TEXTO PARA DISCUSSÃO N° 1103

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* Este trabalho é uma versão revista e ampliada do artigo "Agricultural Growth in the Period 1999-2004, Outburst in Soybeans Area and Environmental Impacts in Brazil", que foi publicado pelo IPEA como Texto para Discussão nº 1062, janeiro de 2005.

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ISSN 1415-4765

JEL Q18

TEXTO PARA DISCUSSÃO

Uma publicação que tem o objetivo de divulgar resultados de estudos desenvolvidos, direta ou indiretamente, pelo IPEA e trabalhos que, por sua relevância, levam informações para profissionais especializados e estabelecem um espaço para sugestões.

SUMMARY

SINOPSE

Este trabalho analisa o crescimento agrícola brasileiro após a mudança da política cambial, em janeiro de 1999. Toma como base, para isso, o comportamento da taxa de câmbio e dos preços internacionais das *commodities* ao longo do período 1999-2004. Discute, também, o comportamento da área cultivada nesse período recente, mostrando que ocorreu um aumento muito grande da área plantada com grãos nos anos agrícolas 2001/2002, 2002/2003 e 2003/2004, em grande parte devido à expansão da soja. O trabalho propõe que essa expansão tão rápida da área plantada com soja deu-se preponderantemente com base em conversão de pastagens. Sugere, ainda, que a expansão da soja não deve ser vista como antagônica à política ambiental, especialmente no que se refere à proteção da floresta amazônica.

ABSTRACT

This paper analyses the Brazilian agricultural growth since January 1999, when a new exchange rate policy was adopted by the country. The analysis focuses on the behavior of the exchange rate and international commodity prices throughout the period 1999-2004. It is also analysed the behavior of cropped area in this recent period, with the conclusion that there has been a fast increase in area planted with grains in the agricultural years 2001/2002, 2002/2003 and 2003/2004, due almost entirely to the growth of soybeans area. The paper proposes that this expansion of area planted with soybeans was based preponderantly on the conversion of pastures. It is also suggested that expansion of soybeans should not be seen as antagonistic to the environmental policy, specially in what respects the protection of the Amazon forest.

1 INTRODUCTION

This paper presents an analysis of Brazilian agricultural growth after the change in the exchange rate regime in 1999. It is clear that this policy shift affected favorably agriculture; however the literature does not contain an analysis of what happened and how it happened, particularly in face of the behavior of international agricultural prices.

The analysis here shows that the decline in international prices partially offset the stimulus provided by the change in the exchange rate regime in 1999. However, the increase in prices observed between 2002 and the first semester of 2004, reinforced the effect of the exchange rate devaluation, leading to a period of great dynamism in the agricultural sector, particularly in the last three agricultural years. This same analysis points to the fact that the decline in prices since the second semester of 2004 is likely to adversely affect the behavior of agriculture in the years ahead.

The data shows also that agricultural growth was leaded by a fast increase in grain acreage: 22.8 % in the three agricultural years of 2001-2002, 2002-2003 and 2003-2004. This is markedly different from the pattern observed during the 1990s, where acreage remained roughly constant and yield increases were the main source of production growth. We observe also that the recent expansion of the grain area was concentrated on soybeans, which increased 39.8 % in the Southern and Southeastern regions and jumped 66.1 % in the Center-Western region.

At first one could identify this as an extensive process of growth in the Ricardian sense. Nevertheless, the expansion of acreage seems to have been made possible by conversion of pastureland, which suggests an intensification, rather than extensive growth, of agriculture.[1]

In addition to indicate that the rapid acreage expansion was heavily based on pasture conversion, rather than on contemporaneous opening of new areas—either in the *cerrado* or in the Amazon Forest—the paper shows that this was facilitated by easier acquisitions of machinery after 2000-2001, thanks to a credit program named Programa de Modernização da Frota de Tratores e Máquinas Agrícolas (Moderfrota).

Finally, the paper argues that the expansion of soybeans acreage does not cause difficulties for environmental policy, particularly in respect to the Amazon Forest. As part of the argument, the paper advocates that BR 163 should be paved as quickly as possible. This will have the effect of reducing transportation costs and, additionally will facilitate planting of soybeans in the vicinity of the highway, increasing the efficacy of environmental preservation initiatives.

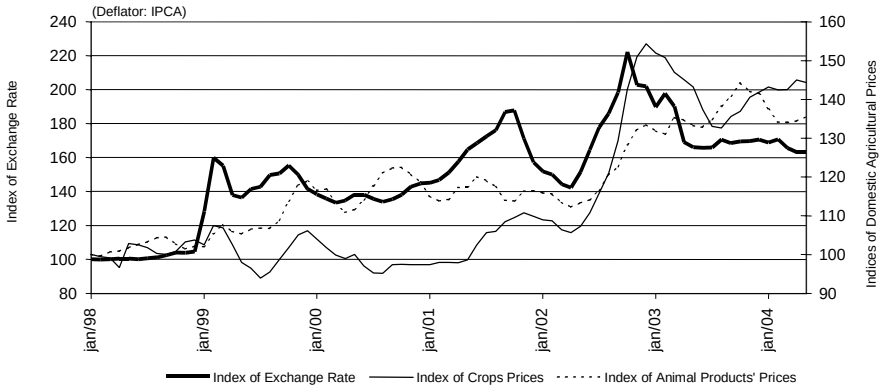
1. With respect to the connection between acreage growth and intensive livestock production, the authors owe much to prof. Guilherme Dias, of the University of São Paulo (USP), who in private correspondence with one of the authors suggested that "the adequate area unit for calculations of yields should be the rotation corn/soybeans/pasture (…)". We warn the reader however, that the recent expansion of soybeans acreage is not a part of the on going process of agriculture and livestock integration. This is justified on the grounds that the expansion of soybean acreage was too fast (an explosion indeed) and also that it is common in the Brazilian *cerrados* to plant soybeans to renovate pastures. On this regard, see *Globo Rural* (2004), and *Panorama Rural* (2004).

The paper is organized as follows. Section 2 shows the behavior of domestic agricultural prices in the period 1998-2004, identifying the role of the exchange rate and of the international prices in the various subperiods. Section 3 analysis the growth perspectives in face of declining prices in 2004, looking in more depth to the effects of soybeans prices. Section 4 documents the expansion of acreage in the recent period. Section 5 contains evidence to support the claim that acreage expansion did not lead to the enlargement of the land base of agriculture and did not represent a threat to the environment. Section 6 argues that soybeans should be seen as a friend, and not as an enemy, of the environment and particularly of the Amazon Forest. Section 7 considers the impacts of Moderfrota and Section 8 concludes and summarizes the paper.

2 THE BEHAVIOR OF DOMESTIC AGRICULTURAL PRICES IN THE PERIOD 1999-2004: THE ROLES OF THE EXCHANGE RATE AND OF THE INTERNATIONAL PRICES

Figure 1 shows that real agricultural prices, deflated by Índice de Preços ao Consumidor Amplo (IPCA), were roughly stable until the second semester of 2001. Livestock prices, on the other hand, have increased in response to the devaluation of the exchange rate in 1999. Agricultural prices have in fact declined significantly when deflated by an index of agricultural inputs, such as the Índice de Preços ao Produtor (IPP) of Fundação Getulio Vargas (FGV).

FIGURE 1
INDICES OF DOMESTIC AGRICULTURAL PRICES AND OF REAL EFFECTIVE EXCHANGE RATE (JAN/98=100)



Source: FGV and Ipeadata.

Part of the explanation for the behavior of agricultural prices can be found in the regularization of supply of important agricultural products, after a short harvest in 1998 [see IPEA (1999)]. An additional explanation, however, can be found in Figure 2, which shows that after the devaluation, world prices of agricultural commodities plummet,[2] following a period of high prices and of historical peaks such as in the 1995-1996 agricultural year.

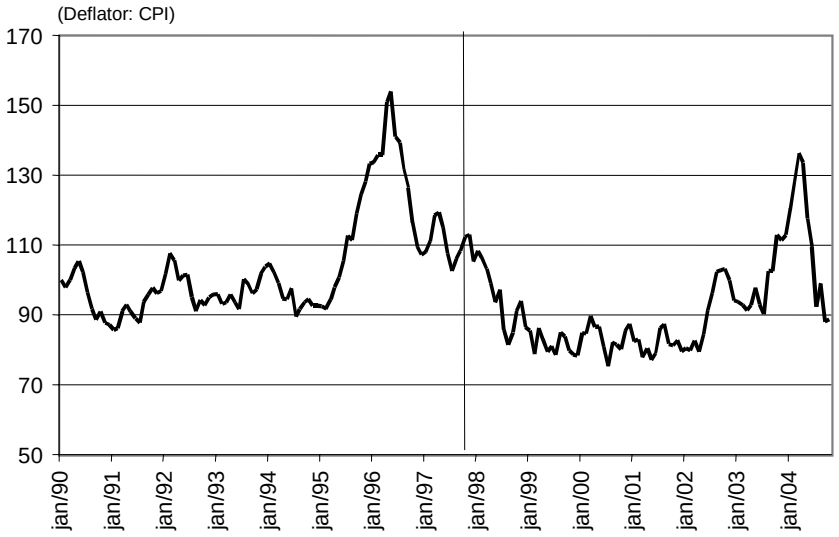
Large variations in international agricultural prices are often associated with variations in world production. This is particularly true for grains and oil seeds,

2. Observe that other indices CRB of agricultural prices show a similar behavior of the index presented in Figure 2.

whose production is heavily concentrated in the United States and thus climate instability in this country influences world supply and world prices. Furthermore, macroeconomic variables also influence prices since they affect final demand through the variations in the value of the dollar, and through its effects in the world financial market, particularly in the behavior of the interest rate in the United States.

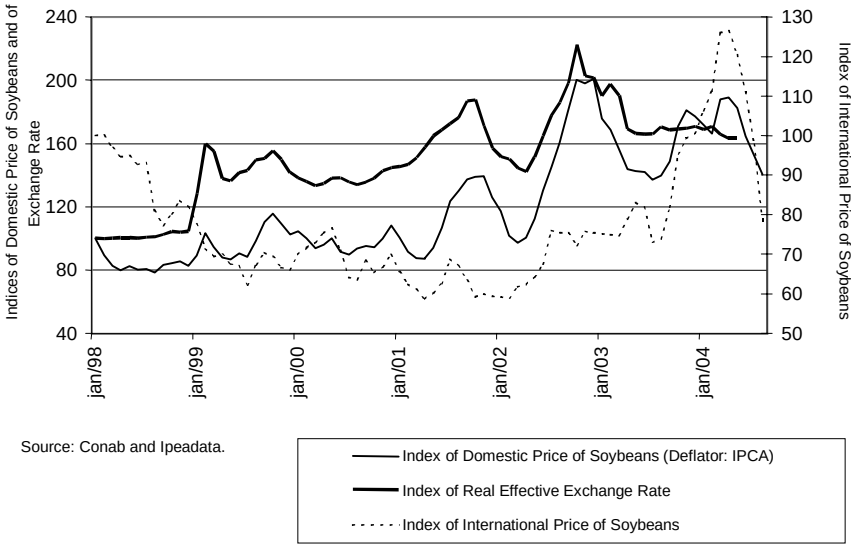
The case of soybeans will shed more light on the behavior of the international markets of agricultural commodities. Figure 3 shows that the international price of soybeans was stable and low and sometimes declined between 1998 and 2001. Beginning in 2002, prices start to increase, and reach a peak in the first semester of 2004 which is followed by a sharp decline in the second semester of 2004.

FIGURE 2
CRB INDEX FOR GRAINS AND OILSEEDS (JAN/90=100)



Source: CRB.

FIGURE 3
INDICES OF DOMESTIC AND INTERNATIONAL PRICES OF SOYBEANS AND OF REAL EFFECTIVE EXCHANGE RATE (JAN/98=100)



Source: Conab and Ipeadata.

Thus, in view of the coincidence of the devaluation of the exchange rate with the cycle of low prices in the world grain markets, one sees that the two effects offset each other, leading to the stability of domestic prices. With the recuperation of world prices in 2001-2002, domestic prices increased, providing the incentives for the observed area expansion.

To make this more precise, Table 1 decomposes the variation of the domestic prices into two components: *a*) variation of the exchange rate and *b*) variation of the international price. The calculation was done for two successive years and two comparison periods: *a*) planting period, August to October and *b*) harvesting/marketing period, March to May. The variation in the soybeans price between two consecutive years, in the planting period, is certainly relevant for the planting decisions. On the other hand, the variation of the price in the harvesting/marketing period between any two years may lead to unexpected losses or windfall gains. Thus, these year to year price variations, in the two periods of the agricultural year, influence farmers' decisions.

TABLE 1
BRAZIL: RATES OF CHANGE OF DOMESTIC AND INTERNATIONAL PRICES OF SOYBEANS AND OF REAL EFFECTIVE EXCHANGE RATE, BETWEEN PERIODS OF PLANTING AND PERIODS OF MARKETING
[%]

Periods	Period of planting			Period of marketing		
	Domestic price	International price	Exchange rate	Domestic price	International price	Exchange rate
1998-1999	32.1	–13.2	47.9	9.9	–27.8	42.8
1999-2000	–12.7	–4.8	–10.5	7.6	8.8	–5.4
2000-2001	43.6	–3.9	35.1	–7.4	–20.0	16.5
2001-2002	33.2	17.6	10.2	15.4	4.6	–7.5
2002-2003	–15.2	12.6	–16.2	42.8	25.6	20.0
2003-2004	–8.3	–6.8	–3.6	26.3	57.6	–6.3

Sources: Conab and FGV.
Note: The periods of planting and of marketing were the months from August to October and from March to May, respectively. The rates of variation were calculated on the basis of the simple averages of the prices calculated for these periods.

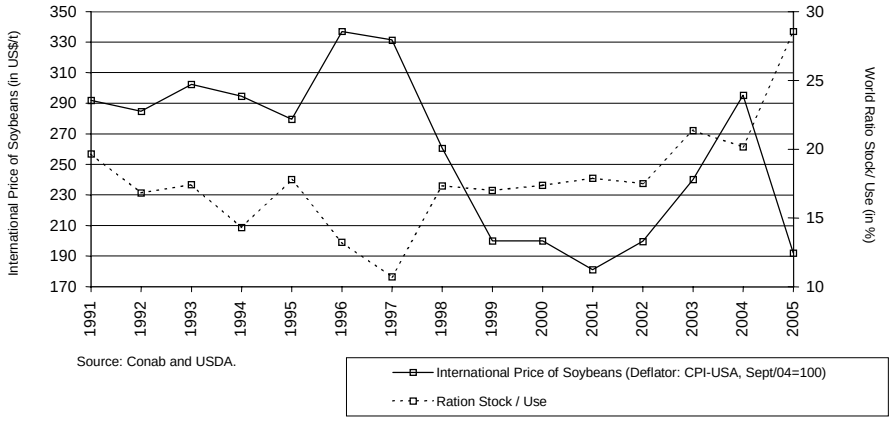
As can be seen in Table 1, there was a persistent reduction in the prices of soybeans between 1998 and 2001; if it were not for the devaluation, agriculture would have experienced a period of low or negative profitability. Nevertheless, this table shows that the increases in the price of soybeans between 1998-2001 were restricted to the planting period, without significant changes in the harvesting/marketing period. But the situation changed drastically afterwards. Price comparisons between 2001 and 2002, between 2002 and 2003 and between 2003 and 2004 show that soybeans producers obtained significant windfall gains mostly due to the behavior of the international market.

The period 1998-2004 can be divided in two sub periods, depending on the role of the exchange rate and of the international prices: *a*) 1998-2001 where the exchange rate was instrumental do avoid a sharp reduction in domestic prices; and *b*) 2002-2004 where the increase in the international prices feeded the upward movement of the domestic price.

Figure 4 shows that the period of declining world soybeans prices (1998-2001) coincided with a phase of high world stocks. It also shows that the recent price

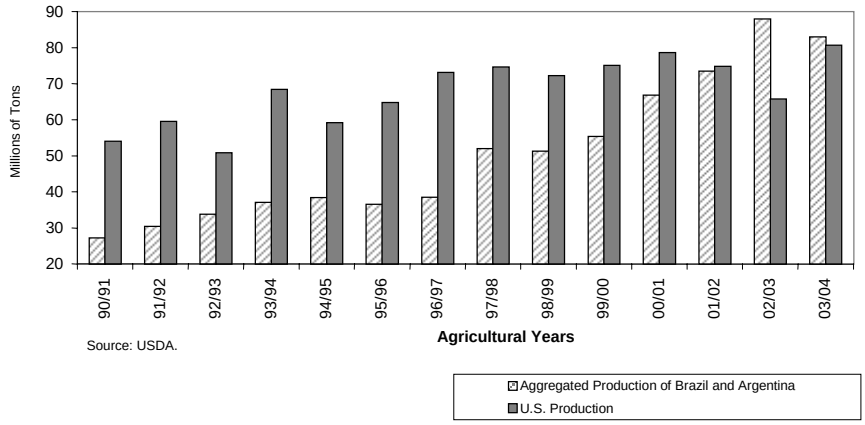
volatility is associated with volatile expectations with respect to estimated stock levels at the end of the crop year 2004-2005. World prices of cotton, corn and wheat show the same cyclical pattern.[3]

FIGURE 4
WORLD RATIO STOCK/USE AND INTERNATIONAL PRICE OF SOYBEANS, 1991/2005



Incidentally, it is worth noting that the short harvests in the United States in 2002 and 2003 were instrumental to avoid a significant reduction in world prices due to the increase in soybeans production that took place in Brazil and in Argentina after 1999. Figure 5 shows this and we note the jumps in the joint production of the two countries in the agricultural years 2000-2001, 2001-2002 and particularly in 2002-2003. In latter year the joint harvest was 88 million tons, 20% above the harvest of the previous year (73.5 million tons).

FIGURE 5
SOYBEANS: AGGREGATED PRODUCTION OF BRAZIL AND ARGENTINA AND AMERICAN PRODUCTION, 1990-91/ 2003-04



In 2003 the harvest in the United States was 65.8 million tons, a drop of 12% in relation to the previous year. This was indeed a second consecutive short harvest in the United States. If the harvests in 2002 and 2003 remained at the 2001 level of 78.7 million tons, world soybeans production would have increased 8.5% in 2002 and 0.9% in 2003 instead of the drop of 4% that actually took place in the latter

3. For details, see IPEA (2004).

year. Had this happened, world prices would not have reached the levels observed in 2002, 2003 and much less the stratospheric levels achieved in the beginning of 2004.

Let us open a parenthesis here to note the similarity between the achievement of high world prices even though strong devaluations took place in both Brazil and Argentina and a discussion that took place in the 1980s. In that discussion, some analysts were concerned that a generalized process of devaluation in developing countries pressed with high external debt would aggravate, rather than alleviate, the shortage of foreign exchange, to the extent that the increase in the world supply of agricultural products would reduce foreign revenues.

3 BRAZILIAN AGRICULTURAL GROWTH PERSPECTIVES IN THE FACE OF LOW INTERNATIONAL GRAIN PRICES IN 2004

Initially we note that brazilian grain producers cannot take decisions based solely on producer prices in Brazil at the time of planting. Due to the great importance of the United States in international markets and the difference in the agricultural years of the two countries, prices at the harvest may be markedly different than those at the time of planting, depending on the harvest in the United States. This is particularly true for cotton, where harvest in Brazil goes into the second semester of the year, when the United States harvest is practically determined. In the case of soybeans, the divergence between prices at the time of planting and prices at the time of harvest in Brazil was at a maximum in 2003-2004, for the pleasure of brazilian producers.

Furthermore, it is known that the short run price elasticity of supply is low, more so yet for the aggregate agricultural product or for a sub group of products using the same inputs, such as grains. The more intense use of capital in agricultural production, as happened in Brazil recently, has contributed to further reduce the supply elasticity.[4] Even with negative expected profitability, production has not decline and so prices remained low.

On the other hand, in the United States, due to the subsidies that compensate for low prices, the elasticity is even lower since total returns from farmers are protected from price reductions. This applies to both aggregate production as well as for individual commodities, such as soybeans.

This analysis explains the cycles in the international grain markets, with dominance of low prices. A price reduction at a given moment in time does not reduce supply in the United States and neither in Brazil or Argentina. Thus, if there is an abundant harvest in the United States, such as in 2004, and normal productivities in the following years, prices will fall and will remain there since supply will not be affected by the lower prices. Therefore the current stage of low prices will be changed if a short harvest takes place, particularly in the United States in view of her importance as a producer of grains. This was what happened in 2002 and 2003.

4. This was pointed out by Ferreira Filho, Alves e Gameiro (2004), for the case of cotton in the Center-West. According to them "(...) the pattern of technology, in view of the large volume of capital that is required, implies a high risk of production and prices for producers. In a period of low prices, this leads to the question of whether this model can be considered adequate".

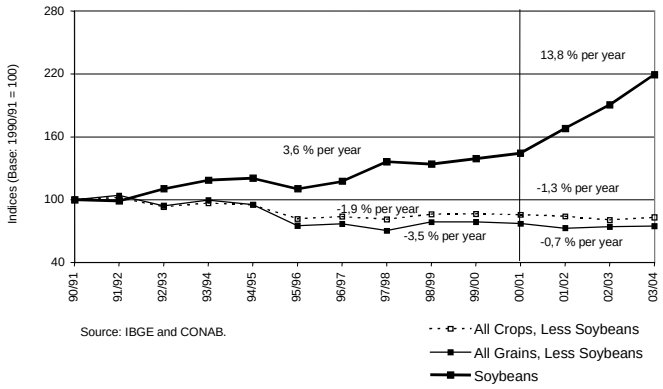
One year of normal production was, however, sufficient to change the price scenario completely.

In summary, unless there is a short supply of soybeans in Brazil and Argentina in the agricultural year 2004-2005, and/or in the United States in 2005 (a fact that won't be known until July or August 2005), it is likely that prices will remain low in 2005. This will reduce agricultural profitability and will, very likely, lead to a financial crisis due to the high level of indebtedness of farmers achieved in the period of high prices.

4 INCREASES IN ACREAGE IN THE RECENT PERIOD, WITH SPECIAL EMPHASIS IN THE CASE OF SOYBEANS

Recent Brazilian agricultural growth, characterized by a strong expansion of cropped area, represents a break up with the pattern observed during the 1990s where acreage remained constant.[5] This can be seen in the case of soybeans, where acreage has grown at an annual average rate of 3.6% during the period 1990-1991/2000-2001 and then experienced a spectacular increase to 13.8% during 2000-2001/2003-2004, as illustrated in Figure 6. Acreage with other grains has also changed its pattern, going from –3.5% to –0.7% between the two periods. Total acreage with all crops, except soybeans, has not changed its behavior between the periods.

FIGURE 6
INDICES OF PLANTED AREA OF SOYBEANS AND AGGREGATES OF CROPS, 1990/91-2003/04



Source: IBGE and CONAB.

Table 2 shows this switch of patterns in the case of soybeans. In the period 1990-1991/2000-2001, acreage increased only in the Center-West, North and Northeast. However, in the recent period acreage increased in all regions. Table 2 also shows that growth of soybeans area in the 1990s in the Center-West, North and Northeast was accompanied by expansion of total acreage, since area planted with crops that compete with soybeans (corn first crop, cotton and rice) did not diminish. It is worth noting also that during the 1990s soybeans acreage remained constant in the South and Southeastern regions, despite the fact that acreage with other grains diminished.

5. This was noted in Brandão and Rezende (2004).

The recent expansion of soybeans acreage, as can be seen in Table 2, contributed also for the increase in area of crops that use the same land during the winter period, such as corn second crop, wheat and even cotton.

TABLE 2
PLANTED AREA AND CHANGE OF PLANTED AREA BETWEEN SELECTED AGRICULTURAL YEARS, ACCORDING TO PRODUCTS AND REGIONS

Products	Planted area			Accumulated change			
				Between 1990/91 and 2000/01		Between 2000/01 and 2003/04	
	1990-1991	2000-2001	2003-2004	(1000 ha)	(%)	(1000 ha)	(%)
Soybeans	9.743	13.970	21.244	4.227	43,4	7.274	52,1
Center-West	2.946	5.760	9.568	2.813	95,5	3.808	66,1
South/Southeast	6.507	7.156	10.006	649	10,0	2.850	39,8
Corn 1st crop	12.652	10.546	9.457	–2.106	–16,6	–1.089	–10,3
Center-West	1.519	1.206	758	–313	–20,6	–448	–37,2
South/Southeast	8.000	6.482	5.573	–1.518	–19,0	–909	–14,0
Beans 1st crop	1.881	1.285	1.371	–595	–31,7	86	6,7
Center-West	40	55	61	16	39,7	6	11,2
South/Southeast	1.473	859	896	–614	–41,7	37	4,3
Cotton	1.939	868	1.069	–1.070	–55,2	201	23,0
Center-West	171	542	605	371	216,9	66	11,8
South/Southeast	935	173	167	–762	–81,5	–6	–3,2
Rice	4.233	3.249	3.598	–984	–23,3	349	10,7
Center-West	777	631	862	–146	–18,8	231	36,6
South/Southeast	1.821	1.326	1.392	–494	–27,1	66	4,9
Total for crops above	30.446	29.918	36.738	–528	–1,7	6.820	22,8
Center-West	5.452	8.193	11.854	2.741	50,3	3.661	44,7
South/Southeast	18.736	15.996	18.034	–2.740	–14,6	2.038	12,7
Corn 2nd crop	800	2.426	3.668	1.627	203,5	1.242	51,2
Wheat	2.146	1.710	2.727	–436	–20,3	1.017	59,5
Beans 2nd and 3rd crops	3.624	2.594	2.886	–1.030	–28,4	292	11,3
Total for winter crops[a]	7.447	7.929	10.525	482	6,5	2.596	32,7
Total for all crops	51.800	51.600	60.640	–200	–0,4	9.040	13,1

Sources: Conab and IBGE.
[a] "Total for winter crops" includes: corn 2nd crop, beans 2nd and 3rd crops, wheat, barley and other minor crops.

Notice also that the expansion of soybeans acreage in the Center-West, North and Northeast between 1990-2001 - 2000-2001 did not take place in areas occupied by competing crops, such as corn first crop and cotton. This land came from other sources even in the earlier period of expansion.

Before an explanation for the process of acreage expansion is offered, it is interesting to consider whether the expansion of area was accompanied by a

reduction in yields for soybeans. As new areas are brought into production a reduction of yields could be seen due to use of less suitable soils. Or, it could be that the new pattern of production was more land intensive (in the neoclassical sense), using less of the other inputs, leading to a reduction of yields.

To verify this, Table 3 shows soybeans yields in the period 1991-1992/2003-2004. Unfortunately, the verification of the hypothesis can not be done in view of the fact that the three year period going from 2001-2002 to 2003-2004 is short to provide a good basis for conclusions, particularly in view of the short supply that occurred in 2003-2004 in the Center-West and in the South and of the fact that 2000-2001 was an year with record yields in all regions.

TABLE 3
PRODUCTIVITY INDEX OF SOYBEANS, BY REGION AND AGRICULTURAL YEAR

	Center-West	Southeast	North/Northeast	South	Brazil
1991-1992	100	100	100	100	100
1992-1993	100	103	109	111	106
1993-1994	105	102	136	108	107
1994-1995	99	98	148	118	110
1995-1996	107	100	117	108	107
1996-1997	118	109	144	109	113
1997-1998	114	106	144	120	118
1998-1999	121	121	142	110	117
1999-2000	124	107	164	108	118
2000-2001	133	118	146	141	136
2001-2002	131	129	131	119	127
2002-2003	131	131	143	148	139
2003-2004	116	120	179	103	116
Coefficient of variation	0,10	0,10	0,15	0,12	0,09

Source: Conab.

5 THE TEMPORARY USE OF DEGRADED PASTURES AS THE MAIN SOURCE OF GROWTH OF SOYBEANS ACREAGE IN RECENT YEARS

The hypothesis advanced in this section is that conversion of degraded pastures, not virgin areas of Amazon Forest, was the main source of land for the recent expansion of soybeans acreage.[6]

6. There is a generalized belief that the expansion of soybeans acreage is based on deforestation of the *cerrado* land and the Amazon Forest. On this, see, for example, "Plantio de Soja Avança sobre Amazônia", *O Globo*, 18/09/03, which, in turn makes reference to an article in the *New York Times* about the same subject. See also "Amazônia: A Soja Avança na Floresta", a special report of *O Estado de São Paulo*, 26/10/03, as well as "Produção de Soja Avança no Oeste do Pará", in *Gazeta Mercantil*, 16/01/04. See also the report "Asphalt and the Jungle", *The Economist*, 24/07/04, p. 33-35.

This hypothesis was also sponsored by Müeller (2003) in his analysis of the process of soybeans expansion in the center west during the decade of the 1990s. Müeller (2003) has shown that acreage expansion in that period took place mainly in the same micro regions where the bulk of soybeans production was already concentrated at the beginning of the 1990s. In other words, there was no significant increase in soybean production in regions that were not already producing this commodity.

The soybeans acreage expansion in period 2001-2002/2003-2004 was much faster than in the decade of the 1990s and was widespread among Brazilian producing regions. This entails the following observations. First, it is hard to open a virgin area of *cerrado* (and much harder yet of areas covered with Amazon Forest) and, in the same year, or even in a longer period, produce soybeans. In other words, production in a new area—whether *cerrado* or Amazon Forest—requires time to develop soils with the adequate conditions for adequate plant development.[7] This statement can be empirically tested. Furthermore, in view of the spectacular increase in prices, we do not rule out the possibility of the adoption of technologies that can shorten to one year the period required for production.[8]

Second, the virgin areas available in the *cerrado* or in the Amazon Forest do not have the required infra structure for an activity such as soybeans. This difficulty, however, is not present in regions where livestock production is already taking place, since these areas have well developed infra-structure and logistics.

Thirdly, contrary to what takes place in virgin areas, pasture land can be converted easily into crop production, and this can take place within the same year. The main reason is that some of the steps for soybean production, such as application of lime, took place in earlier periods. It is worth noting that, according to Agricultural Censuses, the area with planted pastures in the Center-West went from 7 million hectares in 1970 to 50 millions in 1995-1996 and, at the same time, native pasture went from 46 to 23 millions hectares. To put this in perspective, notice that crop acreage in 1995-1996 was only 7 millions hectares. Thus, there is an ample supply of non forest land to be converted into crop area.

Last, but no least, planting soybeans in degraded pastures will yield, after some years—after new grass is planted—a more productive pasture, a fact that contributes to further increase the profitability of the area. In other words, the conversion of land from pasture to soybeans may have as its final objective the production of improved pastures in the future, and this may be a low cost/high profitability procedure to achieve that goal. One particularly interesting feature of soybeans in this case is the fixation of nitrogen in the soil, which reduces fertilizer costs. In fact, soybeans plays

7. On this regard, see Rezende (2003), where, based on Cunha *et al* (1994), he proposes a formal model of *cerrado* land for agriculture with a lag between the allocation of factors of production to produce land and the allocation of other factors—together with the newly produced land—for agricultural production.

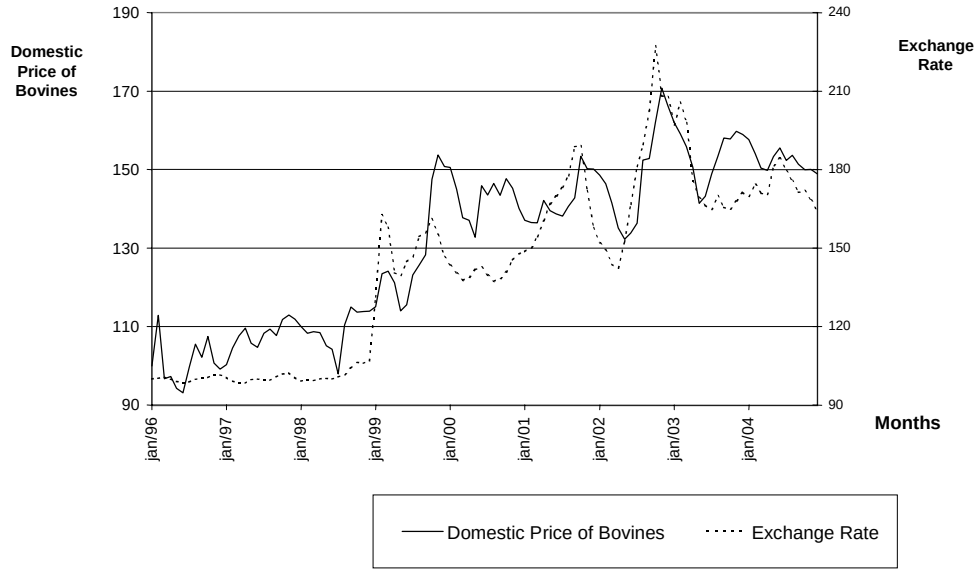
8. André Pessoa, in a personal communication with the authors, informed that a new procedure, adopted in face of the high soybeans prices, allowed a faster conversion of *cerrado* land into land suitable for soybeans production. According to André, following the clearing of the *cerrado*, "a strong application of lime was used to correct the soil accidity, also a strong applicaton of phosporous was used some months before plating and during the planting period high volumes (500 kg per hectare) of fertilizer are appplied. This allows for yields of the order of 40 sacs (of 50 kg) per hectare in the first year. The investment is high, but with the unusually high prices of soybeans the return was high either".

the same role in the case of other activities, such as cotton which is planted after planting soybeans.

Nonetheless, only field research will indicate the specific process behind the rotation pasture/soybeans/pasture. It is known that land leases by soybean producers are frequent, with the advantage of avoiding immobilization of capital.[9] Furthermore, livestock producers normally do not have the equipment necessary for the renewal of pastures, and leasing land will reduce their need for capital immobilization too. Notwithstanding, in a period of euphoria in the livestock sector, such as the recent one, we cannot exclude the possibility that livestock producers themselves made the investments in pasture renewal through planting of soybeans.

The livestock activity indeed experienced an euphoria in this period. As shown in Figure 7, following the devaluation of the real in 1999, the domestic price of meat increased and accompanied the movements of the exchange rate. In addition to this, as shown in Table 4, Brazil had a spectacular performance in the international meat market, reaching the position of larger world exporter of bovine meat in 2004. Finally, Figure 8 shows that the increase in meat exports was not at the expense of the domestic market, since slaughtering increased significantly in the same period.

FIGURE 7
DOMESTIC PRICE OF BOVINES AND THE EXCHANGE RATE



9 Land renting for grain production (cotton, rice, corn and soybeans) accompanied by renovations of pasture at the end of the lease period is a common and long used practice in the areas of *cerrado*. A detailed analysis can be found in Romeiro and Reydon (1994). See also the interesting interview to *Agroanalysis* (2002), by Humberto Guimarães, founder of the "Lease Exchange" (Bolsa de Arrendamento) of Uberaba in the State of Minas Gerais.

TABLE 4
WORLD EXPORTS OF BOVINE MEAT BY COUNTRIES, 1995-2004
[in thousand MT CWE]

Years	Australia	United States of America	European Union	Brazil	Other countries	Total
1995	1.109	826	1.199	228	2.150	5.512
1996	1.026	851	1.101	224	2.293	5.495
1997	1.184	969	1.051	232	2.367	5.803
1998	1.268	985	769	306	2.154	5.482
1999	1.270	1.094	949	464	2.118	5.895
2000	1.338	1.119	615	492	2.364	5.928
2001	1.398	1.029	546	748	2.089	5.810
2002	1.365	1.110	512	881	2.518	6.386
2003[a]	1.261	1.144	456	1.175	2.364	6.400
2004[b]	1.300	1.207	440	1.370	2.617	6.934

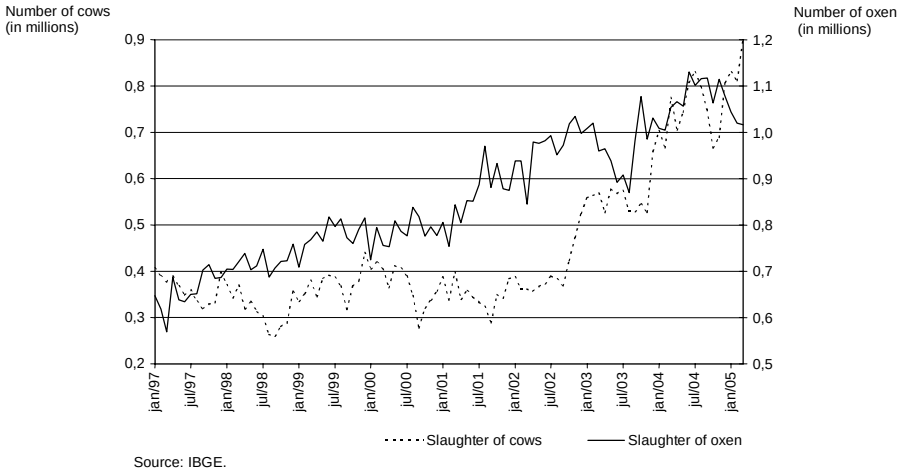
Source: USDA.

[a] Estimative.

[b] Projection.

Another feature to be noted in Figure 8 is the significant increase in the slaughter of cows since 2002. According to Abou Nehmi Filho, a well known Brazilian expert in the sector, this was triggered by the reduction in the availability of pasture caused by the very process of pasture renovation.[10]

FIGURE 8
BRAZIL — EVOLUTION OF BOVINE CATTLE SLAUGHTER, IN NUMBER OF ANIMALS, 1997/2005 (SEASONALLY ADJUSTED DATA)



Source: IBGE.

In a manner entirely consistent with these indicators of bovine livestock production, Table 5 shows that the rate of growth of the stock of animals increased from 1.1 percent per year in the period 1990-1999 to nothing less than 4.3% per year in the 1999-2003 period. This expansion, induced by higher profitability, owes a lot to genetic improvements and to improved pastures. This increase in the herd stock is an evidence in favor of the hypothesis of this paper, namely that soybeans expansion was mostly based on renewal of pastures.

10. See the interview with Abou Nehmi Filho in the report "Boi *versus* Soja", *Globo Rural* n. 223, May 2004.

TABLE 5
BRAZIL AND REGIONS: EVOLUTION OF LIVESTOCK HERD—1999-2003—AND ANUAL AVERAGE ANNUAL GROWTH RATE FOR THE PERIODS 1990-1999 AND 1999-2003
[million heads)

Year	Brazil	Middle-West	Southeast	Northeast	South	North
1990	147,1	45,9	36,3	26,2	25,3	13,3
1991	152,1	48,1	36,7	26,7	25,3	15,4
1992	154,2	48,8	37,2	26,9	25,5	15,8
1993	155,1	52,2	37,6	22,5	25,7	17,1
1994	158,2	53,4	37,6	22,8	26,4	18,0
1995	161,2	55,1	37,2	23,2	26,6	19,2
1996	158,3	53,4	36,6	23,9	26,4	18,0
1997	161,4	54,6	37,0	23,8	26,7	19,3
1998	163,2	56,4	37,1	22,0	26,6	21,1
1999	164,6	57,2	36,9	21,9	26,2	22,4
2000	169,9	59,6	36,9	22,6	26,3	24,5
2001	176,4	61,8	37,1	23,4	26,8	27,3
2002	185,3	65,6	37,9	23,9	27,5	30,4
2003	195,6	69,9	38,7	25,0	28,0	33,9
			Annual Average Growth Rates (%)			
1990-1999	1,09	2,27	0,05	–2,00	0,59	4,92
1999-2003	4,31	4,94	1,24	3,20	1,81	10,43

Source: Pesquisa Pecuária Municipal-IBGE.

A recent work by USDA has called attention to this capacity that Brazil has to increase crop acreage through pasture conversion, a factor viewed as important to increase the competitiveness of Brazilian *vis-à-vis* United States agriculture [see Schean (2003)].

Finally, notice that Torres Jr., Rosa and Nogueira (2004, p. 37) estimate that this process of conversion of pasture land involved about 4.9 millions hectares during 2001/2003 and more than 3.0 millions hectares in 2004. These numbers are of the same order of magnitude of the 6.8 millions hectares of increase in the area planted with grains in Brazil from 2001-2002 to 2003-2004, as shown in Table 2.

The expansion of meat production is consistent with the hypothesis of this paper, namely that conversion of degraded pasture is not a process that is displacing livestock production, but, on the contrary, it is a mechanism through which the livestock sector is being able to renew pastures and to increase carrying capacity in the future.

It is our hypothesis that the conjunction of favorable prices for soybeans and livestock led to a simultaneous increase in demand for and the supply of pasture land for soybeans cultivation. In particular, the increase in soybeans production through temporary land leases is consistent, from the point of view of agronomy, with quick increases in soybeans production (to take advantage of favorable prices). Moreover, it is a better economic alternative than permanent conversion of pasture land or conversion of virgin areas. In this fashion, agriculture will reduce the immobilization

of capital and will be better prepared to face the high price volatility that characterize international grain markets.[11]

We do not exclude the possibility that *cerrado* areas or areas in the Amazon Forest, that in previous years were converted to agriculture, could have been used for the recent expansion of soybeans.

It is worth noting that the South and Southeast of Brazil have also experienced a fast expansion of the soybeans area in the period under analysis, after this area had remained almost unchanged during the decade of the 1990s. Evidently nobody would propose that this expansion was based on the conversion of virgin areas, since these areas no longer exist in those regions. Since crop substitution was small, the bulk of the area for soybeans came from conversion of pasture land.

As far as the Center-West is concerned, we would like to note, particularly in the case of Mato Grosso, that this region has large areas currently occupied with livestock activity induced by deforestation that took place during the military governments.This includes especially the so called *Nortão* of Mato Grosso. A particularly interesting case is the country of Querência, where soybeans is a new crop that has expanded on degraded pasture lands that were formed much before the current boom.[12] A similar case is Vale do Araguaia, as discussed by Müeller (2003). These examples make it clear that it is incorrect to conclude from aerophotos that the expansion of soybeans in the *Nortão* is a menace to the Amazon Forest or to *cerrado* areas.

It should be kept in mind that the argument that it is impossible to convert an area of the Amazon Forest—into a soybean producing area in a short period is restricted to areas of *dense forest*, that is what we consider, more properly, "Amazon Forest", contrary to the common practice of considering "Amazon Forest" any forest that is within *Amazonia Legal.* The latter concept is purely administrative and should not serve as the basis for environmental well as for economic analyses. By the way, as far as adequacy for soybeans production, the Amazon Forest, defined in the strict sense above, has not shown, up to now, aptitude for soybeans production, except for very restricted areas. This is due not only to poor soils but also to inadequate climate, specially in what matters pluviometry.

As a result of this strict definition of Amazon Forest, we exclude here, from this classification, in particular, the so-called Nortão of Mato Grosso, that, precisely for not being neither totally cerrado nor totally Amazon Forest, has always been called "Transition Zone". This is as it should be, for "*Natura non facit saltum"*, what means that a biome does not transform itself in another biome abruptly, it being required a sluggish and unpredictable process of spacial change. The same thing happens, by the

11. The expansion of soybeans through the conversion of pastures, in opposition to virgin lands in the *cerrado*, has been advocated as more adequate from the perspective of preservation of biodiversity [see Abramovay (1999)]. Since the conversion of pasture into soybeans will be permanent, this has a higher oportunity cost than the conversion of virgin areas of the cerrado, as argued by Rezende (2003, p. 202-203).

12. The dramatic changes in land use in Querência were documented in a report entitled "Dupla Aptidão", published in *Globo Rural* (2004). According to the report, soybeans acreage went from practically zero to 65 thousand hectares in 2002-2003, increase further to 113 thousand hectares in 2003-2004 and is expected to increase to nothing less than 180 thousands hectares in 2004-2005. This strong expansion of acreage was totally based on pasture conversion, without requiring one single hectare of deforestation of the *cerrado* or the Amazon Forest.

way, with the yearly seasons, that also change sluggishly and unpredictably, now within the year. It is for this reason that the vegetation, rainfall, soils, and fauna, in countries such as Sorriso, located in the Nortão and the biggest soybeans producer of Brazil, does not resemble at all the biome of the Amazon Forest, being just like the biome of the *cerrado*. [13]

Since the agricultural aptitude of the soils and even the climate in *cerrado* areas is much superior to the Amazon Forest (in the strict sense above), it should be better specified, in the Government information on the deforestation of this Nortão, which part corresponds to *cerrado* areas and which part corresponds to Amazon Forest (strictly considered), since, from the point of view of the social cost-benefit analysis, it makes all the difference the productive destination of the deforested area.[14]

The analysis developed in this paper allows us, now,to criticize the argument, which has received wide attention in the Brazilian press, that soybeans is contributing *indirectly* to the deforestation of the Amazon, since it would be pushing livestock production into cheaper areas in the Amazon.[15]

It is easy to show that this is a weak argument. First, pasture conversion does not mean necessarily substitution of livestock; it is likely that both segments are taking advantage of a favorable situation and reaping mutual benefits through the process of land conversion. Second, if it is true that livestock is expanding in the Amazon, it is not necessary to rely on soybeans expansion to explain this. As shown by a recent study of the World Bank [Margulis (2003)], the expansion of livestock in the Amazon is pushed by two sorts of factors: one, which is taking place within the frontier, is driven by modern technology and high private returns without resorting to any kind of government subsidies; the other path, according to the same study of the World Bank, takes place in the *speculative frontier* with the low productivity livestock activity, that destroys natural resources in order to secure land property. Evidently the expansion of these two livestock activities has nothing to do with soybeans.

6 SOYBEANS AND THE AMAZON FOREST: FRIENDS OR FOES?

The expansion of soybeans in the recent period lead us to take a closer look at the issue, which concerns many groups in Brazil and abroad, whether soybeans expansion is a threat to the Amazon Forest.

This concern has indeed stopped the process of improvement of the infrastructure to permit access to the areas of the Amazon Forest and other regions where preservation is needed. A particularly important aspect of this question is paving highway BR 163, which goes from Cuiabá, in the State of Mato Grosso, to Santarém in the State of Pará. Paving this highway will not only have a favorable

13. In regard to the *Nortão* and to its particular features as compared with dense forest, see the interesting report "Floresta ou Cerrado", published by the magazine *Época*, June 6, 2004.

14. This care was not observed, however, in the Government announcements of the rise in deforestation in 2004, which took place exactly in the *Nortão*.

15. This hypothesis was proposed by Michael Shean, a USDA economist, in the paper "The Amazon: Brazil's Final Soybean Frontier", available at the USDA site (www.usda.gov/pecad). The same argument can be found in the press release of Instituto Socioambiental (www.isa.org.br). See also, *Folha de São Paulo* (2005).

impacts on economic activity in its borders, but also on soybeans producing areas in the Center-West (specially the State of Mato Grosso) which have to transport production to the ports of Santos and Paranaguá. Furthermore, the benefit will also be extended to Zona Franca, in Manaus, through reduction of transportation costs to the Center-South and even the Northeast could benefit since the transport costs from food imported from the Center-West will diminish.[16]

The key argument to support paving BR 163 is that as the soybeans activity becomes viable in the region, it will enhance the efficacy of environmental policy. As transportation costs are reduced, land prices will increase and turn current activities that are mostly responsible for deforestation uneconomical, such as itinerant agriculture with low technology and which uses fire to open new areas, irrational logging activities and low technology livestock production which destroys natural resources.[17]

Before this can happen, however, it is important that the government put additional emphasis in the regularization of property titles and other issues that will reduce tenure uncertainty. If there is tenure uncertainty, land prices will be lower than justified by the profitability of soybeans and thus the selective mechanism that would otherwise operate will fail. In any case, it can be expected that the possibility of utilization of land for soybeans production will create incentives for the process of property title regularization and a reduction of tenure uncertainty, since production of soybeans will not take place on an environment where there is tenure insecurity. On the contrary, small scale itinerant agriculture, that uses fire to clear the forest, and unsustainable logging do not create the incentives for title regularization and remain viable even in the presence of high transportation costs. Thus, it is naive to think that if BR 163 remains unpaved the Amazon Forest will be preserved, on the contrary.

Moreover, a well organized activity such as soybeans production is easily monitored by the public sector, particularly in regard to compliance with environmental policy. In the first place the high visibility of the activity allows for easy detection of mistakes. In the second place because this activity is not compatible with paternalistic and complacent behavior on the part of State officials (in the Administration, in the Legislative and in the Judiciary) that often do not enforce properly environment legislation when the violators are poor. One well-known example of this mechanism can be found in the mountains in the city of Rio de Janeiro (and most other Brazilian cities), where the environment legislation prohibits construction in these areas. The application of the legislation to the construction of houses for the middle and high classes reduced the land value to 0. This has created incentives for house constructions by the poor population—expanding dramatically the number and size of the *favelas*—for which the legislation is not enforced by the responsible State officials.

16. For a comprehensive analysis of the issues involved in the paving BR 163 see *Valor Econômico* (2004, p. A4 and A5). See also the already mentioned report of *The Economist* and *Desafios do Desenvolvimento* (2004, p. 42-51).

17. These activities are called by Müeller (2003) "traditional commercial agriculture", "subsistence agriculture", "speculative activities" and "traditional livestock". In contrast Müeller argues that soybeans is part of "modern comercial agriculture".

Mutatis mutandis, this is analogous to the case of not paving BR 163 due to the fear of the expansion of soybeans. The final result of the refusal of accepting soybeans as an ally of environmental policy is to perpetuate the current unsustainable use of land and deforestation of the Amazon.

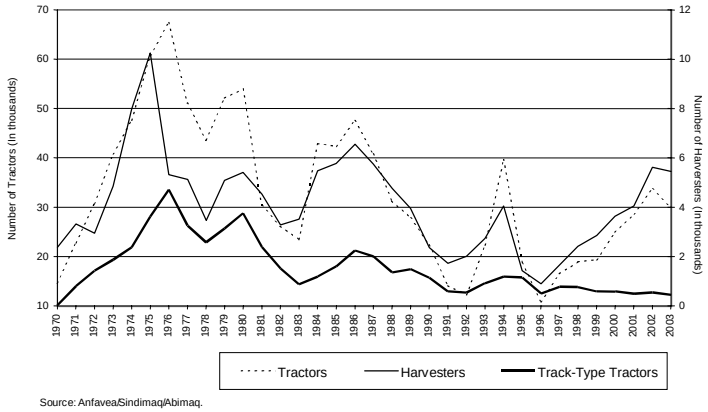
7 MODERFROTA AND THE RECENT EXPANSION OF CULTIVATED AREA IN BRAZIL

An additional element to support the argument of this paper, namely that the recent expansion of soybeans was based on pasture conversion, is that conversion was facilitated by Moderfrota, a credit program that fuelled a great expansion of the stocks of agricultural machinery and equipments in Brazil.

It is plausible to assume that an acreage expansion of the scale observed in the last three years in Brazil would not have been possible without availability of agricultural machinery, particularly tractors. Thus the area growth was a combination of availability of degraded pastureland and of agricultural machinery, in addition, of course, to the exceptional profitability of soybeans. Most of the land under pasture has suffered a process of compaction due to the movement of animals, a fact that required specific equipment, financed by Moderfrota, to allow conversion into soybeans.

Figure 9 shows the sharp increase in sales of tractors and harvesters in the 1990s after a period of stagnation of the domestic market. The graph also shows that the greatest expansion, within the category of tractors, occurred in wheel tractors, a fact that is consistent with the hypothesis that most of the expansion of acreage took place through conversion and not deforestation of the Amazon or the *cerrado*. Figure 10 shows the high correlation between domestic sales of agricultural machinery and Banco Nacional de Desenvolvimento Econômico e Social (BNDES) loans. This program started in the beginning of the 1990s, with the creation of Finame Agrícola, and in 2000, after several improvements, Moderfrota started operating.[18]

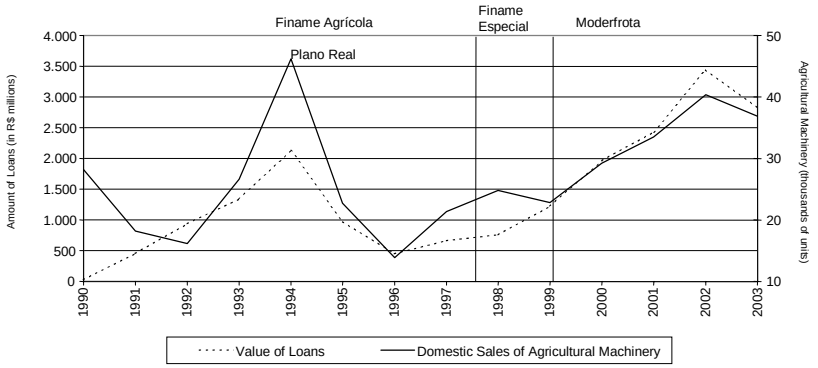
FIGURE 9
EVOLUTION OF AGRICULTURAL MACHINERY



Source: Anfavea/Sindimaq/Abimaq.

18. It was the extension of Finame to agriculture with the creation of Finame Agrícola, that initiated the increase in agricultural investment credit, after a period of almost 0 loans. See Brandão and Rezende (2004).

FIGURE 10
AMOUNT OF LOANS FOR THE PURCHASE AGRICULTURAL MACHINERY WITHIN THE BNDES SYSTEM AND DOMESTIC SALES OF AGRICULTURAL MACHINERY



On this regard, we note the hypothesis of Ferreira Filho and Costa (1999) who argue that the intensive pattern of agricultural development observed in Brazil in the last decades may be a consequence of the low availability of tractors, which hampered the expansion of cultivated area. Despite this, Ferreira Filho and Costa note that the unavailability of tractors may also have imposed difficulties for the intensification of agriculture since it restricts the application of fertilizers and other inputs. These authors note that the fast expansion of no tillage practices is likely to be a response to the unavailability of tractors, since this technology reduces the use of these machines. Finally they note that the expansion of agricultural aviation can also be an indication of low availability of tractors.

Another positive impact of Moderfrota on agriculture is the reduction in the use of labor per hectare, particularly temporary labor. The easy access to agricultural machinery permits substitution of temporary labor, whose cost is high, because of the labor legislation and excessive taxes, is not qualified and whose availability is subject to a high degree of uncertainty.

An additional question for further research is whether Moderfrota is contributing for the concentration of property due to the usual restrictions of access to credit by small farmers and due to the indivisibility of equipments. These issues, however, are left for future analysis.

8 SUMMARY AND CONCLUSIONS

This paper is an attempt to contribute to the analysis of recent agricultural expansion in Brazil. It has shown how the change in the exchange rate regime in 1999 has affected the process of expansion, emphasizing two clearly marked periods, one in which the devaluation of the exchange rate was accompanied by a drop in international prices and the other where an upward burst in international prices was observed. The paper also has called attention to the behavior of acreage, which has experienced an outburst of growth, changing the earlier pattern of agricultural expansion in the country which was based on yield increases.

At first sight, the outburst of acreage may suggest a return to an old paradigm, where production growth was based on extensive technologies (in the Ricardian sense). Nevertheless, the paper has shown that on the contrary, with the conversion

of degraded pastureland into soybeans production one notices in fact an increase in the intensity of the use of land. This process of course does not exclude the possibility that some conversion of *cerrado lands* has taken place. However, due to the limitations of these kinds of soils for agriculture, the scale in which this conversion took place was likely very modest. With respect to the areas of Amazon Forest, it would be a magic to be able, in such a short period, to develop all operations needed to clear the forest and make the soil ready for soybeans.

It is possible that some new areas of the *cerrado* and of the Amazon Forest are in the process of conversion into soybeans. The larger this area, the larger will be in the future the capacity of expansion of soybeans in times of favorable prices.

The fact that the main source of area for the expansion of soybeans was the conversion of degraded pastures, as opposed to incorporation of areas deforested in the same period, leads to the conclusion that the possibilities of continued expansion of soybeans in Brazil are big and it is naïve to fear that this will be a new menace to the environment, whether in the *cerrado* or in the Amazon Forest. The paper goes on to say that there is no reason to fear that soybeans expansion will reduce the effects of environmental policy, on the contrary. The improvement of the transportation infrastructure (as is the case of paving BR 163) together with a reduction in tenure insecurity in the region will enhance the effects of the instruments of environmental policy.

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