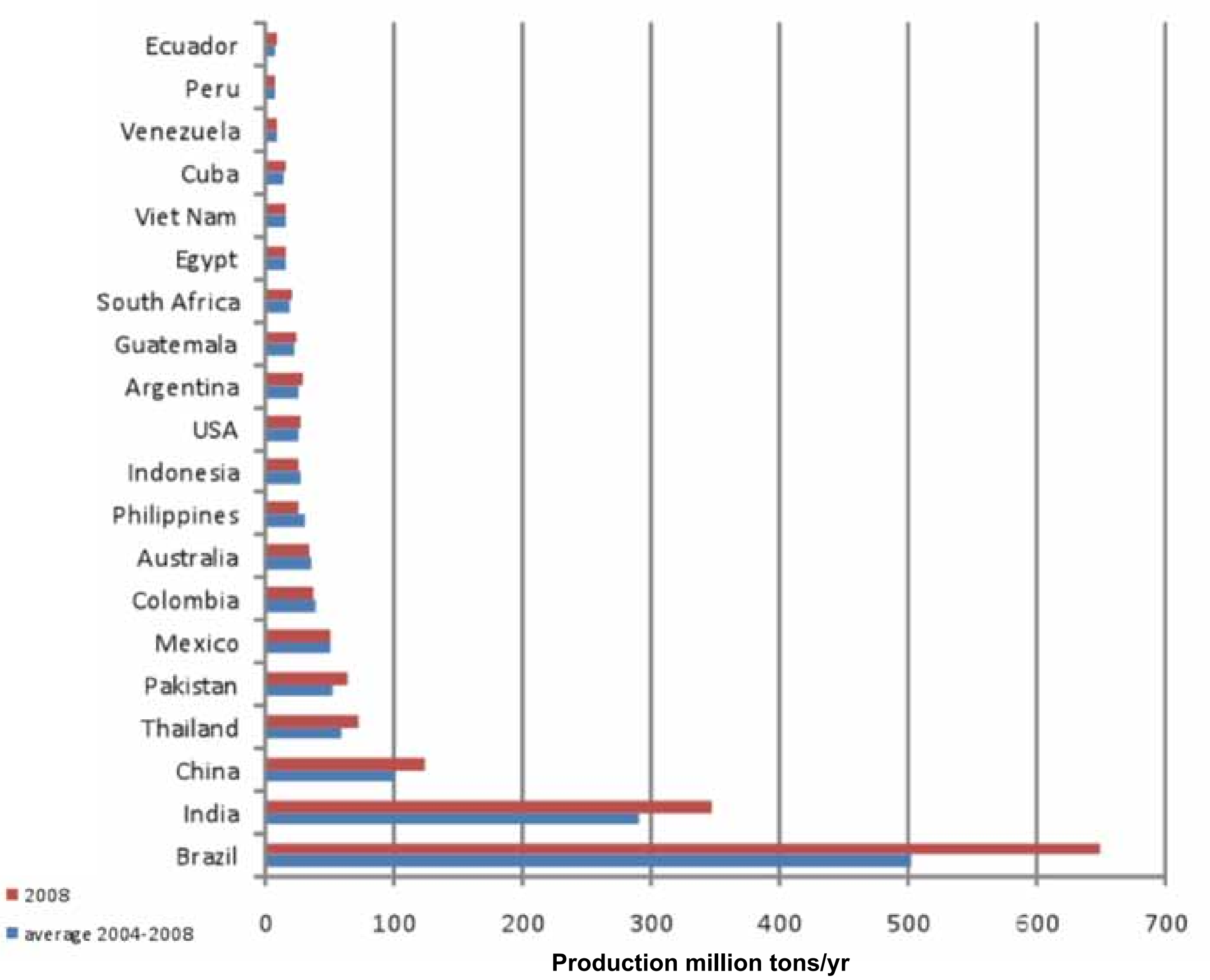
Brazilian ethanol exports were small in the early 1990s but took off in 2004. Even with the increased volume, exports only represented 17% of the total amount of ethanol produced in the country. Ethanol imports – which were between 60 and 474 million liters from 1990 to 1997 – were drastically reduced starting 1998/99, dropping to as little as 2.0 million liters in 2008/09.

Sugar and ethanol are currently produced at 437 mills. Sixteen of the mills are sugar producers, 168 are ethanol producers, and 253 produce both. Of these, 182 are located in the State of São Paulo. In 2010, 49.6% of the primary energy used in Brazil came from renewable sources (the world average is 13%) and 21% from sugarcane derivatives[20]. In recent harvests, the Midwest region stood out as a new area of expansion for sugarcane cultivation, especially in the State of Goiás, which experienced a 345% increase in its sugarcane production between the 1998/09 and 2008/09 harvests, and already accounts for 5.2% of the national production. The eastern part of Mato Grosso do Sul and the southeast of Minas Gerais – also in the Cerrado area – follow this trend of expansion to new areas[21].

20 (Plano Decenal de Expansão de Energia 2019 / Ministério de Minas e Energia. Empresa de Pesquisa Energética. Brasília: MME/EPE, 2010.)

21 (União da Indústria de Cana-de-açúcar/UNICA e Ministério da Agricultura, Pecuária e Abastecimento/ MAPA, 2010.) Avaiable at: http://english.unica.com.br/dadosCotacao/estatistica/

Figure 4 Sugarcane production in the 20 largest producer countries, together contributing more than 90 percent of total production. Source: FAO statistical database (accessed July 7, 2010)



Many factors point to a further expansion of sugarcane ethanol in Brazil, although there are also unfavorable circumstances faced by the sugar and ethanol production sector (see box on page 30). Weighting positive and negative factors, the judgment is that the market for Brazilian sugarcane will grow, even considering the recent global financial crisis and the drop in oil prices. Table 2 summarizes forecasts for short and mid-term sugarcane expansion, according to three major Brazilian institutions. These forecasts differ in point of view, methodological premises, periods of time, or assumptions, and direct comparison between scenarios is consequently difficult to make.

The Interdisciplinary Nucleus for Energy Planning (NIPE, Unicamp) has demonstrated[22] that Brazil can provide enough ethanol to substitute for up to 10% of all gasoline projected to be used worldwide by 2025. To this end, the country would produce 205 billion liters per year (Brazil produced 17.9 billion liters of ethanol in 2006). An additional 30 million hectares would have to be turned into sugarcane fields in order to generate the requisite supply of sugarcane.

The NIPE study has identified 53.4 million hectares of potential land for agricultural production. The assessment takes into account the quality of the soil, rainfall, and slope, excluding regions where irrigation is necessary for production. Of these, 11 million hectares currently used for food production were excluded, as well as preservation areas or areas with environmental restrictions regarding sugarcane production, leaving a total of 42 million hectares that are considered available and without any environmental or social restrictions, such as competition with food production. This land is divided into 17 production areas, all of which are located outside the Center-South, where a strong spontaneous expansion is currently underway[23].

Estimates by the Union of Sugarcane Industries (Unica) indicate that the potential (foreign and domestic) markets for Brazilian ethanol and sugar would use about 685 million tons of sugarcane by 2012/2013, to be produced on 6.4 million hectares. Therefore, the Center-South would need 77 new production units, with investments of US$ 14.6 billion. In 2012-2013, about 60% of all sugarcane would be used for the domestic market. Altogether, in addition to sugar, 35.7 billion liters of ethanol would be produced (7 billion liters for export) [24]. A scenario for the expansion of ethanol production in Brazil, presented by Unica president Marcos Jank in October 2007, show strong growth increasing the ethanol production to 65.3 billion liters and the sugarcane plantation area to 13.9 million hectares by year 2021 (see Table 2).

The Unica scenario was based on the following assumptions: a) productivity

22 (CGEE, 2009.)

23 (CGEE, 2006.)

24 (MACEDO, 2007.)

gains derived from new technologies used for ethanol production (sugar production was not considered to be influenced) and b) genetically improved varieties available after 2015, with a sugar content 20% higher than current varieties. If compared to the total area presently cultivated with varieties that have not been improved for the production of second generation ethanol, the new varieties will occupy areas of 10% in 2015, 30% in 2020, and 60% in 2025; c) the cellulose hydrolysis technology will be available starting 2015, being used by 20% and 40% of all mills in 2020 and 2025, respectively. Hydrolysis will allow for productivity gains of 37 liters per ton of sugarcane.

Areas to be used for the expansion of sugarcane cultivation were identified in Pontal do Paranapanema and in Northeastern São Paulo State, in Southern Goiás, in the Center-South of Mato Grosso do Sul, in Southern Mato Grosso, on the border between Rio de Janeiro and Espírito Santo, and on the border of Espírito Santo and Minas Gerais[25]. Unica representatives have repeatedly commented on the possibilities for sugarcane expansion in Brazil in relation to the concerns over possible negative environmental effects (see citations in box below).

25 (JANK, 2007)

"The president of Unica, Marcos Jank, during an interview with internauts on the Portal Terra chat, declared that the area used for sugarcane cultivation will be twice as large by 2020. (...) The hypothesis that the expansion may cause deforestation was dismissed by Jank, who declared that the new plantations will occur on degraded pasture land in the Center-South region. Besides, new technologies will contribute to achieving production gains. "We are working towards improving the productivity of the cultivated areas (...)", said the Unica president." (Source: Unica website – January 17th, 2008).

"Sugarcane is not moving to new areas. Logistics don't allow for such expansion. What is happening is that pastures are being converted into sugarcane fields on a limited basis, since livestock breeding has become more intensive." Laura Tetti, Unica consultant. (Source: Unica website – July 25th, 2006).

"Mid and long-term perspectives certainly look very promising for Brazil. Unica estimates that an additional 86 mills will be built by 2012, with investments of about US$ 17 billion, in addition to generating thousands of new jobs in rural areas. The segment may become a leader among export commodities and will also become the flagship of agribusiness in terms of private investment." (Source: Procana website – January 22nd, 2008).

Projections for the expansion of the sugar and ethanol sector prepared by the Ministry of Agriculture, Livestock and Supply (MAPA) are given in the National Agroenergy Plan (2006-2011). Estimates are that the market will absorb at least one million flex-fuel vehicles per year over the next few years, leading to an estimated total demand of 25 billion liters of hydrated ethanol in 2013[26]. The international market for Brazilian ethanol is growing but is still considered small. Protectionist measures may hamper access by Brazilian suppliers and delaying purchases from, for instance, the European Union and the United States, which favor domestic production before resorting to imports. However, contracts signed between Petrobras and Venezuelan and Nigerian oil companies, expectations with regard to the Japanese market, and investments in reprocessing in the Caribbean targeting the US market[27], is judged to result in increased Brazilian exports by 4 to 5 billion liters of ethanol. By adding the volume foreseen for export, the study concludes that the overall demand for ethanol – about 30 billion liters in 2015 – can be met based on national production.

The requirements of additional sugarcane area may be reduced if continuous and substantial productivity gains are obtained in the sugarcane cultivation, as well as in the sucrose content. MAPA also pointed to that sugarcane currently occupies only 10% of the country's cropland area and that large areas of cultivable land is still available. Estimates indicate that about 50 million hectares of pasture with some degree of degradation are available, particularly in Cerrado areas[28].

26 Assuming that these vehicles consume an average of 2000 liters/year and discounting 500,000 liters/year as the result of disposing of the old ethanol car fleet.

27 This strategy takes advantage of the US market quotas meant for countries from that region, within the scope of the Caribbean Basin Initiative (CBI).

28 The Brazilian savannah, located in the Central-West Region.

Outlook for further sugarcane ethanol expansion in Brazil

POSITIVE FACTORS:

• Abundant land is already open for extensive use (livestock) in the main expansion areas (Midwest and Triângulo Mineiro);

• Environmental legislation does not impose major restrictions on the main expansion areas;

• Sugar and ethanol industries are merging and going public, opening up to national and international investors;

• The trend is to establish regional clusters of producing companies;

• Mid and long-term perspectives are judged very favorable to ethanol;

• The revitalized and growing internal market is considered low-risk, enabling a transition from current demand levels to the emerging market based on increased export;

• The sector's growth does not depend on major public investments;

• Brazilian ethanol is competitive compared to any other large-scale commercial biofuel option;

• The sector is diversified internally (availability of new markets for electricity, as some Brazilian production regions face power shortages);

• Infrastructure investments are being made in production regions (e.g. pipelines, improved highways).

NEGATIVE FACTORS:

• A possible slow-down or interruption in programs substituting gasoline with ethanol in the main oil-consuming countries;

• The accelerated growth of sugarcane-based ethanol production in Africa and Asia;

• Acceleration in the commercial production of ethanol from second generation raw materials;

• The long-term maintenance of the huge barriers to Brazilian ethanol in the United States and the European Union;

• Abrupt changes in environmental legislation related to licenses for ethanol production;

• A slow-down in the domestic market, which is the basis for the current ethanol market expansion.

[Table 2] Forecasts for the short and mid-term expansion of sugarcane

	Sugarcane				Ethanol				
	Area		Quantity		Quantity				
	Total	Increase	Total	Increase	Volume	Increase			
Source	million hectares	million ha per year	million tons	million tons per year	billion	billion liters per year	**Year of Projection**	**Assumptions**	Source
NIPE	20 to 30	1.12	n.a.	n.a.	205	10.8	2025	Brazil may supply enough ethanol to substitute for 10% of the gasoline being used worldwide by 2025.	(CGEE, 2006)
Unica	8.5	0.83	601	58	29.7	2.6	2011	a) Productivity gains due to new ethanol production technologies (it is assumed that sugar production will not be affected); b) Genetically improved varieties will be available starting 2015, with sugar contents 20% higher than that of current varieties. New varieties will occupy 10% of the total area in 2015; 30% in 2020 and 60% in 2025; c) New cellulose hydrolysis technologies are expected to be available starting 2015, being used by 20% and 40% of all mills in 2020 and 2025, respectively. Hydrolysis will allow for productivity gains of 37 liters per ton of sugarcane.	(JANK, 2007)
	11.4	0.68	829	50	46.9	3.1	2016		
	13,9	0.61	1,038	47	65.3	3.3	2021		
MAPA	9	0.43	650	32	25	0.4	2013	The market will expend at least one million flex-fuel vehicles per year, which represents an increase of over 1.5 billion liters of hydrated ethanol per year for exports (contracts signed with Venezuela and Nigeria, in addition to expectations regarding the Japanese market and investments in reprocessing in the Caribbean).	(MAPA, 2006)
					30	1.6	2015		

2.3 Impacts of expansion – from 1996 to 2006 and lessons learned[29]

The expansion in Brazil between 1996 and 2006 – the period for which the last two national agricultural censuses were made – coincides geographically with the location of mills and distilleries under construction or that are to be built in the near future. In other words, recent and current expansions are in the same region.

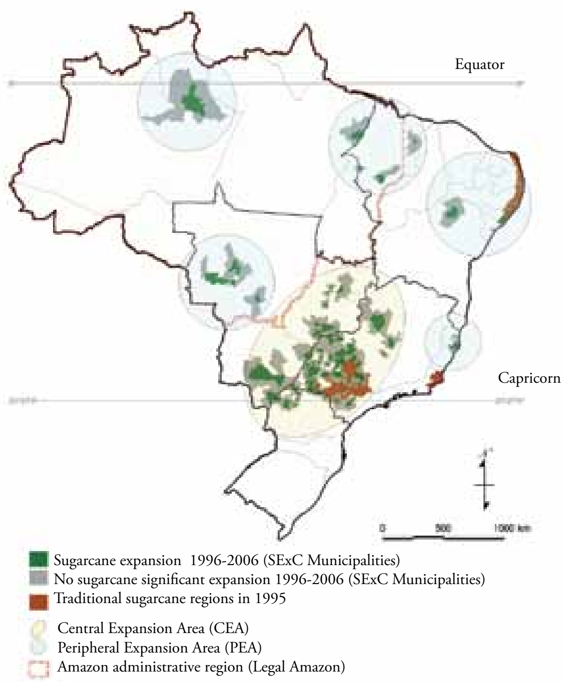
Of the total expansion of 1.3 million hectares that took place between 1996 and 2006, 73% is located in municipalities with high growth rates and prevalence of sugarcane in 2006, here designated "Sugarcane Expansion Municipalities" (ScEx). Neighboring municipalities, with lower increases in cultivated areas, and where the crop was much less prevalent in 2006, are designated "Non Expansion Municipalities" (ScNEx). Taking the data available for ScEx and comparing these to ScNEx offers major clues about the impacts to be expected during the current phase of expansion; since they are neighbors, the effects of any regional variability probably does not influence the results significantly.

Figure 5a shows the location of current mills and distilleries and those under construction. Figure 5b shows ScEx and ScNEx municipalities. The central region of sugarcane expansion represents 91% of the sugarcane area analyzed in ScEx municipalities. Table 3 compares sugarcane expansion and non-expansion areas in the central region in terms of environmental impacts, regional development, and changes in the use of land and food production.

29 For more details, please see: SPAROVEK, G.; Barretto, Alberto; Berndes, Göran; Martins, Sérgio; Maule, Rodrigo. Environmental, land-use and economic implications of Brazilian sugarcane expansion 1996 - 2006. Mitigation and Adaptation Strategies for Global Change, p. 1573-1596, 2008.

Figure 5a Currently operating sugarcane mills and distilleries, and mills under construction

Figure 5b Sugarcane expansion municipalities and comparable non-expansion municipalities (1996 to 2006)



[Table 3] Differences between sugarcane expansion and non-expansion areas in the central region

Variable	Period	Central Area of Expansion			Unit
		ScNEx	ScNEx	Sig. (Student)	
Sugarcane area in the municipality	2006	24.7	9.1	0.00	% of municipal area
Sugarcane increase in the municipality	1997-2006	10.9	6.0	0.00	% per year
Forest area in the agrarian census	2006	10.3	11.1	0.38	% of census area
Difference in forest area on agricultural land (2006 minus 1996)	1996-2006	2.7	2.1	0.30	%
Other crops in the municipality	2006	20.0	19.3	0.77	% of municipal area
Increase of other crops	1997–2006	1.5	2.0	0.57	% per year
Pasture area surveyed in the agrarian census	2006	39.0	51.7	0.00	% of census area
Difference in pasture in census area (2006 minus 1996)	1996-2006	-12.3	-9.4	0.04	%
Animal density in the municipality	2006	53.9	72.5	0.00	unit of cattle per km of municipal territory
Increase in the number of cattle heads	1997–2006	-1.6	-0.2	0.00	% year
Municipal Gross Domestic Product (mGDP)	2005	217,767	13,915	0.02	R$ x 1000 per municipality
mGDP growth	1999-2005	2.0	1.0	0.11	% year

The comparison of ScEx and ScNEx revealed that – compared to their neighboring municipalities where sugarcane did not expand significantly – municipalities with expansion of sugarcane between 1996 and 2006:

- Did not show reductions in forest cover in the agricultural areas surveyed by the census (farmland); the area with forest cover remained stable during that period, but below the legal limits established by the environmental legislation;
- Did not reduce the production of other crops (including food crops);
- Had a higher total municipal GDP and growth rate;
- Presented a significant reduction in livestock and pasture areas, indicated by a decrease in pasture, head of cattle, and animal density.

Likely explanations for the low impact on forest resources are:

• In expansion areas, forest remnants are rare, and thus there are no extensive areas left to deforest (the period of agricultural occupation took place in the 1970s, with the establishment of pastures);

• The region is subject to efficient environmental monitoring and inspection, thus preventing new areas from being cleared;

• The existence of large areas that have already been cleared for pastureland, which are much more easily converted into sugarcane fields.

Coexistence with other crops can be explained by:

• Opportunities for cultivation during seasonal sugarcane renewal (approximately 15% of the total area cultivated with sugarcane);

• A greater supply of machinery and equipment that can also be used for other crops in the region when not used for sugarcane;

• Increases in the price of land attract activities that are more profitable than extensive livestock production;

• The tendency of sugarcane to expand mainly to pastures and not to areas that are intensively used for crops, which have a higher cost.

The indication that there has been little direct competition between sugarcane and other crops (including food crops) in the regions of expansion might be both unexpected and important; the case of Brazil must be studied in greater detail to provide further evidence and to identify the explanatory factors. The answers may be important for other regions with potential for ethanol production and abundant land, such as parts of Africa and specific regions in Asia.

The municipal GDP increased and grew much faster in expansion areas. Such growth reflected the new industrial activity in the municipalities and associated services. The most striking fact about land-use changes in expansion areas was the decrease in extensive livestock production, either for milk, beef, or both. This change affected both large-scale and smallholder family farmers. The increase in land prices, the direct demand for areas for sugarcane cultivation, and the tendency towards more intensive agriculture were the main drivers behind such dynamics.

Nevertheless, the study was not able to determine whether livestock production in expansion areas was totally discontinued. Lost production due to pasture conversion to sugarcane may have been compensated by intensified or extended livestock production elsewhere and displaced ranchers may have gone out of business or moved their cattle ranching to other areas. A combination of all these factors may also have occurred. The study was unable to prove that the activity migrated to neighboring municipalities, since the number of cattle in these areas did not increase.

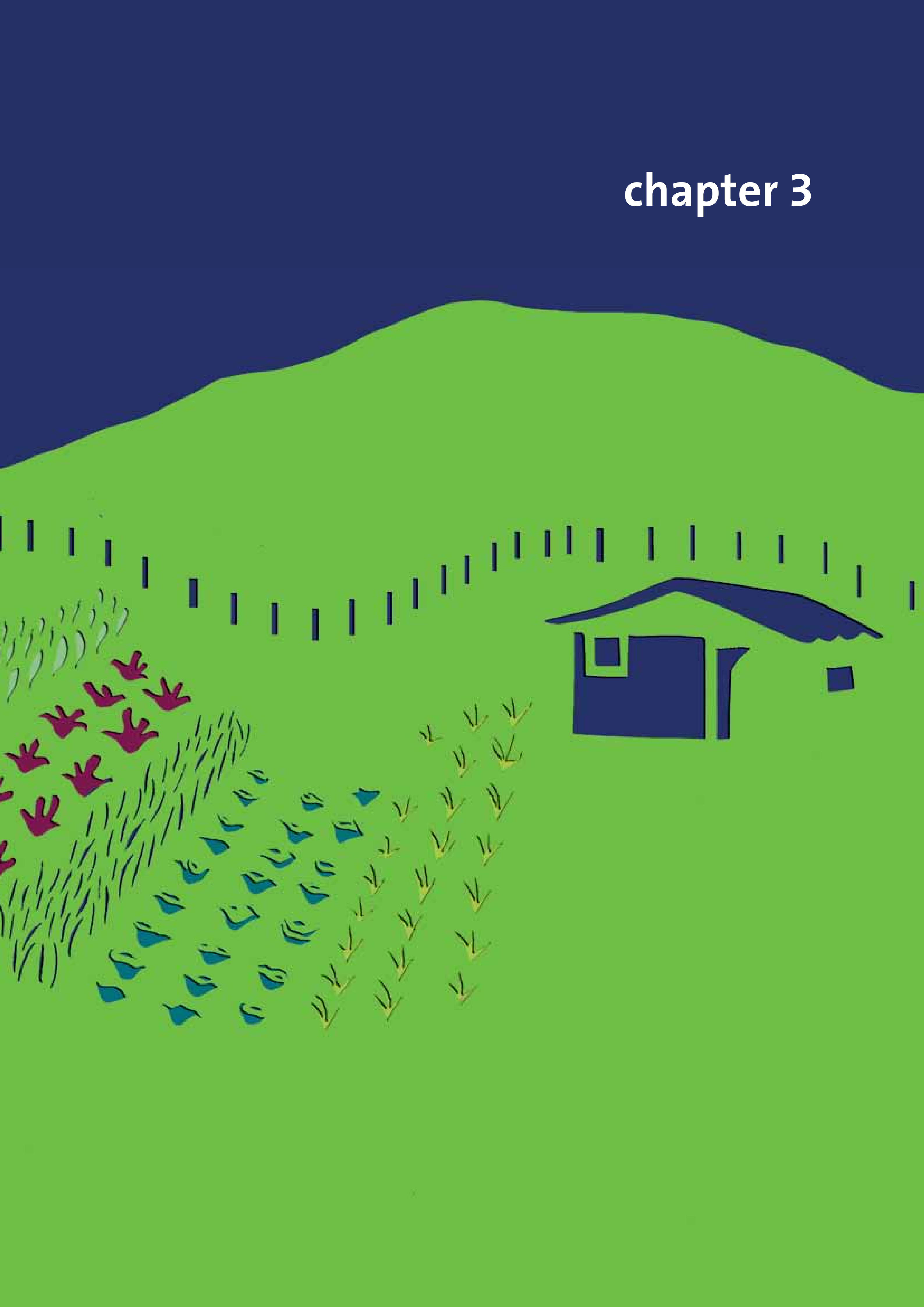
In any case, for family agriculture, the interruption of extensive livestock production represents a discontinuity in milk production, an activity that traditionally generates an significant monetary surplus for the rural poor. The production of beef cattle is an important way to maintain security in the context of family agriculture. In years of crop failure or emergency family situations, the family may sell animals, thus helping to overcome difficulties. Interruption of livestock production would affect the family agriculture system negatively in this regard.

Additionally, should the displacement hypothesis hold true – that sugarcane expansion on pastures leads to the displacement of cattle production to distant areas, such as the deforestation arc in the Southern Amazon Region – sugarcane ethanol may have a much less favorable climate change mitigation capacity due to indirect carbon emissions as a result of deforestation.

The lack of scientific information restricts an objective discussion on the topic and risks leading to uninformed decision-making. This can also pave the way for more radical propositions, whatever the context, either on behalf of the protection of natural resources, social development issues, or for the protection of markets and sector regulation. A more well-informed debate is both essential and urgent, and public institutions have an important role to play in promoting and disseminating relevant information.

chapter 3

chapter 3



Integration of energy and food production

The integration of energy and food production is considered one of the most promising options for the expansion of biofuels. This alternative is very important at the current stage, when first generation sources play a dominant role in commercial production. One main goal in integrating energy and food production is to avoid competition over resources needed for production (e.g. land, credit, labor), thus precluding unwanted externalities. Integration can also reduce the incidence of effects such as GHG emissions arising from indirect land use change.

Ethanol produced from sugarcane offers interesting options for integration. The examples and the model presented below have taken into consideration the current geographical region of sugarcane expansion in Brazil and the variety of existing production chains. Opinions about the integration proposal among several stakeholder groups are presented, and a feasibility study and discussion intended to inform the public regarding policy, regulation, and certification is also included.

3.1 The integration model

Given the variety of production systems, land tenure situations, and development conditions found in the likely region for sugarcane expansion in

Brazil, a range of options for integration must be considered.

The coexistence of sugarcane and other long-established land uses (even if only partial) and the maintenance of the pre-existing land tenure structure may minimize the social and environmental impacts of sugarcane expansion. Opportunities for integration with livestock and grain crops are described separately below, but these conditions can be complementary and allow for different combinations.

3.1.1 Integration with livestock

From the quantitative and strategic point of view, the integration of livestock (beef, dairy, and mixed) and sugarcane is the most important one. The reasons are:

- Sugarcane expansion will likely to a large extent take place on extensive pasture areas;
- Milk production is a typical family agriculture activity and competes for land with sugarcane. Usually both are located close to urban areas and along well-structured road systems;
- The recent expansion of sugarcane in Brazil (1996-2006) has led to a significant decrease in livestock production in expansion areas, herd reduction, and eventual displacement to regions with preserved natural resources.

Sugarcane can be established on pastures with an integrated system, but pastures cannot be established on sugarcane fields. Cultivated pastures in Brazil are permanent and are usually not part of crop rotation systems. Furthermore, sugarcane is renewed every six or seven years, which significantly reduces the area available for a possible rotation. This route of integration (crop rotation on established sugarcane fields) should only be considered for annual crops, and on a maximum of 15% of the area cultivated with sugarcane. Additional technological and scientific developments are also required to make it feasible for livestock production. All the necessary innovations for both sectors (sugarcane and livestock production) would result in additional cultural barriers that would need to be surmounted in order to allow for more comprehensive adoption. Uncertainties due to the lack of large-scale examples, and the necessity of establishing a cooperation that is not customary between these groups, are among the expected difficulties.

Thus, the preferred strategy for integrating sugarcane with livestock would be based on (i) planting sugarcane on part of the pasture area and (ii) producing cattle feed at the mills. The technology required for this type of integration is already fully developed and has been on the market for 30 years. Hence, there are no cultural issues to be surmounted, nor is there any need – at least initially – for major developments in R&D.

The integration would require that the sugarcane mills undergo some minor adaptations in order to produce complete cattle feed made mainly from sugar and ethanol production residues. The feed's main raw material – both as a component and as an energy source – is bagasse. By means of steam pressure hydrolysis, the digestibility of sugarcane bagasse increases from 30% to 65%.

Combined with other residues– yeast, filter cake, vinasse, and raw processed bagasse – and complemented with grain and vitamins, the hydrolyzed bagasse can become a complete ration for beef, dairy cattle, and horses. Hydrolyzed bagasse can also be used as a component for swine feed. This type of feed costs less than other types of cattle feed.

Feed production and keeping livestock feedlots close to the mills were common practices in the 1980s and 1990s. Such a joint production has dropped recently due to the high demand for bagasse for energy cogeneration purposes. Even by reducing the use of the technology, the hydrolyzer-supplying industries are still active in the market, updating technologies and with growth capacity in the case of increased demand for this kind of equipment[30].

In the proposed integration model, the mills supply a complete feed ration to cattle production operations in the surrounding area. Thus, a reduced amount of pasture is required for the same amount of livestock. Through the supply of a complete feed during winter – when mills are processing and there is usually a lack of feed for cattle in the pastures – livestock production may in fact be intensified. The mill may also sell feed, a profitable activity, with a much better price for bagasse than for cogeneration. Cattle farmers who receive the feed increase their efficiency and release areas that can be used for food or sugarcane production, with additional gains in income.

Since there is no interruption in livestock production, there is much less motivation to move the activity, reducing the indirect effects of land-use changes, which could lead to deforestation or the clearing of new areas in still-preserved biomes. Small-holder producers – especially milk producers – can benefit by increasing their production and releasing pasture areas. The mill can expand to serve integrated areas nearby (up to a 40 or 60 km radius), in addition to serving livestock producers in more remote areas.

This integration model is feasible under current market conditions. Being profitable and given the existence of sufficient R&D, it may be readily used for large-scale implementation. Nevertheless, difficulties may arise as a result of:

- Interdependence between the mill and the livestock producers, i.e., a

30 For more detailed information on the process, see: Peterson (1995), Basile & Machado (1990), Burgi (1985), Osório et al (1989).

rancher without the mill feed would need the pasture areas that were released for other uses – probably mostly for the production of sugarcane for the mill. The rancher must have actual guarantees and must trust that the mill will keep supplying him with feed on a regular basis, in appropriate volumes and at decent prices;

• A need to enhance the technological level of cattle production, which is now becoming more intense and productive, requiring investments in genetic improvement and in capacity building for the use of more complex technologies. Technical assistance and investments may be required in order to enhance the system's overall efficiency;

• Rules for determining the cost of feed must be established, as was done by the São Paulo State Council of Sugarcane, Sugar and Ethanol Producers (Consecana), which defines the relationship between mills and suppliers. Long-term guarantees are also necessary, since the integration of livestock producers with mills generates a relationship of mutual dependency that is only feasible if both benefit;

• There may be some resistance to or difficulties in establishing contracts and partnerships with a large number of ranchers, especially among family farmers. They and their leaders may also face obstacles in negotiating with the mills.

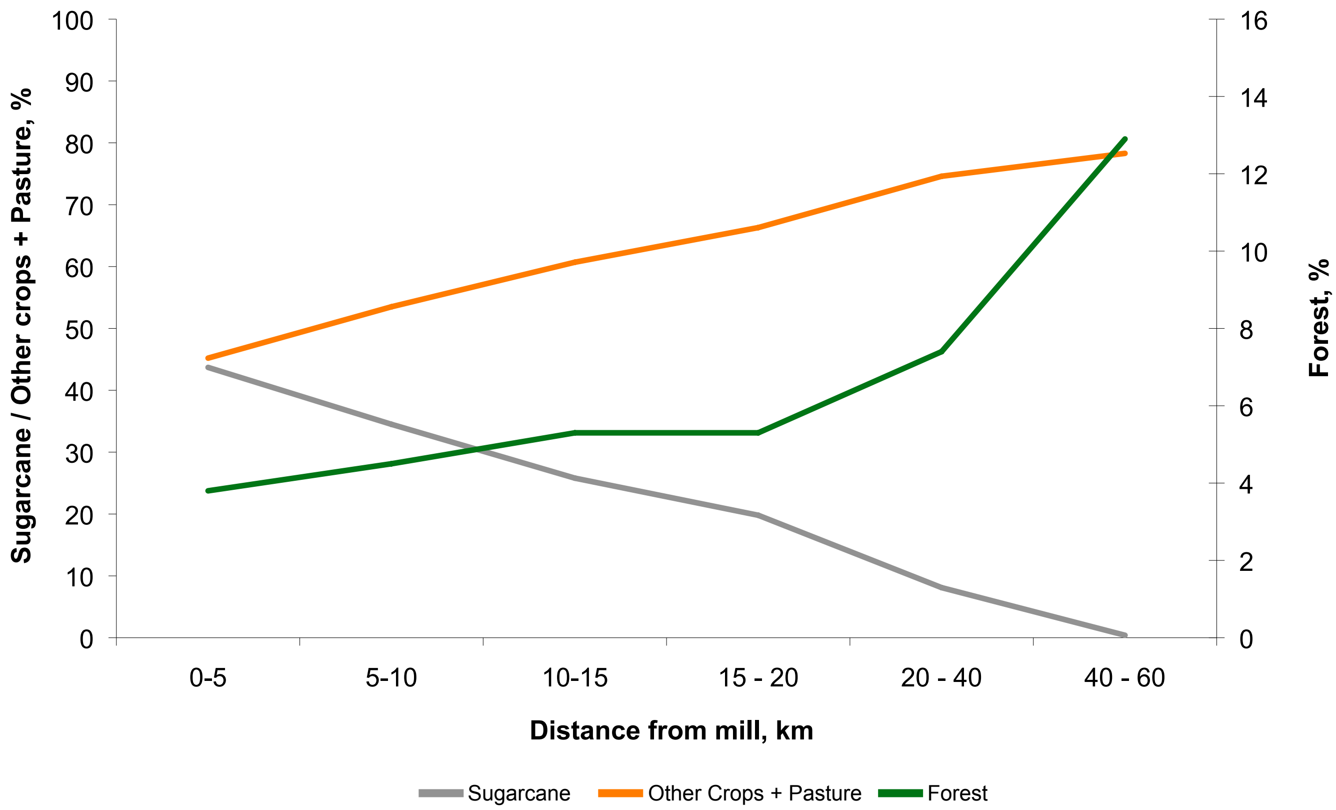
Nevertheless, from the economic point of view, the suggested integration is profitable for both livestock producers and mills.

3.1.2 Integration with agricultural production

The expansion of sugarcane from 1996 to 2006 did not affect food production. One of the likely explanations is that sugarcane production competes with other land uses only in the area immediately surrounding the mill (up to 40 km), as shown in Figure 6 for the State of São Paulo. Even in production areas, about 15% of the sugarcane fields are under crop re-establishment and are thus available for crop rotation with peanuts, soybeans, and other crops used as green manure.

The introduction of sugarcane in a region with a prevalence of extensive livestock production boosts the number of mechanized agricultural services provided by mill suppliers and tenants cultivating areas under re-generation. Such a supply may induce the cultivation of new areas and increase food production. The co-existence of sugarcane and other crops in re-generation areas is a natural dynamic, established without any need for intervention. Both parties benefit: the mill, because it leases a part of its production area during the re-generation period and/or benefits from the weed control in rotation crops or from the nitrogen fixation in the case of soybean, green manure, or peanut. The lessees of such areas enjoy the benefits of farming without any need to invest in the purchase of land.

Figure 6 Area occupied by sugarcane, other crops and pasture, and forests vis-à-vis the distance from mills in the State of São Paulo (average for mills in operation in 2007)



Nevertheless, the synergy between livestock and sugarcane production can be increased by integration with grain and other food crops. Mills have bagasse surplus that can generate bioenergy for industrial processes. The cultivation of soybeans, Jatropha and other oil plants in areas close to mills – either by using areas made available through the integration of sugarcane with cattle production, or not – can provide feedstock for biodiesel production powered by bagasse bioenergy. Such a strategy helps in the following areas:

- By improving the logistics of feedstock production close to the processing site;
- By making bagasse the process fuel for the whole industrial process, GHG emissions will be reduced;

• The supply of low-cost residues and other products derived from the processing of oilseed plants will enhance quality and lower the cost of the complete ration produced in the mill, thus making the integration of livestock production with the mills even more attractive.

The outcome of the overall integration process is a biofuel production hub (ethanol and biodiesel), running on bioenergy from sugarcane bagasse, leading to production of multiple products and an increase in food supply, with intensified dairy and beef cattle production.

Thus, cattle production is not displaced, and competition with family agriculture is minimized. There is room for family farming in the integration of cattle production and the supply of feedstock for biodiesel production. Based on all these factors, the integration model Community Hubs for Energy and Food (CHEF) has been developed. Such a fully integrated model will probably not be implemented spontaneously, due to its high complexity, the multitude of players, and the need to establish stable and long-term formal partnerships, thus requiring different interventions in order for it to be fully adopted.

3.2 The dynamics of integration

Sugarcane integration may be spontaneous or induced. In the spontaneous version, the area surrounding the mill is used for specific components of sugarcane production, but the operation of one is not dependent on the other. Examples of spontaneous integration are:

- The mills' raw material suppliers (sugarcane producers that perform all or some production operations and have a supply contract with the mills);
- Traditional crop producers expanding their activities to areas of sugarcane re-generation, usually for one production cycle;
- Service providers and labor, usually migrant family farmers working as seasonal workers at mills, or large-scale farmers providing mechanized farming services.

The induced integration in CHEF systems takes place mainly between livestock producers and the feed mill, which allows for intensified cattle production, increased profitability, and a significant reduction in the area required for pasture. Integration allows the areas released to be utilized for sugarcane production, among other purposes. Under this integration, the intensified cattle production model is only feasible if feed is supplied by the mill.

Spontaneous integration can be implemented to a greater or lesser extent depending on specific site conditions. It ensures continuity in grain production up to a certain point, but does not provide intrinsic mechanisms for avoiding different major impacts, such as considerable pressure for sugarcane monoculture, the displacement of extensive livestock production– either by small or large-scale producers – and its potential discontinuation.

In the case of large-scale producers, a possible scenario is the relocation of cattle to distant regions: cattle producers selling land may take advantage of the increased value of land due to sugarcane expansion and purchase a larger quantity of land in remote regions, where extensive production is both feasible and profitable. As mentioned, this indirect land-use change – possibly involving deforestation in more preserved areas – can lead to GHG emissions and other negative environmental effects. These emissions can more than outweigh the climatic benefits of the ethanol produced in the new sugarcane fields. In addition, markets characterized by rules involving biodiversity protection and GHG performance requirements may not allow the use of this ethanol.

In the case of small-scale cattle producers – whether or not they are diversified, and included in access-to-land programs (agrarian reform) – the potential for spontaneous integration is very small. For these parties, the most common forms of integration are through the provision of services as seasonal workers or hired mill employees. These dynamics do not ensure the continuity of family agriculture production as the farmer may either sell or lease land.

Any decrease in family farming in the mill's area of influence will lead to a reduction in the diversification of the supply of products for direct food consumption, a decrease in the number of jobs in rural areas, and the concentration of land property, in addition to rural migration to urban areas. Such processes are difficult to reverse and generate long-lasting negative effects.

The starting point for the induced integration of CHEF is a closer relationship between the mill and its surroundings. The mill now supplies complete feed for livestock production during the sugarcane harvest season. The farmers can thus intensify their production, using part of their land for other purposes (including sugarcane), while improving their income through additional agricultural production, without having to migrate.

Consequently, there are benefits both for mills and for traditional producers in the expansion region, with positive results throughout the area where the mills are established. In addition to a better income facilitated by intensified production and the use of lands for productive new activities, the fact that the traditional producers remain on their properties reduces the risks that are intrinsic to any change, in activity or region. By avoiding migration, the social environment is preserved, which is an important condition for family agriculture. Associativism and cooperativism are key factors for the stability of this sector.

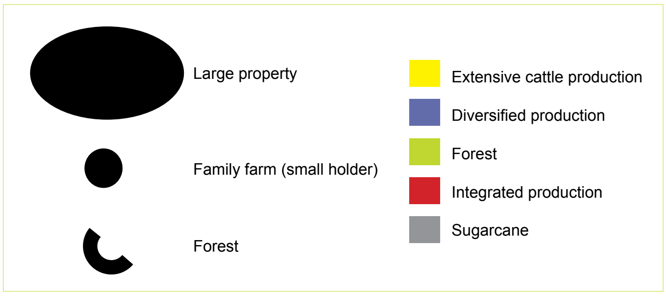
The economy and the local production clusters also benefit from the continuity of traditional activities. Diversity of production is preserved, thus making famers more resilient during moments of crisis in the sector, in addition to expanding and diversifying the demand for services and labor.

The introduction of CHEF in the region may take place without a major rupture, preserving desirable continuity during a transition phase. The new activity will be met with higher acceptance, thereby reducing conflicts, a central factor for family agriculture and its supporting social movements. The expansion of an environment of mutual support and cooperation (rather than displacement and competition) can promote regional development with political and social backing.

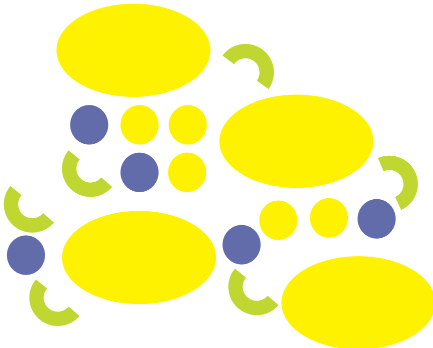
In the case of the joint production of ethanol and biodiesel, costs also tend to be lower, due to the use of cheaper energy sources and reductions in the distance covered by the transport of feedstock. Part of the biodiesel production residues can become a component of the complete feed ration provided by the mill. In other words, the feed can become even cheaper and more efficient with regard to emissions. Thus, to summarize, CHEF may help in the:

- Reduction of GHG emissions;
- Inclusion of many players and production scales into an efficient chain, with few intermediaries;
- Expansion of the food-production capacity through cattle and the expansion of agriculture;
- Increased income from agricultural production, with several products that will be consumed or processed locally;
- A predominantly cooperative – not competitive – environment, since efficiency is the result of stages of production carried out in different interdependent production scales and systems.

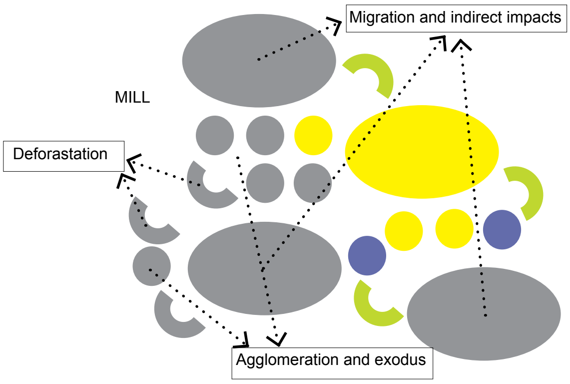
Figure 7 Outline indicating:



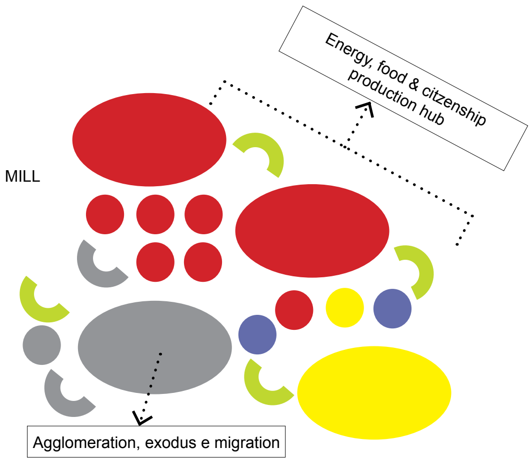
a) Original condition before the mill was established



b) Final conventional condition

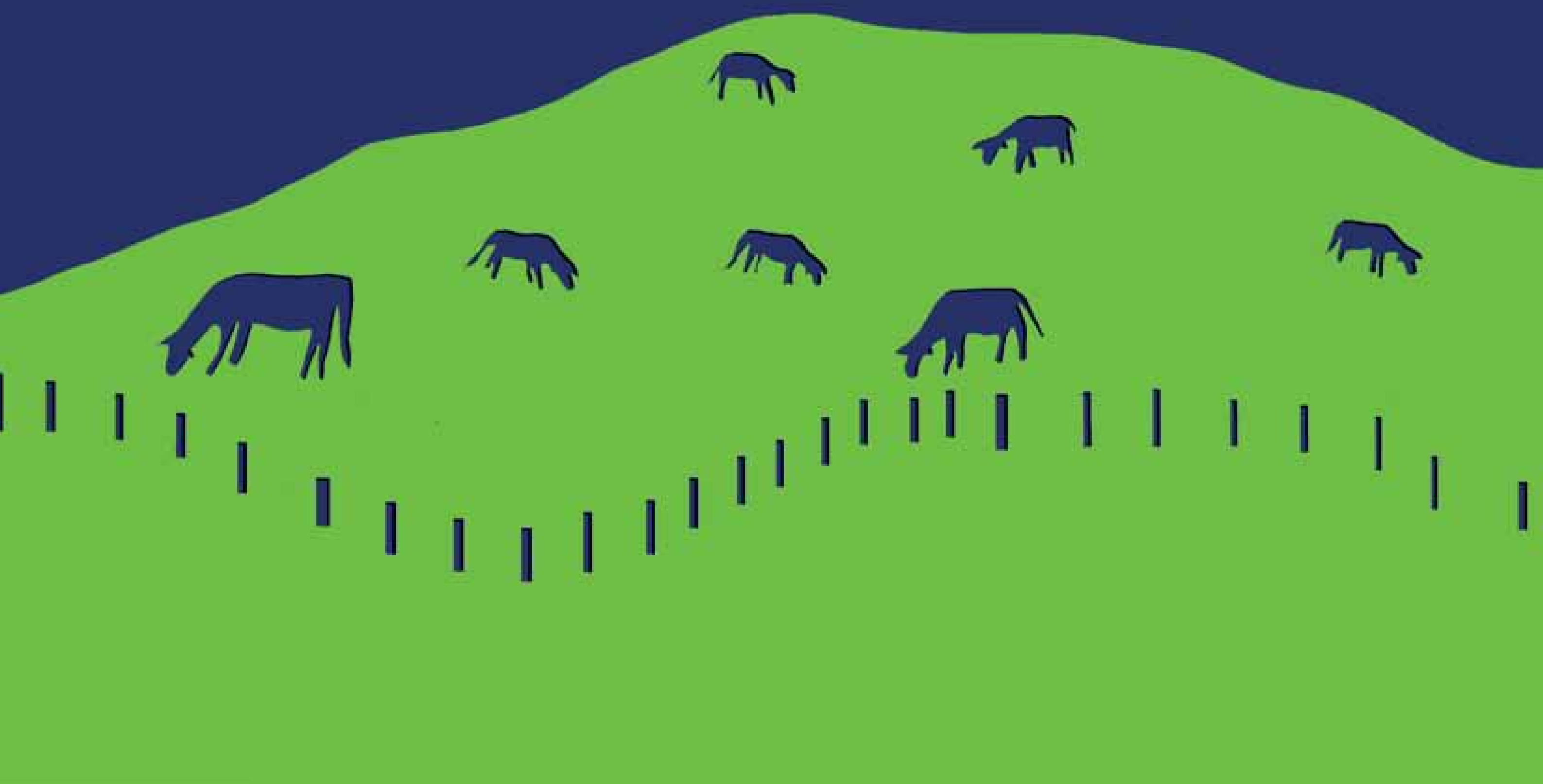


c) Final condition with integrated production



chapter 4

chapter 4



Feasibility of integration

4.1 Livestock production

The assessment of the technical feasibility of the integration model for sugarcane with beef, dairy, and mixed cattle production is divided in two parts: a) from the perspective of the industrial unit (mill) and b) from the perspective of the rancher. The general model is summarized this report and the detailed version is available at http://esalq.usp.br/AgLUE.

First, the technical and economic issues of the process within the feed manufacturing unit are addressed. Next, several different cattle production systems are analyzed by modeling scenarios for applying the overall model to rural activities, with variations in production profile, area, and land use.

4.2 Feasibility in the mill

The starting point for the overall model is a sugar and ethanol industrial unit (mill) with a capacity to process one million tons of sugarcane harvested from a 15,000 hectare area and equipped for the production of 40,000 tons of cattle feed per harvest season. The final balance for this system is summarized in Table 4 and Table 5 provides a more detailed description. The full version is available at http://esalq.usp.br/AgLUE.

In this case, three types of feed would be produced for feeding: i) beef cattle, ii) dairy cattle, and iii) breeding cows. In all cases, even considering a net profit margin of 25% for the production mill, feed-based animal husbandry would be economically feasible:

• Confinement feed would be sold for R$ 120/t, and the total cost of producing 15 kg of beef cattle carcass would be R$ 70, which is equivalent the cost of using traditional feed made from silage or chopped sugarcane;

• The feed for dairy cattle would be sold for R$ 135/t, and the total cost of producing one liter of milk would be R$ 0.50 – a very competitive cost;

• The maintenance feed would be sold for approximately R$ 60/t, the equivalent of the current cost of producing sorghum silage. But the maintenance feed has the advantage of being balanced.

[Table 4] Summarized balance of the processing of 40,000 t of cattle feed in a 200-day harvest (20,000 t confinement feed: 7,500 livestock units confined for 120 days; 15,000 t of feed for dairy cows; 1,500 cows in lactation for 365 days; 5,000 t maintenance feed; 1.75 cows supplemented for 90 days)

Investment		
	R$	
2 hydrolysers + 1 stationary mixer	540,000	
Cost		
	R$	% cost
Cost of ingredients generated inside the mill	1,195,230	31.8
Cost of outside ingredients	1,859,630	49.5
Operational cost	63,000	1.7
Equipment maintenance	54,000	1.4
Depreciation – 10 years	54,000	1.4
Transportation cost - 50 km	528,000	14.1
Total Cost	3,753,860	
Return		
	R$	Average sales price
40,000 t feed	4,692,325	R$ 117/t
Net profit for the mill		
	$ Reais	% cost
	938,465	25

[Table 5] Detailed description of system summarized in Table 4

Investment				
Type	Unit		R$	% invest.
Hydrolyser	2		300,000	56
Stationary mixer	1		240,000	44
Total investment			540,000	
Cost				
Ingredients	R$/t	Tons	R$	% cost
Internal ingredients				
raw bagasse*	10	1,447	14,470	0.4
hydrolyzed bagasse*	40	19,481	779,240	20.8
liquid yeast	25	11,637	290,925	7.8
molasses	200	489	97,800	2.6
filter cake	10	480	4,800	0.1
vinasse	5	1,599	7,995	0.2
Subtotal		**35,133**	**1,195,230**	**31.8**
External ingredients				
ground sorghum	250	3328	832,000	22.2
soybean meal	600	929	557,400	14.8
urea	1,250	207	258,750	6.9
lime	120	169	20,280	0.5
mineral suppl./additives	800	239	191,200	5.1
Subtotal		**4,872**	**1,859,630**	**49.5**
Total cost of ingredients	-		*3,054,860*	*81.4*
Operational cost 1 hydrolyser operator – 3 shifts 1 mixer operator – 3 shifts	-		63,000	1.7
Equipment maintenance	-		54,000	1.4
Depreciation – 10 years	-		54,000	1.4
Transportation cost – 50 km	-		528,000	14.1
Total Cost	-		3,753,860	
Return				
40,000 t of complete feed sold at an average price of R$ 117/t			R$	
			4,692,325	
Net profit for the factory			R$	% cost
			938,465	25

*The cost of hydrolyzed bagasse is four times higher than raw bagasse as it takes into consideration the cost of bagasse burned for generating the steam used by the hydrolyser and the value added to the raw material through processing.

4.2.1 Commitment of the residues

The residues that are generated by the mill and used for producing feed are bagasse, filter cake, yeast slurry, and molasses. The total amount of residues generated depends on factors that are intrinsic to the grinding process, as well as the sugarcane species and maturity when harvested. The amount of each residue used for feed production is described in Table 6.

[Table 6] Residues generated by the standard mill (processing of one million tons of sugarcane)

Residue	*Total Generated*	*Used for Feed*	
	kg/ton sugarcane	*%*	*tons*
Bagasse	300	6-8	20,000 -25,000*
Filter cake	25	20	5,000
	L/L of ethanol produced		*Liters*
Yeast slurry	0.09	100	47,000
	kg		Kg
Molasses [1]	0	-	2,000 – 4,000

1. 2.8 kg of molasses taken from industrial production reduce the output of ethanol by approximately 1 liter.

* 20,000 t used for feed and 5,000 t estimated as additional consumption of bagasse for generating the steam used by hydrolysers.

It is assumed that the mill uses 80% of all bagasse produced in order to meet its internal energy demand for the production of sugar and ethanol, resulting in a 20% surplus, i.e., 60 kg of bagasse per ton of ground sugarcane. The surplus varies between 15% and 35% among the different mills and in specific cases one must consider the real surplus of bagasse, and the fact that many of the new production units operating in the expansion region tend to use it very efficiently, thus increasing the surplus.

For feed production, the use of 20 kg of bagasse per ton of processed sugarcane was assumed, i.e., one third of the bagasse surplus and 6.6% of the total bagasse generated. In a hypothetical situation in which it is necessary to generate steam exclusively for feeding the hydrolysers, 2 kg of bagasse would have to be burned for each kg of hydrolyzed bagasse generated. This system would be very different from one that requires almost 100% of the surplus bagasse[31].

31 Nevertheless, in the context of a sugar and ethanol mill, hydrolysers are set up in a row along the steam line and estimates are that the additional consumption of bagasse will reach a maximum of 25% of the hydrolyzed mass or 0.25 kg bagasse per kg of hydrolyzed bagasse. The overall balance for bagasse consumption in the mill is only slightly affected, reaching no more than 8.3% of the total generated.

4.2.2 Comparison between feed and energy cogeneration

Generally speaking, the more widespread and preferred use for bagasse at mills and distilleries is for energy cogeneration. Table 7 shows the simulation results for three scenarios in which all bagasse available at the mills could be used as fuel for electricity generation and the estimates for the value added to the bagasse through this process. The simulations were made assuming/not assuming cogeneration systems using steam turbines, which are set according to the pressure and temperature levels used for generating steam and the condensation of steam. Systems featuring steam generation at 22 bar and 300°C are the benchmark for energy self-sufficiency.

Generating steam with higher pressure levels allows for the generation of surplus electricity. The usual levels for steam generation have been 32, 42, and 62 bar. Steam generation at 82 bar has not been practiced in Brazil, but should be considered, since this is the maximum pressure allowed in the country. The exportable electric potential was calculated assuming that the mill's own electricity demand is 12kWh/t of sugarcane. This rate remains unchanged over time.

[Table 7] Value added to bagasse in three scenarios of cogeneration and electricity prices

Generated steam P [bar] / T [°C]	Geneneration rate (kWh/t bagasse)*	Exportable generation rate (kWh/t bagasse)	Value MWh (R$)	Value added to bagasse (R$/t)
42 bar / 450°C	141	101	150	15
62 bar / 470°C	175	135	200	27
82 bar / 480°C	206	166	250	41

Adapted from: A. Walter, J.I. Llagostera, A. V. Ensinas, D. S. de Maio, M. Reis, R. M. Leme, "Levantamento do potencial nacional de produção de eletricidade nos segmentos sucroalcooleiro, madeireiro e em usinas de beneficiamento de arroz", UNDP and MME Project, implemented by NIPE/UNICA MP, 2005.

* Yield of bagasse with a moisture level of 50% = 300kg/t sugarcane

In the best possible scenario, with turbines and boilers configured to allow the generation of steam at 82 bar and 480°C, and with a higher remuneration for the energy produced than mid-term market expectations[32], the value added to the bagasse equals R$ 41/t. In feed production simulations, the cost of bagasse was considered to be R$ 40/t, to be comparable to this best possible scenario. Therefore, using bagasse for animal feed was considered economically more favorable than cogeneration, even if we take into account optimal scenarios for energy generation by means of state-of-the-art technology – currently not available at the mills – and favourable market prices for electricity. Under current cogeneration market conditions, the mills will benefit immensely if they sell bagasse for feed instead of electricity.

32 (MME/EPE, 2010)

Table 8 shows the scenarios for a mill that uses all bagasse surpluses for the cogeneration and sale of electricity, compared with another mill that includes feed production, in aggregate value per mill. The economic advantage in this case is also evident, clearly indicating that under market conditions, even without considering the specific allocation of resources, the investment in mills for the production of feed based on bagasse is feasible and is a better option than the traditional cogeneration alternative. It is also essential to create conditions that ensure the consumption of the feed. Through CHEF integration, such a condition is viable and beneficial for both mills and livestock producers.

[Table 8] Comparison between a standard electricity exporting mill with one that exports both energy and cattle feed

	Energy	Energy and Feed
Total bagasse surplus (t)	60,000	60,000
Bagasse for electricity exports(t)	60,000	35,000
Bagasse for feed production (t)	-	25,000
MWh exported*	6,060	3,535
Energy revenues* (R$)	909,000	530,250
Feed production** (t)	-	40,000
Net revenues from feed** (R$)	-	938,465
Total net revenues (R$)	909,000	1,468,715 (+61.5%)

*exportable rate considered: 101kWh/t bagasse at R$150/MWh.

** considering the balance of Table 4.

4.3 Feasibility for cattle producers

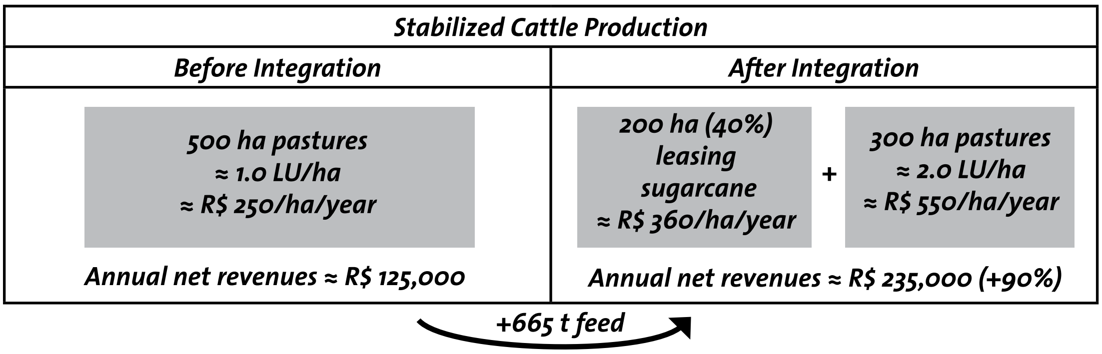
The modelling of integration scenarios for determining the feasibility for cattle producers was done for five animal husbandry systems considered standard in Brazil. The general characteristics of each are described in this report, whereas technical details and spreadsheets on the application of the model in each situation can be obtained at http://www.esalq.usp.br/AgLUE.

4.3.1 Stabilized cattle production

Stabilized cattle production is understood as a large or medium-scale, efficiently practiced activity occupying the majority of a given farm area. It represents the traditional cattle producer who applies appropriate animal management techniques, but for whom the competition with sugarcane crops can jeopardize livestock production, causing its interruption or undesired displacement. Under such conditions, the integration through the CHEF system is perceived as an opportunity for the producer to diversify his income sources or increase the gains obtained from the traditional activity.

In this simulation, the assumed standard was a herd for breeding, rearing, and finishing on 500 hectares of pastures and consisting of 730 animals (523 livestock units (LU)*). The use of feed during the dry period allows about 40% of the pasture area to be used for sugarcane fields. Increased technical efficiency and the leasing of land for sugarcane can increase the net annual revenues of a property by up to 90% (Figure 8).

Figure 8: Simulation of integration in case of stabilized cattle production



4.3.2 Extensive cattle production

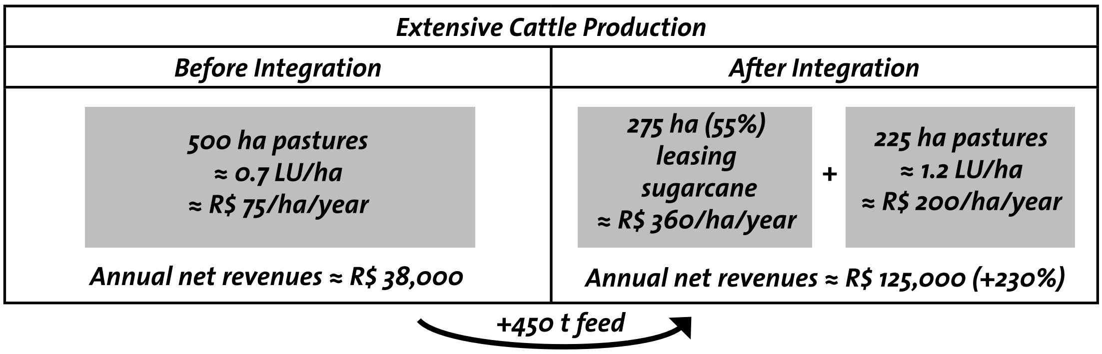
Extensive cattle production is established on large properties where animal husbandry occupies the majority of a given farm area, but is not practiced efficiently in terms of land use. The cattle production is carried out on a strictly extensive basis and cost competitiveness requires that the price of the land be very low. The expansion of sugarcane tends to occur on this type of land due to its availability, thereby changing the landscape and replacing cattle production. In such cases, ranchers do not perceive the maintenance of their traditional activity as an advantage because of its low profitability. The prospect for spontaneous integration is low, but the CHEF model is very attractive.

In the example of the model used, a beef cattle herd made up of 458 animals (338 LU) in a pasture area with 500 hectares was considered. Integration would make 275 hectares (55%) available for sugarcane by using 452 tons of feed for supplementing 143 animals (125 LU) during the dry season, including the confinement and finishing of 77 two years old calves (53 male, 24 female). The total herd after integration will be 382 animals (276 LU). Integration reduces

*The reference unit used for the calculation of livestock units (LU) is the grazing equivalent of one adult beef cow.

the size of the herd and is followed by an increase in efficiency. Additionally, the leasing of 275 hectares for sugarcane provides for additional income which, in addition to increased efficiency in animal husbandry, leads to a 230% increase in revenue, compared to pre-integration net revenues (Figure 9).

Figure 9: Simulation of integration in a case of extensive cattle production



4.3.3 Diversified cattle production

Diversified husbandry refers to a large or small farm where cattle production shares the space with other activities (e.g. crops, horticulture) in a balanced way. Cattle production has a complementary or accessory nature, sharing space with diverse income sources, especially through annual crops. The manager is usually a farmer, and the nature of the farm is unlikely to change significantly with the expansion of sugarcane.

The integration of sugarcane and cattle is perceived as an additional land-use alternative, which may or may not be adapted to the activities already being practiced. There is moderate potential for integration, depending on specific local conditions.

The example shown in the simulation is a 236 head cattle herd (199 LU) for breeding and finishing on 200 hectares of pastures. Integration would make 60% of the area available for other purposes, using 300 tons of feed for the confinement of 123 young calves during the dry period. Additionally, the leasing of 120 hectares for sugarcane represents an increase in profitability per hectare which, combined with cattle production, results in overall gains of 95% in the annual net revenues of the property (Figure 10).

Figure 10: Simulation of integration in a case of diversified cattle production

Diversified Cattle Production	
Before Integration	***After Integration***
200 ha pastures *≈ 1.0 LU/ha* *≈ R$ 200/ha/year*	*120 ha (60%) leasing for sugarcane ≈ R$ 360/ha/year* **+** *80 ha pastures ≈ 1.1 LU/ha ≈ R$ 445/ha/year*
Annual net revenues ≈ R$ 40,000	***Annual net revenues ≈ R$ 78,000 (+95%)***

+300 t feed

4.3.4 Special cattle production

Refers to a small farm where cattle production, albeit inefficient and uncompetitive, is the predominant activity. Due to their smaller size, such farms are not a preferred acquisition target for the mills. Nevertheless, depending on the distance from the mill, the substitution of animal husbandry for sugarcane may occur and thus cause the migration of the families from rural to urban areas.

Special cattle production therefore represents the most precarious social pattern in sugarcane expansion, as its displacement alters the land tenure profile of rural land occupation. Since leasing for sugarcane is very attractive, the integration through the CHEF system does not occur spontaneously. But its potential for mitigating negative effects is encouraging.

In the modeling, a small-scale milk producer was assumed to use 20 hectares of pastures for a herd of 29 animals (21 LU), including 6 lactating cows, with an average production of 5 L milk/cow/day. Through integration, half of the pasture area was made available for sugarcane by using 43 tons of feed for 12 LU during the dry season.

Daily milk production can be doubled by improving management, thus raising the net revenues from animal husbandry by 20%. Moreover, the leasing of pastures made available for sugarcane represents an additional income. The property balance shows a 65% gain in its annual net revenues (Figure 11).

Figure 11: Simulation of integration in special cattle production

Special Cattle Production	
Before Integration	***After Integration***
20 ha pastures *≈ 1.0 LU/ha* *≈ 30 L milk/day* *≈ R$ 470/ha/year*	*11 ha (55%) leasing for sugarcane ≈ R$ 360/ha/year* **+** *9 ha pastures ≈ 2.4 LU/ha ≈ 65 L milk/day ≈ R$ 1,300/ha/year*
Annual net revenues ≈ R$ 9,000	***Annual net revenues ≈ R$ 15,400 (+65%)***

+43 t feed

4.3.5 Strategic cattle production

Refers to small farms in which cattle production shares the area with other agricultural activities in a balanced manner. As in the case of diversified cattle production operations, animal husbandry plays a complementary or accessory role in diversifying sources of income.

Even though the activity aims to achieve efficiency and diversification, it may be displaced due to the territorial pressure of expansion, thus impacting a well-established family agriculture model. Integration by means of the CHEF system has great potential for this group. It is a good option for enhancing efficiency and releasing areas that are suitable for other uses, including sugarcane or any other crop that proves to be more attractive to producers.

The modeling examined an efficient dairy farm based on family labor on 20 hectares of pastureland and a herd consisting of 55 animals (39 LU) including 16 dairy cows, with an average production of 10 kg milk/cow/day. Integration releases 1/3 of the pasture area for sugarcane, with an impact on the average milk productivity, which may increase as much as 35%. Since the farm already operates efficiently, the final balance shows a moderate gain of 10% in the annual net revenue (Figure 12).

Figure 12: Simulation of integration in the case of strategic cattle production

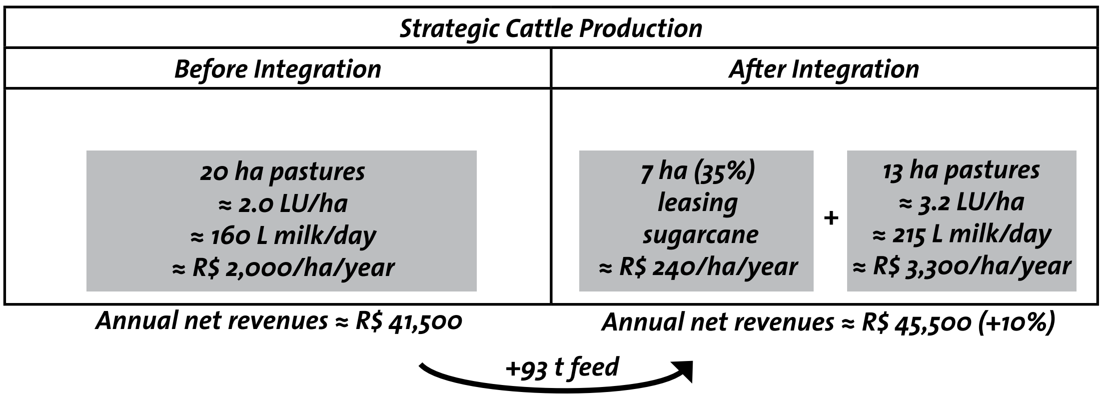


Table 9 summarizes the expected level of negative effects from sugarcane expansion for each of the livestock production systems and the corresponding prospects for integration through the proposed CHEF system.

The viability of the CHEF system is high if we consider the economic aspects of the feed production unit and the benefits for cattle producers. When the farms to be integrated are located within a 30 to 40 km radius from the mill, all analyzed integration models indicate the release of areas previously used as pasture, which can be used for planting sugarcane.

But the area released for sugarcane production is smaller than if cattle production is interrupted or moved to another region. This may be considered restrictive by the mills in case the demand for land is very high.

As for cattle producers, integration always leads to an increase in profitability and, in most cases, in the technological level of production. In some cases – such as extensive or special animal husbandry – cattle producers may resist accepting the integration model due to its requiring them to adopt technologies that are unknown to them and are more intensive and complex. Assuming the displacement hypothesis holds, initiatives that help cattle producers overcome such barriers will be essential for avoiding indirect land-use change with resulting GHG emissions and other negative environmental or social impacts.

Special animal husbandry – which is carried out on small farms by family farmers – can also face integration difficulties due to its need to adapt to more intensive technologies. There is concern over the abandonment of rural activities and migration, or a reversal of the family land tenure pattern through the sale or lease of land over a very long period of time, leading to a situation of land ownership concentration. To mitigate such processes, additional support and adaptation assistance should be provided in addition to the cattle feed supply. Other cattle production systems (stabilized, diversified, and strategic) tend to integrate more easily with the CHEF concept, with less need for intervention or support.

[Table 9] Negative effects of sugarcane expansion for each of the livestock production systems

	Negative effects of expansion			**Potential of spontaneous integration**
Type of cattle breeding	*Territorial*	*Social*	*Land tenure*	
Stabilized	High	low	low	high
Extensive	High	low	low	low
Diversified	Medium	low	medium	high
Special	Low	high	high	medium
Strategic	Low	medium	medium	high

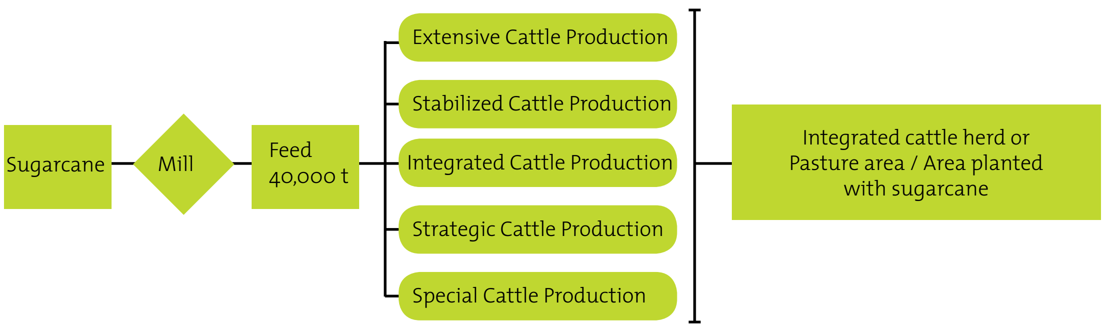
chapter 5

chapter 5

Joint and spatial analysis of integration

Based on the technical characteristics of CHEF, it is possible to establish the relationship between the area cultivated with sugarcane and the integration capacity for the different livestock production systems. As shown in Figure 13, a mill with a cultivated area of 15,000 hectares can produce 40,000 tons of feed, resulting in 2.6 tons of feed per hectare sugarcane planted by the mill. Since the feed enables the herd's technical management to be intensified through integration, the profile of each cattle producer can be associated with a particular level of feed consumption and pasture area, and subsequently with the area of sugarcane planted by the mill and used to produce that feed.

Figure 13: Relationship between the area cultivated with sugarcane by a standard mill and its integration capacity



Data in Table 10 show the relationship between the area planted with sugarcane and the modeled pasture area, with variations according to the type of cattle production. The list presents examples used in the economic feasibility simulations for the integration model and the standard mill, and may vary if the specific conditions differ from the scenarios adopted for the simulations.

[Table 10]
Relationship between the integrated pasture area and the sugarcane area planted by the mill

Profile of cattle producer	*Pasture area prior to integration (ha)*	*Pasture released for other uses (ha)*	*Consumption of mill feed (t)*	*Equivalent of sugarcane area planted by the mill (ha)*	*Integrated pasture/ Equivalent sugarcane plantation area (ha/ha)*	*Released pasture/ Equivalent sugarcane plantation area (ha/ha)*
Extensive	500	275 (55%)	452	169	2.95	1.62
Stabilized	500	200 (40%)	665	249	2.01	0.80
Diversified	200	120 (60%)	450	169	1.19	0.71
Strategic	20	7 (35%)	93	35	0.57	0.20
Special	20	11 (55%)	43	16	1.24	0.68

Depending on the different examples of cattle production, a relationship can also be established between the size of the herd and the amount of feed used for its integration, including the herd that is not fed directly with the feed produced in the mill, but is indirectly included in the integrated system.

Based on the 2006 Agricultural Census, the sugarcane expansion area required for integrating 100% of the cattle herd in all Brazilian municipalities can be estimated. Figure 14 represents the expansion area required in each municipality for integrating the entire municipal cattle herd through the integration process.

Figure 14: Sugarcane expansion area large enough to integrate the municipality's total herd based on the CHEF system

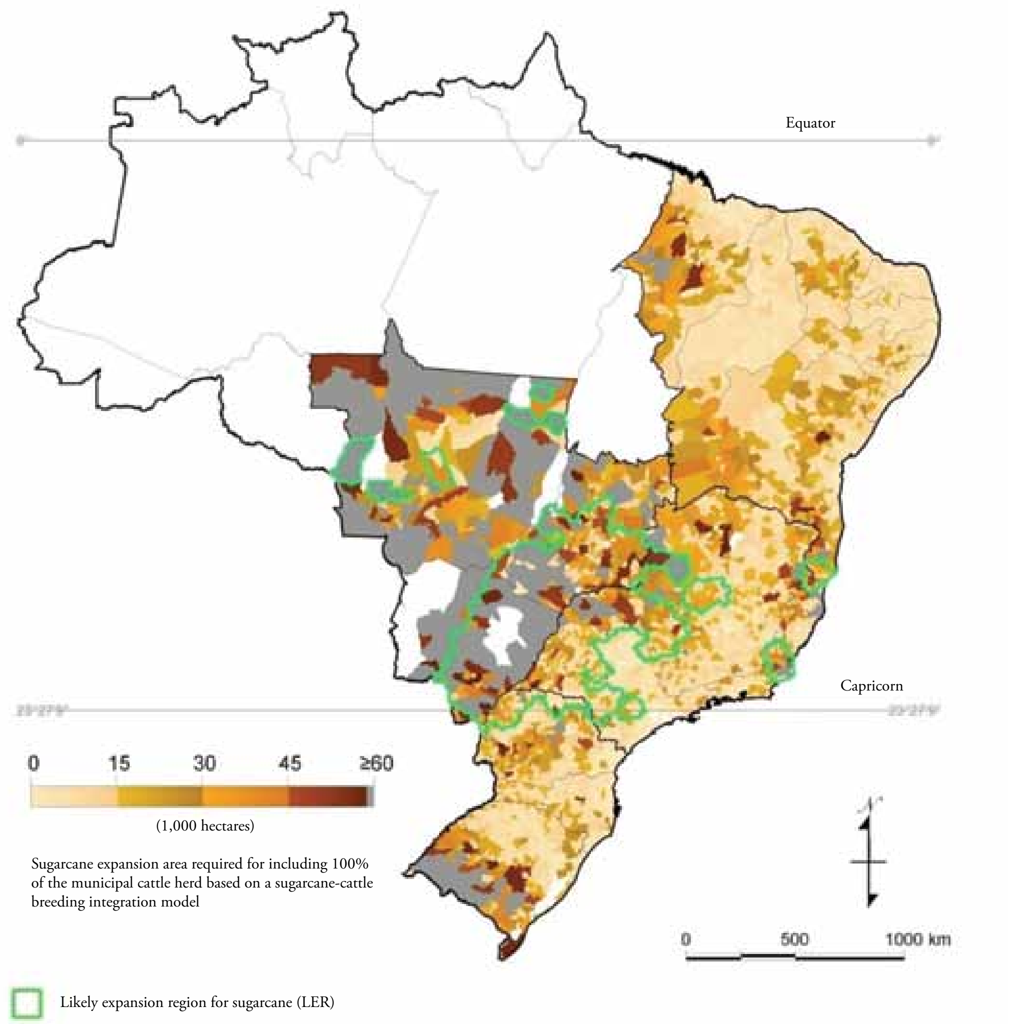


Figure 14 was designed according to a color scheme that allows the clear visualization of the numerical distribution quartiles. Each quartile (15,000 hectares) corresponds to a standard mill, so that the different shades of color in the image indicate the number of mills with feed production systems needed by each municipality to integrate total cattle production.

Distinct patterns in the most likely region for sugarcane expansion can be noticed. Light colors (one standard mill for integrating 100% of all cattle production) are rare throughout the expansion area. Darker colors and gray (many mills required in order to achieve 100% integration) are more common and dominate large areas in Mato Grosso do Sul and Mato Grosso. The intermediate situation is found in the State of São Paulo and Southern Goiás.

Such a distribution suggests that even a relatively low adherence by livestock producers to the integration system (CHEF) ensures a sufficient demand for the feed produced by the mills. In other words, there is little risk of a lack of sufficient interest in integration and the subsequent under-use of the feed-producing facilities.

For cattle producers, there is also the guarantee that the integrated producers, with increased productivity, efficiency, and profitability, will not eliminate non-integrated traditional production, which will continue to predominate. The integrated plots will have their advantages, but they will probably be quantitatively limited to pre-defined targets of integration, or to the integration capacity outlined by each mill.

5.1 Assessment of stakeholders' views and opinions

5.1.1 Methodology

In order to improve understanding of the CHEF systems within a broad range of technological levels, production targets, and land tenure conditions, qualitative interviews were conducted with groups of stakeholders involved with ethanol production, or affected by it through its expansion. Through the interviews, information was collected about the stakeholders' interests and perceptions related to integration potentials and possibilities for ethanol certification. The possible pathways for generating integrated production systems were also analyzed based on a wide range of opinions.

By using a standardized methodology, the information gathered has enabled different points of view about the same concepts to be aired, facilitating a consensus-building discussion among the different groups. The results of these interviews also help anticipate possible criticism or resistance regarding voluntary actions – such as the certification of a part of the market – or imposed actions – such as the sector's licensing, zoning, or regulation.

Qualitative and semi-structured questionnaires about the expansion of sugarcane in Brazil for the production of biofuels were used. To facilitate the group's overall understanding, the questionnaires were presented by way of a five-step discussion:

1) The background: why sugarcane production is important

The interview started with the presentation of a map showing the likely region of sugarcane expansion and the location of the new mills. At this stage, an analysis of the overall situation from the economic, social, environmental, and land tenure points of view, and the relationship with other productive segments was proposed. The first question allowed an assessment of the importance of ethanol production from different perspectives, and a discussion based on the interviewees' point of view about the process underway, without the interviewer influencing opinions or making any kind of value judgment.

2) Ethanol certification

The purpose of this stage was to find out the interviewee's point of view on the criteria to be considered for the ethanol certification process, on expectations regarding the timeframe for the implementation of certified trade, the impact on the commercialization scale, and the effects of a certification process on the sector, considering both advantages and restrictions. The possibility of integrating sugarcane and food crops in this process was also discussed. In this part, the answers provided by the interviewees were based on elements and concepts provided by the interviewer.

3) Possibility of integrating sugarcane with food production

At this stage, an attempt was made to record the point of view in each sector with regard to integrating sugarcane with food production (food crops and livestock production). Participants were also questioned about how establishing targets for food production could be part of a certification process. The intention was to assess whether such a situation could positively influence food production from the interviewee's point of view.

4 – Introducing a proposal for CHEF systems

Stimulated by a schematic representation of the proposal and its description, this stage of the interview addressed the possibilities associated with establishing an integration process between the mills and livestock production based on CHEF, and the benefits likely to result from such integration.

5) Interviewee's reaction to the proposal

The final part of the interview attempted to identify possible obstacles and restrictions to CHEF and to explore its advantages. Specific aspects associated with the production system for each sector have been addressed as well: costs, destination of the bagasse, and logistics, among others.

The dialogue with sector representatives was based on a constructivist model: the elements and opinions expressed initially, without being influenced, were used again during the subsequent stages of the interview, establishing a connection with the new concepts presented at each stage. This sequence helped encourage interviewees to reflect on the real possibilities of integration, both from the point of view of their own business, and with regard to the risks and opportunities involved. The intention was to avoid influencing opinions by prejudice, biased points of view or lack of information on the content of the proposal.

The methodology was successful in that many interviewees clearly changed their opinion as the questions evolved. Even when an initial outlook or bias contrary to the sugarcane expansion process was perceived, or when the negative impacts of expansion – in environmental or social terms – were minimized or unknown, the final stage of the interview always culminated in the interviewee's acknowledgement that CHEF did indeed contain important elements for:

- Creating synergies between sectors;
- Indicating models capable of providing answers to questions about food production;
- Aggregating segments that had been excluded from the ongoing expansion process;
- Mitigating relevant environmental impacts.

Twenty interviews, distributed among the segments listed below, were carried out. The different segments are below identified by a number that allows associations between the position, concept, or opinion and its author. This facilitates the understanding of pros and cons by juxtaposing convergent or contrary ideas, as associated with their author.

(1) Mills (including their representative association: UNICA. A total of 7 representatives);

(2) Entity representing sugarcane suppliers (2 representatives);

(3) Social movements and rural workers' movements (4 representatives);

(4) Representative entities and institutions from the milk-producing and processing sector (2 representatives);

(5) Certifiers (2 representatives);

(6) Technical consulting firms (2 representatives);

(7) Export trading company (1 representative).

5.1.2 Results

Results were grouped into topics and presented in separate categories. The opinions and conclusions of the survey's authors are in italics in order to distinguish them from the interviewees' opinions, which appear in normal font, followed by the numeral that identifies each stakeholder group.

a) The role of ethanol production in development

The initial contact with interviewees focused on two different aspects, depending on their professional activity and general outlook: one focused on the local sphere, limiting the analysis to the specific geographic area of activity, and segments specialization (1) and (2); the other used a much broader approach, addressing how the sugarcane expansion process unfolds in general terms, for segments (3), (4), (5), (6) and (7). The different approaches are discussed here.

Economic aspects

There is consensus among the different segments about the importance of sugarcane cultivation for Brazil's development, and its strategic role in the global scene in replacing fossil fuel consumption and expanding biofuel consumption, especially ethanol, due to the excellence, capacity, technology, and efficiency of national production.

Even for segment (3), the importance of sugarcane cultivation was emphasized, both at the farm level – due to its diverse uses (food and energy) – and at the national level, since the crop is capable of generating wealth both through domestic consumption and exports. This segment highlights the fact that it would be possible to implement a "national unity" agreement for the expansion of production and processing, as long as the model includes family-based production.

Restrictions for sugarcane expansion were pointed out mainly by segment (3) and are related to the model that concentrates land and income in the hands of large economic consortia, and to monoculture on large plots of land, with negative environmental impacts and social context. With regard to the environmental aspect, criticism of the expansion of a sugarcane monoculture is also corroborated by segments (5) and (6).

The criticism expressed by segment (3) of a model that excessively concentrates income and land ownership, in addition to its globalization aspect and threat against national sovereignty, is challenged by segment (1). This group also argues that in new mills, the areas to be used for the industrial facility and part of the sugarcane fields are indeed purchased, but only enough to ensure minimum levels of industrial operations. The argument used by segment (1) is that due to the highly perishable nature of sugarcane, production must be concentrated around the mills, *an aspect that must be added to the low added value of sugarcane, which in turn limits the costs of investments in logistics*. Another major part of the production – as per segment (1) – is provided by sugarcane planted on land that is owned or leased, or obtained from third-party suppliers[34]. Representatives of segment (1) thus argue that they do not concentrate land ownership. Another aspect highlighted by segment (1) refers to the economic development in areas where mills are established, generating more qualified and better employment. The opposition expressed by segment (3) highlights social exclusion and the migration of small and medium-scale farmers to urban areas or to new agricultural frontiers.

Social aspects

Whenever the social aspects associated with sugarcane are mentioned, the first one addressed by each segment refers to its considerable job-generating capacity, especially during the harvest season, and the impact caused by the increase of mechanized harvesting, especially in the State of São Paulo.

All segments believe that mechanization is inevitable, leading to a significant reduction in seasonal harvest jobs. Manual harvesting will be restricted to the Northeast and to areas with more than 12% of slope. In expansion areas, projects are already being implemented, anticipating the use of mechanized harvesting. They also are unanimous regarding the limited possibilities for employing manual harvest labor for other activities. For segment (1), some of the personnel displaced by mechanized harvesting[35] will be used to operate agricultural machinery in the new mills and on plantations, which are expected to expand, thus reducing the social impact of mechanization.

According to segment (2), the relatively high gains achieved by workers engaged in sugarcane harvesting are also important because they contribute to the local economy in these workers' home regions. In addition, they would not obtain similar gains in other agricultural activities due to their low level of professional qualifications. It must also be noted that a significant number of the workers employed in harvesting were absorbed by traditional sugarcane-producing municipalities and that mechanization will also have a negative impact on the local economy, where investments in harvesting machinery contributes further to the concentration of wealth.

Since this trend cannot be denied, segment (3) says that mill owners must contribute to the professional capacity-building process, using workers for other activities as well. For segment (6), mechanical harvesting will release areas that are inappropriate for mechanization for other crops, increasing the need for feasible proposals for the integration of these areas.

As far as social aspects are concerned, some companies in the sector maintain foundations with social responsibility profiles. The actions carried out by such foundations are mostly dedicated to education and health. They usually focus

34 For expansion areas, interviews showed that the supply of sugarcane for operating the mills must be in percentages that are from 50 to 80% of the sugarcane produced on the mill's own land or leased land; another amount – between 20 and 50% - should be purchased from suppliers, considering the operational capacity of the different industrial units. In the Northeast, mills work with high percentages of their own sugarcane. It is important to highlight that the Sugarcane Culture Statute (Decree-Law no. 3855, of November 21st, 1941), which remains in effect, establishes rules for the establishment of quotas for suppliers and ensures the grinding of sugarcane by the mill. Law no. 4870, of 1965, has updated the provisions of the statute and added the suppliers' participation in the evaluation of stocks and the payment of sugarcane according to its sucrose content. With time, the rigid legal provisions of the statute lost their power vis-à-vis the reality of the market, especially with the growth of Proalcool. The sector's deregulation, which started in 1990, also contributed to the inapplicability of such legal provisions.

35 According to information collected from mills operating in expansion areas and from consulting firms working in project design, mechanized harvesting is expected to take place mostly on the mills' own sugarcane areas and on about 50% of the suppliers' areas where mechanization is feasible.

on delivering services to communities in their area.

According to segment (1) representatives, social projects in this sector amount to about R$ 158 million, benefitting over 500,000 people. About half of these funds goes to education-related projects and about one quarter goes to environmental actions. Most of the beneficiaries are involved in cultural activities, amounting to almost 280,000 people, while 154 projects invest in work force capacity building, serving 30,000 people. Most of the projects involve training tractor drivers, general drivers, and machinery and combine operators, which clearly illustrates the trend toward mechanization in the sector[36].

Environmental aspect

The points of view of the different segments are divided among a rather broad spectrum. Divergences between segments (1) and (3) seem irreconcilable. One point of view that is widely disseminated among segment (1) representatives is that the sugarcane sector is under greater pressure from inspecting agencies than other sectors. They argue that sugarcane is a soil conserving crop because soil erosion control practices and appropriate management are widely adopted. Entrepreneurs also highlight the growing trend to comply with environmental legislation, mainly with regard to Areas of Permanent Protection (APP). The sector even affirms that it extends its environmental practices to leased land and to the areas of its suppliers, supporting them with concrete actions for the preservation of APP and the demarcation of Legal Reserve (LR) areas.

Opinions diverge on the economic feasibility and the rationality of reforesting areas that are currently being cultivated. According to segment (6), the sector will hardly be in a condition to comply with the legislation related to Legal Reserves, mainly in more traditional regions in the State of São Paulo. This group recommends that the sector should seek consensual feasible alternatives that may provide environmental gains. That must be done in forums that are appropriate for this debate.

For segment (3), the negative environmental impact of sugarcane expansion lies in burning and in the extensive areas of monoculture, which jeopardize biodiversity. According to this group, a continued expansion as per the current model will have negative impacts on the Amazon – due to the expansion of livestock production – and on the Cerrado, with rising rates of deforestation and desertification. The amount of vinasse produced also represents an environmental threat to this sector. For segment (1), this aspect is compensated for by the important role of ethanol in reducing greenhouse gases and its extremely positive energy balance. As for segment (6), certification is a major

36 Data provided by Unica

contribution to the environmental preservation of production areas, due to the requirements that will be established for exports.

Land tenure structure

Land tenure issues differ between areas that have traditionally been occupied by sugarcane and the new expansion areas. There is a well-consolidated land tenure structure in traditional production areas in the State of São Paulo and in the Northeast. Segment (1) highlights that there is no availability of land that is appropriate for crop expansion in these regions. Segments (3) and (6) agree. In the State of São Paulo, recent growth has taken place in areas previously dedicated to citrus production. Nevertheless, the volume of such areas is rather small, especially considering the magnitude of expansion anticipated[37]. In the Zona da Mata, in the Northeast, there is no room for a significant expansion of sugarcane, according to the segments interviewed.

As for segment (1), the expansion of sugarcane in new regions takes place based on economic effectiveness, which is dictated by the market. Therefore, sugarcane – which is more profitable than extensive livestock production – takes the lead, replacing pastures. The overall trend of sugarcane is that expansion takes place predominantly in these areas, but some units in Southern Minas Gerais and in states of the Central-West managed to establish sugarcane in areas cultivated with soybean and corn, when the remuneration levels were comparably lower than the economic gains obtained from sugarcane during harvests prior to 2006/2007.

Representatives of segment (1) say they face problems consolidating a 15 to 20,000 hectare module, which is required for their industrial units. The remuneration provided by the crop hampers the occupation of areas cultivated with grain, while traditional cattle ranchers resist leasing their areas.

For segment (1), expansion takes place without mobilizing relevant resources for land acquisition. For the implementation of new projects, the only land purchased will be that needed for the installation of the industrial unit and for the minimum module required for complementing the equation for its economic viability, which also provides the guarantees required for financing. Sugarcane itself is made viable mostly through the leasing of land for production. The remaining needs are met by suppliers. According to such an equation, segment (1) emphasizes that there is no concentration of land ownership in expansion areas. On the other hand, segment (3) expressed strong criticism towards the land lease practices in expansion areas, which established 12-year contracts, in which the revenues for the last 2 years are paid for in advance, during the first

37. 60% of Brazilian sugarcane production is concentrated in the State of São Paulo and 87.4% in the Center-South. Between 2002 and 2006, there was an expansion of 1.03 million hectares, 77% of which occurred on pastureland, 12% on other cropland, and 11% in new areas, according to data provided by ICONE. Production can still increase by an estimated additional 30-40% in the western part of the state, occupying pasture areas.

year of the contract. Thus, close to the end of the contract, land owners are at a disadvantage when the time comes for contract renewal. They are then willing to sell the area, since they have no possibility of earning any income the two following years.

Under these circumstances, the lease formats adopted break the existing ties between the owner and his land, leading to the interruption of the pre-existing activity. Segment (1) argues that the most common lease contracts are currently made for a 6 or 7-year period, without any anticipated payment. The sector also highlights that the mechanism for the remuneration of sugarcane based on the value of the final product – as established by Consecana[38]– is a transparent procedure that encourages production.

All segments unanimously point out that the arrival of sugarcane causes extensive livestock production to migrate to the new frontiers, which, according to group (3), will have an impact upon the Amazon Region. For segment (1), the arrival of sugarcane is perceived as a solution to the problem of full productive occupation of the farms, mostly for family agriculture with many heirs who are not willing to continue with agricultural activities.

For segment (3), a major problem of expansion with regard to land tenure is the increase in land prices and, consequently, its effects upon the governmental Agrarian Reform program, reducing the number of areas available for expropriation and the settlement of rural workers.

Relationship with other sectors

For segment (1), there are no problems in their relationship with other sectors. This group highlights the existing synergy with grain production in areas used for the renovation of sugarcane, demonstrating a positive co-existence. Nevertheless, the sector expressed some overall difficulties in expansion areas, one of these being the leasing of land. According to this segment, dialogue with traditional cattle ranchers is difficult, as they are opposed to the possibility of making their land available. Another factor underscored in the interviews was that the remuneration from grain production is currently higher than from sugarcane.

For segment (3), interaction could be enhanced if the mills were willing to stimulate the economy in the surrounding areas by buying locally produced food for their workers, for example. According to this group, this could benefit the dynamism of the local economy, thereby promoting a more harmonious relationship with family agriculture and food-producing settlements.

38. Consecana – the Council of Sugarcane, Sugar and Ethanol Producers of the State of São Paulo – is an association made up of representatives from the sugar and ethanol industries and sugarcane planters. Its main responsibility is to establish mechanisms for the relationship between suppliers and mills. A payment system for sugarcane was established based on the so-called Total Recoverable Sugar – TRS. TRS corresponds to the amount of sugar available in the raw material, minus the losses from the industrial process, and the prices for sugar and ethanol sold by the mills to domestic and foreign markets, based on technical criteria for assessing the quality of the product delivered by planters to the mills, and for determining the price to be paid to the rural producer. The adoption of the system is voluntary.

Certification

Even though the ethanol certification process is perceived differently by the various sectors, there is consensus that certification is an essential requirement for expanding consumption, and that it should be based on an economic-social-environmental tripod. Most interviewees affirm that certification should take place in the short and medium term.

For segment (1), such a necessity is the result of a common understanding that certification would be linked to the establishment of technical specifications for the different products, based on their use and according to the proposal being drafted by the National Institute for Metrology, Normalization and Quality – Inmetro[39]. The proposal aims to safeguard Brazilian biofuels against possible international trade barriers related to sustainability issues. The sector shares a widespread understanding that the Brazilian proposal for regulation is expected to be subject to additional foreign pressure, especially from European countries, due to their protectionism and agricultural subsidies, thus raising requirement levels.

For UNICA, which is represented in segment (1), there are no consensual principles or criteria established for certification at the international level. Nevertheless, a series of initiatives are underway, the majority of which are of European origin. The principal initiative is the European Union Directive on promoting the use of renewable energy sources. Despite its regional character, since it is intended for the European continent, the directive will be essential for increasing the demand at the global level, as it establishes rates for substituting fossil fuels for renewable energy sources. UNICA also highlights the existence of global multi-stakeholder initiatives. In general terms, the point of view of segment (1) is to defend the sector and to react against any certification process that may impose too many restrictions upon their actions.

Segment (3) showed an asymmetrical understanding of the topic. The concerns of the National Confederation of Agricultural Workers (Contag), represented in this segment, revolve mostly around labor issues. Environmental requirements are expected to lead to the acceleration of mechanized harvesting processes, which will in turn lead to reductions in employment. The organization says it faces a dilemma: on the one hand it wants to preserve harvesting jobs, on the other it wants to put an end to burnings and improve environmental conditions in production areas.

For the Federation of Rural Wage Earners of the State of São Paulo – Feraesp, also part of segment (3), certification as a market-driven regulation process has clear limits of outreach, but will have a major influence on production systems.

39. Inmetro published Administrative Rule no. 282, of 7 August 2008, submitting the proposal for a Regulation on Conformity Assessment for Fuel Ethanol for public consultation.

For the Small Farmers Movement (MPA) (segment 3) – which promotes biofuel production based on family agriculture – the certification and standardization of the product are essential and cannot be established solely according to the production conditions of large companies.

The entity proposes the adoption of levels of tolerance regarding the product's technical specifications depending on the scope of its use, based on the "captive fleet" concept and the sharing of responsibilities between suppliers and consumers. The Landless Workers Movement (segment 3) has a more extreme viewpoint. It sees certification as a cosmetic solution the intention of which is to please the market, providing elements that will enable it to adapt its discourse and itself to international requirements, given that the production model has been socially unfair ever since it was first conceived.

According to segment (7), international markets will only start demanding certification once they are certain that producers are apt to comply. They expect consumer markets to exert immediate pressure upon making certification more expeditious. According to segment (5) and (6), certification will be in effect starting in 2010 and will be important for exports, especially to Europe.

It is important to highlight that a high degree of certification requirements could lead to an extremely strong income concentration process in the sector, which would exclude small holders from competitive production. Compliance with guidelines and criteria may require major investments, which are not feasible for these producers. They would therefore be excluded from sugarcane production for ethanol. An example of this is the end of crop burnings prior to harvesting, which will require mechanization. The costs of a mechanical combine harvester and the adaptation of trucks for transporting the product to the mill exceed R$ 1 million, an amount that is inaccessible for many small and medium-scale producers.

b) Integration between sugarcane and food

The idea that sugarcane stimulates the production of food crops in sugarcane re-generation areas has been disseminated – to a greater or lesser extent – throughout the different segments interviewed. Planting grain in sugarcane re-generation areas belonging to large mills requires a high degree of specialization, technology, and logistics, due to the rigid programming of sugarcane planting in these areas, aimed at improving the yield and anticipating the harvest. Therefore, the mills usually outsource all activities related to grain crops.

Rotating sugarcane with commercial or green manure crops is more prevalent in the Southeast, while in the Northeast the occurrence of such a practice always had a social significance. In the latter, areas being renovated were offered to the workers responsible for harvesting sugarcane for the cultivation of subsistence crops, since they lived in areas near the mill or in the vicinity.

Workers harvest the sugarcane and are authorized to cultivate the areas under re-generation for their own consumption. The advantage for the mill owner – in addition to the fact that their workers obtain benefits from the indirect salaries provided by these crops, free of taxes and without any kind of additional disbursement – is weed control, which occurs through the cultivation of the area.

Such production is currently at a low technical level contrasting with the production Center-South region of the country. According to segment (1), progress in this field would be conditional on support and provision of machinery and technology.

In the Central-West Region, such synergy could be improved by alternating sugarcane with soybean or peanuts. Grain could be planted during two consecutive harvests before replanting sugarcane, which would improve soil conditions, according to segment (1). To achieve this, the current legal framework for land leasing — which is still governed by the Land Statute[40] — must be reviewed. The Statute's provisions do not make it attractive for traditional lessees to expand their scale of operation, mainly due to the timeframes to ensure a return on investments for machinery and inputs.

For segment (3), integration between food production and energy must take place at the farm level, based on agro-ecological systems for local consumption, sharing responsibilities between producers and consumers. Segment (4) highlights that milk processing agro-industries have been established in sugarcane expansion areas. Moving milk production to distant regions involves risks for the milk producers.

Sugarcane cultivation can stimulate food production effectively. The interviews did not provide any proposals for food production as an element for sugarcane certification, or propose targets for integration as a certification criterion. On the contrary, arguments were presented that oppose such an idea. The main argument refers to the specificities of each product: the different production processes may create obstacles for the certification process.

Two aspects proved highly relevant for the possibilities for integrating sugarcane production with livestock production and other crops, thus increasing food production:

40. Leasing is governed by Law no. 4504 of 1964, known as the Land Statute and by Decree 59566, of 1966.

• An essential aspect for rural development is the capacity for regional diversification in agriculture and for the farmer's specialization. One objective to be pursued is to ensure that the expansion of sugarcane production occupies areas currently used for other activities, without land ownership concentration and without displacing any groups from their land. Therefore, the integration of sugarcane, food, and livestock production (CHEF) represents a powerful opportunity, since it facilitates the release of areas for sugarcane based on the increased efficiency of the pre-existing production activities;

• The great availability of key elements such as sugarcane, grain, and energy clear the way for the implementation of clusters that are more sustainable for the production of grain – sugarcane – energy. In these regions, the production of ethanol could be associated with oilseed crops and the energy surplus could be used in the production of biodiesel.

c) The CHEF system

In general terms, the reactions to the different parts of the CHEF system were favorable, either by rotating with grain production, or integrating with livestock production.

The production of food in sugarcane re-generation areas is broadly accepted by segment (1) due to the improvements it makes in soil conditions for planting sugarcane. Integration with beef cattle production was considered extremely viable by segment (1), except by the representative of one mill, who argued that it was not economically feasible to use bagasse as cattle feed. All other interviewees were open to this type of integration, basing their standpoints on the availability of residues for feed production and the perspective that some of these products could be used more profitably than presently (bagasse used for electricity cogeneration).

Besides showing a generally positive view about the prospects for integration based on CHEF, the interviews resulted in the identification of several aspects that should be taken into consideration in the design of the integration system:

• Integration with food production in the Northeast Region and in sugarcane expansion areas requires the appropriate technology, adapted to the different types of regions and infrastructure, such as that of traditional production areas in the State of São Paulo – segment (1);

• In areas of irrigated sugarcane production, bagasse availability is more limited, due to use for energy for irrigation – segment (1);

• Additional studies should be conducted on the use of yeast for animal nutrition by optimizing drying processes and potential uses – segment (1);

• Integration with grain production in the Central-West Region takes place through a two-year period of grain cultivation before sugarcane re-establishment. It is therefore desirable that an adaptation to the legal framework for land leasing be carried out, creating more attractive conditions for lessees and stimulating investments, especially in machinery – segment (1);

• Integration with livestock production may be an important intervention for the co-existence between mills and land owners in sugarcane expansion areas, aiming at a more intensive use of arable land – segment (1);

• Integration enables the diversification of productive activities and revenues in the same production areas, especially with the use of areas that are not suitable for sugarcane production for pastures for beef cattle production – segment (2);

• Sugarcane planters' cooperatives could coordinate the implementation of integration, performing the necessary commercial mediation, such as the distribution of feed – segment (2);

• The negative impacts of large sugarcane monoculture areas can be mitigated through the zoning for sugarcane planting – segments (1) and (3);

• Integration with livestock production will promote greater efficiency in family agriculture, but public policies must be designed so that farmers can harmonize their productive systems – segment (3);

• Negotiations regarding the integration of sugarcane and food crop production must be collective, protecting the interests of workers and social movements – segment (3);

• In order to participate in the integration, farmers can organize themselves through rural condominiums – segment (4);

• Integration can be established by means of a Territory Certification, a concept still being formulated, but with great potential – segment (6).

Segment (1) judges that there are operational restrictions related to transport costs in relation to the area used by the farmers; logistics costs should not make the product more expensive. Segment (1) also highlighted two types of difficulties that are related to ideology and market constraints. At the ideological level, entrepreneurs say that the prejudice against the mills is a factor that inhibits dialogue with social movements and worker representatives. Market constraints are associated with feed production costs and the competitiveness compared to beef cattle produced on extensive pastures in agricultural frontier areas, according to segment (2).

The preferential use of bagasse for energy cogeneration – a potential limitation on the proposal – did not appear to be a bottleneck due to increased availability of bagasse. No restrictions are thus envisioned with regard to its use in feed production. Likewise, there is enough yeast available and there are no technical or cost-related difficulties. It should be noted, however, that improvements in the drying process could allow for a greater use of the product.

Another restrictive aspect refers to the integration mechanism. According to segment (3), it cannot duplicate the models currently used in the production of poultry and pork, or even of biodiesel, which social movements understand as "employment for wages in disguise". With regard to certification, segment (5) points to the fact that the system adopted for beef cattle should not be duplicated: they view it as a 'notary public' operation, due to the bureaucratic requirements for producers.

Another issue raised by the representatives of segments (3) and (6) refers to the need for public policies that promote the trade of the products generated by integration. The production stimulus must be associated with the establishment of mechanisms that foster trade. The intention is to avoid that eventual production excesses lead to a reduction in prices paid to producers, thus discouraging their activities.

chapter 6

chapter 6

The integration model and public policies

The CHEF system can be designed and implemented to reflect different market conditions, generate significant social benefits, and mitigate relevant environmental impacts. The main opportunities provided by the CHEF system are:

• Integration with livestock production (milk, beef, and mixed), by supplying feed made from sugarcane processing residues (bagasse, filter cake, yeast);

• Use of sugarcane re-generation areas for food crops;

• Intensified cattle production – based on the supply of feed – and the use of areas released for food or sugarcane production;

• Use of machinery and tractor (services that are often outsourced by the mills) downtime for cultivating areas previously used for extensive cattle production.

The main social benefits generated by such an arrangement are:

• Avoidance of the displacement or interruption of existing land use activities, either by small or large-scale producers;

• Income distribution income by generating opportunities outside the sugarcane sector;

• Preservation of traditional rural occupations, and added opportunities for labor and income to the sugarcane system;

• Diversified regional production, minimizing the effects of possible sector crises;

• Increased average income obtained from livestock production through intensification and technological gains.

The main examples of environmental impact mitigation are:

• Reduced risk of migration of extensive activities to preserved areas, minimizing the indirect land-use change effects on sugarcane expansion;

• Improved use of sugarcane production residues and increasing its value;

• Reduced risk of environmental impacts deriving from inappropriate residue disposal;

• Reduced greenhouse gas emissions.

As demonstrated in the analysis of the recent sugarcane expansion period (1996-2006), integration does not occur naturally. Despite the advantages of integrated production, concerted actions and large-scale operations that reach beyond the private sectors involved are needed in order to make it viable.

As shown in Figure 15, the likely region for sugarcane expansion and for the construction of new mills and distilleries corresponds to several rural territories in seven states and the Federal District. Figure 16 presents Production Credits for Family Agriculture (Pronaf) implementation in relation to the sugarcane expansion area. Despite the predominance of extensive large-scale beef cattle production in the sugarcane expansion area, there also is a significant number of family farmers.

Each territory has specific characteristics with regard to land tenure status, productive matrix, physical environment, infrastructure, and development. These conditions entail a diversity of situations and actors that need to be considered individually. The first strategy is to promote a discussion of sugarcane expansion at the territorial level – both in terms of geography and management – to promote a better understanding.

The point of view and the needs of each sector have to be considered to find a technical approach and an organizational arrangement that make sense in each specific territory. Responsibilities and duties must be attributed to stakeholder groups in order to promote an integrated productive adjustment capable of ensuring mutual benefits, and so that the concessions made by each party may be balanced and distributed in an equitable manner.

This agreement should also define management mechanisms, indicators, and targets for sugarcane expansion. These must be in line with public policies and subject to adjustments, according to the specific needs of the agreement being proposed. New mechanisms and regulatory authorities may arise. Examples include Consecana and voluntary certification. But the measures for creating synergy and the conditions for integrated production will be specific to each territory and its multiple actions. An agreement between the different stakeholders involved is essential.

The Ministry of Agrarian Development (MDA) may act as the focal point of the coordination process, due to the role it plays with regard to family agriculture and the overall vision that has already been created through extensive discussions about rural territories. The following mechanisms may serve as examples for creating such an agreement:

a) Integration with Citizenship Territories

There is considerable overlap between the Citizenship Territories and the areas for sugarcane expansion in seven states and the Federal District: MS (Reforma and Grande Dourados), MG (Northeastern Minas Gerais), SP (Pontal do Paranapanema), GO (Vale do Rio Vermelho, DF/GO/MG (Águas Emendadas), RJ (North), ES (North), and MT (Baixo Araguaia).

In order to discuss the formats for the integration of these territories, specific forums with a diverse composition could be established, reflecting the points of view of multiple stakeholders. Social movements, mills, dairy farms, grain and plant oil producers, and government agencies should participate, among others.

Discussions in these forums could be supported by capacity building and training actions for development agents on specific topics. The dialogue would be supplemented with available data and enriched with complementary information provided by the 2006 Agricultural Census. Elements contained in this study can provide inputs for discussions and for the training of participants, helping to establish a common ground and supplying all the databases available in order to meet the needs for regional information.

b) Agreements on territory-based integration: food – energy – community – environment

Discussions, proposals, and actions regarding integrating sugarcane with livestock and food production could be set out in a document structured as an agreement, with clearly defined targets and responsibilities for each segment. The agreement would be included in the Territorial Plans for Sustainable Rural Development (Planos Territoriais de Desenvolvimento Rural Sustentável –

PTDRS). The MDA would be responsible for providing support for drafting this agreement.

c) Coordination between agreements and public policies

A central aspect would be the coordination with:

• Actions for the sustainable organization of production, especially with credit provided under the National Family Agriculture Program – Pronaf, whose purpose is to allow farmers to structure their productive systems according to the new possibilities provided by integration;

• Technical Assistance and Rural Extension services, in order to provide support in terms of the knowledge, techniques, and organization required for family farmers' adaptation;

• The Food Purchase Program (Programa de Aquisição de Alimentos), so that it may buy the additional output that will be provided by these territories.

Criteria for prioritizing the actions contained in the pact could be negotiated whenever they involve obtaining credit from the National Bank for Development - BNDES and other official banks by means of credit lines such as Finame, or even for obtaining licenses for these undertakings, since their implementation would be subject to the regional development strategies stated in the agreement.

d) Forums of municipalities not included in the Citizenship Territories

In those states where sugarcane expansion does not coincide with the Citizenship Territories – such as in Paraná – or where municipalities with major expansions are not organized as territories, specific forums could be established with a similar design, and with the aim of drafting the agreements. In these cases, the MDA could offer the same kind of management support, helping to draft the agreement and provide capacity building to agents on specific topics.

In order to render the actions proposed in the pact effective, the same degree of priority would have to be ensured for the integration of public policies for the sustainable organization of production that has been granted to the Citizenship Territories.

e) Mediation of relationships

The implementation of actions foreseen under the agreements will certainly require mechanisms for mediating relationships among the various economic agents. Such mechanisms must be capable of overcoming asymmetries in information and proposing fair remuneration criteria that may ensure the profitability of products and activities. For example, the price to be charged for cattle feed must be rewarding for both the mills and the cattle ranchers.

Consecana has a successful model that could be studied and used as a benchmark for devising mechanisms capable of ensuring the mediation of relationships in the territories and for establishing transparent ways of arriving at fair prices for the products.

f) Certification

The experience of implementing specific forums and the drafting of territory-based agreements may generate new types of relationships between concerned groups – as well as socially, economically, and environmentally sustainable forms of production – offering ideas for innovations regarding certification mechanisms. A new type of certification may include groups of family farmers and a territorial focus, with regulations that are typical for certification processes. The harmonious coordination of all these elements may provide a solution for the development of sustainable systems for food and energy production, possibly relevant also in other countries around the world.

g) Food and energy production conglomerates

Ethanol-processing industries have energy surpluses that could be used by other industries, such as food-processing companies and businesses that process oilseed crops for biofuel production. MDA could devise mechanisms and instruments for encouraging the agglomeration of these units and the formation of clusters, since many sugarcane expansion areas have conditions that are favorable to the production of grain, in addition to having family farmers that can participate in the integration project. Furthermore, the proximity of these industries increases the potential for integration with cattle breeding and food production.

h) Monitoring in support of productive clusters and agreements

The monitoring and evaluation of targets and the responsibilities contained in the agreement are essential for providing feedback and input for implementation and modifications, whenever necessary. Information is also required to ensure an effective follow-up.

Figure 15 Distribution of Rural Territories and an indication of regions likely to experience sugarcane expansion.

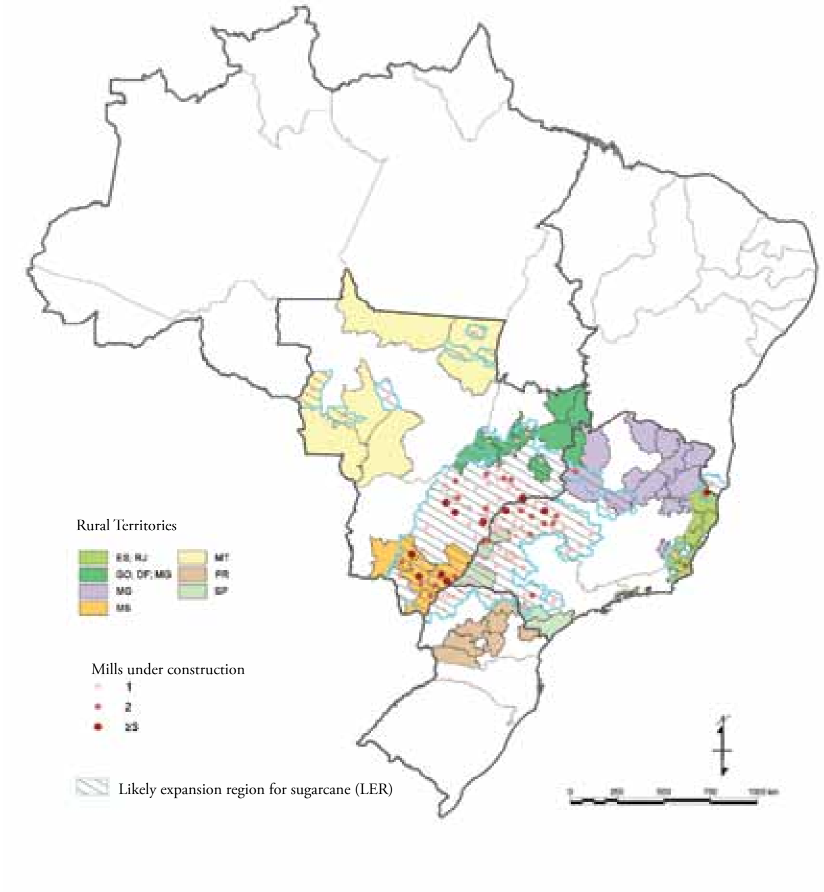
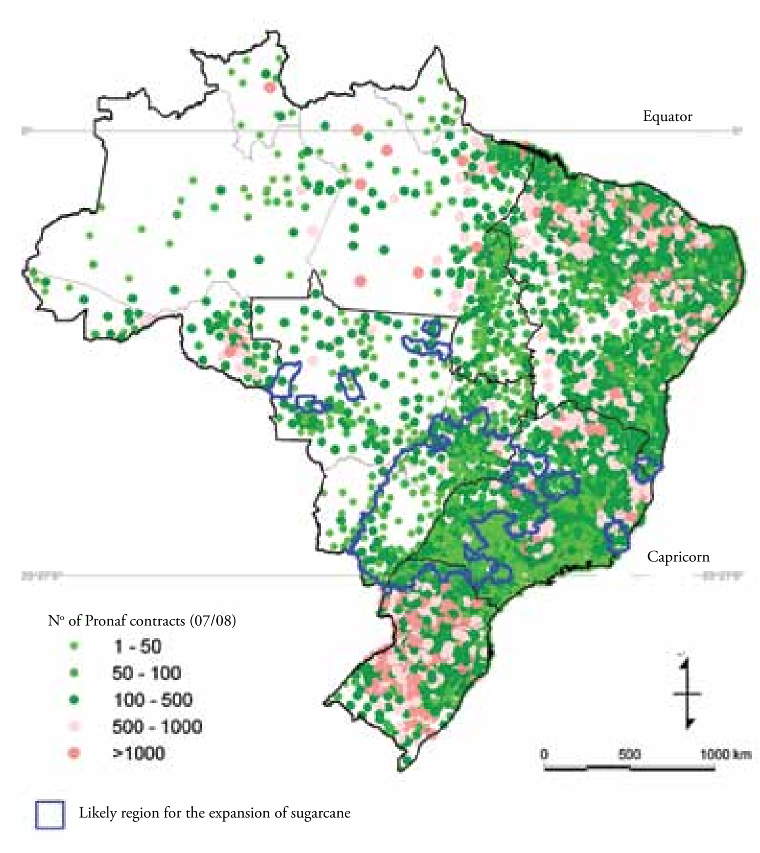


Figure 16 Production Credits for Family Agriculture (Pronaf) implementation in relation to the sugar-cane expansion area



chapter 7

chapter 7

Final remarks

Ensuring sustainable, inclusive, and socially fair expansion of sugarcane ethanol in Brazil, with its complex and rapidly developing agriculture and biofuel sectors, will likely require several complementary actions. The mutual cooperation mechanisms that have actually been implemented in the recent history of sugarcane expansion in Brazil are less diversified and synergistic than the here described possibilities for integrating sugarcane production with traditional land-use dynamics in the expansion regions.

Stakeholders involved with or affected by sugarcane ethanol expansion (rural workers, land owners, cattle ranchers, farmers, mill owners) appear to have rather limited and narrow views on the possibilities for cooperation and integration. But existing models for ethanol production may not be applicable given the growing organizational complexity, the new environmental challenges, and the desire for a more fair and equitable society.

There is no single solution for the difficult issues raised and the magnitude of the problems at hand. This report presents a promising model for integrated food and biofuel production and a conceptual framework upon which agreements may be built, involving several stakeholder groups and engaging their capacity to contribute. In relation to this, MDA could play a key role as an agent capable of changing how biofuel expansion is perceived in Brazil.

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annex A

Integration of the sugar and alcohol industry with cattle breeding

1. Size of industry (assumption)

- Industry processing 1 million tons
- 15,000 hectares of sugarcane fields
- Daily grinding of 6,000 tons of sugarcane

2. Availability of byproducts

Assuming that the industry uses 36.5% of all harvested sugarcane for the production of sugar and 63.5% for the production of alcohol and that its industrial yields are 109 kg sugar/ton of ground sugarcane and 82.3 liters of alcohol/ton of sugarcane, it will produce 39,785 tons of sugar and 52.26 million liters of alcohol. This output will enable the industry to supply the following quantities of byproducts:

• Sugarcane bagasse – 60,000 tons (60 kg per ton of ground sugarcane).

The bagasse surplus being considered is 20% => 60 kg of bagasse (50% of dry matter) per ton of ground sugarcane. For the simulation of mill production we considered the use of only 20 kg of bagasse (50% of the dry matter) for each ton of ground sugarcane;

• Filter cake – 25,000 tons (25 kg per ton of ground sugarcane).

Considering a surplus of 25 kg per ton of ground sugarcane. This would only be used for the maintenance feed, at the rate of 3 kg/cow/day. In the simulation of cattle breeding integration, we took into consideration the use of only 20% of the filter cake produced by the mill.

• Yeast slurry – 4.7 million liters (0.09 liter per liter of alcohol produced).

By using 4% of the yeast milk obtained from the centrifugation of the fermented juice, the production of liquid yeast (20% of the dry matter) would be 0.09 liter/liter of alcohol produced. This slurry would be integrally used for feed production.

• Vinasse – 525 million liters (10-11 liters of vinasse per liter of alcohol produced).

Production of 10-11 liters of vinasse per liter of alcohol produced. It would be used only for the maintenance feed, at a rate of 10 liters/cow/day. Vinasse was not considered for use in the size-related simulations of the beef cattle or dairy farms associated with the mill.

• Molasses (every 2.8 kg of molasses withdrawn from the industry reduces the production of alcohol by about 1 liter).

The byproducts generated by a standard mill are presented in Table 17 below.

[Table 17] Byproducts generated by a standard mill (processing 1 million tons of sugarcane)

Byproduct	*Total generated*	*For use as feed*	
	kg/ton of ground sugarcane	*%*	*tons*
Bagasse	300	6-7	20,000
Filter cake	25	20	5,000
	L/L of alcohol produced		*liters*
Yeast slurry	0.09	100	47,000
Vinasse	10-11	-	-
	kg		*kg*
Molasses[1]	0	-	2,000 – 4,000

1. 2.8 kg of molasses withdrawn from the industry reduce the production of alcohol by about 1 liter.

3. Treatment of Bagasse

Sugarcane bagasse is the most relevant byproduct of the mill–cattle breeding integration. However, its nutritional value is low (30 – 35% digestibility). High pressure steam hydrolysis can increase its digestibility to values above 65%, turning it into a bulky feed, the equivalent of a good pasture in terms of digestible energy.

The hydrolysis treatment is carried out inside pressure vessels: the hydrolyzers. The available equipment has capacity for up to a 5 m^3/treatment cycle, which is carried out in batches, whereas the hydrolyzer is fueled by sugarcane bagasse. Next, the hydrolyzer is closed and vapor is injected. The bagasse is cooked in vapor for 3 to 8 minutes, depending on several factors, such as the initial temperature of the pressure vessel, the humidity of the bagasse, the vapor pressure, etc. Next, vapor is suddenly liberated through a quick opening valve and its expansion transports the cooked bagasse to a cyclone that separates the vapor from the treated bagasse. The investment for a 5 m^3 hydrolyzer is between R$ 100,000 and R$ 150,000, depending on the adaptations required in the industrial plant. Hydrolyzers are usually installed at the end of the bagasse conveyor, after the boilers.

Production capacity of one 5 m^3 hydrolyzer
700 kg/batch
4 batches/hour
56 t/day (in 20 hours of operation – 3 shifts)

Labor force productivity
1 operator can operate up to 4 hydrolyzers simultaneously

4. Feed preparation

Hydrolyzed bagasse can be mixed with industry byproducts and other external ingredients to produce feed for beef cattle and dairy cows. For the preparation, a stationary feed mixer with a scale is required for weighing and mixing the ingredients. The equipment's mixing capacity can be up to 5,000 kg/batch and may handle up to 4 batches/hour. For confined or dairy cattle diets, the mix is about 50% bagasse. This feed mixer can thus be used for the production of hydrolyzed bagasse of up to four 5-m^3 hydrolyzers, resulting in a daily output of up to 400 tons of feed.

The complete moist feed produced can be used for beef and dairy cattle production systems located within 200 km from the mill. It can be conserved for up to 3 days without any special handling requirements. But if it is ensilaged – like maize or sorghum silage – it can be stored for long periods of time (beyond 12 months). Daily portions can be removed from the silo as necessary. A stationary feed mixer and its accessories (silos, loading hoppers, conveyors, etc.) cost between R$ 200,000 and R$ 300,000. Table 18 presents suggestions for feed for confined and dairy cattle and cattle in maintenance.

[Table 18] Examples of feed in which an average of 50% of the mixture consists of hydrolyzed bagasse

Inputs	Unit cost (R$/kg)	Quantity (kg/LU/day)		
		Total feed for confined cattle DWG = 1.0 kg/LU/day	Total feed for lactating cows = 12 kg milk/cow/day	Total feed for breeding cows - maintenance
Natural bagasse	0.010	1.00	1.00	-
Hydrolyzed bagasse	0.040	11.00	14.00	12.00
Liquid yeast	0.025	7.00	8.00	6.00
Molasses	0.200	0.30	0.40	-
Filter cake	0.010	-	-	3.00
Vinasse	0.005	-	-	10.00
Ground sorghum	0.250	2.30	2.30	-
Soybean meal	0.600	0.30	1.20	-
Urea	1.250	0.12	0.15	0.10
Calcite	0.120	0.10	0.12	0.08
Mineral suppl./ additives	0.800	0.15	0.16	0.10
TOTAL OM*		22.27	27.33	31.28
DM**		10.32	12.96	8.88
GP***		1.28	1.78	0.91
TDN****		6.46	8.20	5.11
Cost of inputs (R$/LU/day)		1.73	2.48	0.92
Operational cost mill (R$/LU/day)				
(R$ 17,47/ton of feed)		0.39	0.48	0.55
Other costs at farm (R$/LU/day)		0.25	1.97	0.25
Total cost (R$/LU/day)		2.37	4.93	1.72
Cost (R$/t of feed)		95.19	108.30	47.00

*Organic matter; ** Dry matter; *** Gross protein; **** Total digestible nutrients.

The types of feed described in the chart above are merely suggestions for using byproducts from the sugar and alcohol industry. There also are feed alternatives for other cattle categories as well as for sheep and horses. Such feed could be used for confinement or for feeding premises located close to the mill. It could also be sold in bulk for cattle breeders also located close to the mill. The feed can be conserved for long periods of time as silage, with a minimum loss of nutritional value.

Confinement feed is formulated for daily gains of only 1 kg/LU in order to reduce the inclusion of inputs that are not mill byproducts. It can also be formulated for gains of 1.2 or 1.3 kg/LU/day simply by raising the proportion of grain in the diet. Using such feed will result in a production cost of R$ 1.91/kg, according to the example shown in Table 19.

[Table 19] Weight gain and yield of the initial and final carcass in a 120-day confinement example with complete feed

	Initial	Final	Gain
Weight of live cattle	360 kg (12@)	480 kg (17@)	120 kg
Carcass yield	50%	53%	3%

The feed for lactating cattle meets the needs of cows with 400 – 500 kg of live weight that produce 12 kg of milk/day. Thus, with complete feed and considering that the product provides for about 60% of total milk production costs, the cost of the milk produced would only be R$ 0.41/kg. This feed can be used for cows with higher production levels by providing an additional kilogram of concentrate for each 3 kg of milk produced – above the average of 12 kg milk/cow. For cows with lower production and good body condition, the feed can be supplied in limited quantity, depending on the animal's nutritional requirements.

A herd with 100 lactating cows can be fed for a year with 1,000 tons of this feed, or 10 tons of feed/cow/year. The feed can be ensilaged and its post-compacting density will exceed 750 kg/m^3. The dairy herd can be kept in pastures under intensive management during the rainy season and confined with feed during the dry period.

Maintenance feed can be used for breeding cattle during the dry season by complementing what is available from the pastures, enabling farm support to be adjusted according to the cattle holding capacity during the rainy season. It can also be used for maintaining other categories of cattle, such as raising dairy heifers, rearing bull-calves and non-lactating dairy cattle. The use of this feed will result in a production cost of R$ 1.91/kg or R$ 0.41/kg of milk, which represents a 50% average net margin for the producer.

5. Size of Supplemented Herd

The table below shows the total availability of protein and energy (TDN) that the byproducts of a mill with capacity for one million tons of sugarcane could provide for feeding cattle.

[Table 20] Gross protein (GP) and total digestible nutrients contained in the byproducts of a mill that annually processes one million tons of sugarcane

Byproduct	Quantity (t)			
	OM**	DM***	GP****	TDN*****
Hydrolyzed bagasse (*)	20,000	10,000	100	5,600
Filter cake	25,000	7,500	675	4,125
Yeast slurry	4,700	940	282	752
Vinasse	525,000	26,250	3,675	15,750
Total	614,700	64,690	4,932	37,127

(*) The bagasse surplus would be 60,000 t.. Nevertheless, 2t have to be burned in order to produce vapor and hydrolyze 1t; (**) Organic matter; (***) Dry matter; (***) Gross protein; (*****) Total digestible nutrients.

Of course, using vinasse for animal feed, which is already widely used for the fertirrigation of sugarcane plantations, is more difficult. But considering only the TDN of bagasse and yeast, and using 20% of filter cake, with an additional 15% of external ingredients (energy grains, meal, mineral supplements, feed additives, etc.), a mill this size can produce feed for the following herds annually:

Confined cattle

16,000 LUs for 120 days

Daily weight gain = 1 kg/LU/day

Annual production = 1,950 tons to 2,100 tons

Lactating cows

4,000 lactating cows

Daily production = 12 kg milk/cow/day

Daily production = 40 to 50,000 liters milk

Annual production = 16 – 18 million liters milk

[Table 21] Example of a supplemented beef cattle herd

Producer	Number of producers	Confined LU	Total LU
Small	40	25	1,000
Medium	40	250	10,000
Large	5	1,000	5,000
Total	85	-	16,000

[Table 22] Example of a supplemented dairy cattle herd

Producer	Number of producers	Lactating Cows	Milk/day	Total milk/day
Small	100	10	100	10,000
Medium	50	40	500	25,000
Large	5	120	1,500	7,500
Total	155	-	-	42,500

6. Total Investment

A mill with 1 million tons of sugarcane/year would be well equipped with two 5-m^3 hydrolyzers and one stationary feed mixer, amounting to a total investment of about R$ 540,000. The daily amount of feed produced would be 200 to 250 tons, with a total of about 40,000 tons for a 200-day harvest.

Table 23 shows a balance sheet for processing 40,000 tons of feed during a 200-day harvest.

[Table 23] Balance sheet for the processing of 40,000 tons of feed during a 200-day harvest (20,000 t confinement feed -> 7,500 LUs confined for 120 days; 15,000 t dairy cattle feed -> 1,500 lactating cows for 365 days; 5,000 t maintenance feed -> 1,750 cows supplemented for 90 days)

Investment				
Type	Unit		Reais	% Invest.
Hydrolyzer	2		300,000	56
Stationary mixer	1		240,000	44
Total investment			540,000	
Cost				
Inputs	$ Reais/t	Tons	Reais	% Cost
Internal inputs				
Natural bagasse	10	1,447	14,470	0.4
Hydrolyzed bagasse	40	19,481	779,240	20.8
Liquid yeast	25	11,637	290,925	7.8
Molasses	200	489	97,800	2.6
Filter cake	10	480	4,800	0.1
Vinasse	5	1,599	7,995	0.2
Subtotal		**35,133**	**1,195,230**	**31.8**
External inputs				
Ground sorghum	250	3,328	832,000	22.2
Soybean meal	600	929	557,400	14.8
Urea	1,250	207	258,750	6.9
Calcite	120	169	20,280	0.5
Mineral suppl./additives	800	239	191,200	5.1
Subtotal		**4,872**	**1,859,630**	**49.5**
Cost of ingredients	-		*3,054,860*	*81.4*
Operational cost (*) 1 Hydrolyzer operator – 3 shifts 1 Mixer operator – 3 shifts	-		63,000	1.7
Equipment maintenance	-		54,000	1.4
Depreciation 10 years	-		54,000	1.4
Transportation cost 50 km	-		528,000	14.1
Total cost	-		3,753,860	
Return				
Ceiling for competitive feed sales price: Confinement feed (+25%) (**) Lactating cow feed (+25%) (***) Maintenance feed (+25%) (****)			$ Reais 4,692,325	
Net profit for mill			938,465	

(*) Operational cost of feed production is equal to 23% of cost of ingredients or R$ 17.47/ton of feed; (**) Confinement feed would be sold for R$ 120/t and the production cost of fed cattle would be R$ 2.33/ kg, the equivalent of the cost of traditional feed made from silage or chopped sugarcane; (***) Lactating cow feed would be sold for R$ 135/t and the production cost of milk would be R$ 0.50/l - very competitive; (****) Maintenance feed would be sold for about R$ 60/t, equivalent to the current production costs for sorghum silage. But the maintenance feed is already a balanced feed. Silage would require protein and mineral supplements.

Figure 23: Integration sugar & alcohol industry – dairy cattle breeding

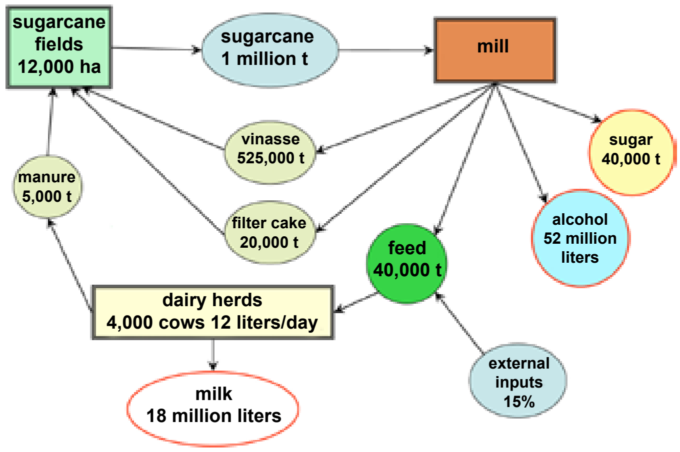
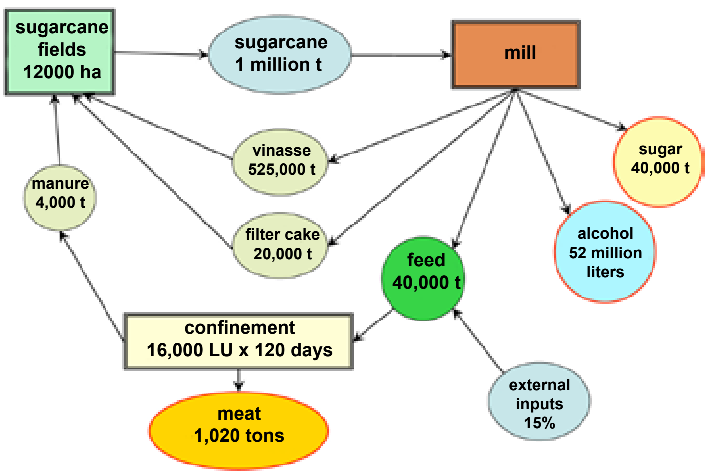


Figura 24: Integration sugar&alcohol industry – beef cattle breeding



annex B

Integration between the sugar-alcohol industry and cattle breeding, the cattle breeder's profile and a simulation of the impact of integration on the production system

Introduction

The five profiles of cattle breeding activities that may become part of an integration project with the sugar-alcohol industry by liberating part of their pasture areas for sugarcane production are listed below. These groups can maintain or improve their herds and productivity rates by using complete feed during the dry season. The availability of feed during this period enables integrated cattle breeders to balance the use of their pastures due to the support they have during the rainy season. Therefore, the integration simulations presented herein indicate that it is possible to maintain herds in a smaller pasture area and still register gains in productivity.

Profiles

1 – Stabilized Cattle Breeding: Cow-calf, raising and finishing herd. Efficient. 500 ha of pastures.

2 – Extensive Cattle Breeding: Cow-calf, raising and finishing herd. Low production efficiency. 500 ha of pastures.

3 – Integrated Cattle Breeding: Raising and finishing herd. Average production efficiency. 200 ha of pastures.

4 – Special Cattle Breeding: Dairy herd. Low production efficiency. 20 ha of pastures.

5 – Strategic Cattle Breeding: Dairy herd. High production efficiency. 20 ha of pastures.

According to the profiles considered and the type of cattle breeding practiced, integration managed to liberate the following percentages of pasture areas for sugarcane production:

1- Stabilized Cattle Breeding – beef (cow-calf, raising and finishing) -> 42.5% of pasture area liberated
2 – Extensive Cattle Breeding – beef (cow-calf, raising and finishing) ->55.0% of pasture area liberated
3 – Integrated Cattle Breeding – beef (raising and finishing) -> 60.0% of pasture area liberated
4 – Special Cattle Breeding – dairy -> 55.4% of pasture area liberated
5 – Strategic Cattle Breeding – dairy -> 34.6% of pasture area liberated

Profile 1 Stabilized Cattle Breeding
Cow-calf, raising and finishing herd – 500 hectares of pastures

Description: Profile 1 refers to cattle breeders specializing in beef cattle breeding, raising and finishing; adopting appropriate zootechnical practices, such as having a mating season, industrial crossing and herd supplementation. Some animals are used for milk production and extraction, with the aim of generating an additional monthly income and to cover the labor costs incurred as well as other minor expenditures.
Herd size: 314 beef cows, 730 animals, 30 lactating cows.
Annual production:
241 animals for sale, distributed as follows:
111 weaned calves;
24 twenty-month-old bull-calves;
23 fed cattle for slaughter;
17 twenty-month-old heifers;
54 culling cows and heifers for slaughter;
1 culling bull;
87,600 kg milk (240 kg/day).
Impact of integration: Liberation of 212.4 ha for sugarcane planting; use of 665 t of feed for feeding 280 animals (confinement and lactating cows) during the dry season. The improved nutrition of lactating cows during the dry season will increase average milk production. Calves fattened on the farm will be ready for slaughter at 24 months of age – using confinement at the final finishing stage.
Size of integrated herd: 314 beef cows, 817 animals, 30 lactating cows.
Annual production: 239 animals for sale, distributed as follows:
121 young calves (24 months) are for slaughter:
54 24-month heifers for slaughter;
64 culling cows and heifers for slaughter;

1 culling bull;

109,500 kg milk/year (300 kg/day).

Integration will provide for an increase in net revenues of about R$ 34,400 (about 28%), only from cattle breeding. In addition, the leasing of 212.4 ha for sugarcane planting can provide a supplementary revenue of R$ 76,448/year.

STABILIZED HERD - BEEF CATTLE - WITHOUT INTEGRATION
breeding, raising and finishing activities + extractive milk production

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS	247			3	37	207	247	247
2-3 YEAR CALVES	67				27	40	67	67
1-2 YEAR CALVES	86			1	17	67	86	51
0-1 YEAR F CALVES	124			1	37	86	124	37
BORN CALVES YEAR		259		12		247		
0-1 YEAR M CALVES	124			1	74	48	124	49
1-2 Y YOUNG BULLS	48			1	24	23	48	34
2-3 YEAR OXEN	23				23		23	23
BULLS	11		1		1	11	11	14
TOTAL	730	259	1	19	241	730	730	523

birth rate(%)	= 82
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows = 314	
cow/bull ratio = 30	
No. of lactating cows = 30	Average Production = 8 kg cow/day

CHART 2. STABILIZED HERD - HERD STATUS DURING THE "RAINY" AND "DRY" SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS	247	247	247		210	210	210		
2-3 YEAR CALVES	67	54	67		40	34	40		
1-2 YEAR CALVES	86	51	86		68	48	68		
0-1 YEAR F CALVES	124	37	124		87	43	87		
BORN CALVES YEAR									
0-1 YEAR M CALVES	124	37	124		49	25	49		
1-2 Y YOUNG BULLS	48	39	48		24	19	24		
2-3 YEAR OXEN	23	21	23		12	10	12		
BULLS	11	14	11		11	14	11		
TOTAL Animals	730		730		501		501		
TOTAL LU		500	500			404	404		
NUMBER OF BREEDING COWS TO BE SUPPLEMENTED DURING DRY SEASON WITH VOLUMINOUS FEED = 0									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine					0
Days of confinement/supplementation	45	150	100	70	-
Feed consumption (kg/Animals/day)	25	25	20	18	-
Total feed required (t) (*)					-

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine				0
Days of confinement	45	100	70	-
Initial weight (kg)	350	300	280	-
Weight gain (kg/Animals/day)	1,100	1,300	1,200	-
Slaughter weight (kg)	400	430	364	-
Carcass yield (%)	50	52	52	-
Slaughter weigth (@)	13.32	14.91	12.62	-

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (LU/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.00	0.81		500.0	500.0
Intensive	3.00	1.20			
TOTAL				500.0	500.0
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- **first semester: R$ 80.00**
- **second semester: R$ 85.00**

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle			5,950.00	5.65
- Pasture fertilization				
- Pasture maintenance and cleaning	500.0 ha	12.00	6,000.00	5.69
- Mineral salt	16.43 t	1,275.00	20,941.88	19.87
- Protein mineral salt	2.18	560.00	1,221.57	1.16
- Feed				
- Electricity	12 months	200.00	2,400.00	2.28
- Veterinary products	500.0 UA	12.75	6,375.00	6.05
- Harness and several utensiles	500.0 UA	11.05	5,525.00	5.24
- Labor force	4	10,368.00	41,472.00	39.36
- Diesel oil and lubricants				
- Taxes and levies			4,510.72	4.28
- Maintenance of premises	500.0 UA	17,00	8,500.00	8.07
- Miscellaneous			2,482.53	2.36
TOTAL			**105,378.69**	**100.00**

ANNUAL REVENUES (R)				Amount (R$)	Avge. Value R$/Animals
CATTLE SALES	**No.Animals**	**Weight (@)**	**Value (R$/@)**		
Culling cows/heifers	64	12.00	72.00	55,697.66	864.00
20-month heifers	17	8.00	79.20	10,844.84	633.60
Weaned female calves	37	5.00	86.40	16,029.87	432.00
Weaned male calves	74	6.00	100.00	44,527.42	600.00
20-month young bulls	24	9.00	88.00	19,196.07	792.00
Oxen finished on pasture	23	16.00	80.00	29,743.95	1,280.00
Culling bulls	1	20.00	80.00	1,600.00	1,600.00
SUBTOTAL	**241**			**177,639.81**	**735.95**
MILK PRODUCTION	**kg/day**	**kg/year**	**Value (R$/kg)**	**Total A. (R$)**	
Milk production	240	876.00	0,60	52,560.00	
SUBTOTAL				**52,560.00**	
LEASING FOR SUGARCANE	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane		12	30.00		
SUBTOTAL					
TOTAL				**230,199.81**	

ANNUAL INCOME (R-C)	**124,821.12**

STABILIZED HERD - BEEF CATTLE - WITH INTEGRATION
breeding, raising and finishing activities + extractive milk production

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS	247			3	37	207	247	247
2-3 YEAR CALVES	67				27	40	67	67
1-2 YEAR CALVES	123			2	54	67	123	74
0-1 YEAR F CALVES	124			1		123	124	37
BORN CALVES YEAR		259		12		247		
0-1 YEAR M CALVES	124			1		123	124	49
1-2 Y YOUNG BULLS	123			2	121		123	86
2-3 YEAR OXEN								
BULLS	11		1		1	11	11	14
TOTAL	817	259	1	21	239	817	817	574

birth rate(%)	= 83
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows= 314

cow/bull ratio = 30

No. of lactating cows = 30

Average Production = 10 kg cow/day

CHART 2. STABILIZED HERD - HERD STATUS DURING THE “RAINY” AND “DRY” SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS	247	247	247		210	210	142		68
2-3 YEAR CALVES	67	53		67	40	34		13	27
1-2 YEAR CALVES	123	74		123	69	48		15	54
0-1 YEAR F CALVES	124	37	124		124	5		124	
BORN CALVES YEAR									
0-1 YEAR M CALVES	124	37	124		124	49		124	
1-2 Y YOUNG BULLS	123	98		123	121	97			121
2-3 YEAR OXEN									
BULLS	11	14	11		11	14	11		
TOTAL Animals	817		505	312	698			275	270
TOTAL LU		560	335	225		457	155	76	225
NUMBER OF BREEDING COWS TO BE SUPPLEMENTED DURING DRY SEASON WITH VOLUMINOUS FEED = 31									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine	64	31	121	54	270
Days of confinement/supplementation	45	150	120	90	100
Feed consumption (kg/Animals/day)	25	27	22	18	22
Total feed required (t) (*)	79	140	350	96	665

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine	64	121	54	238
Days of confinement	45	120	90	93
Initial weight (kg)	360	350	280	337
Weight gain (kg/Animals/day)	1.200	1.200	1.100	1.177
Slaughter weight (kg)	414	494	379	447
Carcass yield (%)	50	52	52	51.5
Slaughter weigth (@)	13.80	17.13	13.14	15.32

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (UA/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.50	0.70		223.3	223.3
Intensive	3.50	1.18		64.3	64.3
TOTAL				287.6	287.6
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle			5,950.00	2.91
- Pasture fertilization	64.3 ha	160.00	10,291.48	5.04
- Pasture maintenance and cleaning	287.6 ha	12.00	3,451.20	1.69
- Mineral salt	16.38 t	1,275.00	20,878.14	10.22
- Protein mineral salt	5.52	560.00	3,091.72	1.51
- Confinement feed	525.5 t	120.00	63,060.88	30.86
- Dairy feed	139.9 t	150.00	20,991.52	10.27
- Maintenance feed		60.00		
- Electricity	12 months	200.00	2,400.00	1.17
- Veterinary products	560.1 UA	12.75	7,141.43	3.50
- Harness and several utensiles	560.1 UA	11.05	6,189.24	3.03
- Labor force	4	10,368.00	41,472.00	20.30
- Diesel oil and lubricants				
- Taxes and levies			7,094.98	3.47
- Maintenance of premises	560.1 UA	17.00	9,521.90	4.66
- Miscellaneous			2,779.42	1.36
TOTAL			204,313.91	100.00

ANNUAL REVENUES (R)				Amount (R$)	Avge. Value R$/Animals
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)		
Culling cows/heifers	64	13.80	72.00	63,297.17	993.60
20-month heifers	54	13.14	80.75	57,272.49	1,060.95
Weaned female calves		5.00	86.40		
Weaned male calves		6.00	100.00		
20-month young bulls	121	17.13	85.00	175,678.86	1,455.65
Oxen finished on pasture		16.00	80.00		
Culling bulls	1	20.00	80.00	1,600.00	1,600.00
SUBTOTAL	239			297,848.52	1,244.28
MILK PRODUCTION	kg/day	kg/year	Value (R$/kg)	Total A. (R$)	
Milk production	300	1,095.00	0.60	65,700.00	
SUBTOTAL				65,700.00	
LEASING FOR SUGARCANE	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane	212.4	12	30.00	76,447.58	
SUBTOTAL				76,447.58	
TOTAL				439,996.10	

ANNUAL INCOME (R-C)	235,682.19

Profile 2 (Extensive Cattle Breeding)
Cow-calf, raising and finishing herd – 500 hectares of pasture

Description: Cattle breeders exploiting cow-calf, raising and finishing herds, operating extensively but with only moderately productive pastures, without a reproduction management plan or herd supplementation.
Herd size: 215 beef cows, 458 animal.
Annual production:
140 animal for sale, distributed as follows:
64 weaned calves;
14 20-month bull-calves;
13 fed cattle for slaughter;
10 20-month old heifers;
38 culling cows and heifers for slaughter;
1 culling bull.
Impact of integration: Liberation of 275 hectares for planting sugarcane. Use of 452 tons of feed for 179 animals (confinement and cows under supplementation for maintenance) during the dry season. Calves and heifers may grow fat on the farm and will be ready to be slaughtered at 24-26 months of age, using confinement at the final finishing stage. For successful integration, the cattle breeder must adapt to a more intensive management at the finishing stage and run a small confinement.
Size of integrated herd:
161 beef cows, 382 animals.
Annual production:
105 head of cattle for sale, distributed as follows:
53 young bull-calves (24 months old) for slaughter;
24 heifers (24 months old) for slaughter;
27 culling cows and heifers for slaughter;
1 culling bull.

Integration reduces the net revenues for cattle breeding by R$ 11,000 (about 30%). Nevertheless, the leasing of 275 ha for sugarcane generates an additional income of R$ 98,969/year, increasing the annual net revenue for the property by R$ 87,964, which represents an increase of 233% on the pre-integration net revenue.

STABILIZED HERD - BEEF CATTLE - WITHOUT INTEGRATION
breeding, raising and finishing activities

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS	176			2	26	148	176	176
2-3 YEAR CALVES	39				11	28	39	39
1-2 YEAR CALVES	50			1	10	39	50	30
0-1 YEAR F CALVES	71				21	50	71	21
BORN CALVES YEAR		150		7		143		
0-1 YEAR M CALVES	71				43	29	71	29
1-2 Y YOUNG BULLS	29			1	14	13	29	20
2-3 YEAR OXEN	13				13		13	13
BULLS	8		1		1	8	8	10
TOTAL	458	150	1	11	140	458	458	338

birth rate(%)	= 70
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows = 215

cow/bull ratio = 30

CHART 2. STABILIZED HERD - HERD STATUS DURING THE “RAINY” AND “DRY” SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG’T		EXIST. MID YEAR		No. Animals/MANG’T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS	176	176	176		150	150	150		
2-3 YEAR CALVES	39	31	39		28	24	28		
1-2 YEAR CALVES	50	30	50		40	28	40		
0-1 YEAR F CALVES	71	21	71		50	25	50		
BORN CALVES YEAR									
0-1 YEAR M CALVES	71	21	71		29	14	29		
1-2 Y YOUNG BULLS	29	23	29		14	11	14		
2-3 YEAR OXEN	13	12	13		7	6	7		
BULLS	8	10	8		8	10	8		
TOTAL animals	458		458		326		326		
TOTAL LU		325	325			269	269		
NUMBER OF BREEDING COWS TO BE SUPPLEMENTED DURING DRY SEASON WITH VOLUMINOUS FEED = 0									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine					0
Days of confinement/supplementation	45	150	100	70	-
Feed consumption (kg/Animals/day)	25	25	20	18	-
Total feed required (t) (*)					-

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine				0
Days of confinement	45	100	70	-
Initial weight (kg)	350	300	280	-
Weight gain (kg/Animals/day)	1,100	1,300	1,200	-
Slaughter weight (kg)	400	430	364	-
Carcass yield (%)	50	52	52	-
Slaughter weigth (@)	13.32	14.91	12.62	-

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (LU/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	0.65	0.54		500.0	500.0
Intensive	3.00	1.20			
TOTAL				500.0	500.0
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle			5,950.00	9.10
- Pasture fertilization				
- Pasture maintenance and cleaning	500.0 ha	12.00	6,000.00	9.18
- Mineral salt	10.68 t	1,275.00	13,612.22	20.83
- Protein mineral salt				
- Confinement feed				
- Dairy feed				
- Maintenance feed				
- Electricity	12 months	120.00	1,440.00	2.20
- Veterinary products	325.0 UA	12.75	4,143.75	6.34
- Harness and several utensiles	325.0 UA	11.05	3,591.25	5.50
- Labor force	2	10,368.00	20,736.00	31.73
- Diesel oil and lubricants				
- Taxes and levies			2,797.13	4.28
- Maintenance of premises	325.0 UA	17.00	5,525.00	8.45
- Miscellaneous			1,556.41	2.38
TOTAL			65,351.75	100.00

ANNUAL REVENUES (R)				Amount (R$)	Avge. Value R$/Animals
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)		
Culling cows/heifers	37	12.00	72.00	31,948.52	864.00
20-month heifers	10	8.00	79.20	6,332.43	633.60
Weaned female calves	21	5.00	86.40	9,251.93	432.00
Weaned male calves	43	6.00	100.00	25,699.79	600.00
20-month young bulls	14	9.00	88.00	11,307.91	792.00
Oxen finished on pasture	13	16.00	80.00	16,995.41	1,280.00
Culling bulls	1	20.00	80.00	1,600.00	1,600.00
TOTAL				103,135.99	737,86
LEASING FOR SUGARCANE	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane		12	30.00		
TOTAL				103,135.99	

ANNUAL INCOME (R-C)	37,784.23

STABILIZED HERD - BEEF CATTLE - WITH INTEGRATION
breeding, raising and finishing activities

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS	132			2	20	110	132	132
2-3 YEAR CALVES	29				7	22	29	29
1-2 YEAR CALVES	54			1	24	29	54	32
0-1 YEAR F CALVES	54					54	54	16
BORN CALVES YEAR		112		5		107		
0-1 YEAR M CALVES	54					54	54	21
1-2 Y YOUNG BULLS	54			1	53		54	38
2-3 YEAR OXEN								
BULLS	6		1		1	6	6	8
TOTAL	382	112	1	9	104	382	382	276

birth rate(%)	= 70
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows = 161

cow/bull ratio = 30

CHART 2. STABILIZED HERD - HERD POSITION DURING THE “RAINY” AND “DRY” SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS	132	132	132		112	112	53		60
2-3 YEAR CALVES	29	23	29		22	19	15		7
1-2 YEAR CALVES	54	32	54		30	21	6		24
0-1 YEAR F CALVES	54	16	54		54	5	54		
BORN CALVES YEAR									
0-1 YEAR M CALVES	54	16	54		54	21	54		
1-2 Y YOUNG BULLS	54	43	54		53	42			53
2-3 YEAR OXEN									
BULLS	6	8	6		6	8	6		
TOTAL Animals	382		382		330				143
TOTAL LU		270	270			228	103		125
NUMBER OF BREEDING COWS TO BE SUPPLEMENTED DURING DRY SEASON WITH VOLUMINOUS FEED = 40									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine	27	40	53	24	143
Days of confinement/supplementation	45	150	130	90	113
Feed consumption (kg/Animals/day)	25	32	22	18	25
Total feed required (t) (*)	33	211	166	42	452

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine	27	53	24	103
Days of confinement	45	130	90	99
Initial weight (kg)	360	300	280	311
Weight gain (kg/Animals/day)	1,200	1,200	1,100	1,177
Slaughter weight (kg)	414	456	379	427
Carcass yield (%)	50	52	52	51.5
Slaughter weigth (@)	13.80	15.81	13.14	14.67

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (UA/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.20	0.46		225.1	224.6
Intensive	3.00	1.20			
TOTAL				225.1	224.6
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle			5,950.00	6.10
- Pasture fertilization		160.00		
- Pasture maintenance and cleaning	224.6 ha	12.00	2,695.13	2.76
- Mineral salt	7.61 t	1,275.00	9,702.96	9.95
- Protein mineral salt				
- Confinement feed	241.2 t	120.00	28,949.38	29.69
- Dairy feed				
- Maintenance feed	211.2 t	60.00	12,672.00	12.99
- Electricity	12 months	120.00	1,440.00	1.48
- Veterinary products	270.2 UA	12.75	3,445.44	3.53
- Harness and several utensiles	270.2 UA	11.05	2,986.05	3.06
- Labor force	2	10,368.00	20,736.00	21.26
- Diesel oil and lubricants				
- Taxes and levies			3,049.78	3.13
- Maintenance of premises	270.2 UA	17.00	4,593.92	4.71
- Miscellaneous			1,298.37	1.33
TOTAL			97,519.03	100.00

ANNUAL REVENUES (R)				Amount (R$)	Avge. Value R$/Animals
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)		
Culling cows/heifers	27	13.80	72.00	26,879.95	993.60
20-month heifers	24	13.14	80.75	25,052.30	1,060.95
Weaned female calves		5.00	86.40		
Weaned male calves		6.00	100.00		
20-month young bulls	53	15.81	85.00	70,766.57	1,343.68
Oxen finished on pasture		16.00	80,00		
Culling bulls	1	20.00	80.00	1,600.00	1,600.00
TOTAL				124,298.82	1,191.37
LEASING FOR SUGARCANE	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane	274.9	12	30.00	98,968.17	
SUBTOTAL				98,968.17	
TOTAL				223,266.99	

ANNUAL INCOME (R-C)	125,747.96

Profile 3 (Integrated Cattle Breeding)
Raising and finishing herd – 200 hectares of pastures

Description: Cattle breeder who practices several different agricultural and cattle breeding activities on his property, reserving 200 ha for pastures and for beef cattle raising and finishing. Adopts appropriate zootechnical practices, with regular pasture lock up, herd supplementation and use of resting areas for annual crops for the partial maintenance of the herd during the dry season.
Herd size: 236 raising and finishing animals
Annual production:
122 head of cattle for sale, distributed as follows:
12 bull-calves (20 months old) for culling;
110 fed cattle (36-40 months) for slaughter.
Impact of integration: Liberation of 120 hectares for the planting of sugarcane, reducing the raising-finishing system by 12 months, as it allows for a 12-month raising followed by a 3 to 4-month confinement, sending them for slaughter at 2 years of age. Use of 300 tons of feed for 123 early calves confined during the dry season. With integration, the raising and finishing systems allow for a greater liberation of area for sugarcane, since cattle in these categories can be much more easily supplemented during the dry season, and managed with a higher density on pastures during the rainy season.
Size of integrated herd:
125 raising animals (November to April) or 125 raising calves + 123 confined calves (May to October)
Annual production:
123 young calves (20-26 months old) for slaughter.

Integration will lead to a reduction in net revenues of about R$ 4,650 (about 12%) from cattle breeding only. But the leasing of 120 hectares for sugarcane can represent additional revenues of R$ 43,200/year.

STABILIZED HERD - BEEF CATTLE - WITHOUT INTEGRATION
breeding, raising and finishing activities

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS								
2-3 YEAR CALVES								
1-2 YEAR CALVES								
0-1 YEAR F CALVES								
BORN CALVES YEAR								
0-1 YEAR M CALVES			126	1		125		
1-2 Y YOUNG BULLS	125			2	13	111	125	88
2-3 YEAR OXEN	111			1	110		111	111
BULLS								
TOTAL	236		126	4	122	236	236	199

birth rate(%)	nihil
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows =

cow/bull ratio = 30

CHART 2. STABILIZED HERD - HERD STATUS DURING THE “RAINY” AND “DRY” SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS									
2-3 YEAR CALVES									
1-2 YEAR CALVES									
0-1 YEAR F CALVES									
BORN CALVES YEAR									
0-1 YEAR M CALVES									
1-2 Y YOUNG BULLS	125	100	125		113	90	113		
2-3 YEAR OXEN	111	100	111		74	67	74		
BULLS									
TOTAL Animals	236		236		187				
TOTAL LU		200	200			157	157		
NUMBER OF BREEDING COWS TO BE SUPPLEMENTED DURING DRY SEASON WITH VOLUMINOUS FEED =									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine					0
Days of confinement/supplementation	45	150	100	70	-
Feed consumption (kg/Animals/day)	25	25	20	18	-
Total feed required (t) (*)					-

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine				0
Days of confinement	45	100	70	-
Initial weight (kg)	350	350	280	-
Weight gain (kg/Animals/day)	1,100	1,300	1,200	-
Slaughter weight (kg)	400	480	364	-
Carcass yield (%)	50	52	52	-
Slaughter weigth (@)	13.32	16.64	12.62	-

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (LU/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.00	0.79		200.0	200.0
Intensive	3.00	1.20			
TOTAL				200.0	200.0
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle	126	600.00	75,600.00	68.54
- Pasture fertilization				
- Pasture maintenance and cleaning	200.0 ha	12.00	2,400.00	2.18
- Mineral salt	6.57 t	1,275.00	8,376.75	7.59
- Protein mineral salt				
- Confinement feed				
- Dairy feed				
- Maintenance feed				
- Electricity	12 months	80.00	960.00	0.87
- Veterinary products	200.0 UA	12.75	2,550.00	2.31
- Harness and several utensiles	200.0 UA	11.05	2,210.00	2.00
- Labor force	1	10,368.00	10,368.00	9.40
- Diesel oil and lubricants				
- Taxes and levies			3,631.05	3.29
- Maintenance of premises	200.0 UA	17.00	3,400.00	3.08
- Miscellaneous			802.91	0.73
TOTAL			110,298.71	100.00

ANNUAL REVENUES (R)				Amount (R$)	Avge. Value R$/Animals
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)		
Culling cows/heifers		12.00	72.00		
20-month heifers		8.00	79.20		
Weaned female calves		5.00	86.40		
Weaned male calves		6.00	100.00		
20-month young bulls	13	9.00	88.00	9,927.06	79.,00
Oxen finished on pasture	110	16.00	80.00	140,553.54	1,280.00
Culling bulls		20.00	80.00		
TOTAL				150,480.60	1,230.00
LEASING FOR SUGARCANE	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane		12	30.00		
SUBTOTAL					
TOTAL				150,480.60	

ANNUAL INCOME (R-C)	40,181.89

STABILIZED HERD - BEEF CATTLE - WITH INTEGRATION
breeding, raising and finishing activities

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS								
2-3 YEAR CALVES								
1-2 YEAR CALVES								
0-1 YEAR F CALVES								
BORN CALVES YEAR								
0-1 YEAR M CALVES			126	1		125		
1-2 Y YOUNG BULLS	125			2	123		125	88
2-3 YEAR OXEN								
BULLS								
TOTAL	125		126	3	123	125	125	88

birth rate(%)	nihil
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows = 0
cow/bull ratio = 30

CHART 2. STABILIZED HERD - HERD STATUS DURING THE "RAINY" AND "DRY" SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS									
2-3 YEAR CALVES									
1-2 YEAR CALVES									
0-1 YEAR F CALVES						5			
BORN CALVES YEAR									
0-1 YEAR M CALVES					126	51	126		
1-2 Y YOUNG BULLS	125	100	125		123	99			123
2-3 YEAR OXEN									
BULLS									
TOTAL Animals	125		125		250				123
TOTAL LU		100	100			154	51		99
NUMBER OF BREEDING COWS TO BE SUPPLEMENTED DURING DRY SEASON WITH VOLUMINOUS FEED = 0									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine			123		123
Days of confinement/supplementation	45	150	100	90	100
Feed consumption (kg/Animals/day)	25	32	22	18	22
Total feed required (t) (*)			298		298

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine		123		123
Days of confinement	45	100	90	100
Initial weight (kg)	360	350	280	350
Weight gain (kg/Animals/day)	1,200	1,200	1,100	1,200
Slaughter weight (kg)	414	470	379	470
Carcass yield (%)	50	52	52	52.0
Slaughter weigth (@)	13.80	16.29	13.14	16.29

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (UA/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.25	0.63		80.0	80.0
Intensive	3.00	1.20			
TOTAL				80.0	80.0
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle	126	600.00	75,600.00	55.88
- Pasture fertilization		160.00		
- Pasture maintenance and cleaning	80.0 ha	12.00	960.00	0.71
- Mineral salt	2.41 t	1,275.00	3,067.55	2.27
- Protein mineral salt				
- Confinement feed	298.5 t	120.00	35,818.40	26.48
- Dairy feed				
- Maintenance feed		60.00		
- Electricity	12 months	80.00	960.00	0.71
- Veterinary products	100.3 UA	12.75	1,278.48	0.95
- Harness and several utensiles	100.3 UA	11.05	1,108.02	0.82
- Labor force	1	10,368.00	10,368.00	7.66
- Diesel oil and lubricants				
- Taxes and levies			3,996.86	2.95
- Maintenance of premises	100.3 UA	17.00	1,704.65	1.26
- Miscellaneous			426.16	0.32
TOTAL			135,288.12	100.00

ANNUAL REVENUES (R)					
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)	Amount (R$)	Avge. Value R$/Animals
Culling cows/heifers		13.80	72.00		
20-month heifers		13.14	80.75		
Weaned female calves		5.00	86.40		
Weaned male calves		6.00	100.00		
20-month young bulls	123	16.29	85.00	170,819.91	1,384.93
Oxen finished on pasture		16.00	80.00		
Culling bulls		20.00	80.00		
TOTAL				**170,819.91**	**1,384.93**
LEASING FOR SUGARCANE	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane	120.0	12	30.00	43,200.27	
SUBTOTAL				43,200.27	
TOTAL				**214,020.18**	
ANNUAL INCOME (R-C)				**78,732.06**	

Profile 4 (Special Cattle Breeding)
Dairy herd – 20 hectares of pastures

Description: Small-scale dairy producers exploiting 20 hectares of pasture, using only family labor. Adoption of simple zootechnical and less competitive practices due to the lack of large-scale production. Extensive operations, with less productive pastures, and no reproduction management or herd supplementation plan. Due to the irregular availability of pastures and supplements, cows have a short lactation period (7 months) and low milk production (5 kg/cow/day).
Herd size:
13 dairy cattle – average of 6 lactating cows – with an average production of 5 kg milk/cow/day.
Total herd: 29 animals.
Annual production:
9 animals for sale, with:
6 weaned calves;
1 20-month-old heifer;
2 culling cows and heifers for slaughter;
10,950 kg milk/year (30 kg/day).
Impact of integration: Liberation of 11.1 hectares for sugarcane planting; use of 43 tons of feed for 13 animals during the dry season (8 lactating cows and 5 cows and heifers in maintenance supplementation). Improved nutrition may increase the lactation period (to 9 months) and milk production, resulting in a daily average of 64 kg of milk (2.13 times more).
Size of integrated herd: 13 milking cows – 8 lactating on average– with an average production of 8 kg milk/cow/day.
Total herd: 30 animals.
Annual production:
9 animals for sale, with:
5 weaned calves;
2 heifers (20 months old);
2 culling cows and heifers for slaughter;
23,360 kg milk/year (64 kg/day).

Integration will provide for a net increase in revenue of about R$ 2,070 (about 22%) only from cattle breeding. In addition, the leasing of 11.1 hectares for sugarcane may provide supplementary revenues of R$ 3,990/year.

STABILIZED HERD - BEEF CATTLE - WITHOUT INTEGRATION

breeding, raising and finishing activities

- average production per cow = 5,0 kg milk/cow/day
- lactation period = 7 months

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS	11			1	2	8	11	11
2-3 YEAR CALVES	2				0	3	2	2
1-2 YEAR CALVES	4			1	1	2	4	3
0-1 YEAR F CALVES	5				1	4	5	2
BORN CALVES YEAR		12		1		11		
0-1 YEAR M CALVES	5				5		5	2
1-2 Y YOUNG BULLS								
2-3 YEAR OXEN								
BULLS	1					1	1	1
TOTAL	29	12		3	9	29	29	21

birth rate(%)	86
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows = 13

cow/bull ratio = 30

No. of lactating cow = 6

CHART 2. STABILIZED HERD - HERD STATUS DURING THE “RAINY” AND “DRY” SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS	11	11	11		9	9	9		
2-3 YEAR CALVES	2	2	2		3	2	3		
1-2 YEAR CALVES	4	3	4		3	2	3		
0-1 YEAR F CALVES	5	2	5		4	2	4		
BORN CALVES YEAR									
0-1 YEAR M CALVES	5	2	5						
1-2 Y YOUNG BULLS									
2-3 YEAR OXEN									
BULLS	1	1	1		1	1	1		
TOTAL Animals	29		29		21		21		
TOTAL LU		20	20			17	17		
NUMBER OF BREEDING COWS TO BE SUPPLEMENTED DURING DRY SEASON WITH VOLUMINOUS FEED = 0									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine					
Days of confinement/supplementation	45	150	100	70	
Feed consumption (kg/Animals/day)	25	25	20	18	
Total feed required (t) (*)					

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine				
Days of confinement	45	100	70	
Initial weight (kg)	350	350	280	
Weight gain (kg/Animals/day)	1,100	1,300	1,200	
Slaughter weight (kg)	400	480	364	
Carcass yield (%)	50	52	52	
Slaughter weigth (@)	13.32	16.64	12.62	

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (LU/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.00	0.87		20.0	20.0
Intensive	3.00	1.20			
TOTAL				20.0	20.0
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle				
- Pasture fertilization				
- Pasture maintenance and cleaning	20.0 ha	12.00	240.01	9.18
- Mineral salt	0.66 t	1,275.00	837.68	32.04
- Protein mineral salt				
- Confinement feed				
- Dairy feed				
- Maintenance feed				
- Electricity	12 months	40.00	480.00	18.36
- Veterinary products	20.0 UA	12.75	255.00	9.75
- Harness and several utensiles	20.0 UA	11.05	221.00	8.45
- Labor force				
- Diesel oil and lubricants				
- Taxes and levies			141.14	5.40
- Maintenance of premises	20.0 UA	17.00	340.00	13.00
- Miscellaneous			99.87	3.82
TOTAL			2,614.69	100.00

ANNUAL REVENUES (R)				Amount (R$)	Avge. Value R$/Animals
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)		
Culling cows/heifers	1	12.00	72.00	1,242.38	864.00
20-month heifers	1	8.00	79.20	544.57	633.60
Weaned female calves	1	5.00	86.40	432.00	432.00
Weaned male calves	5	6.00	100.00	3,178.46	600.00
20-month young bulls		9.00	88.00		
Oxen finished on pasture		16.00	80.00		
Culling bulls		20.00	80.00		
SUBTOTAL				5,397.41	627.98
MILK PRODUCTION	kg/day	kg/year	Value (R$/kg)	Total A. (R$)	
Milk production	30	10,950	0.60	6,570.00	
SUBTOTAL				6,570.00	
LEASING FOR SUGARCANE	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane		12	30.00		
SUBTOTAL				-	
TOTAL				11,967.41	

ANNUAL INCOME (R-C)	9,352.72

STABILIZED HERD - BEEF CATTLE - WITH INTEGRATION

breeding, raising and finishing activities

- average production per cow = 8,0 kg milk/cow/day
- lactation period = 9 months

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS	11			1	2	8	11	11
2-3 YEAR CALVES	2				0	3	2	2
1-2 YEAR CALVES	5			1	2	2	5	3
0-1 YEAR F CALVES	5					5	5	2
BORN CALVES YEAR		12		1		11		
0-1 YEAR M CALVES	5				5		5	2
1-2 Y YOUNG BULLS								
2-3 YEAR OXEN								
BULLS	1					1	1	1
TOTAL	30	12		3	9	30	30	21

birth rate(%)	87
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows = 13

cow/bull ratio = 30

No. of lactating cows= 6

CHART 2. STABILIZED HERD - HERD STATUS DURING THE "RAINY" AND "DRY" SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS	11	11	3	8	11	11			11
2-3 YEAR CALVES	2	2		2	3	2	0	3	
1-2 YEAR CALVES	5	3	5		3	2	0	1	2
0-1 YEAR F CALVES	5	2	5		5	5	5		
BORN CALVES YEAR									
0-1 YEAR M CALVES	5	2	5						
1-2 Y YOUNG BULLS									
2-3 YEAR OXEN									
BULLS	1	1		1	1	1		1	
TOTAL Animals	30		19	11	23			5	13
TOTAL LU		20	9	11		22	5	5	12
NUMBER OF BREEDING COWS TO BE SUPPLEMENTED DURING DRY SEASON WITH VOLUMINOUS FEED = 8									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine	3	8		2	13
Days of confinement/supplementation	45	150	100	90	116
Feed consumption (kg/Animals/day)	25	27	22	18	25
Total feed required (t) (*)	4	36		4	43

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine	3		2	5
Days of confinement	45	100	90	63
Initial weight (kg)	360	350	280	328
Weight gain (kg/Animals/day)	1,200	1,200	1,100	1,160
Slaughter weight (kg)	414	470	379	400
Carcass yield (%)	50	52	52	50.8
Slaughter weigth (@)	13.80	16.29	13.14	13.55

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (LU/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.80	0.95		5.2	5.2
Intensive	3.00	1.22		3.7	3.7
TOTAL				8.9	8.9
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle				
- Pasture fertilization	3.7 ha	160.00	591.36	6.44
- Pasture maintenance and cleaning	8.9 ha	12.00	106.80	1.16
- Mineral salt	0.54 t	1,275.00	692.04	7.53
- Protein mineral salt				
- Confinement feed	7.3 t	120.00	879.52	9.58
- Dairy feed	35.6 t	150.00	5,346.00	58.20
- Maintenance feed		60.00		
- Electricity	12 months	40.00	480.00	5.23
- Veterinary products	20.5 UA	12.75	261.22	2.84
- Harness and several utensiles	20.5 UA	11.05	226.39	2.46
- Labor force				
- Diesel oil and lubricants				
- Taxes and levies			159.12	1.73
- Maintenance of premises	20.0 UA	17.00	340.00	3.70
- Miscellaneous			102.79	1.12
TOTAL			9,185.24	100.00

ANNUAL REVENUES (R)					
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)	Amount (R$)	Avge. Value R$/Animals
Culling cows/heifers	1	13.80	72.00	1,289.13	993.60
20-month heifers	2	13.14	80.75	2,121.89	1,060.95
Weaned female calves		5.00	86.40		
Weaned male calves	5	6.00	100.00	3,178.46	600.00
20-month young bulls		16.29	85.00		
Oxen finished on pasture		16.00	80.00		
Culling bulls		20.00	80.00		
SUBTOTAL				6,589.48	766.68
MILK PRODUCTION	kg/day	kg/year	Value (R$/kg)	Total A. (R$)	
Milk production	64	23,360	0.60	14,016.00	
SUBTOTAL				14.016,00	
LEASING FOR SUGARCANE	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane	11.1	12	30.00	3,989.52	
SUBTOTAL				3,989.52	
TOTAL				24,595.00	

ANNUAL INCOME (R-C)	15,409.76

Profile 5 (Strategic Cattle Breeding)
Dairy herd – 20 hectares of pastures

Description: Small-scale milk producer. Utilizes about 20 hectares of pastures using family labor only. Adopts crop integration and uses agricultural byproducts as animal feed, as well as resting areas for herd maintenance during the dry season. An intensive operation, with productive pastures, a reproduction management plan, pasture fertilization and herd supplementation. Dairy cows are of a specialized breed with a long lactation period (270 days). Average milk productivity (10 kg/cow/day) is limited by the inadequate nutrition of the lactating cows during the dry season.
Herd size: 26 dairy cattle – 16 lactating cows on average – with an average production of 10 kg/cow/day.
Total herd: 55 animals
Annual production:
18 animal for sale, with:
13 weaned calves;
1 heifer (20 months old);
4 culling cows and heifers for slaughter;
58,400 kg milk/year (160 kg/day).
Impact of integration: Liberation of 6.9 hectares for planting sugarcane – 34.6% of the pasture area; use of 92.7 tons of feed for 26 animals (18 lactating cows and 8 cows and heifers in maintenance supplementation) during the dry season. Integration will have an impact on average milk productivity and the lactation period, since the nutrition of cows during the dry season will improve greatly. Expectations are that milk production will reach 12 kg milk/cow/day and a 10-month lactation period. Daily average production will increase to 216 kg/day (a 35% increase).
Size of integrated herd: 26 dairy cows – with 18 lactating on average – with an average production of 12 kg milk/cow/day.
Total herd: 59 animals
Annual production:
18 animals for sale, with:
10 weaned calves;
4 20-month-old heifers;
4 culling cows and heifers for slaughter;
78,840 kg milk/year (216 kg/day).

Integration will increase annual net revenues by R$ 1,544 (about 3.7%) only from cattle breeding. The leasing of 6.9 hectares for sugarcane can also generate additional revenues of R$ 2,489/year.

STABILIZED HERD - BEEF CATTLE - WITHOUT INTEGRATION

breeding, raising and finishing activities

- average production per cow = 10,0 kg milk/cow/day
- lactation period = 9 months

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS	22			1	3	17	22	22
2-3 YEAR CALVES	5				1	4	5	5
1-2 YEAR CALVES	7			1	1	5	7	4
0-1 YEAR F CALVES	10				3	7	10	3
BORN CALVES YEAR		23		2		21		
0-1 YEAR M CALVES	10				10		10	4
1-2 Y YOUNG BULLS								
2-3 YEAR OXEN								
BULLS	1					1	1	1
TOTAL	55	23		4	19	55	55	39

birth rate(%)	86
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows = 26

cow/bull ratio = 30

No. of lactating cows = 16

CHART 2. STABILIZED HERD - HERD STATUS DURING THE "RAINY" AND "DRY" SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS	22	22	22		18	18	9		
2-3 YEAR CALVES	5	4		5	4	4	2	2	
1-2 YEAR CALVES	7	4		7	6	4		6	
0-1 YEAR F CALVES	10	3		10	7	4	7		
BORN CALVES YEAR									
0-1 YEAR M CALVES	10	3		10					
1-2 Y YOUNG BULLS									
2-3 YEAR OXEN									
BULLS	1	1	1		1	1	1		
TOTAL Animals	55		23	33	37			8	
TOTAL LU		37	23	14		31	16	6	
NUMBER OF LACTATING COWS THAT WILL RECEIVE LACTATION FEED DURING DRY SEASON = 0									
NUMBER OF BREEDING COWS MANAGED IN RESTING AREAS DURING DRY SEASON = 9									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine					0
Days of confinement/supplementation	45	150	100	70	-
Feed consumption (kg/Animals/day)	25	25	20	18	-
Total feed required (t) (*)					-

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine				0
Days of confinement	45	100	70	-
Initial weight (kg)	350	350	280	-
Weight gain (kg/Animals/day)	1,100	1,300	1,200	-
Slaughter weight (kg)	400	480	364	-
Carcass yield (%)	50	52	52	-
Slaughter weigth (@)	13.32	16.64	12.62	-

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (LU/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.50	1.06		15.2	15.2
Intensive	3.00	1.20		4.8	4.8
TOTAL				20.0	20.0
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle				
- Pasture fertilization	4.81	160.00	770.06	14.72
- Pasture maintenance and cleaning	20.0 ha	12.00	239.99	4.59
- Mineral salt	1.22 t	1,275.00	1,558.88	29.80
- Protein mineral salt				
- Confinement feed				
- Dairy feed				
- Maintenance feed				
- Electricity	12 months	40.00	480.00	9.18
- Veterinary products	37.2 UA	12.75	474.55	9.07
- Harness and several utensiles	37.2 UA	11.05	411.27	7.86
- Labor force				
- Diesel oil and lubricants			192.52	3.68
- Taxes and levies			286.65	5.48
- Maintenance of premises	37.0 UA	17.00	629.00	12.02
- Miscellaneous			187.97	3.59
TOTAL			5,230.89	100.00

ANNUAL REVENUES (R)				Amount (R$)	Avge. Value R$/Animals
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)		
Culling cows/heifers	4	12.00	72.00	3,320.25	864.00
20-month heifers	1	8.00	79.20	925.51	633.60
Weaned female calves	3	5.00	86.40	1,296.00	432.00
Weaned male calves	10	6.00	100.00	6,182.16	600.00
20-month young bulls		9.00	88.00		
Oxen finished on pasture		16.00	80.00		
Culling bulls		20.00	80.00		
SUBTOTAL				11,723.93	630.07
MILK PRODUCTION	kg/day	kg/year	Value (R$/kg)	Total A. (R$)	
Milk production	160	58,400	0.60	35,040.00	
SUBTOTAL				35,040.00	
Leasing for sugarcane	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane		12	30.00		
SUBTOTAL				-	
TOTAL				46,763.93	

ANNUAL INCOME (R-C)	41,533.04

STABILIZED HERD - BEEF CATTLE - WITH INTEGRATION

breeding, raising and finishing activities

- average production per cow = 12,0 kg milk/cow/day
- lactation period = 10 months

CHART 1. STABILIZED HERD - CATTLE MOVEMENT PER YEAR

CATEGORY	EXIST. BEG. YEAR	BIRTHS	PURCHASES	DEATHS	SALES	YEAR END BALANCE	CHANGE CAT. BEG. YEAR	No. OF LU
COWS	22			1	3	17	22	22
2-3 YEAR CALVES	5				1	4	5	5
1-2 YEAR CALVES	10			1	4	5	10	6
0-1 YEAR F CALVES	10					10	10	3
BORN CALVES YEAR		23		2		21		
0-1 YEAR M CALVES	10				10		10	4
1-2 Y YOUNG BULLS								
2-3 YEAR OXEN								
BULLS	1					1	1	1
TOTAL	59	23		4	19	59	59	41

birth rate(%)	84
mortality(%)	
calves born year	= 5
others	= 1
cull. cows(%)	= 15

No. of breeding cows = 26
cow/bull ratio = 30
No. of lactating cows = 18

CHART 2. STABILIZED HERD - HERD STATUS DURING THE "RAINY" AND "DRY" SEASON

	RAINY				DRY				
	EXIST.BEG. YEAR		No. Animals/MAG'T		EXIST. MID YEAR		No. Animals/MANG'T		
CATEGORY	Animals	LU	Extensive	Intensive	Animals	LU	Extensive	Intensive	Conf/Suppl
COWS	22	22	4	18	22	22	18		
2-3 YEAR CALVES	5	4	5		5	5	5		
1-2 YEAR CALVES	10	6		10	10	7	2	4	4
0-1 YEAR F CALVES	10	3		10	10	5		10	
BORN CALVES YEAR									
0-1 YEAR M CALVES	10	3		10					
1-2 Y YOUNG BULLS									
2-3 YEAR OXEN									
BULLS	1	1		1	1	1		1	
TOTAL Animals	59		9	50	48			15	4
TOTAL LU		39	8	32		40	24	9	3
NUMBER OF LACTATING COWS THAT WILL RECEIVE LACTATION FEED DURING DRY SEASON = 0									
NUMBER OF BREEDING COWS MANAGED IN RESTING AREAS DURING DRY SEASON = 4									

CHART 3. MATING SEASONS

MATING SEASONS	"SUMMER"	"AUTUMN"
% BREEDING COWS	100	%
PERIOD	NOV to JAN	MAY and JUN
BIRTHS	AUG to OCT	FEB and MAR
WEANINGS	APR and MAY	OCT and NOV

CHART 4. FEED REQUIRED

CATTLE TO BE CONFINED/SUPPLEMENTED	CULLING COWS/ CALVES	COWS SUPPLEMENT.	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine					0
Days of confinement/supplementation	45	150	100	70	-
Feed consumption (kg/Animals/day)	25	25	20	18	-
Total feed required (t) (*)					-

(*) 10 % safety margin

CHART 5. CONFINED CATTLE PERFORMANCE

CONFINEMENT	CULLING COWS/CALVES	20-MONTH YOUNG BULLS	20-MONTH HEIFERS	TOTAL
No. Animals to confine	4		4	8
Days of confinement	45	100	90	67
Initial weight (kg)	360	350	280	321
Weight gain (kg/Animals/day)	1,200	1,200	1,100	1,152
Slaughter weight (kg)	414	470	379	397
Carcass yield (%)	50	52	52	51.0
Slaughter weigth (@)	13.80	16.29	13.14	13.49

CHART 6. PASTURE REQUIREMENTS

TYPES OF PASTURE OR FORRAGING AREAS	Max. Capacity (UA/ha)		Production (t/ha)	Area required (ha)	
	Rainy	Dry		Rainy	Dry
Extensive	1.50	1.09		5.2	21.8
Intensive	4.00	1.15		7.9	7.9
TOTAL				13.1	29.7
Adjustment of Total Area - Rainy x Dry Season				Adjustment OK	

CHART 7. ANNUAL COSTS AND REVENUES - STABILIZED PRODUCTION

VALUE PER @ (1@ = 30 kg live weight or 15 kg carcass)
- first semester: R$ 80.00
- second semester: R$ 85.00

ANNUAL COST (C)	Qtt.	Unit V (R$)	Amount (R$)	%
- Replacement cattle				
- Pasture fertilization	7.9 ha	160.00	1,264.57	17.12
- Pasture maintenance and cleaning	29.7 ha	12.00	355.96	4.82
- Mineral salt	1.28 t	1,275.00	1,628.29	22.04
- Protein mineral salt				
- Confinement feed	12.5 t	120.00	1,494.45	20.23
- Dairy feed		150.00		
- Maintenance feed		60.00		
- Electricity	12 months	40.00	480.00	6.50
- Veterinary products	39.4 UA	12.75	502.20	6.80
- Harness and several utensiles	39.4 UA	11.05	435.24	5.89
- Labor force				
- Diesel oil and lubricants				
- Taxes and levies			363.36	4.92
- Maintenance of premises	39.0 UA	17.00	663.00	8.98
- Miscellaneous			199.73	2.70
TOTAL			7,386.79	100.00

ANNUAL REVENUES (R)				Amount (R$)	Avge. Value R$/Animals
CATTLE SALES	No.Animals	Weight (@)	Value (R$/@)		
Culling cows/heifers	4	13.80	72.00	4,276.06	993.60
20-month heifers	4	13.14	80.75	4,243.79	1,060.95
Weaned female calves		5.00	86.40		
Weaned male calves	10	6.00	100.00	6,182.16	600.00
20-month young bulls		16.29	85.00		
Oxen finished on pasture		16.00	80.00		
Culling bulls		20.00	80.00		
SUBTOTAL				14,702.02	790.12
MILK PRODUCTION	kg/day	kg/year	Value (R$/kg)	Total A. (R$)	
Milk production	216	78840	0.60	47,304.00	
SUBTOTAL				47,304.00	
Leasing for sugarcane	Area (ha)	t/ha/year	Value (R$/t)	Total A. (R$)	
Revenues from sugarcane	6.9	12	30.00	2,489.05	
SUBTOTAL				2,489.05	
TOTAL				64,495.07	

ANNUAL INCOME (R-C)	45,566.43

annex C

Geoprocessing and database modeling

1. Spatialization methodology of types of cattle breeding

The spatialization of cattle breeding types was limited by the lack of access to micro-data from the 2006 Agricultural Census. We have therefore not been able to classify establishments individually or to precisely identify the spatial distribution of frequencies of each type of cattle breeding in each municipality or in any territorial aggregation of interest.

The solution was to analyze the available quantitative variables of the census, aggregated by municipality, and to assume that the position held by each value in the distribution of the total nymber of Brazilian municipalities analyzed reflected the pattern of calculation for the municipal average. In other words: it is theoretically assumed that the distribution of municipal variables found in Brazil represents the distribution that can be found in each municipality but on a macro-level scale. The position held by the municipality is the reflection of its own distribution hidden in the aggregation.

The municipalities were classified according to the following procedures:

(i) Selection of basic variables of the 2006 Agricultural Census (Table 25)

[Table 25] Basic variables of the 2006 Agricultural Census used in the modeling

Basic variables[1]	Description
NestTotal	Total number of agricultural establishments
NestPast	Number of agricultural establishments with pastures
Total Area	Total area of agricultural establishments (hectare)
PastArea	Area of agricultural establishments with pastures (hectare)
NestEfCat	Total number of agricultural establishments with cattle
EfCat	Effective number of cattle (LU)
NestMilkCow	Number of agricultural establishments with cow milk production
CowMilk	Cow milk production (thousand liters)

1. Source: Censo Agropecuário 2006, IBGE (www.sidra.ibge.gov.br, accessed in August 2008).

(ii) Calculation of derivative variables (Table 26)

[Table 26] Derivative variables and calculation procedure

Derivative variables	Calculation procedure	Description
AveAreaEst	*TotalArea/NestTotal*	Average area of agricultural establishments (ha)
FreqPec	*NestEfCat/NestTotal*	Relative frequency of establishments with cattle breeding
AllotEst	*(EfCat/NestEfCat)/(PastArea/NestPast)*	Average allotment of animal of agricultural establishment (LU/ha)
AveEfEst	*(EfCat/NestEfCat)/AveAreaEst*	Average effective number of cattle of agricultural establishments (LU)
MilkAreaYearEst	*[(CowMilk*1000)/NEstCowMilk] /AveAreaEst*	Average annual milk production per hectare of agricultural establishments (L/ha/year)
proxyProfile	*(AveAreaEst+AveEfEst)/2*	Proxy of producer profile regarding property size and cattle breeding practiced
proxyEffic	*(EstAllot+MilkAreaYearEst)/2*	Proxy of technical animal efficiency with which cattle breeding is practiced

(iii) Normalization of distribution and removal of outliers.

The procedure adopted was to calculate the normal cumulative distribution for the average and the standard deviation for all Brazilian municipalities with non-null data and based on that, to exclude all values with a cumulative distribution higher than 0.99. Values for the country's Northern region were excluded because most of them presented inconsistent data.

(iv) Normalization of distribution of remaining values without outliers.

The same procedure was applied to the non-null remaining values.

(v) Operation of the Boolean logic classification key (Table 27)

[Table 27] Logic classification key for municipalities as per cattle breeding type

IF [(ProxyPerfil =< 0.5) AND (ProxyEfic > 0.5)] THEN Class == "ESTRATÉGICA"
ELSE IF [(ProxyPerfil =< 0.5) AND (ProxyEfic =< 0.5)] THEN Class == "ESPECIAL"
ELSE IF [(ProxyPerfil > 0.5) AND (ProxyEfic > 0.5) AND (FreqPec < 0.5)] THEN Class == "INTEGRADA"
ELSE IF [(ProxyPerfil > 0.5) AND (ProxyEfic >= 0.5) AND (FreqPec > 0.5)] THEN Class == "ESTÁVEL"
ELSE IF [(ProxyPerfil > 0.5) AND (ProxyEfic =< 0.5)] THEN Class == "EXTENSIVA"
ELSE IF Class == NULL

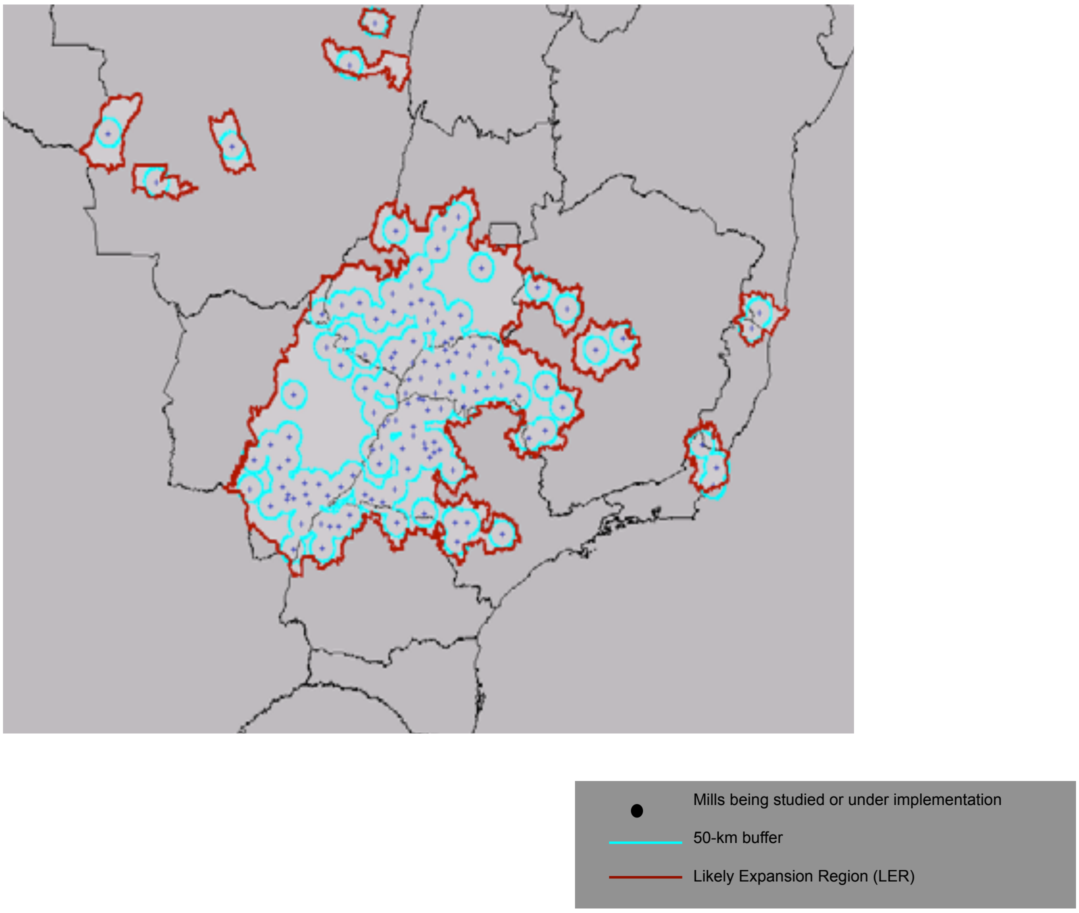
(vi) Spatialization of results based on geoprocessing tools.

2. Methodology for the delimitation of the likely expansion region

The results of cattle breeding classification were quantified for the large geographic regions and for one region denominated Likely Expansion Region (LER). The delimitation of the region was based on the location of municipalities with projects for sugar and alcohol industrial plants currently being studied or under implementation, according to data from the Ministry of Agriculture, Livestock and Supply (MAPA).

The delimitation of the LER was based on the suitability of the IBGE municipal digital network (2005) and includes all municipalities within a 50 km radius of influence (buffer) of each mill project. Since the precise location of mills was not available, the study used the geographic centroid of each municipality as a reference for calculating the buffer, as shown in Figure 23 below.

Figure 23: Diagram of the methodology used for generating the Likely Expansion Region (LER)



Brazilian Ministry for
Agrarian Development