FOOD SECURITY, LABOR MARKET AND POVERTY OF THE BIO-ECONOMY IN BRAZIL

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ABSTRACT

This paper deals with the social implications of ethanol expansion in Brazil. The evolution of the labor market in sugar cane production in the country is analyzed together with its regional patterns of expansion, to illustrate how the changes in the recent expansion are modifying the traditional pattern of labor demand in the activity. At the same time, the distributional effects of sugar cane expansion, as well as it´s impacts on food security and land use change was approached with the aid of general equilibrium simulation models. The analysis shows that both the average earnings and the average years of schooling in sugar cane production are actually higher than in general agriculture in Brazil, and that this is linked to the fast increase in production in Southeast and Center-west. Sugar cane production in those regions is more capital intensive and has much higher productivity than in other traditional regions in Northeast Brazil. The study concludes that the expansion in sugar cane production in the actual patterns is poverty friendly, and has small impacts on food prices and deforestation. The increase in the regional economic imbalances inside the country seems to be the problem to deserve attention.

Keywords: sugar cane expansion; social impacts; labor market; food security; deforestation.

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Joaquim Bento de Souza Ferreira Filho[1]

1 Introduction

The worldwide expansion of biofuels production has raised concerns about its impact on food security and food supply, due to competition for agricultural land. Researchers have linked this competition to recent hikes in food prices, which has obvious consequences for poverty and food security.

In Brazil the issue is also highly controversial. The country is one of the world´s leaders in ethanol production, initiating as early as in the 1970s a program which led to the development by local automobile companies of flex-fuel engines. Presently, around half of all Brazilian cars (and nearly all new cars) use these hybrid engines, which can run with any mixture of pure ethanol and gasohol (around 80% gasoline and 20% ethanol). In 2010 cars used nearly equal volumes of gasoline and ethanol (although diesel, used mainly by trucks and other commercial vehicles, accounted for nearly 50% of transport energy use).

Although the production and use of ethanol in Brazil has increased greatly in the last decade, Bacha (2009) points out that no food scarcity has arisen. On the contrary, the per capita production of fruits, agricultural raw materials, food and beverages has increased in the period (Bacha, 2009). This phenomenon was accompanied by strong productivity increases in agriculture, as well as by an increase in land use.

Several leading Brazilian institutions have recently produced scenarios for the ethanol and sugarcane expansions in Brazil (EPE, 2008). These scenarios comprise, in general, the increase in the sugarcane supply, land use, ethanol and energy generation, as well as projections for the demand side. A much less studied issue, however, is the social impacts to be expected with such an expansion. The technology of sugarcane production

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differs significantly across Brazil's regions, and the same can be said about the structure of land ownership, which suggests that the pattern of sugarcane expansion will be central to distributional outcomes.

Ferreira Filho and Cunha Filho (2008), for example, showed that the sugarcane produced in Northeast Brazil is more labor intensive than the one produced in Southeast Brazil. Moreover, those regions also differ in terms of the structure of labor demand in agriculture in general, and in sugarcane in particular, with the Northeast demanding proportionately more low-skill workers than the Southeast, which demands more high-skill workers (Ferreira Filho and Cunha Filho, 2008).

Agriculture is a key sector of Brazil's economy. With strong forward and backward linkages, agriculture accounted for 5.6% of total Brazilian GDP in 2009, and rural population still accounted for about 15.6% of total population in 2010. It is natural, then, that changes in the agricultural sector have important impacts in the economy as a whole. Due to its particular characteristics in the labor market, and as a food supplier as well as energy supply source, these impacts are of complex nature, with net results depending largely on the structural characteristics of the economy. The impacts of the projected sugarcane and ethanol expansion in Brazil upon labor demand, income distribution and poverty in the country is the object of this study.

2 Sugarcane and ethanol expansion and land use in Brazil[2]

Ethanol production in Brazil doubled in the period between years 1990 and 2008, and, as shown in Figure 1, has been increasing continuously since year 2000, reaching a peak of around 27.5 billion litres in 2009. The Brazilian sugar/ethanol production complex in Brazil has presently 437 producing units, among which 168 produces only ethanol, 16 only sugar, and 253 both ethanol and sugar[3]. The increase came mainly from the Center-South[4] region, which produces 90% of the total. Figure 2 shows that the bulk of expansion

[2] The author is grateful to Prof. Rodolfo Hoffmann, from the University of Campinas – UNICAMP for his invaluable assistance in data gathering for chapters 2 and 3, as well as for his comments. Errors and omissions remain my sole responsibility.

[3] http://www.mdic.gov.br/sitio/interna/interna.php?area=2&menu=999

[4] Brazil groups its 26 states plus the Federal District (Brasilia) into 5 "macro-regions": **North** (Rondônia, Acre, Amazonas, Roraima, Para, Amapá, Tocantins), **Northeast** (Maranhão, Piauí, Ceara, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia), **Southeast** (Minas Gerais, Espirito Santo, Rio de

of sugarcane planted area happened in São Paulo[5], which in 2009 accounted for 61% of total Brazilian ethanol production. São Paulo's planted area grew from 1.8 million hectares (Mha) in 1990 to 5.1 Mha in 2010.

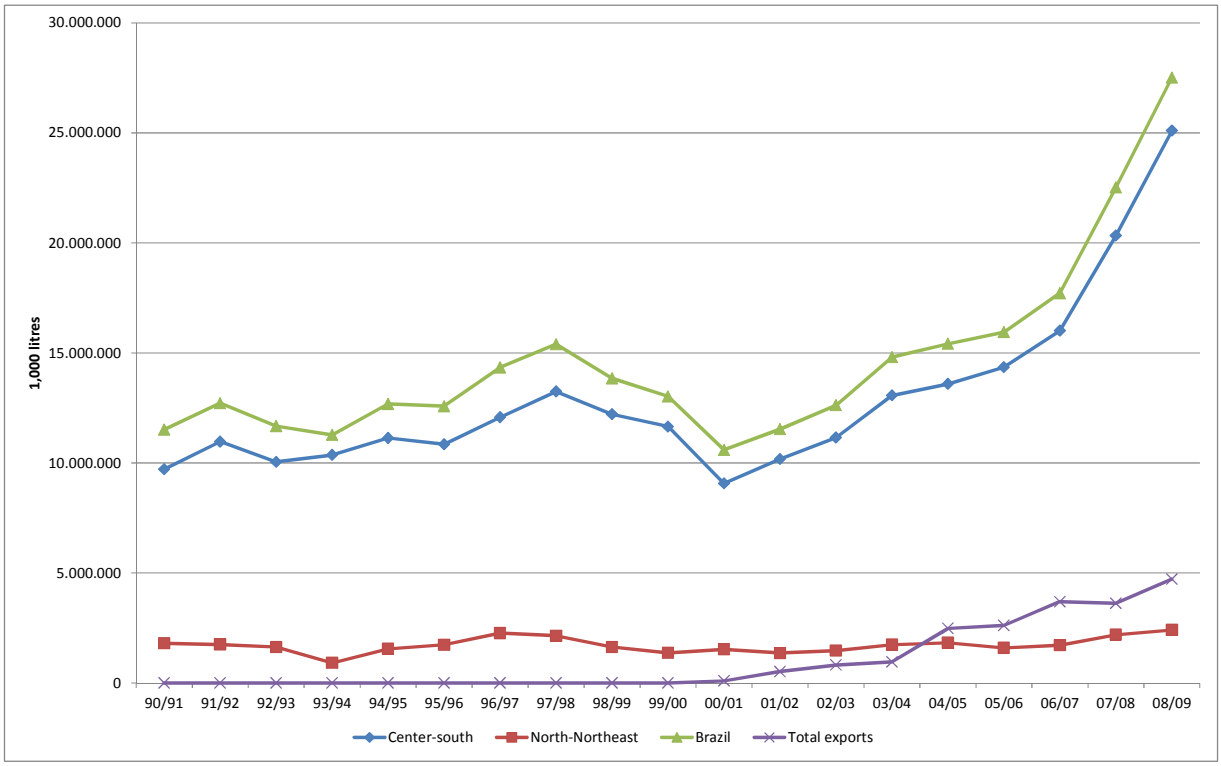


Figure 1. Evolution of ethanol production and exports in Brazil. (1,000 litres).
Source: Produção Agricola Muncipal – IBGE, and Secretaria de Comércio Exterior do Brasil (SECEX).

Janeiro and São Paulo), **South** (Paraná, Santa Catarina and Rio Grande do Sul), and **Center-west** (Mato Grosso do Sul, Mato Grosso and Goiás/Brasilia).

[5] In this paper "São Paulo" refers always to São Paulo state, rather than to its capital city, also named São Paulo.

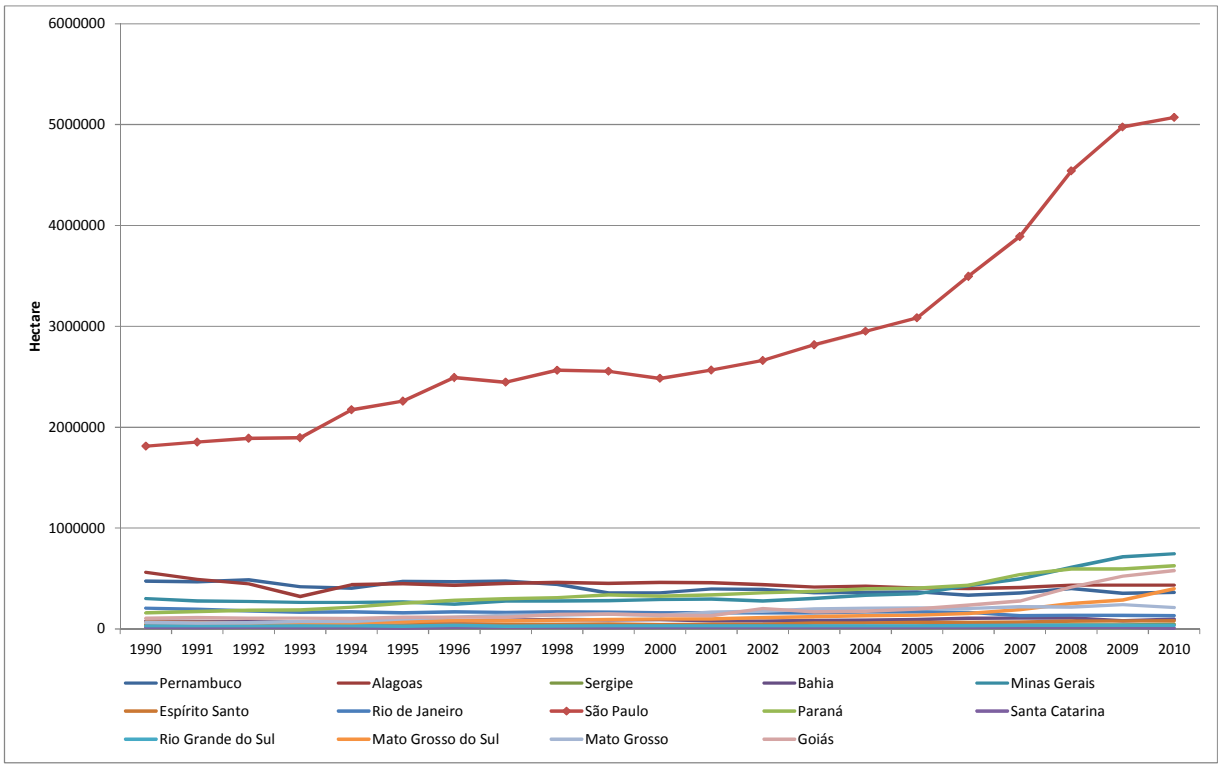


Figure 2. Evolution of sugarcane planted area in Brazil, by state. Hectares.

This regional concentration of sugar cane in Southeast Brazil, and particularly in the state of Sao Paulo, is likely to have important income distribution implications. São Paulo is the richest state in Brazil, concentrating about 33.5% of national GDP in 2009. As mentioned before, the sugar cane production in the state is less labor intensive (more capital intensive) than in the traditional regions in Northeast. This, naturally, implies that the labor content by unit of product will be lower as sugar cane expands in Sao Paulo. On the other hand, the labor market in the state is also relatively more organized than in northeast Brazil, with a higher degree of formality in employment. Wages are also higher in the region. As will be discussed in what follows, this regional concentration of production is being accompanied by important changes in the characteristics of labor demand in the activity. In the next chapter we analyze the evolution of labor market variables in the sugar cane production, in order to infer about social impacts of both the expansion in area and the regional change that accompanied the process.

3 The evolution of labor demand in the sugar cane production in Brazil

The characteristics of the labor market in the Brazilian agriculture have changed significantly in the last two decades. In this chapter we present some figures related to that evolution, together with figures for sugar cane activity, for the sake of comparison. Table 1 displays some statistics related to the general agriculture and the sugar cane sector in Brazil.

The number of persons occupied in agriculture in Brazil with positive earnings decreased from 9.3 million workers in 1992 to about 8.3 million in 2009, despite the strong agricultural growth between those years. The number of workers only in sugar cane production fell from about 709 thousand to 570 thousand workers in the same period. The share of sugar cane in total agricultural occupations, however, fell until 2001, and started to increase again after that date, reaching the maximum of 8.1% in 2008. These figures, however, vary considerably in time, depending on the economic and agricultural cycles.

Table 1. Number of persons, average earnings and GINI index of earnings in agriculture and sugar cane in Brazil. 1992-2009.

	Number of workers			Average earnings (R$)		GINI index	
	Agriculture	Sugar cane	Share (%)	Agriculture	Sugar cane	Agriculture	Sugar cane
1992	9334444	709716	7.6	486.64	435.81	0.57	0.43
1993	9200910	627938	6.8	535.88	464.34	0.61	0.45
1994	-	-	-	-	-	-	-
1995	9264321	645213	7.0	560.63	493.38	0.56	0.43
1996	8570693	671623	7.8	582.37	541.85	0.56	0.45
1997	8861126	583486	6.6	554.63	500.79	0.57	0.39
1998	8417682	477299	5.7	537.31	507.71	0.54	0.40
1999	9061914	489451	5.4	509.72	518.77	0.53	0.37
2000	-	-	-	-	-	-	-
2001	8322519	449385	5.4	517.60	495.35	0.55	0.41
2002	8652840	489837	5.7	531.78	467.53	0.56	0.36
2003	8854697	488217	5.5	528.19	582.33	0.56	0.48
2004	9006730	523000	5.8	539.34	553.34	0.55	0.41
2005	8935282	553032	6.2	565.00	589.78	0.56	0.41
2006	8701155	557090	6.4	586.48	636.86	0.55	0.38
2007	8261752	547451	6.6	630.35	656.34	0.54	0.33

2008	8298577	671343	8.1	649.12	713.64	0.53	0.34
2009	8252594	570413	6.9	646.17	736.00	0.52	0.35

OBS: excludes residents in rural areas of North region, not included in PNAD until 2003.

Source: PNAD, various years. The survey was not performed years 1994 and 2000.

Sugar cane accounts presently for about 7% of total agricultural employment in Brazil. The share of earnings in sugar cane production in total agricultural earnings, however, has been consistently higher than the respective share in employment since year 2003. This shows that the average earnings in the sugar cane sector are higher than in total agriculture. Actually, as it can be seen from Table 1, since 2003 the average earnings in the sugar cane sector are consistently higher than in general agriculture in Brazil, reversing the pattern observed in the nineties. This change is a consequence of the structural changes the sector is facing in Brazil presently, which includes the regional concentration in Southeast Brazil, as discussed before.

The share of sugar cane in the Brazilian agriculture, then, is increasing both in terms of employed workers (as seen in Table 1) and also in terms of earnings, as can be seen in Figure 3. As discussed above, as a consequence of the faster increase in average earnings in sugar cane, the share of the activity in total agricultural wage income is also increasing, and is higher than the respective share in employment.

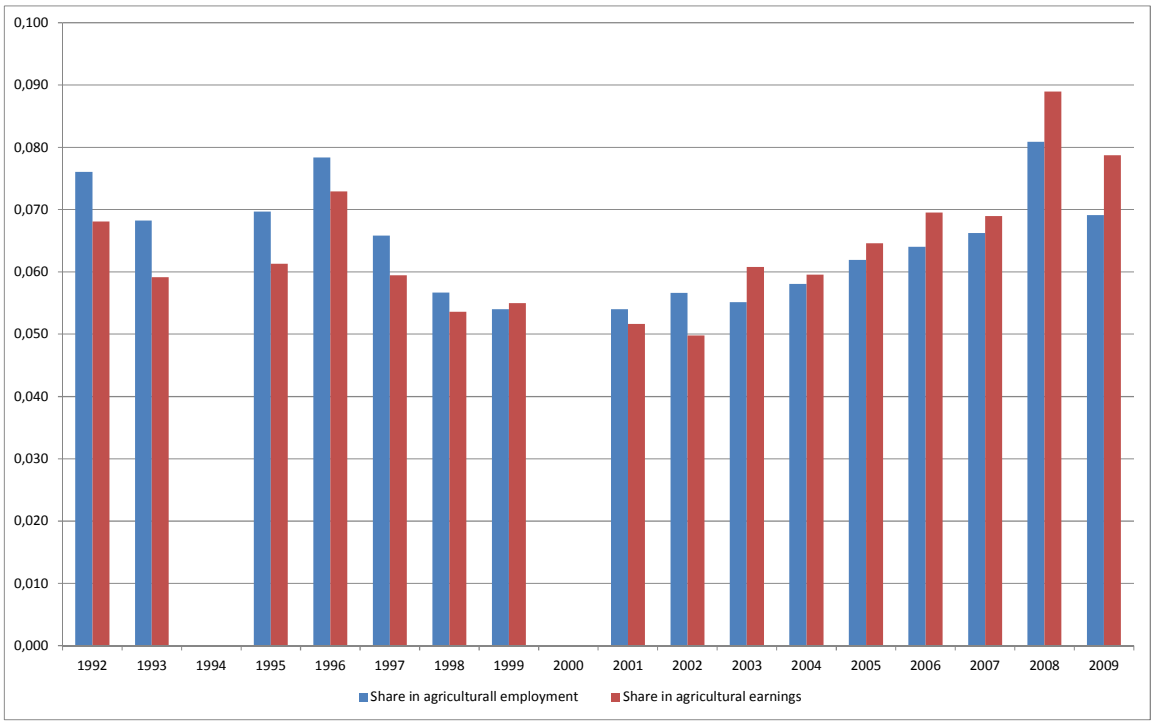


Figure 3. Share of sugar cane in total agricultural employment and earnings. Brazil, 1992-2009.

Sugar cane planted area, on the other hand, evolved from 4.2 million hectares in 1992 to 8.8 million hectares in 2009. This means that the labor content of each hectare in production must have fallen considerably in the period. In fact, Figure 4 shows that the activity is becoming less labor intensive in the recent period: the relation worker/ha in sugar cane production fell from 0.16 in 1992 to 0.06 in 2009.

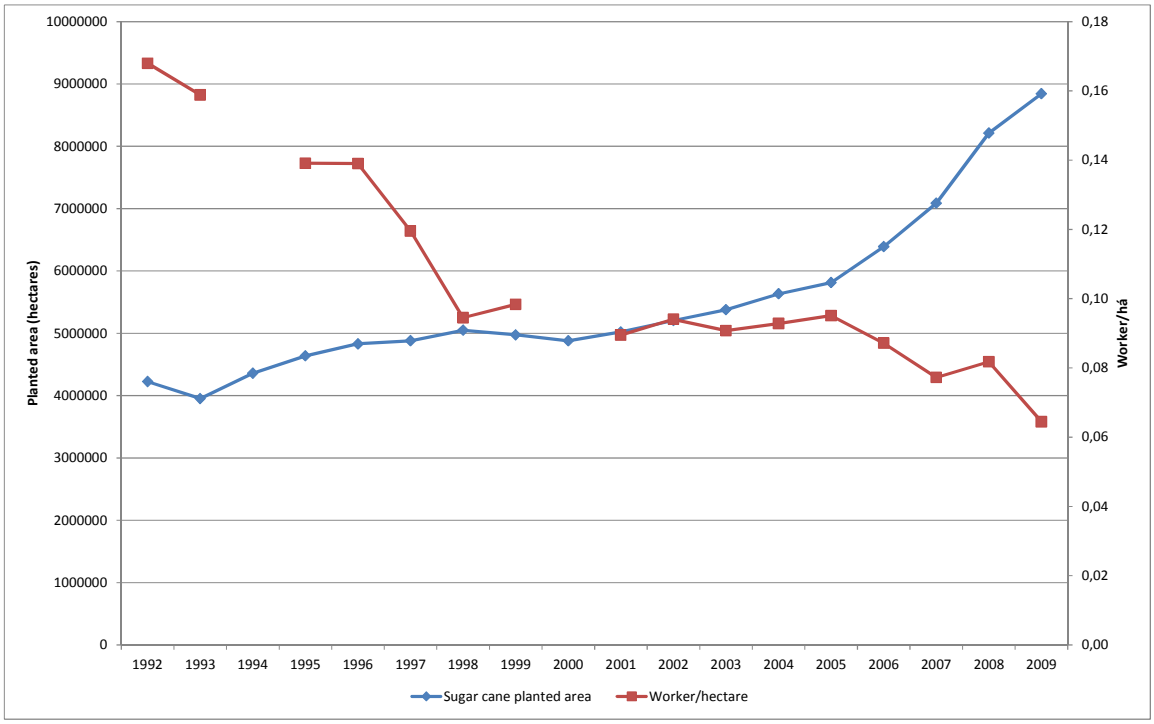


Figure 4. Sugar cane planted area and relation worker/hectares in sugar cane production. Brazil, 1992/2009.

This fall in labor use is matched by a strong increase in productivity, as sugar cane moves to Southeast Brazil. As can be seen in Figure 5, the productivity per hectare in Sao Paulo is more than 50% higher than in Pernambuco, in Northeast Brazil. This difference in productivity is due both to climate and technological conditions. The dynamic region for sugar cane in Brazil, presently in Southeast, is expanding more recently to Center-West, which uses also a more capital intensive technology. The regional displacement of production, then, entails also a change in the technological pattern of the activity, which certainly has impacts not just on total employment, but also on the profile of labor demand in the sector, since capital is typically complementary in production to skilled labor.

Indeed, it can be observed that this higher technological pattern is also accompanied by an increase in skills demand in production. As can be seen in Figure 6, the average number of years of school attendance has been increasing continuously in Brazil, a phenomenon that is not exclusive to the agricultural sector. The average years of schooling for workers in sugar cane, however, are higher than those in agriculture in general since 2005, what is certainly linked to the previous discussion about productivity increases. Sugar cane, then, is becoming a skill demanding agricultural activity, as the sector moves to

more modern technological patterns. This particular aspect of the problem will be discussed in more details later.

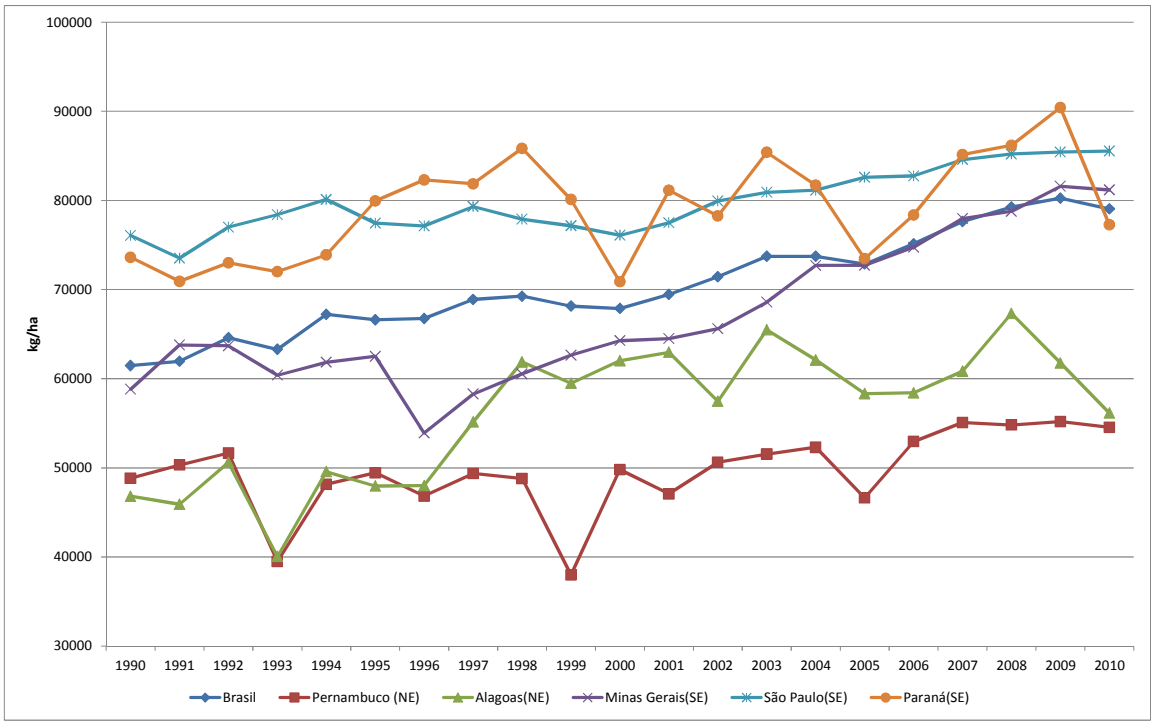


Figure 5. Evolution of sugar cane productivity in Brazil, in kg/ha.

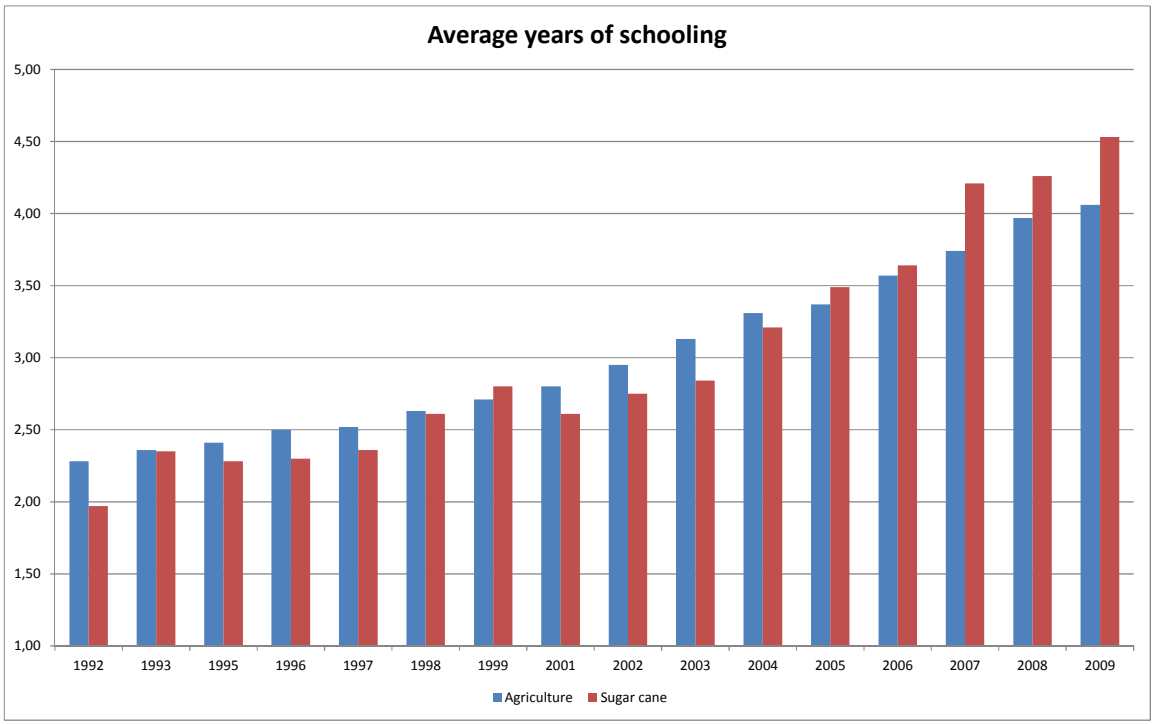


Figure 6. Average years of schooling for workers in agriculture and in sugar cane production in Brazil. 1992-2009.

The previous discussion seems to contradict the pessimistic view frequently seen in Brazil in regard to the expansion of ethanol (and sugar cane) production in the country. As it can be inferred from the above data, this expansion is actually contributing to the increase in the average earnings in agriculture, a sector which still concentrates the bulk of poverty in Brazil. The increase in ethanol (and sugar cane) production in Brazil is happening in a technological pattern more capital intensive, with higher productivity per area, and at the same time with higher average earnings in the activity than in agriculture in general.

The negative aspect of this transition, of course, is that the activity is expanding in the richest regions in Brazil, moving out of Northeast, a region that concentrates some of the poorest states in the country. This regional imbalance is certainly important, and the net effects of these changes are complex, and will be further explored analytically in the next sections.

At the same time, the expansion of sugar cane in Brazil has also raised concerns about the indirect land use change in the country: the expansion of sugar cane in southeast Brazil would displace other agricultural activities that have to be grown elsewhere. Two main concerns were raised in relation to this expansion: concerns about food security and

about deforestation, or the need of new agricultural areas to accommodate the sugar cane expansion in Brazil. In what follows, those questions are also analyzed in more depth, to try to gain insight about their importance.

4 Poverty implications of the ethanol expansion in Brazil

The issue of poverty implications of ethanol expansion in Brazil was analyzed by Ferreira Filho and Horridge (2009). A detailed computable general equilibrium (CGE) model of the Brazilian economy was used to assess the economic and distributional impacts of the prospective scenario of ethanol expansion proposed by EPE (2008a,b), with a focus on the distributional implications.

For this analysis, the authors increased the level of detail in the sugar cane production labor market, extending the decomposition of labor types used in the activity to the regional level. Among the points raised by the authors, it´s important to note the structure of labor demand, distinguished by sector, labor type, and region, to take into account the technological differences in the ethanol production chain inside Brazil. According to that study, in 2004 there were 571,336[6] workers in sugarcane production, 87,521 in ethanol production and 107,429 in sugar production. Primary sugarcane, then, has the prominent role in labor income composition of the sugarcane complex in Brazil.

The study takes into account the regional distribution of production and wages[7] discussed before, to simulate the expansion of ethanol production in Brazil. They notice, for example, that the states in the Centerwest region (Mato Grosso do Sul, Mato Grosso and Goiás), in which the sugarcane expansion is much more recent, are specializing in ethanol (not sugar), with capital intensive technology. Indeed, the flat lands and sparse populations of these regions favor mechanization, including mechanical harvesting, in contrast to the NE regions, where the bulk of the sugarcane is still manually harvested. The distribution of workers by region, according to occupational wages can be seen in Figure 7.

[6] This number is slightly different from what is displayed in Table 1, due to differences in criteria in both studies.

[7] The study refers to wages, in contrast to the more general concept of earnings used in the previous chapters.

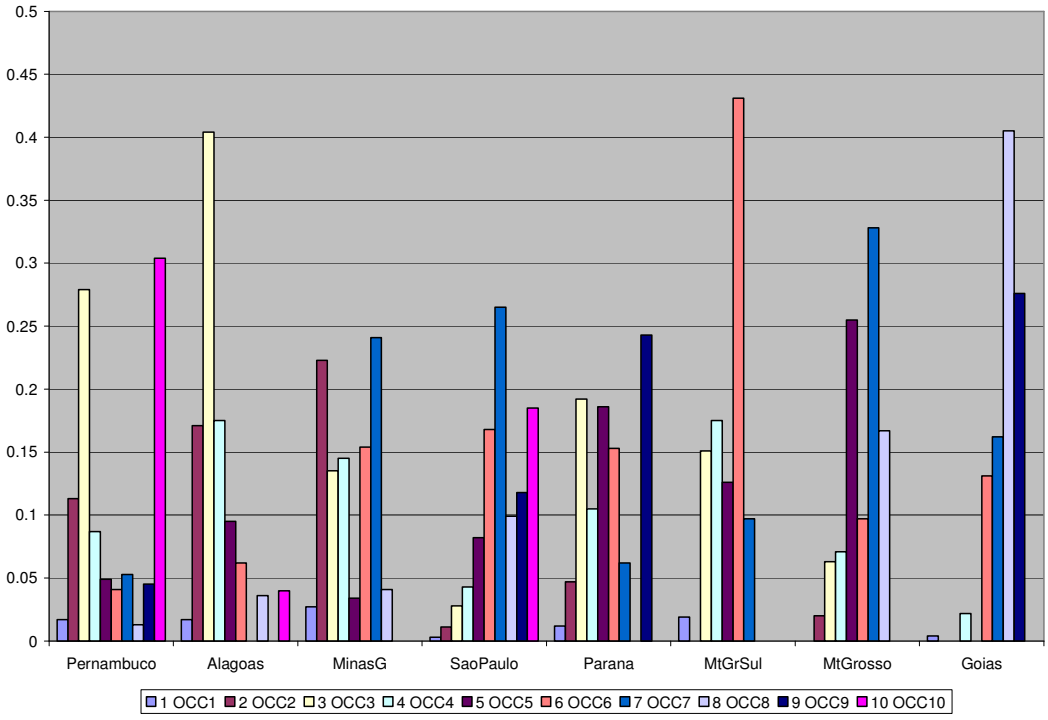


Figure 7. Share of workers by occupational wages, by region. Brazil, 2004.

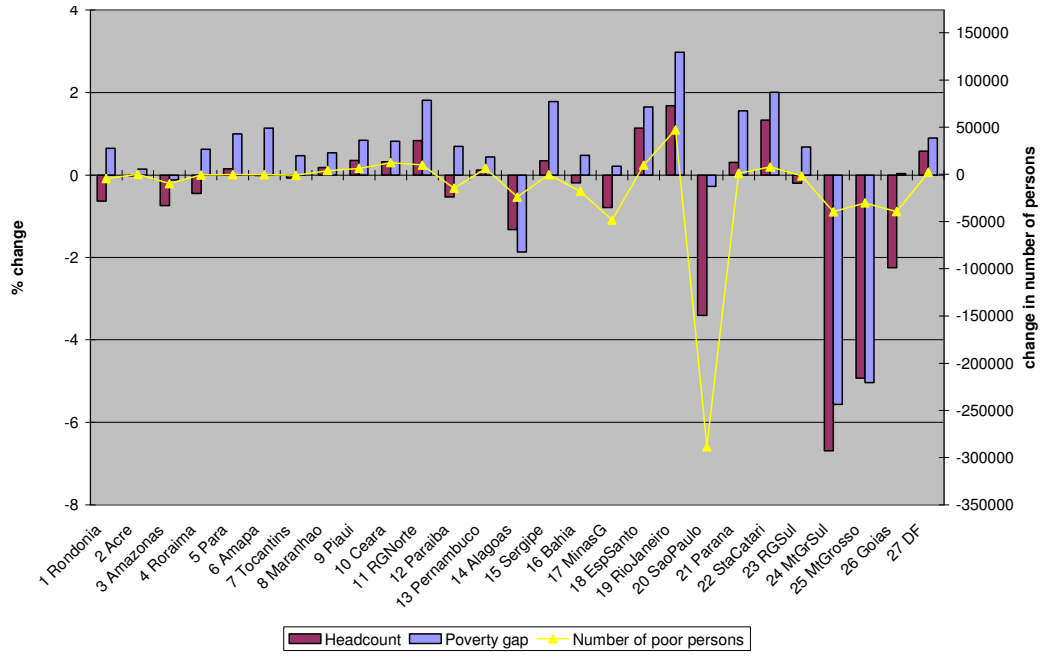
Source: Ferreira Filho and Horridge (2009).

In Figure 7, OCC1 to OCC10 refer to wage classes, as a proxy for skills, where OCC1 is the lowest wage group. Only the most important states in sugarcane production are listed, to avoid clutter. The Northeast states (Pernambuco and Alagoas) specialize in employing the less skilled workers (OCC1 to OCC3), while São Paulo (the most important producing state) concentrates in the middle to upper range. The first three occupational groups account for 72.3% and 70.5% respectively in Pernambuco and Alagoas, and 10.9% in São Paulo. Goiás, which is representative of the new expansion area (together with Mato Grosso do Sul and Mato Grosso), has a labor demand pattern strongly concentrated on the upper wage groups, or more skilled workers. As seen before, this seems to be the pattern of labor demand in the new areas, bringing important consequences for income distribution.

The results by Ferreira Filho and Horridge (2009) suggest that the ethanol demand increase has a small positive impact on income distribution, resulting in a 0.19% fall in the GINI index. In regional terms, the number of poor persons would fall mostly in the states of São Paulo, Minas Gerais, and in the Centerwest states of Mato Grosso do Sul, Mato Grosso and Goiás. In the poorest states of Northeast Brazil only Alagoas shows a fall both in the

headcount and in the poverty gap, while Pernambuco shows a slight increase in the number of poor persons. Poverty measures rise in the other Northeast states.

Figure 8. Regional results: percentage changes in the headcount ratio and poverty gap, and change in the number of poor persons.



Model results point to a 0.58% fall in the headcount ratio, what would correspond to a reduction of 87,382 poor households, or 413,690 poor persons in Brazil, due to the increase in ethanol demand projected in the simulation.

The observed trend of a more capital and skill intensive sugar cane production in Brazil seems to be the pattern that can be expected. Recent developments, especially environmental and labor regulations point to this more capital intensive type of activity. São Paulo state, for example, passed a law banning sugar field burning after 2021 for lands suitable to mechanization and 2031 for the entire state. A protocol[8] between the private sector and the Sao Paulo government, however, has anticipated the dates to 2014 for lands suitable for mechanization, and 2017 for the rest of the state. This will have severe consequences for labor demand, since non burnt sugarcane cannot be harvested manually. Figure 8 shows that the bulk of reduction in the poverty ratio would happen in São Paulo, already the richest state in Brazil, and where relative poverty is one of the lowest. The same

[8] The Agro-environmental Protocol can be seen at http://www.unica.com.br/content/show.asp?cntCode={BEE106FF-D0D5-4264-B1B3-7E0C7D4031D6} .

can be said about the Center-west states, where the regional headcount ratio is about half the value observed in the poorest Northeast. As shown by Liboni (2009), this is also the region which shows the highest educational profile for workers in the sugarcane complex, either in agriculture or in the industrial stages, in contrast to the Northeast region.

This intensification trend in the activity, then, is likely to continue in the future, turning sugar cane production more and more capital intensive and reducing its relative capacity of absorbing unskilled labor, an important feature of sugar cane production in the past.

5 Food supply and land use implications of ethanol expansion in Brazil

The implications of ethanol expansion in Brazil, now with a focus on food supply and land use, was also analyzed by Ferreira Filho and Horridge (2011) with the aid of a dynamic general equilibrium model designed for analysis of indirect land use change – ILUC – in Brazil. This model has an endogenous land use module, and the same ethanol expansion scenario was analyzed to assess the implications for land use and food supply.

The departing point for the discussion is the observation that although the production and use of ethanol in Brazil has increased greatly in the last decade, authors like Bacha (2009), for example, pointed out that no food scarcity has arisen. On the contrary, the per capita production of fruits, agricultural raw materials, food and beverages has increased in the period (Bacha, 2009). This phenomenon was accompanied by strong productivity increases in agriculture, as well as an increase in land use.

As is well known, Brazil still has a vast stock of land which could be converted to agricultural uses. Land clearing for agriculture is a complex and multi-dimensional phenomenon that raises great concerns. Although the rate of land clearing is now easier to measure, *via* satellite monitoring, its causes are much harder to assess, as pointed out by Babcock (2009), who also argues that …"the debate about whether biofuels are a good thing now focuses squarely on whether their use causes too much conversion on natural lands into crop and livestock production around the world". The debate is of economic importance, since regulations regarding biofuels will depend crucially on the indirect land use changes (ILUC) caused by the expansion in energy agricultural-based products.

Figure 9 shows how land use evolved between the last two Brazilian Agricultural Censuses (1995 and 2006). There, "Unused" land is defined as the total area of each state

minus the used areas: crops, pastures and planted forests, as shown in each respective Agricultural Census. It includes, then, all areas not used in agriculture, like natural forests, but also urban areas, lakes and roads. These areas, however, are expected to change much less than the land-cleared areas, so the change in "Unused" is used here as a proxy for deforestation, or land clearing for agricultural uses.

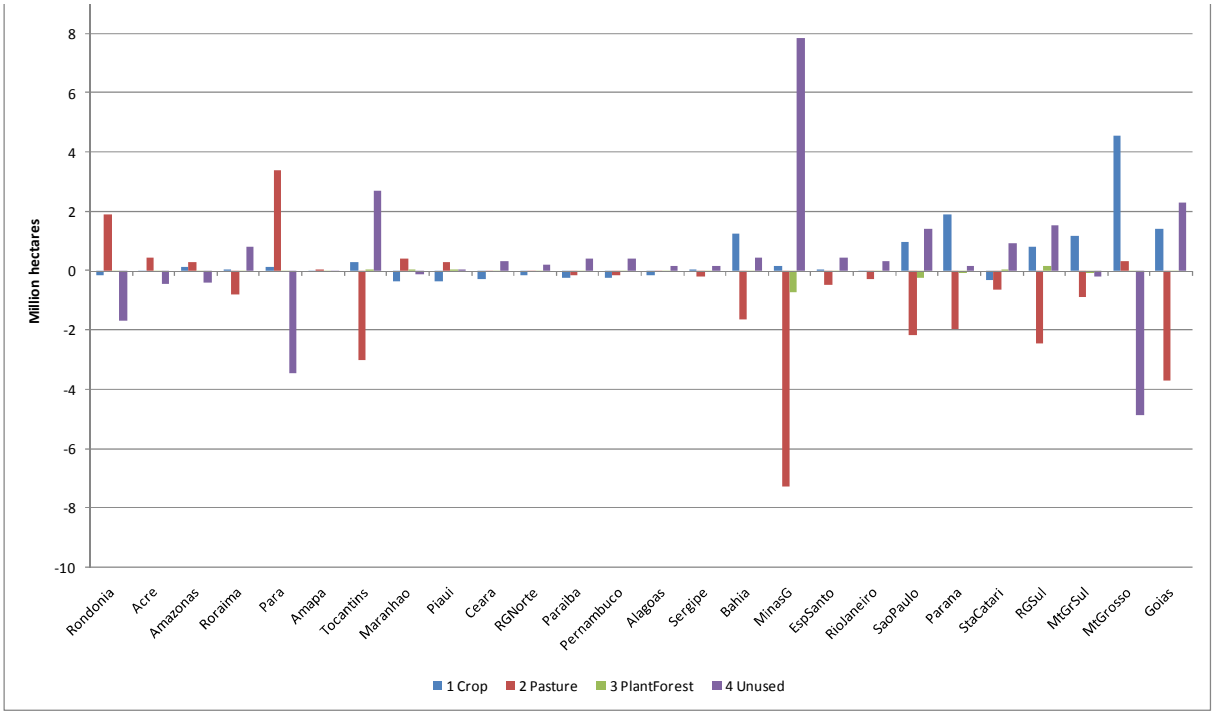


Figure 9. Land use change in Brazil, by state. Variation between 1995 and 2005.
Source: Brazilian Agricultural Censuses 1995 and 2006.

As seen in Figure 9, the fall in unused land occurred mostly in the states of Rondônia and Para, in the North (Amazon) region, and in the state of Mato Grosso, also in the Legal Amazon. However, while in Rondônia and Para there was a strong increase in pastures areas, in Mato Grosso the increase was in crops areas (which was used mostly for soybean). By contrast, in São Paulo, the most important sugarcane expansion region, the unused land area actually increased in the period, as well as the land for crops, while pasture areas decreased.

This suggests, of course, that land substitution for sugarcane expansion in São Paulo occurred at the expense of land use for pastures, and not deforestation, since, as noted before, land stocks are run out in this state. But this seems to be the case with most other states, apart from those three states mentioned above. In Paraná state, for example, the 1.9

Mha increase in area under crops in the period was matched by a 1.97 Mha fall in pasture area. In Rondônia state, on the other hand, the 1.8 Mha increase in pasture area was matched by a 1.7 Mha fall in unused land. However, the land use transition differed markedly between states. While in São Paulo virtually no unused land was converted for any other use in the period, in Mato Grosso (on the agricultural frontier) about 840 thousand hectares were directly converted from unused to crop, and 4 Mha to pastures.

The authors conclude that the increase in ethanol production, although attracting land from other uses, would have only a slight impact on food prices in Brazil. The price of the food bundle for the poorest households would be increased by only 0.037% compared to the baseline, accumulated in year 2020. Part of this result is determined by the fact that Brazil still has a huge "intensive" agricultural frontier represented by a large amount of low productivity pastures which are incorporated for agriculture as prices rise. The authors also notice that the increase in sugar cane production required to meet the targets would be about the double of the extra land requirements, due to the concentration of production in regions with higher productivity.

This is found to be an important aspect of the problem in terms of food security. The higher the productivity of sugar cane, the smaller the extra land amount needed. The same happens with the need of new land to be incorporated to the production process: the ILUC effect found in the study would be -0.14 for the deforestation/sugar cane area relation, and -0.47 for the pastures/sugar cane area relation. This means that, under the hypothesis of the study, which is largely based on the observed past land use transition patterns, each new hectare of sugar cane would be associated to 0.14 ha of new land to be incorporated to production process, and to less 0.47 hectare of land attracted from pastures. There are, of course, important regional differences inside the country, and this is actually found by the study to be the important issue associated with the ethanol expansion in Brazil.

6 Final remarks

The results presented above do not support a pessimistic view regarding the social impacts of ethanol and sugar cane expansion in Brazil. Actually, that seems to have a potential to reduce poverty, through the increases in average wages in agriculture as sugar cane incorporates the more "southeastern" wages standards. The main reason is that, unlike

in the past, the projected expansion of the sugarcane complex has a new technological basis, which relies heavily on mechanization of agricultural activities. This raises several points for policy-makers to consider.

The first is related to the pattern of expansion in labor demand. As seen before, the pattern of labor demand in the recent sugar cane expansion is actually of better skilled, and better paid, workers than observed in average in Brazilian agriculture. The increase in labor demand will continue to happen mostly in São Paulo and in the Center-west regions, and among middle-waged workers, with a decrease in employment of the less skilled in the Northeast region. UNICA (2008), according to Liboni (2009), estimates a loss of around 420 thousand jobs in sugarcane production in São Paulo state due only to the expansion of mechanization in harvesting, an effect that will be attenuated by the simultaneous expansion of cane-growing in the state. But this slowing down of the decrease in sugar cane jobs due to mechanization will be lost after 2014, if the complete ban of manual harvest on lands not suitable for mechanization is really enforced[9]. Hence labor force training arises as a key policy problem.

Second, the results suggest that the food *versus* energy dilemma, central in recent discussions about ethanol production expansion, is not really a serious problem in Brazil. Actually, there is no factual basis for the catastrophist forecasts which became popular during the surge in international food prices observed in 2008. Even if food prices increase, due to the fall in land available for food production, the increase is small, and could easily be counteracted by small productivity increases in food production. The food price increase would actually raise the cost of the consumption bundles of the poorest, but this increase would be more than compensated by the increase in incomes, generating a net positive effect on poverty. However, even though the ethanol demand expansion is shown here to be poverty-friendly in aggregate, it is only by a small amount. The distributional side-effects are positive, but not striking. The main benefits associated with Brazil's ethanol expansion are related to diversification of the energy matrix, and to reduction in greenhouse gas emissions.

[9] The pace of introduction of mechanization in harvesting is actually faster than initially predicted, but uncertainties remain. Some important producing regions in São Paulo have hilly lands, unsuitable for mechanized harvesters. Besides, these regions are the ones with a higher share of small to medium-sized producers.

The most serious social imbalances associated with ethanol demand increase will likely be related to the regional redistribution of economic activity inside Brazil. The Southeast and Center-west regions are the most important winners, and the Northeast states lose most. This redistribution and the potential negative effects on regional equity deserve the attention of policymakers in Brazil.

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