

Background paper for the  
**Competitive Commercial Agriculture in Sub-Saharan  
Africa (CCAA) Study**

**THE BRAZILIAN CERRADO EXPERIENCE WITH  
COMPETITIVE COMMERCIAL AGRICULTURE  
A Critical Review**

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# THE BRAZILIAN CERRADO EXPERIENCE

## WITH COMPETITIVE COMMERCIAL AGRICULTURE

### Index

<b>EXECUTIVE SUMMARY.....</b>	<b>8</b>
<b>I. A brief summary.....</b>	<b>8</b>
<b>II. Development through Industrialization: the role of the Cerrado .....</b>	<b>9</b>
<b>III. Consequences for the Cerrado Region .....</b>	<b>11</b>
<b>IV. Agricultural Policies .....</b>	<b>12</b>
<b>V. Overall Benefits of the Cerrado Experience.....</b>	<b>14</b>
<b>VI. Lessons from the Cerrado Experience .....</b>	<b>16</b>
<b>Part 1. AGRICULTURE IN BRAZIL’S TWENTIETH CENTURY DEVELOPMENT STRATEGY .....</b>	<b>18</b>
1.1. Introduction.....	18
1.2. The “Marcha para o Oeste” – From the II World War to the Seventies .....	23
1.3. The Occupation after the seventies .....	25
1.3.1. The seventies.....	25
1.3.2. The eighties .....	28
1.3.3. The nineties and twenties.....	29
1.4. Agricultural Policies.....	31
1.4.1. The Rural Credit System.....	32
1.4.2. Funding & Hedging – The CPR.....	37
1.4.2. The Price Support System.....	40
Source: Rezende (2001). .....	42
1.5. Technology Policy and Impacts on Output .....	49
1.5.1. Soybeans .....	50
1.5.2. Cotton .....	56
Source: CEPEA-ESALQ/USP.....	57
1.5.3. Bovine cattle.....	58
1.5.4. Pasture Development in Brazil.....	60
1.5.5. Rice, the Supporting Actor .....	61
1.5.6. Sugar .....	62
1.5.6.1. Constructing a market .....	64
1.5.7. EMBRAPA’s Funds .....	65
1.6. Production and Productivity in the Cerrado .....	65
1.6.1. Output Performance.....	69
1.6.2. Individual crops yields.....	74
1.6.3. The reflection on Prices .....	79
1.6.4. The external front .....	82

1.7. The Cerrado Development – The role of the private sector and domestic market .....	86
1.8. Concluding Comments .....	87
<b>Part 2. ENVIRONMENTAL ANALYSIS OF THE CERRADO .....</b>	<b>89</b>
2.1. Introduction.....	89
2.2 The Characteristics of the Cerrado.....	93
2.2.1 Size .....	93
2.2.2. Geology, topography and soil .....	94
2.2.3. Climate and meteorology .....	96
2.2.4 Vegetation .....	98
2.2.5. Fauna.....	100
2.3. Impacts of Agriculture on the Environment .....	101
2.3.1. Deforestation .....	101
2.3.2. Soil degradation.....	102
2.3.3. Water Resources.....	104
2.3.4. Air Quality .....	105
2.3.5. Intended and Accidental Fire .....	105
2.3.6. Beef Cattle.....	107
2.3.7. Soybean-Corn.....	109
2.3.8 Milk and Staples.....	113
2.4. Concluding Remarks on Environmental Issues .....	114
<b>Part 3. SOCIAL ANALYSIS OF THE BRAZILIAN CERRADO’S OCCUPATION. 116</b>	
3.1 Introduction.....	116
3.2. The occupation of Goiás – misleading propaganda leads to social conflicts .....	120
3.3. The Occupation of Mato Grosso – The role of the “gaucho” .....	121
3.4. Impacts of the Induced Occupation on Agriculture .....	123
3.5. General Impacts on the Cerrado Region .....	130
3.6. Concluding Remarks on Social Issues .....	145
<b>MAP OF BRAZIL .....</b>	<b>147</b>
<b>ACRONYMS .....</b>	<b>148</b>
<b>ENDNOTES REFERENCES.....</b>	<b>149</b>

## Index of Graphics

Figure 1. Consumer Food Price Index versus General Consumer Price Index (CPI) São Paulo. 1939/64.....	19
Figure 02. Periodical Percent of Settled Families – 1970 –1999 .....	21
Figure 03. Numbers of farms, farming areas and workers – Brazil:1970-1995.....	21
Figure 04. Regional Shares of Family Farm Credit (%) - 2005 .....	38
Figure 05. Rural Credit Debt as Share of Agricultural GDP. ....	39
Figure 06. Maize Price Support Purchase (AGF) and Loans (EGF) and Output Regional Shares – Center West .....	44
Figure 07. Rice Loans (EGF) as Shares (%) of Production, Brazil and Center West – 1980-1992.....	45
Figure 08. Rice Purchases (AGF) as Shares of Production, Brazil and Center-West, 1980-1998.....	45
Figure 09. Rice production (1000 tons) in Rio Grande do Sul and Center-West, 1973 .....	47
Figure 10. Soybeans Share of Marketing Loans on Production , Brazil and Center-West Region, 1980/1992.....	48
Figure 11. Last year of significant intervention to support prices.....	49
Figure 12. Composition of Soybean Shipment Value .....	54
Figure 13. Input composition of the soybean farm costs .....	55
Figure 14. Domestic private, taxes and foreign composition of the soybean farm costs .....	55
Figure 15. Composition of cotton shipment value, Cerrado, 2006.....	57
Figure 16. Composition of Beef Shipment Value, Cerrado, 2006 .....	59
Figure 17. Composition of Sugar Shipment Value, Cerrado, 2006.....	63
Figure 18. Labor and input real costs, Brazil, 1989/2006.....	67
Figure 19. Land Prices, Indices, Brazil (BR), Mato Grosso (MT) and Rio Grande do Sul (RS), 1977/2006.....	68
Figure 20. Total factor productivity of Brazil’s farm sector – 1994 to 2004.....	68
Figure 21. Share (%) of the Center-West in National Production – Cotton, Rice, Maize and Soybeans, 1965/2005 .....	72
Figure 22. Share of the Center-West in National Production – Cane, Beans and Cassava, 1965/2005 .....	72
Figure 23. Milk production (1000 liters), Brazil and Center-West region – 1970/1996 .....	73
Figure 24. Livestock Inventory Center-West Shares – Bovine, Swine and Poultry, 1970/1995 .....	73
Figure 25. Aggregate Crop Yield, Acreage and Output .....	74
Figure 26. Cotton Yields (tons/ha), Brazil and Center-West States, 1973/2005.....	75
Figure 27. Maize Yields (tons/ha), Brazil and Center-West States, 1959/2005 .....	75
Figure 28. Rice Yields (tons/ha), Brazil and Center-West States, 1959/2005 .....	76
Figure 29. Soybeans Yields (tons/ha), Brazil and Center-West States, 1959/2005 .....	76
Figure 30. Cassava Yields (tons/ha), Brazil and Center-West States, 1959/2005 .....	77
Figure 31. Sugar-cane Yields (tons/ha), Brazil and Center-West States, 1959/2005.....	78
Figure 32. Beans Yields (tons/ha), Brazil and Center-West States, 1959/2005.....	78
Figure 33. Wheat Yields (tons/ha), Brazil and Center-West States, 1959/2005 .....	79
Figure 34. Farm prices for food crops: rice, beans, cassava and wheat. Brazil. 1967/2005 ....	80
Figure 35. Farm prices for animal products: beef cattle, swine, poultry and milk. Brazil. 1967/2005 .....	81
Figure 37. Crop Products Exports and Domestic Currency Unit Value of Exports 1989/2005. ....	82

Figure 38. Animal Products Exports and Domestic Currency Unit Value of Exports 1989/2005. ....	83
Source: FGV .....	83
Figure 39. Brazil's Current Account, Total Trade and Agriculture's Trade Balances, 1989/2005 .....	84
Figure 40. The Cerrado Area in Brazil .....	94
Figure 41. The climate in the Centre-West .....	97
Figure 42 - Percent of Cerrado Remnant Area according to Hydrographic Basins .....	100
Figure 43. Deforestation in Mato Grosso and Legal Amazon (km <sup>2</sup> ) .....	103
Figure 44. Economically Active Population (10 years and older)– 1991 to 2000 .....	134
Figure 45. Ratios of Percent of Poor to Percent of State Population versus Ratio of Percent of State Family Grants to Percent of Poor .....	143
Figure 46. Gini coefficient of the per capita family income – Brazil, 1977/2005 .....	144

## Index of Tables

Table 01. Number of Farm Operators, Farm Area and Workers – 1970-1995/96 .....	22
Table 02. Official Rural Credit (Indices) – Brazil and CENTER-WEST.....	34
Table 03. Indices of Brazil’s Agricultural GDP and Rural Credit – 1975/2006 .....	35
Table 04. Brazil’s Annual Real Interest Rates on Rural Credit by Destinations – 1969/1986	36
Table 05. Share of Rural Credit Subsidy on Agricultural and Total GDP, 1970/86 .....	37
Table 06. Soybeans: Paraná to Production Regions Price Differences and Transportation Costs <sup>a</sup> .....	42
Table 07. Maize: São Paulo to Production Regions Price Differences and Transportation Costs <sup>a</sup> .....	43
Table 08. Rice: São Paulo to Production Regions Price Differences and Transportation Costs <sup>a</sup> .....	43
Table 09. Farm size Distribution – Brazil’s States, 2005 .....	53
Table 10. Cost Composition (R\$/ton) for Typical Farms in Center-Western and Southern Brazil, 2006.....	54
Table 11. Cotton Farm Costs (R\$/ton), Cerrado/Brazil,2006 .....	57
Table 12. Beef Cattle Shipment Value (R\$/ton) and Composition at the Cerrado’s Farm Gate .....	59
Table 13. Sugar cane Shipment Value and Composition at the Cerrado Farm Gate .....	63
Table 14. EMBRAPA Budget – R\$ Million of 2004 and Percent of Agriculture GDP .....	66
Table 15. Brazilian Crop Production – Volume (tons) and Rate of Growth – 1965/2005 .....	69
Table 16. Brazilian Livestock Inventory (number of animals and growth rates) – 1970/1995	70
Table 17. Slaughtered Animals – Numbers – 1978/1996 .....	70
Table 18. Carcass Weight per Animal, Brazil- 1977/1976. ....	71
Table 19. Production Turnover (Percent of Livestock Inventory), Brazil 1980/1996.....	71
Table 20 (a) Dollar Value of Agricultural Exports , 1997/2007(april).....	85
Table 20 (b) Dollar Value of Agricultural Exports , 1997/2007(april) .....	85
Table 21 – Cerrado Soil Classes.....	96
Table 22 - Percent of Cerrado Remnant Area - 2006 .....	99
Table 23. Internal Rate of Return on Beef Cattle Investment –2002 .....	108
Table 24. Planted Area, yield, and production: “Second Crop Corn” 1992-95 e 2002-05 ...	111
Table 25. No-Till Area in Cerrado and in Brazil, 1974-2000 .....	112
Table 26 – Occupation of Cerrado Areas (million hectares) .....	113
Table 27. The Population in the Cerrado Region and Brazil – 1872 to 1950 (thousands) ...	117
Table 28. Status of Farm Operator - Goiás – 1970/ 1995/96 .....	124
Table 29. Status of Farm Operator –Mato Grosso do Sul – 1975/ 1995/96.....	124
Table 30. Status of Farm Operator – Mato Grosso – 1970/ 1995/96 .....	125
Table 31. Land Use in Goiás , 1970 to 1995/96.....	126
Table 32. Land Use in Mato Grosso do Sul , 1970 to 1995-1996.....	126
Table 33. Land Use in Mato Grosso , 1970 to 1995-1996.....	127
Table 34. Average Farm Size in the Cerrado Area (ha) , 1975 and 1995/96.....	128
Table 35. Number of Farm Workers in the Cerrado Area– 1970 to 1995-1996 .....	128
Table 36. Number of Workers per 1000 hectares of planted land <sup>1</sup> – 1970 to 1995/96 .....	128
Table 37. Tractor-Planted Area Ratios (Tractor units/1000ha) <sup>1</sup> – 1970 to 1995/96 .....	129
Table 38. Workers/Tractor Ratios – 1970 to 1995/96 .....	129
Table 39. The Population of Cerrado and Brazil – 1970 to 2000 – (thousands).....	130
Table 40. Ethnic Population Ratios in the Cerrado (%) – 1950 to 2000.....	131

Table 41. Regional and States' Share in Brazil' GDP (%) – 1970/2004.....	131
Table 42. Relative GDP per capita (Brazil =1.00) .....	132
Table 43. Share of Agriculture in Regional and Brazil's GDP (%), 1950 - 2000.....	132
Table 44. Number of Worker's Register Books – Brazil and Center-West Region, 1940/2000 .....	133
Table 45. Regional Urbanization Ratios in Brazil, 1960/2000 .....	135
Table 46. Regional and Brazil's Percent of “favela” homes – 1980-2000 .....	135
Table 47. Net Immigration to the Center West and States (thousand people)– 1970-2000...	136
Table 48. Health Facilities in Brazil e and the Center-West Region – 1940 to 2000.....	137
Table 49. Inhabitants per health facility– Brazil and Center-West Region – 1940 to 2000. .	138
Table 50. Elementary Schools in Brazil and in Center-West Region – 1950 to 2000.....	138
Table 51. Inhabitants per Elementary School in Brazil and in Center-West Region – 1950 to 2000.....	139
Table 52. Literacy of Population 5 years or more.– Center-West Region – 1985 to 2000....	139
Table 53. Literacy Rates (%) – Brazil and Center-West States – 1960/2000 .....	140
Table 54. Social and Economic Indices – Center West and Other Selected States- 1996.....	141

# **EXECUTIVE SUMMARY**

## **THE BRAZILIAN CERRADO EXPERIENCE WITH COMPETITIVE COMMERCIAL AGRICULTURE**

### **A Critical Review**

#### **I. A brief summary**

The history of the Cerrado experience is a major piece of the history of Brazil's economic development in the 20th century. From the beginning, Brazil firmly wished to move from an agrarian to an urban, industrialized society. There was a national project aiming to that goal.

It took in the first place a political revolution in 1930 to substitute an ancient agrarian dominated political system for an industrial-oriented one; that put Brazil in an authoritarian form of government for 15 years, during which many of at the time modern (labor, social security, public funding for state companies) institutions were created.

Then there was a clear diagnosis that agriculture had to be developed to support industrial/urban development: the Cerrado was a natural resource that could be explored if the nation could count on the necessary physical and human capital. Physical capital was raised through public funds (fiscal and inflationary taxation) and foreign investment that were heavily applied on transportation facilities. Human capital was available from European and Oriental migration to Southern and Southeastern Brazil that followed the end African-based slavery in the end of the 19th century and continued for several decades.

Investments in agricultural technology were not disregarded. EMBRAPA was created in the early seventies as the core agricultural institution and as the coordinator of the agricultural research system in Brazil. Funds to the system have not been maintained at desirable trends but minimum levels have been assured so that the flow and standard of research have been preserved by different administration since the system was implanted.

The occupation of the Cerrado was not a pacific process: it was an unfair and violent process with heavy costs on native population and migrants from the Northeast. At some point the occupation process got off control of the authorities. As a result one of stated objective – establishing a reasonably equitable agrarian system – was not attained.

The occupation process also had environment costs: soil degradation, water misuse and contamination, air pollution, fauna and flora sacrifices and deforestation. There was not at the time anything close to a clear appreciation by society and authorities of the cost implied by these phenomena. Only recently concrete steps have been taken to circumvent these problems and even more recently the very first concrete results began to become visible.

After most of the public investment in the Cerrado was completed in the eighties, the federal government investment capacity collapsed so that even the agricultural credit and commercialization instruments had to be severely curtailed. Then the private sector took most of the regional development into its own hands: investment in farm capital, warehouses and processing facilities took hundreds of billion dollars. A flow of new technology was kept and the agribusiness sector was able to employ it efficiently by exporting part of the increased output, thereby avoiding that a weak domestic market inhibited the growth of a strong agro-energy, fiber, grain and meat agribusiness. Plenty of foreign reserves was generated and helped Brazil keep its financial solvency during the severe financial crises of the nineties.

Six decades after the initial official programs and 30 years after the direct policy (credit, storage, technology) instruments began to be concretely applied, the fruits of the Cerrado experience were ripe to be harvested. Brazil counts since the nineties with significant trade surpluses on agricultural products and income redistribution measures are no longer simple short term demagoguery but are now able of offering long term benefits to the poor. As today Brazil appears to be in the verge of a long cycle of more domestically oriented economic growth, the country can count on a strong and competitive agribusiness sector as one of the leading sectors.

## **II. Development through Industrialization: the role of the Cerrado**

Brazil's economic development process experienced several significant changes over the last 70 years. In the thirties, forties and fifties, Getúlio Vargas – the Brazilian president who took over power in 1930 and whose dictatorship extended until 1945; in 1950 he was elected president and governed up to 1954 - created most of the institutions necessary to implement an industrialization process in Brazil based on marked presence of the public sector as the driving force. In the late fifties and early sixties as urbanization accelerated the escalating cost of living was attributed mainly to prices of food, the production of which grew too slowly compared to accelerating demand. The resulting pressure upon industrial wages created almost permanent

social unrest and a continuously unstable labor market thus producing political support for a land reform program to put an end to the allegedly inefficient plantation system.

Academic discussion tended to oppose, on one side, the land reform solution – to deal with the so-called “agrarian problem” - and, on the other, the farm modernization strategy – to solve the “traditional-agriculture problem”, allegedly “efficient but poor”. Although most analysts would say that the first option was rejected, the truth is that Brazil has ever since been involved with diverse intensity in a never-ending land reform and colonization program. The fact is that the political options fell upon a mixed strategy. Agriculture ought to be engaged in the import substitution wagon with a multiple role: a) agriculture could be an effective demander of modern inputs and capital goods that could be produced by the infant industry being implanted in the country; b) agriculture modernization could reduce food costs and help the country to balance its external trade; c) at the same time a special attention to land reform would meet the demands of part of the political forces then in evidence and reduce the accelerated migration flow out of the rural sector, d) in addition, colonization would meet both the objectives of occupying national territory and expanding the potential of the production of food and fibers for domestic consumption and exports. That these strategies were contradictory proves the common observation of a historical flow of farmers out of agriculture at the same time that land reform and settlements multiplied over the last 40 years.

For Getúlio Vargas the Brazil’s Center-West region was an “empty space” to be occupied without many local restrictions. The strategy was the association of public and private colonization efforts to absorb population excesses from other regions into the Center West. Most of today’s evaluations point this colonization process as a failure considering the objectives of developing land settlements based on family farms to produce for the domestic market. Massive litigation over land ownership was the rule all over the occupation process: there was not enough “empty space” for everybody who came to region. As to the objective of providing the necessary conditions to support the industrialization and urbanization processes underway in São Paulo and Rio de Janeiro there is a consensus that it was met. Producing cheap food and generating external currency to finance strategic imports was reached albeit after a couple of decades of investments.

The peak of the incorporation of the Center-West took place after the transference of the federal capital to central plateau in 1961. Only then the promises related to government investment in infrastructure were really fulfilled. Private companies would carry out the occupation based on large enterprises with the support of preferential fiscal incentives. At about the same time the “realistic” strategy of occupying the new frontier lands was really assumed: in

the turn of subsidized credit and prices to induce a remarkable migration of southern and southeastern farmers to central states to explore large-scale farms.

Farmers from Northeast, South and Southeast in an uncontrolled westward movement began to arrive to the region in search for better social and economic living conditions. Only in the decade of the seventies the Center-West population grew by 46% while the Brazil's total population increased 26%. Large capital amounts were used for infrastructure along with credit and fiscal incentives while land occupation and tenure were left uncontrolled. The government gets better focused when the Second National Development Plan presents its Special Programs: POLOAMAZONIA, POLOCENTRO, POLONOROESTE and PRODECER. The programs focused on economic growth with investments in transportation and storage facilities building, energy, extension and research, rural electrification and mechanization and intensive soil correction. The programs were a technological success as they brought to the Cerrado profitable crops as well pasture formation and forage production, despite the natural inadequacy of the soil.

### **III. Consequences for the Cerrado Region**

Social investment to facilitate the adaptation of migrants to those unfriendly regions was not adequately included in the programs. The number of migrants exceeded the expectations making funds insufficient for the demanded settlement. The excess of migrants had to be absorbed in towns with increasing conflicts over land property and invasion of Indian lands and forest reservations. Schools and health services and other social infrastructure were supplied at the same (insufficient) levels of the rest of the country. That means that in general the Center-West population are not in worse social-economic conditions than it would be if it had remained in its original region instead of migrating. Small farmers who were granted access to land had hard time to settle in the region. Due to deficient access to credit, extension and marketing facilities, small farmers were easy prey for larger capitalized farmers with the obvious consequence in terms of land property concentration.

Environmental impacts of the Center-West occupation are still to be better evaluated. There is generalized perception that undesirable effects occurred upon natural resources. Soil erosion, vegetation and fauna losses, air and water pollution are pointed to in the specialized literature. However, there is a lack of hard (data-based and measurable) evidence, which could be generalized to the whole region. Worldwide there is growing concern with deforestation and

its global consequences. Available data and studies, however, indicate that agriculture and livestock are not the primary forces behind the process. Livestock, for instance, is a profitable activity independent of cheap land resulting from deforestation: regionally adequate pasture grass plus proper technical management lead to economically sound activity in combination with several crops.

That the occupation ended up favoring a large farm based agrarian structure is understandable in economic terms. A combination of cheap land, subsidized credit for modern inputs and machinery and artificially (legislation induced) costly labor does all the necessary explanation. Of course the most important ingredient in the recipe was human capital. Not available locally, it had to be imported from the South and Southeast. Northern migrants could not – at that time - compete with the first group.

#### **IV. Agricultural Policies**

During the sixties the Brazilian government institutionalized the subsidized rural credit system to stimulate new technology – and the use of new machinery now being produced in the country – and to partially compensate the agricultural sector for the low prices resulting from overvalued currency and price control. Simultaneously to creation of the rural credit system, a price support and storage program was established. Of course, because the ultimate goal was the production of cheap food the price support system could not be very stimulating to farmers. So it turned out to be a program of market risk reduction. Since the sixties up to the eighties the rural credit was the leading agricultural policy instrument. “Ex- post” real rate of interest of -36% were charged during the period of largest credit supply. Currently the proportion of official credit to agriculture’s GDP has stabilized around 20% of what it used to be in credit heydays. The alternative that came out was to use input supplier and/or output buyers credit at market rates. An important portion of this credit is supplied under informal condition and even when formal the transactions are not reported to financial authorities. Thus the volume of credit from private sources is really unknown.

Agricultural price support policies in Brazil was important to secure minimum profitability for the Center-West farm production. That took massive intervention so that spatially agricultural prices became inconsistent and the government was the major purchaser during most of the seventies and eighties. Although most of the price policy changes of the

eighties were intended to benefit domestic oriented crops, soybeans in the Center-West ended up gaining as well: in 1987, for instance, up to 56% of Center-West production was marketed with government loans. In addition price guarantee for maize and rice indirectly favored the expansion of soybeans: rice was a crop that fulfilled the role of financing the clearing of the Cerrado area, while maize was used for crop rotation with soybeans. When in the late eighties fiscal restraint became necessary, a strategy of saving public funds and avoiding direct involvement of the government with product handling had to be conceived. New put-options programs are now at work and awaiting for proper evaluation.

As the government quit the leading role of supporting prices and financing agriculture, input suppliers and output buyers took up these roles. By advancing funds prior to harvest, these companies guarantee prices and supply working capital to farmers certainly at higher costs. At the same time the public National Bank for Economic and Social Development became the big supplier of investment credit to the agricultural sector.

The occupation of the Center-West area was contemporaneous with an acceleration of the national investments in agricultural technology, with a central role attributed to EMBRAPA as head of an organized national system. The system produced technologies that made the occupation of the Cerrado viable. Special credits are given to the system for the achievements in the grain production (particularly the adaptation of soybeans), plus beef, pork and poultry, milk and vegetables. A number of management techniques have been developed or adapted for the Cerrado region. The no-tillage system has been rapidly accepted and used by farmers for simplifying operations and reducing costs besides the possibilities it opens for diversification, rotation and succession of crops, not to mention the cattle-crop association and its optimistic perspectives regarding Cerrado's sustainability.

Crop production in Brazil has increased substantially over the last 40 years and the Cerrado expanded its share of national output of soybeans (to more than 50%), maize (to 20%) and recently of cotton (to 60-70%). At the same time the share of rice fell from 30% to around 20%. The cassava share has been falling (to 5-6%), beans presented a swing and now is around 12%, while the share of sugar cane reached 9% in 2005. As for livestock production, the Center-West milk production is increasing; in fact the regional share has evolved from 7.8% to 14.6% of the country production. The Center-West bovine inventory share increased inventory from 22% to 37%.

In Brazil the farm total factor productivity increased by 72% over the 1994/2005 period. In fact crop output has increased continuously in that last forty years. However, until 1980,

yields were almost constant, so that output growth was due to acreage expansion. From 1980 on yield increase – specially in the nineties- is the dominant force behind output growth. In the last couple of years, however, yield has stabilized and acreage began to rise again. In the last year both remained almost unchanged as a possible result of currency appreciation.

Historically the Center West regional cotton yields have been above the national average. An acceleration in yields is observed since the end of the nineties for both the region and Brazil as a whole. In Mato Grosso yields increased 1.3 ton per hectare to 4 tons per hectare within a 6-7 year period. Maize yields have changed from 1-2 tons per hectare to 3-5 tons over the last 40 years, above national average. As for rice, yields have increased since the nineties: in Mato Grosso do Sul yields grew from 1.7 ton per hectare to 4.8 tons per hectare from 1991 to 2005. Soybeans yields have increased significantly since the mid-seventies: in Mato Grosso yields rose from 1.5 ton per hectare to 3 ton per hectare in that period. Cassava yields have not changed very much over the last 45 years, except in Mato Grosso do Sul where a jump was observed in the late eighties to 18-20 tons per hectare. Sugar-cane yields have been increasing since the mid-seventies and have stabilized around 70-80 tons per hectare. In the nineties national beans yields rose from 500 kilos per hectare to around 800 kilos. The Goiás beans yield, however, reached 2.4 tons per hectare.

## **V. Overall Benefits of the Cerrado Experience**

Looking at farm prices a general falling trend is observed over the last 30 years (after the seventies' commodity shock dissipated). Prices of beans, cassava, rice and wheat (essential in the Brazilian poor's diet), presented strong downward trend starting in the mid-eighties. These were periods of strong growth in yields for rice and beans but not for cassava. With respect to livestock products, the behavior of poultry prices should be highlighted for its long term fall. As was the case of most food crops, the current real prices of poultry, milk, beef cattle and swine current level are around 1/3 of the level in the seventies and eighties.

The real value of the food-CPI experienced a continuous fall, accumulating an 80% decrease in the thirty-year period to 2005. Not only farm prices decreased but also retailers had a huge reduction in margins. At first (until the late eighties) the retail margin reduction was due to the wholesale market power. Then reduction continued due to increased efficiency (during the nineties) as a few large groups held a substantial market share and competed fiercely in prices. In

addition, in the years 2000, both retail and wholesale reduced their margins to adjust to imports prices at an appreciated currency value. Poor families benefited the most from all these changes so that for the first time since data are available significant reductions in Brazil's poverty and in concentration of the income distribution have been observed.

Brazil's exports of crop and livestock products have been growing despite decreasing export prices in domestic currency (international dollar price times domestic price of the American dollar). Since the mid-nineties crop products exports increased 100% and livestock products exports increased almost 700%. All that happened at historically very low farm prices. Growth in productivity is the main event explaining that performance of the Brazilian agricultural sector.

The role of agriculture in Brazil's international finances cannot be overlooked. During the nineties agriculture's trade balance – around 10 billion dollars surplus per year - played a key role in keeping Brazil's solvency. When finally the currency market was liberalized and devaluation occurred, agriculture's trade surplus jumped fourfold to the US\$40 billion level thus leading to surplus to both the whole economy's trade and current accounts after a 10-year period of persistent deficits.

One question frequently asked when the subsidized programs were exhausted in the eighties was: is the Cerrado agribusiness system going to be sustainable from now on? A second question was: were the investments worthwhile?

The answer to the first question is that apparently the Cerrado is now strong enough to dispense with the public sector help. More than 15 years have passed by since most of the subsidies were taken away from the farmers and the sector is growing in productivity and efficiency.

The easy answer to the second question is to show (a) the reduction that happened to the cost of food to the majority of Brazil's population – which is still poor and (b) the huge trade surplus the sector generates, that has been so important for the solvency of Brazil – thus avoiding that the country faced long and deep recession as observed in other emerging countries. The difficult answer is to talk about the cost account that exceeds the public sector investments. The social cost to the local population, to Indians, small farmers and rural workers who lost their income and jobs and, unfortunately, for many their own lives. How to properly evaluate the environmental costs: the deforestation, the soil erosion, the loss in water quality and public health? This is a work still to be done.

The Center-West population was relatively small (3% of national population) when occupation effectively started; that means that it would not be too costly to make sure locals would benefit from modernization as much as new comers. But apparently locals got mixed with countless migrants of the Northeast to make up for a large group of untrained farmers, who ended up not doing well with modernization.

## **VI. Lessons from the Cerrado Experience**

What are the lessons to extract from the Brazilian Cerrado experience for the development of other similar regions, like some African countries?

First, the experience of occupying an extensive region like the Cerrado must take the form of a national priority. Because it takes a lot of social resources, the whole country must be motivated to support the resource transfer that the initiative demands. There is not even an approximate estimate of the total investment made by Brazil and by foreigners in the Cerrado. The building of roads, railways, storage facilities, plus education and health institutions was really very expressive by any standard. But beyond the financial resources required, for a new experience in Africa many deep institutional changes will certainly be in order: land reform and ownership definitions and adjustments, community organization (cooperatives, farmers' association), input and output market formation and definition of trade rules. An information system is required to avoid the exploitation of small farmers by concentrated output and input dealers. In the case of Brazil after decades of market control by the government, an information system led by the University of São Paulo facilitated the development of balanced free market for many agricultural commodities and processed raw materials. The University also acted as a exempt third party in negotiations between farmers' associations and agro-industry in designing contracts and other matters.

Second, there is the technology and human capital side. That certainly demands investments of even longer term. The transplantation of technologies from elsewhere – even when they are perfectly transferable due soil and climate similarities - to the region under transformation is very risky unless the proper human resources are available. That means that the education (schooling and training) of the local population should be the first investment priority. The real challenge is related to the lack of entrepreneurial capacity that in general depends on on-the-job experience. The recommendation is that the Brazil's Cerrado experience be applied to

some extent. Farmers from Brazil and other successful farming countries could be stimulated to participate in the experience and serve as multipliers of the new technologies, management practices and share the associationism experiences. Third, it is important to keep in mind that people needs education, health, security and leisure services. That demands investments some of which not directly related to production, but essential for the well-being of the local population. Farming will tend to be the dominant activity at first but later other types of business will develop if the initiative succeeds. Of course farming can be the pole for the development of many agriculture-related activities. But human resources must be prepared also to work off-farm while doing in-the-farm business to complement income, but also to move to urban sector if and when the right time comes.

Fourth, the environment questions. If back in fifties and sixties these questions willingly or for ignorance were given a low priority, today this procedure would be entirely inappropriate and unjustifiable because of the availability of tested means to take adequate care of natural resources. And those means – such as no-tillage systems , should part of the education farmers should be exposed to from the beginning. Farmers should be the group most interested in the preservation of the soil and natural resources since these resources still represent an important share (at least 30%) of a Cerrado's commercial soybean farm assets despite of all its machinery and buildings investments.

# THE BRAZILIAN CERRADO EXPERIENCE WITH COMPETITIVE COMMERCIAL AGRICULTURE<sup>1</sup>

## A Critical Review

### Part 1. AGRICULTURE IN BRAZIL'S TWENTIETH CENTURY DEVELOPMENT STRATEGY

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#### 1.1. Introduction

Brazil's economic development process experienced several significant changes over the last 70 years. As the worldwide trade and capital restrictions of the 1930s reached Brazil, an inward development strategy won the support of the new political force that had just overthrown the president Washington Luiz (and impeding that the president elected Julio Prestes de Albuquerque was invested one month later), a representative of the so-called old agrarian oligarchy.

Getúlio Vargas takes over power under the priority of industrializing the country looking for self-sufficiency. In the thirties, forties and fifties, he created most of the institutions necessary to implement an industrialization process in Brazil based on marked presence of the public sector as the driving force. It is important to mention<sup>4</sup> (A) that the revolutionary Vargas of the 1930 to 1945 in fact not only increased the number of labor laws but also created the mechanisms to guarantee their implementation and monitoring. Since these were years of effective dictatorship, the Vargas policy really combined social oriented and pro-labor laws with rigid control over

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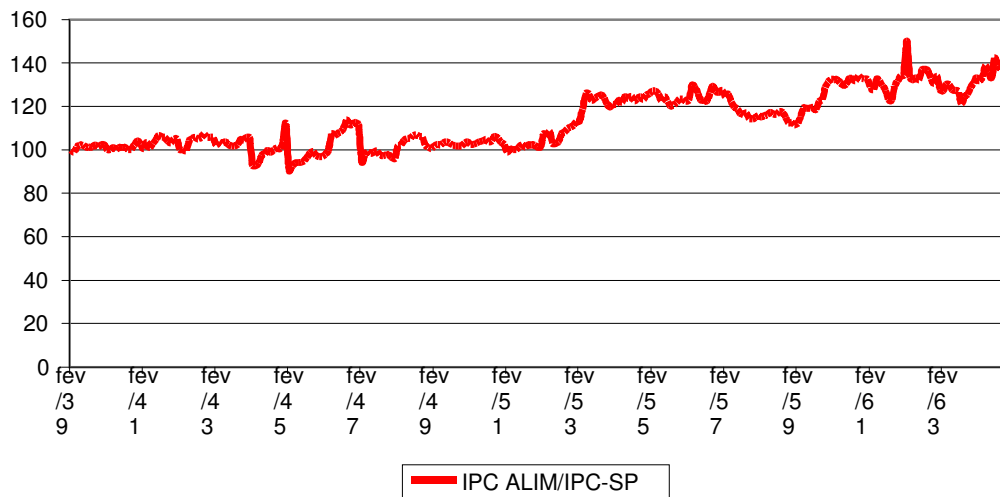
<sup>3</sup> CEPEA's researchers: [hfsspola@carpa.ciagri.usp.br](mailto:hfsspola@carpa.ciagri.usp.br) and [adami@carpa.ciagri.usp.br](mailto:adami@carpa.ciagri.usp.br)

<sup>4</sup> Fundação Getúlio Vargas (FGV-CPDOC). 2007.

workers and unions activities. When Vargas returns democratically elected in 1950, the union movements re-articulated and could make effective their rights including the one of promoting strikes. So labor pressures to have wages adjusted to cost of living became a powerful instrument.

In the late fifties and early sixties the escalating cost of living was attributed mainly to prices of food, the production of which grew too slowly compared to accelerating demand. The resulting pressure upon industrial wages created almost permanent social unrest and a continuously unstable labor market. Political support for a land reform program to put an end to the allegedly inefficient plantation system was an expected and confirmed consequence that ended up contributing to much political unrest. Figure 1 shows that real cost of food jumped up by more than 20% in the early fifties and more 20% in the early sixties.

**Figure 1. Consumer Food Price Index versus General Consumer Price Index (CPI) São Paulo. 1939/64.**



Source : FIPE -SP

These were days when agriculture was mostly done within the so-called plantation system: major exports-oriented crops – coffee, sugarcane, cocoa, – with subsidiary production of food and fiber for the domestic market. Most of the latter was produced under part-time sharecropping systems by the so-called “colonos<sup>5</sup>” who lived in the farm and worked as hired labor in export crops.

Marketing facilities directed to domestic consumption were traditional in accordance with the then existing agricultural production structure. Regional wholesalers acquired excess subsistence staple goods from farmers and delivered them to the urban areas through the foreign-owned railway system and the recently growing public highway system. The domestic marketing system really served of the exports logistical system linking farmlands to ports from the west to east. Towns were then forming at points along the railways and new highways.

Academic discussion tended to oppose, on one side, the land reform solution – to deal with the so-called “agrarian problem” (land and other agrarian resources were ill distributed and used) - and, on the other, the farm modernization strategy to deal with the “traditional-agriculture problem” (agriculture allegedly was “efficient but poor”). Although most analysts would say that the first option was rejected, the truth is that Brazil has ever since been involved with diverse intensity in a never-ending land reform program. See in figure 2, as indicated by Sousa<sup>6</sup> (<sup>B</sup>) with data from the Agrarian Development Ministry<sup>7</sup> (<sup>C</sup>), that the share of land settlements has been strongly increasing over time.

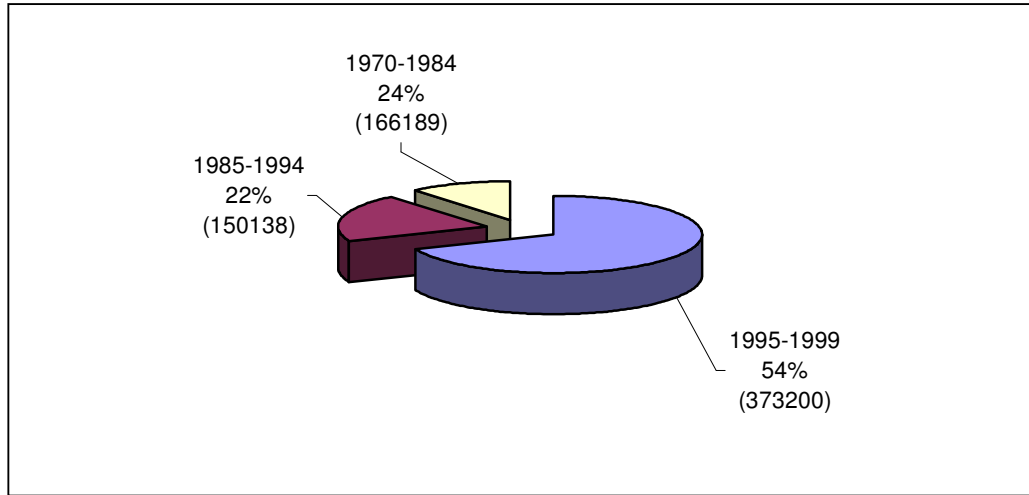
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<sup>5</sup> “Colono” is a farmer working and living in someone else’s land.

<sup>6</sup> Souza, R.P.2004.

<sup>7</sup> MDA/INCRA.2001.

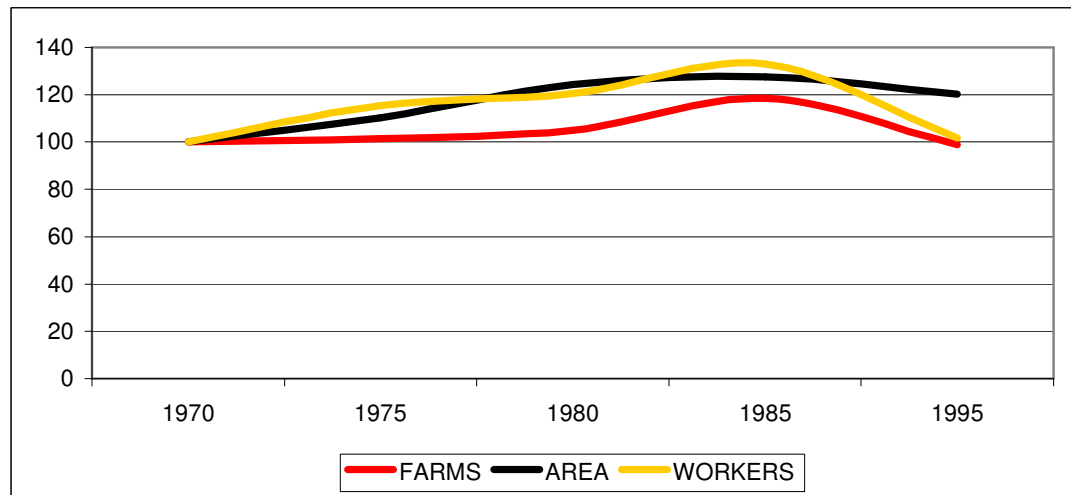
**Figure 02. Periodical Percent of Settled Families – 1970 –1999**



Source: Sousa, MDA/INCRA

Paradoxically, as the number of settlements escalated, the number of farm operators, agricultural land and farm workers decreased since 1985. See figure 3 and Table 1. In other words, despite the efforts to promote land settlements, the agricultural sector became over the last 20 years, a less important source of employment.

**Figure 03. Numbers of farms, farming areas and workers – Brazil:1970-1995**



Source: IBGE

**Table 01. Number of Farm Operators, Farm Area and Workers – 1970-1995/96**

	1970	1975	1980	1985	1995
OPERATORS (thousand)	4919	4993	5160	5820	4860
AREA (million ha)	294	324	365	375	353
FARM WORKERS (million)	17.6	20.3	21.2	23.4	17.9

Source: IBGE

The fact is that the political options fell upon a mixed strategy. The strategy meant to engage agriculture in the import substitution wagon with a double effect. On the one hand, agriculture could be an effective demander of modern inputs and capital goods that could be produced by the infant industry being implanted in the country. On the other, modernization could reduce food costs and help the country to balance its external trade. At the same time a special attention to land reform would meet the demands of part of the political forces then in evidence and reduce the accelerated migration flow out of the rural sector. That these two strategies were contradictory is the common observation of a historical flow of farmers out of agriculture at the same time land reform settlements multiplied over the last 40 years.

The agriculture modernization strategy had many components: (a) domestic production of farm machinery, equipment and inputs in general, (b) creation of new research and extension systems, (c) large amounts of subsidized rural credit, (d) price support and commodity storage programs, (d) extensive price control on “strategic” wage-goods: wheat and bread, milk, etc. (e) extensive price and production control plus specific credit support to special exportable products: coffee, sugarcane and byproducts, rubber, cocoa, etc.

Import substitution was the macroeconomic orientation, which essentially involved the domestic production of previously imported industrial goods. São Paulo and Rio de Janeiro in the Southeast ended up being the larger beneficiaries of the process. Nationalism became even stronger as Brazil breaks the agreements with the IMF and World Bank in 1959.

The vent for economic development restricted by shortage of capital, however, leads President Juscelino Kubitschek to stimulate foreign private investment in vehicles and machinery sectors during the fifties and early sixties. As indicated by Birchall, as industrial import substitution developed, the traditional food and textile industry shrank in relative terms: it

represented more than 35% of the industrial GDP up to the mid-fifties and began to lose importance to metallurgy, machinery and mechanical sectors. Ten years later, their share had fallen to 26%, and since the mid-seventies has settled down on around 17%<sup>8</sup> (D).

## 1.2. The “Marcha para o Oeste” – From the II World War to the Seventies

Already in the thirties, Getúlio Vargas had introduced the colonization and occupation<sup>10</sup> “Marcha para o Oeste (Westward March)” program with focus in the Center-West’s “empty space” where the so-called “Colonias Nacionais” (National Colonies<sup>11</sup>) – agricultural colonies in fact – should be created. In 1940 the law 2009 establishes the “colonias-núcleos” (nucleus-colonies) and the relationships between colonization companies and the colonists.

The stated objective was to foment the small farm property through government support and supervision of technical organs and family social assistance all through the emancipation of the nucleus. The focus of the march was to settle “colonos” primarily in today’s Mato Grosso do Sul with the double objective of producing food and occupying the “empty space” of the Brazilian region<sup>12</sup> (E). States and municipalities were also to be involved in colonization programs subject to the central government represented by the Colonization and Immigration Counsel.

Also in 1943, the federal government promoted the Roncador/Xingu Expedition with the objective of reaching Santarém, state of Pará, eventually getting to Manaus (state of Amazonas) through yet unknown regions. The expedition basis was at Barra do Garças (Mato Grosso) and should get to the confluence of the Kuluene e Xingu rivers, surpassing the Rio das Mortes (Mato Grosso). The idea was to have several nuclei created along the expedition way to support the colonization process. The Central Brazil Foundation had its site established – already in 1943 - at the Rio das Mortes – today’s Nova Xavantina (Mato Grosso).

At the “Vale do Sonhos” (Dreams Valley) – Barra do Garças a small nuclei colonization

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<sup>8</sup> Birchal, S.O. 2002.

<sup>9</sup> This section is – except when specifically mentioned – based in the text: Secretaria do Planejamento do Estado do Mato Grosso. [www.zsee.seplan.mt.gov.br/divulga/Socio%20Economico%20e%20Juridico%](http://www.zsee.seplan.mt.gov.br/divulga/Socio%20Economico%20e%20Juridico%20)

<sup>10</sup> Occupation means take possession of a place.

<sup>11</sup> In Brazil, colony means a group of migrants established in other region of the country. To colonize means to begin to live in some previously unoccupied place.

<sup>12</sup> Batista, L.C., C.Martins Jr., J.C. Ziliani. (Jan 3rd 2007).

was tried and failed just like the global colonization idealized for the region. The main reason for such failures was massive litigation over land ownership. The lands were already taken by an estimated population of thirty thousands “garimpeiros” (seekers of gold and other precious metals). In addition these really were Indians’ lands. When colonists tried to occupy the Xavantes’ lands the results were several conflicts and violence.

No significant change was observed in the Mato Grosso population as a result of those colonization efforts: the state presented a population annual growth of only 0.96% from 1940 to 1950.

A new strategy is then devised in the fifties: associating public and private colonization efforts to absorb population excesses from other regions into the Center-West. In the decades of the fifties and sixties 29 official colonies were partially settled – a region encompassing 400 thousands hectares (0.32% of the original state of Mato Grosso). With the exception of one of them (the private Rio Branco Colony with 200 thousand hectares), other colonies had 75% of the farms smaller than 500 hectares and the remaining 25% smaller than 1000 hectares. A total of 8.739 parcels with 10 to 15 hectares absorbed 68.920 colonists, not without work and life condition difficulties.

The private experience in Rio Branco was based in transferring colonists that had had difficulties in Dourados. Companies in charge of the project acquired property titles under special conditions but failed to fulfill the established infrastructure requirements. Irregularities in land transactions from public to private hands were a factor contributing to the failure of the project.

Most of the evaluations point this colonization process as a failure. The state is blamed for not keeping the promises related to infrastructure (access and circulation (within settlement) roads, health and education services, technical assistance and production credit. Negative evaluations of both public and private experiences are born out of perspective of stated objectives: to develop land settlements based on family farms to produce for the domestic market.

### **1.3. The Occupation after the seventies<sup>13</sup>**

#### **1.3.1. The seventies**

The so-called exhaustion of the traditional southern and southeastern area lands of the forties and fifties really meant that those lands were already taken in the juridical property sense. It did not mean that all those lands were being used up to their productive capacity or that productivity could not be improved. From 1940 to 1960 the farm area in Brazil duplicated: 21.5% to 43.5%. But land use effectively increased not yet in the Center West, but rather in the states of Paraná, Minas Gerais (the Triângulo Mineiro, Minas' Triangle), Western São Paulo and Rio Grande do Sul. The availability of these areas – all close the then developing industrial areas – meant that there was no need to incorporate the frontier land in the Center West.

One decade latter, however, the scenario was completely different. Cheap lands in the South of both Mato Grosso do Sul and Goiás favored the cattle ranching activity, which was promoted by private colonization projects under the initiative of Southeastern slaughterhouses. Despite of that, most of the Center West territory remained unused.

The real incorporation of the Center West would take place after the transference of the federal capital to central plateau in 1961. After that transference government investment in infrastructure was really carried out as evidenced by the construction of the Belém-Brasília, BR-364 and BR-163 highways. Occupation and colonization programs were implemented in Goiás, Mato Grosso do Sul and later in the seventies in Mato Grosso.

In the mid-sixties a military coup would began a successive of authoritarian government that lasted until the mid-eighties.

At about the same time the new strategy of occupying the new frontier lands was really assumed, taking a lot of subsidized credit and prices to induce a remarkable migration of southern and southeastern farmers to central states to explore large-scale farms.

The 1970's were the years of severe macroeconomic supply shocks: one resulting from the formation of the OPEC cartel that raised the oil prices to unprecedented levels, the other from the commodity side. As the Bretton Woods exchange rate system broke down, the dollar began to fluctuate and to devalue: commodity prices skyrocketed. Exports from the Brazilian

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<sup>13</sup> Unless otherwise mentioned the discussion in this sections is based in: <http://zsee.seplan.mt.gov.br/>

agricultural sector increased giving rise to the polemic question: is it possible to export without harming domestic supply of food and fibers? Not only tradable goods prices increased, but those of domestic-oriented food products as well. It was what was then called the “agricultural problem”.

Due to the intense rural-urban migration as the Southern and Southeastern regions industrialized plus the consequent increasing demand for food, the National Integration Plan (PIN) <sup>14</sup> was created in 1970 to intensify the occupation of the Legal Amazon, part of which is located in the Center-West.

There apparently was an understanding between government and national and foreign private companies regarding the role of each in the programs. The public sector would be in charge of infrastructure, research and planning, providing fiscal incentives and subsidies. Private companies would carry out the occupation based on large enterprises and to do that they expressed the preference for fiscal incentives as the instrument to develop the Center-West. So fiscal incentives legislation was adjusted to stimulate participation of private national and foreign investors.

The initial strategy was to promote colonization alongside the Transamazonian Highway by distributing public lands to migrants plus fiscal incentives to investment in the region. In Mato Grosso the BR-364 was built from Cuiabá to Santarém, thus opening up the access to the Northern part of the Center-West. Agricultural expansion follows the BR-364, the Cuiabá-Porto Velho and Porto Velho- Manaus axes. A 100-kilometer strip on the federal highways was freed for occupation.

The “Programa de Colonização Dirigida” (Directed Colonization Program) should have settle one million families in the Amazon by 1980. That goal was not fulfilled, but the program turned out to be a strong indication of the national occupation strategy. Farmers from Northeast, South and Southeast in an uncontrolled movement began to move northward after better social and economic conditions. Just in the decade of the seventies the Center-West population grew by 46% while the Brazil’s total population increased 26%. The government, however, did not acted to support the public demands resulting of such an intense colonization process. Space was open in the Amazon, large capital amounts were used for infrastructure and credit and fiscal incentives were provided to big agricultural and mineral projects. Land occupation and tenure were left

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<sup>14</sup> The funds for the PIN were: budget resources, fiscal incentives, contributions from public companies and loans from national and international institutions. (Decree - 1106/1970).

uncontrolled.

The government gets better focused when the Second National Development Plan presents its Special Programs: POLAMAZONIA and POLOCENTRO. The “Cerrado Development Program” and the “Exportation Corridors” are part of the new phase. Colonization companies could count on funds from the PROTERRA - Programa de Redistribuição de Terras e de Estímulo à Agroindústria do Norte e do Nordeste (Land Redistribution and Stimulus to North and Northeast Agro-industry Program) – a credit program so that farmers could finance the purchase of land. Land was first bought by the government and then resold to farmers.

From 1975 to 1981, a series of development programs were implemented in the Center West. Local programs were designed to the Pantanal, to Dourados and to the two states that resulted from the division of Mato Grosso. PRODEPAN, PROSUL, PROMAT and PRODEGRAN POLOAMAZÔNIA, POLOCENTRO, POLONOROESTE and PRODECER are directed to more ample areas. All are analyzed by Abreu<sup>15</sup> (F).

The priorities were: Transportation (highways, waterways and railroads); Sanitation (refuge platforms, water wells, the Paiaguás Channel, the Rio Manso barrage, water studies in the Pantanal); Energy (production, transmission distribution and transformation); Industrialization (studies of the opportunities of industrializing Pantanal’s raw materials: iron, manganese, phosphate, lime, wood, - installation of slaughterhouses in Corumbá); livestock development (research on pasture improvement, sanitary techniques, introduction of proper management and technical assistance to farmers).

The support to extensive cattle growing and livestock industrialization was more effective than other goals. For Abreu with the focus on economic growth Indigenous population was not properly considered: roads and other constructions just crossed their territories. Social investment to facilitate the adaptation of migrants to those unfriendly regions was not included in the program.

According to Silva<sup>16</sup> (G) the 1975 POLOCENTRO intended to occupy agricultural frontier in selected Cerrado areas (3 million hectares in 4 years). It really succeeded in incorporating 2.5 million hectares especially with soybeans and pastures. As pointed out by Diniz<sup>17</sup> (H), the POLOCENTRO funds would be directed to infrastructure while farmers would

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<sup>15</sup> Abreu, S. 2001.

<sup>16</sup> Silva, L. L., 2000.

<sup>17</sup> Diniz, B. P. C. 2006.

obtain rural subsidized credit for in-farm investment and working capital. For Diniz the POLOCENTRO was a technological success as it brought to the Cerrado profitable crops as well pasture formation and forage production, despite the inadequacy of the soil. Research and development of new technologies warranted the incorporation of 2 million hectares or 31.5% of the incremental Cerrado area (Goiás, 42.3%, Mato Grosso do Sul 30.5% and Mato Grosso 21.3%)<sup>18</sup>.

### **1.3.2. The eighties**

The eighties represented a crucial change for Brazil development plans. The new scenario included: economic recession, cessation of external loans, excessive government fiscal deficit, low international commodity prices. To reorganize the process of occupation of the Cerrado, the Brazilian government and the World Bank supplied funds to the POLONOROESTE program directed to Mato Grosso and Rondônia. Many tasks had been redone and began to be taken care of. The BR 364 - connecting Cuiabá to Porto Velho - had to be rebuilt. Secondary and feeding roads had to be built or consolidated. Rondônia's Directed Settlements Projects (PADs) had to be implanted. Land property in Mato Grosso needed regularization and small farmers communities needed social services and infrastructure. Family farming (food producers) was focused to receive support credit, storage and marketing infrastructure and extension services. Two million hectares in Natural Parks and support to Indian communities were also projected.

Results were not quite as expected. The BR – 364 improvement opened up the way to migration of Southern and Southeastern farmers to Mato Grosso and Rondônia. The number of migrants exceeded the expectations making funds insufficient for settlement. The excess of migrants had to be absorbed in towns with increasing conflicts over land property and invasion of Indian lands and forest reservations. Schools and health services were not properly dimensioned and located. (Malaria occurrences increased during the eighties in Rondônia). Roads location ended up benefiting mostly large farmers; in other cases roads were unusable in rainy seasons. Non properly located and dimensioned were also storage facilities in part due the substitution of cattle for crops. Rural electrification was considered inefficient: too few

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<sup>18</sup> In 1985 SUDAM carried out an evaluation of a sample of 10% of the 952 projects implemented over the past 20 years. A total of 581 of them were agricultural and livestock projects supported by fiscal incentives. Benefited farms ranged from 3000 hectares to 300000 hectares (with a mean of 16600 hectares) located in Pará (210), Mato Grosso (208) and other Legal Amazon states (163). Results in terms of jobs, income and life quality are as yet unknown.

connections per kilometer and absorbed mostly in home but not as a productive input. High cost diesel electricity generators had to be used instead.

Due to deficient access to credit, extension and marketing facilities, small farmers were easy prey for larger capitalized farmers – especially cattle growers - with the obvious consequence in terms of land property concentration. Although legally impeded of selling their lands, settlers were forced to in order to overcome the economic difficulties they faced.

The PRODECER (Japan-Brazilian Cooperation Program for the Development of the Cerrado) resulted from the 1979 agreement between Brazil and Japan International Cooperation Agency (JICA). Japan had special interest in the program since the United States's embargo to the soy-meal exports to Japan. According to Osada<sup>19</sup> (1), Japan depended exclusively on the United States for the supply of that animal feed. In 1980, before the program started, regional soybean and corn production represented 15% and 28%, respectively, of national production. In 2000 these percents were 52% and 31%. Rice though reduced its share in national production despite having had its output almost doubled in 20 years. Beans and cotton had their share increased: from 16% to 40% for beans and from 8% to 74% for cotton. Livestock was another activity supported by PRODECER. In 1980 the Cerrado region's cattle herd represented 30% of the national stock; in 1995/96 it reached 50%. Diniz estimates that between 1975 and 2003, the region's cattle herd increased at an annual rate of 3.2% while the stock in rest of the country grew at 1.8% per year.

### **1.3.3. The nineties and twenties**

The government intervened strongly in the Brazil's economy – particularly in the agricultural sector - all over the industrialization process. Some public organisms were in fact in charge of taking several sectoral decisions; fixing prices and stocks, financing procedures, exporting, etc. Examples are the Brazilian Coffee Institute and The Sugar and Alcohol Institute. The prices of several commodities and goods were controlled for one reason or another: milk, wheat and bread, and other food items. The price of milk, for instance, had been controlled for more than forty years.

Most of liberalizing measure began to be implemented in the second half of the eighties as a consequence of the scarcity of public funds. External default had been declared so no

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<sup>19</sup> Osada. N. M.1999.

external funds were available, and the public debt had surpassed its acceptable limits so that the government capacity of intervention had exhausted. The first two (directly elected) administrations in the nineties rapidly moved to liberalize the economy as the only way out of stagnation crisis. President Collor and after him, President Franco, reduced trade tariffs so Brazil economy was suddenly exposed to fierce external competition. The Real Plan was implemented in 1994 and maintained by its administrator that would be elected president (President Cardoso). Based on desindexation and strongly tight monetary policy (because fiscal reform was not applied as needed), the Plan made the inflation rate fall substantially thanks to high interest rate, highly appreciated currency, high levels of imports and huge amounts of external capital inflow.

Despite the success of reducing inflation, Brazil got itself trapped in a vicious cycle: high interest rate increased the public debt and the public debt demanded high interest rates to be financed. Investment levels remained very low because of interest rates and heavy fiscal burden. Despite of primary fiscal surplus, the size of the government expenditure continued to grow mainly because of the social security system and the current expenses of the public sector.

The nineties were years of severe turbulences in the international financial markets, and Brazil ended up hit in 1998. The only way out was to change the exchange rate regime to a flexible one. This represented a significant help to exports – specially from agriculture - as the rate devalued markedly. Brazil adopts the “Inflation Target” strategy in 1999 as well, which has been successful from the beginning.

In 2002, amidst the electoral process from which President Lula was selected, a new and stronger devaluation occurs. Despite its not recommendable cause, the devaluation was beneficial to exports. The rise of the emergent countries – led by China and India – strengthened foreign demand for agricultural commodities (and many other nonagricultural goods) contributed for the country accumulate unprecedented levels of foreign currency. Foreign debt a Brazil’s old problem is practically paid up. However, as a one result of this good news, Brazil’s currency moved fast in the appreciation direction (compared to the levels observed during the political uncertainty of 2002-2004 period). This is today considered a difficulty to some economic sectors; nonetheless Brazil’s trade surplus continues to grow vigorously, with precious help to the agricultural sector.

As the public sector – due to fiscal debt - lost its ability to intervene, most of the actions directed to the agricultural sector changed. Rural credit was curtailed and new cost saving price support programs introduced. As President Lula extended the social programs to reduce impacts of income concentration, the agriculture sector was involved in three ways: a) as a source of

cheap food to make viable the income redistribution program and b) as another beneficiary of the programs as far as the family farm segment was selected for special public programs (rural credit and government privileged purchases) and c) as a beneficiary of the rural worker retirement program – the age-based rural retirement program, which benefited more than 4 millions farm people with a minimum wage per month, without require previous contributions to the social security system, provided the beneficiary has worked 15 years in farm activities<sup>20</sup>.

As for the commercial farms, the public sector counts on them to assure competitiveness in external markets and contribute to cheap food for the predominantly poor population. The relationship between government and farmers has been basically of two natures. On the one side, the debt crisis that last more than 15 years. On the other, the lack of security related to land reform and invasions by the land related social and political organizations. The first one was born with the several inflation fighting plans on the late eighties: liabilities and assets were corrected by different inflation indexes, with severe loss to farmers. Since no definite solution was found thus far, palliative endless negotiations take place in a time consuming and politically sensitive process. The second one relates to a process that is forty years old now: landlessness persists despite the continuous and unstable land settlement program. As more land is distributed, more interested people show up looking for a piece of land. At the same time, many small farmers quit farming because of lack of profitability.

Aside for this chronic problems, farmers face great difficulties related to infrastructure. All past highway and railway and ports investments are by now depreciated and badly need maintenance and amplification. In addition, new transportation facilities are demanded as the economy grows. The Cerrado's farmers are particularly affected because of the distance to the main consumer centers and exporting ports. The current administration has not thus far found a way to solve this urgent problem as it resists to extend the privatization or private concession projects.

#### **1.4. Agricultural Policies**

During the sixties the Brazilian development strategy through import substitution was well underway. The agricultural sector should then be set into motion to fulfill its role in that process. Its basic role was to secure a supply of wage-goods at accessible prices to the growing

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<sup>20</sup> See [www.dataprev.gov.br](http://www.dataprev.gov.br)

urban sector. This had to be possible under a set import substitution policy instruments: (a) overvalued (and sometimes multiple) exchange rates to facilitate selected imports and a complex set of trade policies to create protecting barriers to the infant industry, (b) a set of wage goods (food typically) were kept under price control, (c) institutionalization of subsidized rural credit system to stimulate new technology – and the use of new machinery now being produced in the country – and to partially compensate the agricultural sector for the low prices resulting from overvalued currency and price control. Simultaneously to creation of the rural credit system, a price support and storage program was established. Of course, because the ultimate goal was the production of cheap food the price support system could not be very stimulating to farmers. So it turned out to be a program of market risk reduction. Later these measures were complemented with an agricultural research and extension system. If this would help in increasing productivity the goal of having increased agricultural output at lower prices would be more easily reached.

Brandão<sup>21</sup> (J), for instance estimated that 8% to 9% of the agricultural income were transferred to Brazil's society between 1975 and 1983 through output and input price distortions associated with explicit and implicit taxations. However, a transfer inversion is estimated when rural credit subsidies were considered: agriculture turned into a net beneficiary of 5% to 6% of the sector income. Araújo et al<sup>22</sup> (K) estimated that credit subsidy represented an average of 12% the agricultural income during the eighties.

### **1.4.1. The Rural Credit System**

Since the sixties up to the eighties the rural credit was the leading agricultural policy instrument. Table 02 shows that official rural credit had its heydays by the end of the seventies, when the supply quintupled compared to the sixties. Since then the rural credit crumbled to only one-tenth in 1993. During the rest of the nineties up to 2005 new funds were allocated to rural credit, but currently it corresponds to only 40% of the peak value of seventies. The Center-West

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<sup>21</sup> Brandão, A.S.P. 1989.

<sup>22</sup> Araújo, P.F.C. et al 1990 (b).

succeeded to extend the period of benefit from that policy instrument up to the mid-eighties – credit supply to the region reached 10 times the value of the late sixties. Even presently the Center-West has maintained a significant share –more than a fifth of the total credit supply to the agricultural sector. Credit supply to the region has presented a narrower oscillation pattern.

As matter of fact the official rural credit has been reducing as a proportion of agricultural GDP since 1980. See table 03. Currently the proportion has stabilized around 20% of what it used to be. Indeed as indicated in the third column that used to be around 1 to 1, in recent years fell below 0.2 to 1. Farmers have had to look for alternative ways of financing their business. The alternative that came out was to use input supplier and/ or output buyers credit. An important portion of this credit is supplied under informal condition and even when formal the transactions are not reported to financial authorities. Thus the volume of credit from private sources is really unknown.

**Table 02. Official Rural Credit (Indices) – Brazil and CENTER-WEST**

<i>Year</i>	<i>Total</i>	<i>Center-West</i>	<i>% Center –West</i>
1969	100	100	7
1970	119	107	7
1971	138	138	7
1972	171	209	9
1973	242	280	8
1974	300	362	9
1975	438	611	10
1976	448	720	12
1977	400	532	10
1978	407	562	10
1979	507	766	11
1980	485	707	11
1981	420	601	10
1982	407	578	10
1983	307	472	11
1984	188	337	13
1985	268	602	16
1986	399	1000	18
1987	213	546	19
1988	116	359	22
1989	92	419	33
1990	74	175	17
1991	71	181	18
1992	69	194	20
1993	51	146	21
1994	115	427	27
1995	73	196	20
1996	65	156	17
1997	94	276	21
1998	105	263	18
1999	93	257	20
2000	98	240	18
2001	115	312	20
2002	117	326	20
2003	148	429	21
2004	171	523	22
2005	195	563	21

Source: Banco Central, Anuário Estatístico do crédito Rural

**Table 03. Indices of Brazil's Agricultural GDP and Rural Credit – 1975/2006**

<b>YEAR</b>	<b>AGRIC GDP</b>	<b>AGRIC CREDIT</b>	<b>CREDIT/GDP</b>
1975	100	100	100
1976	102	103	101
1977	115	92	80
1978	112	93	83
1979	117	116	99
1980	128	112	88
1981	138	96	70
1982	138	93	67
1983	138	71	51
1984	141	43	30
1985	155	62	40
1986	142	92	65
1987	164	72	44
1988	165	51	31
1989	170	48	28
1990	163	26	16
1991	166	27	16
1992	175	30	17
1993	176	25	14
1994	189	43	23
1995	200	20	10
1996	206	17	8
1997	208	24	12
1998	215	27	13
1999	229	25	11
2000	235	26	11
2001	249	30	12
2002	266	33	12
2003	281	39	14
2004	288	46	16
2005	289	45	16
2006	301	46	15

Source: Banco Central and IBGE

During the days of easy credit, farmers were granted substantial subsidies . As shown in Table 04, substantial interest rate subsidies were received by farmers in Brazil from 1969 to 1986, according to Shirota<sup>23</sup> (L). “Ex- post” real rate of interest oscillated down to -52% per year for fertilizer. Rates of -36% were charged during the period of largest credit supply. Since regulated nominal rates were relatively stable, subsidies tended to increase when inflation was high. Table 5 indicates the share of interest rate subsidy to agricultural GDP from 1970 to the eighties. This share was close to 22% in 1980.

<sup>23</sup> Shirota, R. 1988.

**Table 04. Brazil's Annual Real Interest Rates on Rural Credit by Destinations – 1969/1986**

YEAR	WORKING	INVESTMENT	MARKETING	FERTILIZER	OTHERS
1969	-1,8	-1,8	-1,8	-1,8	-1,8
1970	-1,9	-1,9	-1,9	-10,2	-10,2
1971	-2,3	-2,3	-2,3	-10,7	-10,7
1972	-0,4	-0,4	-0,4	-7,4	-7,4
1973	-0,6	-0,6	-0,6	-7,5	-7,5
1974	-14,5	-14,5	-14,5	-20,5	-20,5
1975	-11,1	-11,1	-11,1	-11,1 <sup>b</sup>	-22,7
1976	-21,3	-21,3	-21,3	-21,3 <sup>b</sup>	-31,6
1977	-17,2	-15,0	-15,0	-28,0	-17,2
1978	-18,3	-16,2	-16,2	-29,0	-18,3
1979	-35,1	-31,7	-31,7	-43,6	-35,1
1980	-36,8	-34,4	-38,7	-52,5	-36,8
1981	-25,7	-25,7	-25,7	-25,7	-25,7
1982	-27,4	-13,9	-27,4	-27,4	-27,4
1983	-30,1	-9,5	-30,1	-30,1	-30,1
1984	0,9	0,9	0,9	0,9	0,9
1985	-1,3	-1,3	-1,3	-1,3	-1,3
1986	-35,5	-35,5	-35,5	-35,5	-35,5

Source: Shirota

As the volume of official credit supplied to farmers shrank over the nineties, and, after 1994, inflation rate (which provided the implicit subsidy through fixed interest rates) was reduced, the program lost most of its relevance. Today most of the credit is directed to family farms at preferential rates (4% at most). The share of the Center-West in this type of credit is rather small (7%). See Figure 04.

As for the normal (official) rural operational credit, supply is restricted according to type of crop or livestock<sup>24</sup>: cotton (R\$500,000), Irrigated rice, cassava, maize and sorghum (R\$400,000), highland rice, cassava, maize and sorghum (R\$200,000), soybeans in center-west and north (R\$200,000) in other regions (R\$150,000), coffee (R\$140,000). Interest rates was fixed at 8.75% a year. As for investment, funds are allocated mostly from the National Bank for Economic and Social Development, at around 13% per year. Given Brazil's expected rate of

<sup>24</sup> An exchange rate of R\$2/US\$1 is approximately valid at the time.

inflation of about 3.5%, real rates are no longer negative, albeit lower than the real rate for other sectors.

**Table 05. Share of Rural Credit Subsidy on Agricultural and Total GDP, 1970/86**

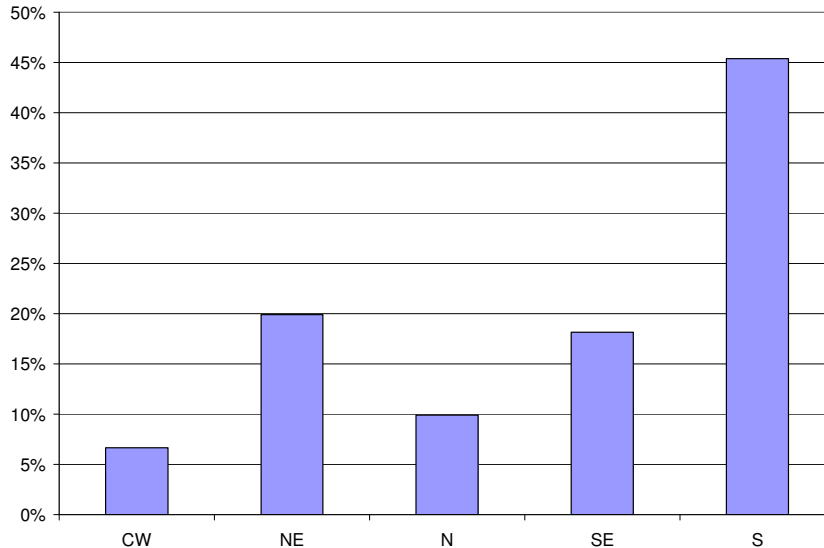
YEAR	SUBSIDY/AGR GDP(%)	SUBSIDY/TOTAL GDP(%)
1970	0,66	0,08
1971	0,78	0,10
1972	0,15	0,02
1973	0,25	0,03
1974	7,23	0,93
1975	7,53	0,91
1976	11,92	1,55
1977	6,79	0,99
1978	8,85	1,03
1979	20,29	2,24
1980	21,98	2,37
1981	14,11	1,41
1982	15,98	1,37
1983	10,06	1,11
1984	-0,18	-0,02
1985	0,78	0,09
1986	16,49	1,56

Source: Shirota.

#### **1.4.2. Funding & Hedging – The CPR**

Large farmers in general find the official credit supply not sufficient for their needs. So they count today on funds provided by input suppliers and output buyers. These financial operations are not officially regulated and no data is available on their volumes and costs. However it is known that they are quite relevant for the farming activities. In general this credit system is linked to the input purchase or output sale by the farmers. In the first case, the inputs are delivered to be paid at harvest time, sometimes with pre-specified amounts of output. In the second, processors pay for part of the output value before harvest. In both cases it is believed that financial costs are much higher than the values charged for official credit funds.

**Figure 04. Regional Shares of Family Farm Credit (%) - 2005**



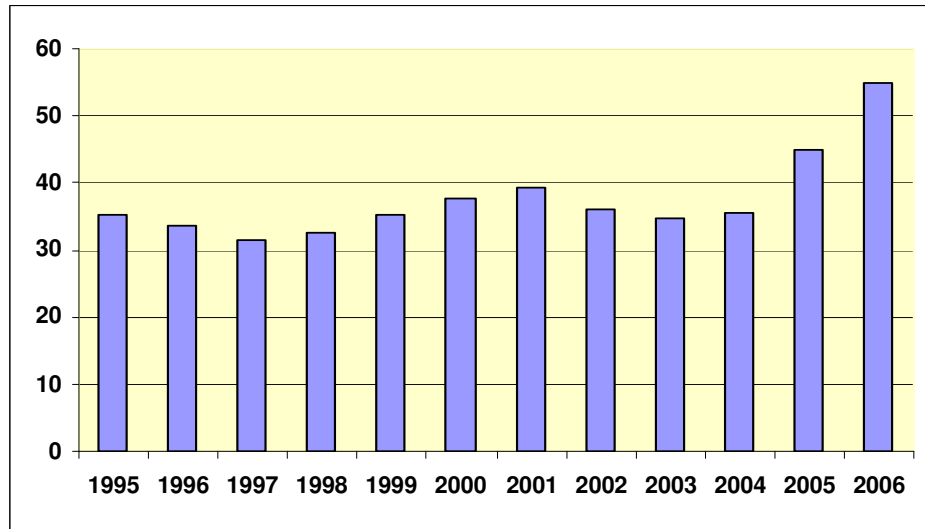
Source: Ministério do Desenvolvimento Agrário – MDA

Although official rural credit reduced its significance as a source of funds to agriculture, it remains an important source of disturbance for commercial farmers. Figure 5 indicates that agricultural debt as a share of the sector's GDP is 55% up from 35% in the mid-nineties when debt negotiations started. The apparent reason for this problem is a original mistake made by authorities when the Collor Plan was implemented, as already mentioned. Since then the reduced volume of credit plus the high value of outstanding debt have made farmers extremely dependent on current income for investments. Input and machinery suppliers have been accepting doing business in such uncertain environment. Moral hazard conduct from both parts have been pointed out by many analysts. Consequences have been serious specially to farmers and the Federal Treasury.

The “Cédula de Produto Rural” – CPR (Rural Product Note), as regulated in 1994, is a private credit instrument issued by farmers or farmers' cooperatives and associations, who promise to deliver the production in a specified amount and quality at a future date. The credit amount (or correspondent input cost) is received at the issuance time of the CPR and is repaid in product equivalent terms. In 2001, the financial CPR was regulated permitting the cash settlement instead of physical delivery. Cash settlement may be tied to one price index: futures

prices or price indexes calculated by CEPEA/University of Sao Paulo. Another version has a fixed value based on a pre-specified price. This latter type of CPR represented 89% of CPRs operations by Banco do Brasil (Brazil's largest bank); other banks trade only financial CPRs.

**Figure 05. Rural Credit Debt as Share of Agricultural GDP.**



Source: IBGE, Central Bank, in Lovatelli<sup>25</sup> (M).

CPRs – with a proper bank warranty have been used as a means (a) for farmers to obtain funds in advance; (b) for agroindustry to assure the supply of raw material; (c) for input suppliers to exchange farm production for farm inputs (sometimes establishing a trade triangle among farmers, agroindustry and input suppliers); (d) as an asset in investment funds' portfolios. Currently more than 400 brokers trade CPR electronically through the Brazilian Commodity Exchange (BBM), the registrar and custody institution. The note can be endorsed to third parties and in general is registered at the notary public. This registration gives the owner of a CPR preferential foreclosure rights (the product being traded is officially mortgaged).

CPRs are used by farmers not only for the lack of financial alternatives, but also because they represent a sort of crop hedging since the debt is indexed to the price of the good the production of which is being financed. One important reason behind farmers' cyclical losses in Brazil has been the diverse directions taken by prices and debts. For instance, the volume of

<sup>25</sup> Lovatelli, C. 2007.

Banco do Brasil's CPRs increased threefold from 2003 to 2004 (from US\$1.5 to US\$4.5 billion) as a result of the restrictions faced farmers in the rural credit system (In 2004 and 2005 farmers' prices fell substantially because of the dollar devaluation so that many did not pay interest and amortization on their debts). In 2006 – as the market conditions improved, CPR's volume fell by 1/3.

Because of notary public registration and bank warranty costs, it is believed that most of the CPRs are traded informally with no registration. CPR's costs are considered high by farmers. For instance, financial plus bank warranty charges may be as high as 25-30% per year, according to farmers. Informal consultations with market agents put the unregistered CPR volume at around R\$40 billion in 2007, at least 10 times the registered amount.

#### **1.4.2. The Price Support System**

Agricultural price support policies in Brazil began with the creation of the Production Financing Commission (CFP) in 1943. In 1945 minimum prices were established for rice, beans, maize, peanuts, soybean and sunflower. There is no official indication of purchases or loans by CFP prior to 1952. In the fifties, according to Delgado<sup>26</sup> (N), minimum prices were fixed well below market prices and values were announced only after the crops were planted.

Since 1962 – when the minimum price policy changed – the government endowed the program with more funds. As part of the 1962 changes, two state companies were created: the Brazilian Food Company (COBAL) to act upon the available food supply and distribution and the Brazilian Storage Company (CIBRAZEM) to deal with the operation of the minimum price program. Due to the food supply crisis of the sixties, the minimum price levels were supposed to be set at levels capable to stimulate production and not only to reduce farmers' market risk. In 1966 new changes in the program were implemented to make farmers the sole beneficiaries of the policy, excluding from then on the commercialization intermediaries.

Until 1980/81 minimum prices were announced two or three months before the planting season and farmers would be paid those prices one year later. Because of high inflation rates observed those days, the real values of the minimum prices tended to fall during the production

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<sup>26</sup> Delgado, G.C. 1978.

season thus tending to make the program ineffective. Rice was the Center-West crop demanding most of the support government support. Since 1981/82 basis-minimum-prices were announced before planting and to them monetary correction (given by the consumer price index – INPC - variation) was applied up to the month before harvest. Higher real minimum prices raised purchases by the government: for several years in seventies rice and maize were acquired in significant percentage by the government.

Not only the government raised purchases but also the loans (EGF). Cotton and soybean had a large fraction of their storage financed at subsidized rates by the government. Since guaranteed price increased and because the government had no consistent stock and imports management rule, the private sector reduced storage leaving thus most of this function to the public sector. Since rural credit volumes were also indexed to minimum prices, the volume of loans to the rural sector became incompatible with the goals of the monetary policy. It is important to keep in mind that up to 1986 the federal government had no fiscal budgeting separated from the Central Bank. The agricultural programs could be financed by the Central Bank in case the Treasury faced scarcity of funds.

Although most of the price policy changes of the eighties were intended to benefit domestic oriented crops, soybeans in the Center-West ended up gaining as well. In July, 1984, two more changes were applied: price indexing was extended two more months ahead and basic prices were raised. These changes led to minimum prices that approached or exceeded market prices. That made very attractive to sell to the government and or borrow for marketing purposes. Even a crop like soybeans had marketing loans reaching 50% of the annual production.

Increases in AGF purchases and EGF loans demanded expansions on government funds. And the public sector became the leading storage agent in Brazil. As support levels were increasingly perceived as excessively high, by 1985, minimum price indexation was extinct.

In the second half of the eighties the Brazilian economy underwent a series of inflation fighting plans with an important component: price-freezing. To make the ends meet the government had to reduce minimum prices so much that for a time the policy instrument lost any market relevance.

In 1993 the government held in stock 41% of the rice and 42% of the wheat output, as indicated by Rezende (2003). That was considered excessive. Then another innovation was introduced. Working capital production credit could from now on automatically – with no sale of production - be transformed into marketing credit. This credit also had its duration extended so

that farmers could transfer their commodity from one harvest season to the other. In other words purchases were substituted for loans so that pressure on federal fiscal debt would ease. By the same token a liquidation premium (minimum price-market price difference) was introduced: it would be paid to farmers who sold products in the market and not to the government. This strategy would prevent the government of excessive spending in stocks and facilitate debt repayment by farmers.

Table 06 shows the sort of price misalignment that may be attributed to minimum price program<sup>27</sup> (°). As a destination region, Paraná naturally exhibited higher prices. But from 1989 on price differences were below transportation costs signaling that prices at the production regions were too high. Similar results are observed for maize and rice (from Mato Grosso do Sul). See tables 07 and 08.

**Table 06. Soybeans: Paraná to Production Regions Price Differences and Transportation Costs<sup>a</sup>**

Regions	Price Differences				Transportation Costs	
	80-84	85-89	90-94	95-99	Cascavel	Ponta Grossa
<b>Goiás</b>						
Harvest	39	18	22	14	20	33
Off harvest	59	23	22	22		
<b>Mato Grosso do Sul</b>						
Harvest	36	22	16	12	15	28
Off harvest	53	21	17	16		
<b>Mato Grosso</b>						
Harvest	48	46	38	28	38	51
Off harvest	56	63	39	37		

<sup>a</sup> Data in BR\$/ton

**Source: Rezende (2001).**

<sup>27</sup> Rezende, G. 2001.

**Table 07. Maize: São Paulo to Production Regions Price Differences and Transportation Costs<sup>a</sup>**

Regions	Price Differences				Transportation Costs
	80-84	85-89	90-94	95-99	
<b>Paraná</b>					
Harvest	17	4	25	7	24
Off Harvest	50	68	53	23	
<b>Goiás</b>					
Harvest	-31	-8	13	8	36
Off Harvest	37	52	36	22	
<b>Mato Grosso do Sul</b>					
Harvest	-10	-19	21	12	38
Off Harvest	43	46	42	29	
<b>Mato Grosso</b>					
Harvest	-32	-9	38	14	48
Off Harvest	52	66	64	35	

<sup>a</sup> Data in BR\$/ton

**Table 08. Rice: São Paulo to Production Regions Price Differences and Transportation Costs<sup>a</sup>**

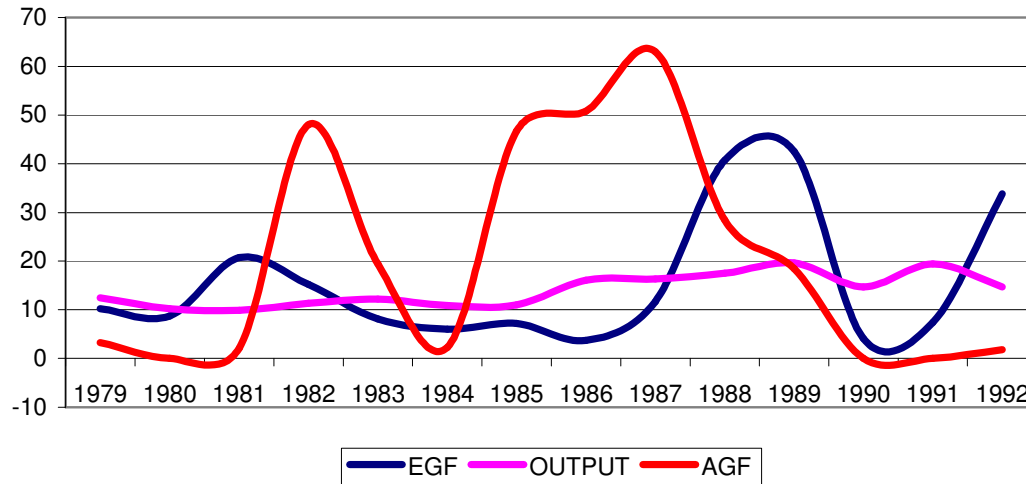
Regions	Price Differences				Transportation Cost
	80-84	85-89	90-94	95-99	
<b>Rio Grande do Sul</b>					
Harvest	162	91	66	47	51
Off Harvest	278	169	91	39	
<b>Goiás</b>					
Harvest	117	11	46	18	36
Off Harvest	133	41	86	69	
<b>Mato Grosso do Sul</b>					
Harvest	63	-9	20	31	38
Off Harvest	118	64	56	40	
<b>Mato Grosso</b>					
Harvest	136	22	84	54	53
Off Harvest	155	84	120	91	

<sup>a</sup> Data in BR\$/ton

Figure 06 shows that the share of maize purchase and loans to the Center-West tended to exceed the relative production importance of the region. In 1982, 50% of the purchases took place in the region, which produced little more than 10% of the national maize production. In 1987, the production share was around 16% e the purchase share 63%. Loans increased in

importance in the late eighties and in the early nineties: again the government action exceeds the regional production share.

**Figure 06. Maize Price Support Purchase (AGF) and Loans (EGF) and Output Regional Shares – Center West**

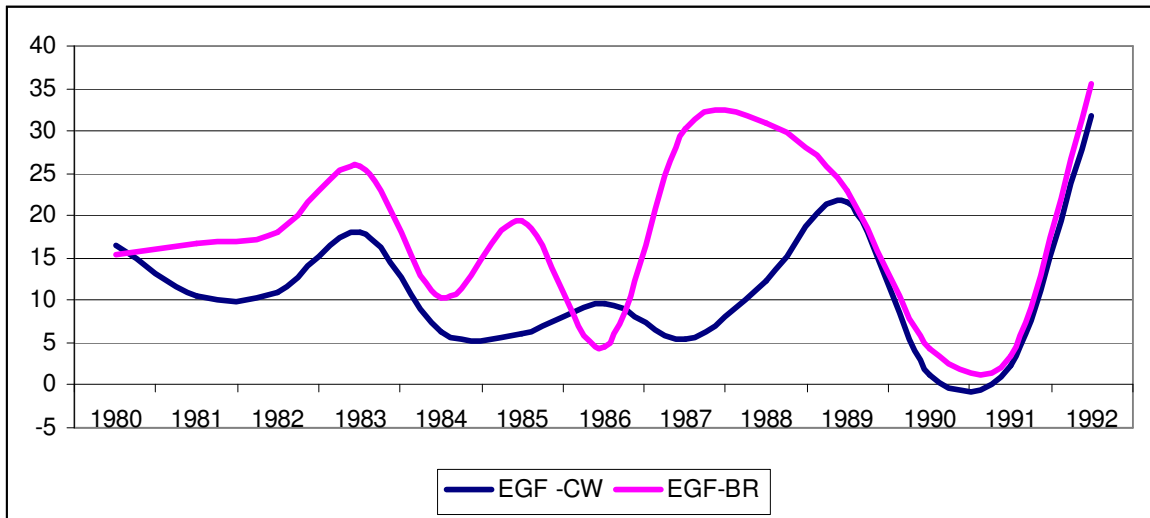


Source: Rezende (2002)

In figure 07 data for the rice market are presented. In general it shows that the proportion of the regional production traded via official loans is lower than the national average; since the early nineties the loans for the Center-West follow the national average proportion of production.

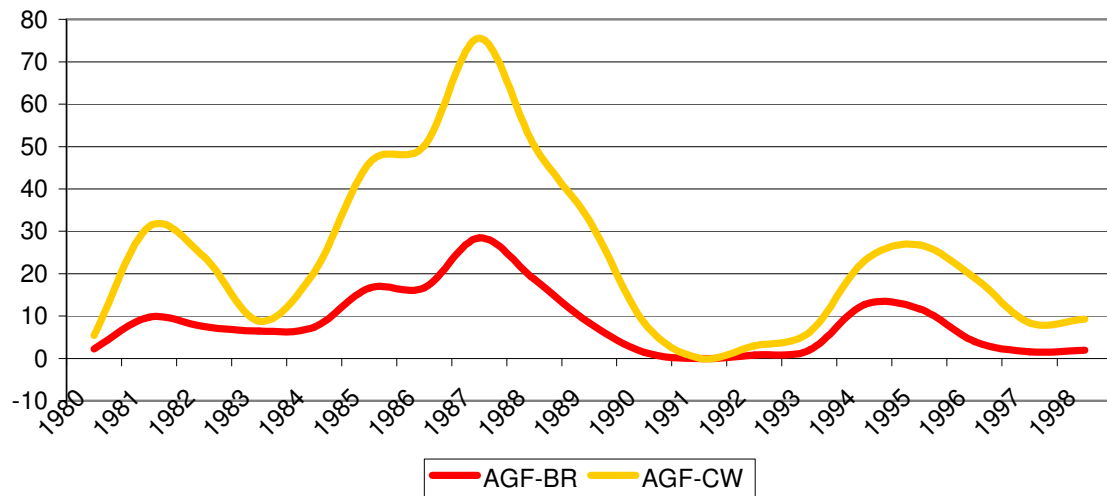
Purchases by government, however, as indicated in figure 08, were above national share in production: in 1987, for instance,  $\frac{3}{4}$  of the rice Center-West production was purchased by the government at the minimum price. Despite the fact that this price was set well above the level consistent with other regional markets, the rice production in Center-West failed to keep its share in Brazil. Rio Grande do Sul – which counted with substantial support in the eighties as well - really was the state where rice production expanded. See figure 09.

**Figure 07. Rice Loans (EGF) as Shares (%) of Production, Brazil and Center West – 1980-1992**



Source: Rezende (2002)

**Figure 08. Rice Purchases (AGF) as Shares of Production, Brazil and Center-West, 1980-1998.**



Source: Rezende (2002)

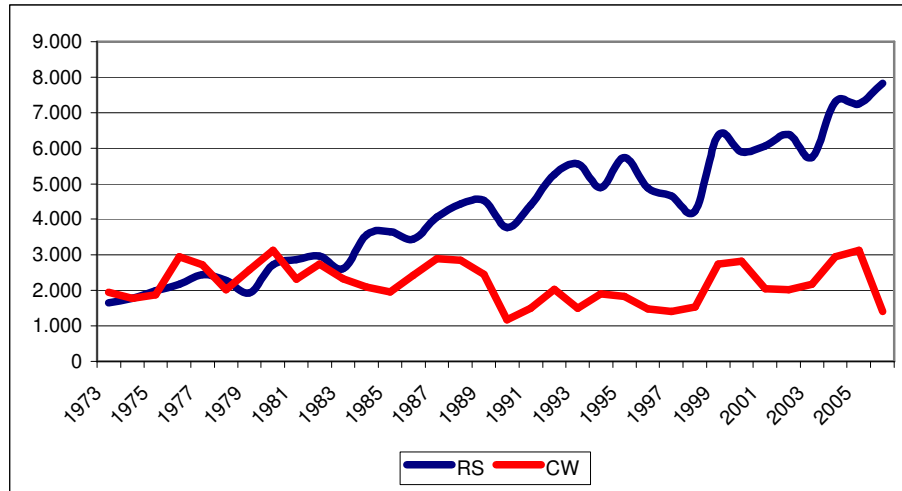
According to Rezende (2003), by the end of the eighties Center-West farmers strongly lobbied for large product purchases at nationally uniform prices. Farmers from other regions, however, wanted the government to hold longer the Center-West stocks to prevent disruption of the market prices' structure all over the country. In the early nineties stocks were piling up in many states except in the Center-West because market prices persisted below the level needed to cover storage costs.

In order to avoid such storage losses in 1993/4 the product-equivalence system was implanted. Credit to farmers was indexed to the product quantity equivalent units, determined by the division of the volume of credit by the minimum price. When debt repayment was due, farmers could hand the government a certificate that that quantity was stored in authorized storehouses.

In 1995/96 rural credit indexation was extinct and a fixed nominal interest rate of 16% per year on working capital credit was introduced. Extinct was also the product equivalence system and minimum prices were fixed in nominal terms.

The strategy of saving public funds and avoiding direct involvement of the government with product handling (transporting , storing, and so on) was prospering in the mid-nineties. A new policy instrument was then introduced: the Product Movement Premium (PEP). The government would pay market agents the difference between the minimum price (they should pay to farmers) and the market price. Market agents are supposed to purchase the local production – sometimes to pre-specified destinations. Put options contracts issued by the government were also introduced in 1996/1997. Exercise price corresponds to the minimum price plus storage costs.

**Figure 09. Rice production (1000 tons) in Rio Grande do Sul and Center-West, 1973**

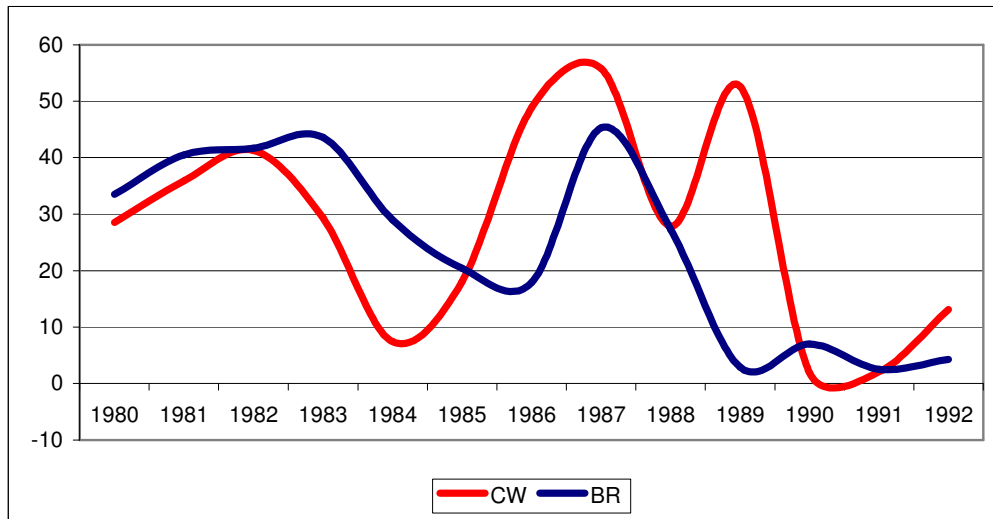


Sources: Rezende (2002, CONAB (2006).

As for soybeans marketing loans were the dominant form of supporting prices. This program had its highest relevance in eighties, specially in its second half. See figure 10. In 1987, for instance, up to 56% of Center-West production was marketed with government loans. In fact, the region succeeded to have support for a longer time span –up to 1989 – than the rest of Brazil. As pointed out by Rezende, price guarantee for maize and rice indirectly favored the expansion of soybeans as well. Rice was a crop that fulfilled the role of financing the clearing of the Cerrado area, while maize was used for crop rotation with soybeans, earlier as another summer crop and later as a second crop in the same crop-year.

As the government quit the leading role of supporting prices and financing agriculture, input suppliers and output buyers took up these roles. By advancing funds prior to harvest, these companies guarantee prices and supply working capital to farmers.

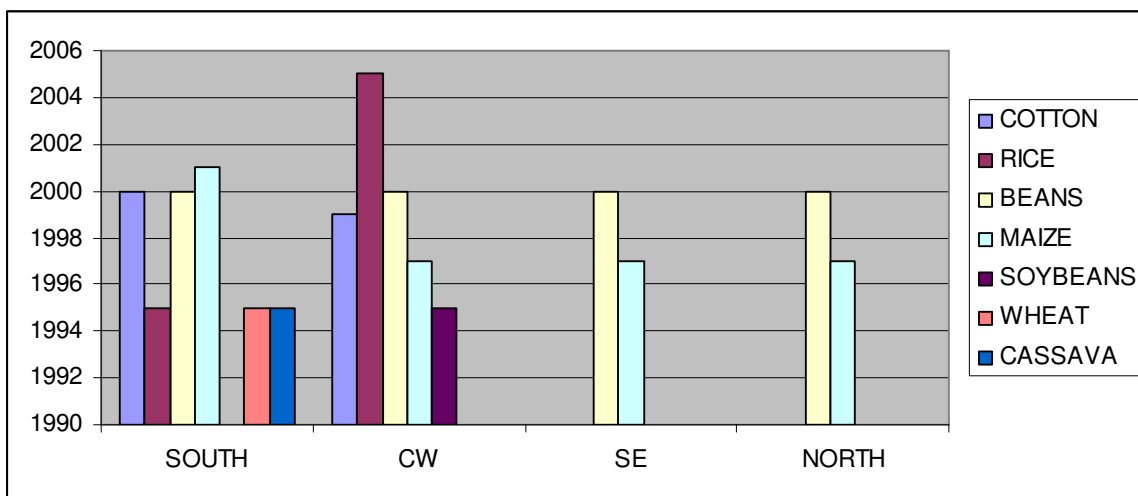
**Figure 10. Soybeans Share of Marketing Loans on Production , Brazil and Center-West Region, 1980/1992**



Source: Rezende (2002)

Most of the support price program as much as the credit policy was extensively curtailed in the nineties. In 1991 the National Supply Company (CONAB) substituted for CFP, COBAL and CIBRAZEM. The minimum price program as well the new price support instruments are under responsibility of CONAB. The trend, however, is that CONAB concentrates in these new instruments rather on the old minimum price policy. The Product Shipment Premium (PEP) auctions the minimum premium the government pays to output buyers to purchase commodities from farmers at an established price. The Option Contract Program sell put options to farmers with the duration extending until the off harvest season. Currently, however, CONAB focuses on harvest predictions and to securing commercialization to family farms and to deliver food to Indians and beneficiaries of the “Zero Hunger Program”. As indicated by Stefanelo in figure 10, in 2000 almost all crop prices were no longer supported significantly by federal government’s purchases and loans.

**Figure 11. Last year of significant intervention to support prices**



Source: Stefanelo<sup>28</sup> (P).

### 1.5. Technology Policy and Impacts on Output

The occupation of the Center-West area was contemporaneous with an acceleration of the national investments in agricultural technology. In 1973 the Brazilian Agricultural Research Company was created by the federal government. It coordinates the National Agricultural Research System congregating federal and state government institutions, universities, public and private companies and foundations. The system produced technologies that made the occupation of the Cerrado viable. Special credits are given to the system for the achievements in the grain production (particularly the adaptation of soybeans), plus beef, pork and poultry, milk and vegetables<sup>29</sup>. Since 1995, when the agricultural zones were implemented, soybeans, cotton, beans, maize and coffee were the crops selected for the Cerrado region of Brazil.

A number of techniques have been developed or adapted for the Cerrado region. The no-till system has been rapidly accepted and used by farmers for simplifying operations and reducing costs besides the possibilities it opens for diversification, rotation and succession of crops, not to mention the cattle-crop association and its optimistic perspectives regarding

<sup>28</sup> Stefanelo, E.L. 2005.

<sup>29</sup> See [www.cpac.embrapa.br/tecnologias](http://www.cpac.embrapa.br/tecnologias) for information related to EMBRAPA's contribution to the Cerrado agriculture.

Cerrado's sustainability.

The Cerrado contains only 10.4% of soils with natural fertility comparable to the observed in Paraná, and São Paulo. Oxisols represents 46% of the Cerrado. They present favorable physical conditions but are highly acid and low in phosphorus, calcium, magnesium and potassium. EMBRAPA in association with other national and international institutions developed new techniques to detect and correct acidity and fertility problems adapted to different production systems. Results were particularly positive for soybeans and maize.

Agricultural gypsum – a byproduct phosphatic fertilizers – are used to correct calcium deficiencies in the deepest soil layers, reducing aluminum saturation and providing for the soil sulphur needs. Maize, soybeans and coffee are the crops that benefited the most by the use of gypsum.

Soybeans, beans and peas have expressively benefited of the nitrogen-fixing bacteria inoculation practice. Besides saving large amounts of urea, inoculation also provides environment gains since it avoids water sources contamination.

### **1.5.1. Soybeans**

The EMBRAPA's research on soybean to be planted in the Cerrados began in 1975 focused in the adaptation of cultivars of high productive potential and resistance to diseases and pests. EMBRAPA has been releasing new cultivars with these properties over the last fifteen years. Precocious cultivars for early planting to be succeeded by corn or sunflower were made available to framers in 2003. Options of different cycle durations have been offered to farmers as well. Transgenic cultivars – such as RR soybean - are also available to farmers to increase crop management flexibility and saving on some inputs usage.

The Brazil's soybean story<sup>30</sup> can be summarized as follows.

Although soybean originated from Asia where it was cultivated since 5,000 years ago, only in the 1910s the USA started its commercial production, first as forage and later as a feed crop. Adaptation tests to Brazil's conditions began in 1900 at the Instituto Agrônômico in Campinas. But it was in Rio Grande do Sul that the crop expanded thanks to similar climatic similarity with the Southern USA.

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<sup>30</sup> Based on <http://www.cnpso.embrapa.br/producao soja/osjanobrasil.htm>

By the mid 1950s, when the government began to stimulate – through fiscal incentives - wheat production in Brazil, soybean was indirectly favored for its technical – as a leguminous - and economic potential to succeed wheat – a gramineous - as a summer crop. Soybean crop could share labor and machinery with winter wheat crop.

The subsidies to wheat production, especially in the 1960s helped to quintuple the soybean production to 1.05 million tons in that decade. The so-called “Operação Tatu” (Armadillo Operation) promoted at that time the fertility correction of Southern soils. The crop consolidation occurs in the 1970s when production grows tenfold to 15 million tons as yield expanded from 1.14 ton to 1.73 ton per hectare. By that time, still more than 80% of soybean output concentrated in the South. In that decade, however, the Cerrado’s output share of soybean jumped from 2% to 20% of national production. By this time the international market for soybean as a protein component in livestock feed expanded substantially. Simultaneously animal fat – both butter and lard – started to be substituted by vegetal oil for human consumption. The processing industry rapidly settled in the Brazil as the cooperative system spread in the region. The government support facilitated exports by providing agile highway and port and communication systems.

Soybean production expanded in the Center West as the new capital – Brasilia – was founded in early sixties and infrastructure improvements followed at the same time that fiscal incentives to open new agricultural lands and to build storing capacity were provided. Comparatively low price of land and subsidized credit for machinery and equipments coupled with new labor cost increasing legislation signaled to capital-intensive soybean cropping. Agro-industry also moved to the region in part stimulated by fiscal incentive. Land fertility was poor but additional expenditure with chemicals was at least partially compensated for by flat topography that favored mechanization. The rain regime was mostly favorable to summer crops as opposed to the Southern troubles provoked by the so-called “veranico” – at least four days with no rain, low humidity and high insolation mainly at the winter beginning. The development of new technologies permitted soybean production in the low latitude of the Center-West. Last, but certainly not least, the managerial and technical capacity of farmers migrated from the South were fundamental to put all these factors together to generate an efficient soybean system in the region.

Up to the 1960’s soybean research was little and concentrated in the South where USA varieties were adapted. In the 1950s the Instituto Agrônômico began a consistent research program for soybean. In the 1970s EMBRAPA was created and soon instituted the National

Soybean Program designed to join efforts with institutions in the South and Southeast. Universities and state research institutes in Minas Gerais, Goiás, the Federal District and Mato Grosso started or reinvigorate soybean research.

Until the seventies research focused on yields – and to lesser extent on plant height to facilitate mechanized harvesting, resistance to plant lodging and opening of the pods. Since the eighties disease resistance was included for cultivar recommendation. The development of cultivars adapted to low latitude took the development of germoplasm adapted to tropical conditions thereby turning 200 million hectares from unproductive land into areas potentially usable for soybean production. EMBRAPA's partnership models with farmers' associations provided financial support to genetic improvement programs thus increasing the potential to develop new cultivars. Integrated management led to sizable reduction in pesticide use. Nutrition research led to better fertilizer and lime management. Soil management and crop rotation permitted no-till planting substitution for conventional seeding with positive effects upon the system sustainability. The agro-ecological zoning developed by EMBRAPA indicated the most apt regions for soybean production. In 1997 the Cultivar Protection Law led to new research by the private sector in Brazil, by Mato Grosso Foundation and companies such as Monsoy, Syngenta, Pioneer and Milenia.

Although Brazil's is notoriously known for its soybean production in the Cerrado, that crop still is produced in the South, where it was first introduced. Conte<sup>31</sup> (Q) reports that while in the Cerrado production takes place in rather large farms, in the South, small and medium farms dominate. See table 09. As a rule southern farms are more diversified and use family work more intensively than in the Center West. Farmers in the South are older, live in the farm, spend more time in the farm and few depend on off-farm income. A distinguishing factor is the cooperative system as the major source of financing to farmers. Finally it is worth mentioning that in the South transgenic soybeans dominates the opposite occurring in the Center West. Conte's estimated optimum scales were 3,555 ha in Goiás and 3,931 ha in Mato Grosso. For southern states the results were: 2,256 ha in Rio Grande do Sul and 2,530 ha in Paraná. Conte suggests, however, that high land prices and low credit supply restrict the possibility of expanding soybean crop size in the South. On the other hand, higher output may help and lower inputs prices may act the other way, partially compensating for the lack of scale.

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<sup>31</sup> Conte, L. 2006.

**Table 09. Farm size Distribution – Brazil’s States, 2005**

STATE	FARM SIZE (HA)				
	<10	10.0-99	100-999	1000-9999	>10000
MT	0.3	5.8	51	40.5	2.4
GO	0.7	20	62.2	16.9	0.2
MS	12.6	39.6	38.2	9.2	0.5
RGS	27.9	66.7	5.1	0.3	0
PR	20.4	68.4	10.7	0.5	0

Source: IBGE, in Conte.

CEPEA has recently collected data for typical farmers in the Southern region of Brazil. A comparative analysis can be done with data reported in table 10. The farm size in the Cerrado was 4,600 ha while in the South it was 280m ha. Yields per hectare were 2.52 tons in the Cerrado and soy acreage was 3,000 ha and 2.7 tons and 280 ha in the South. Prices were R\$369/ton in Cerrado, R\$450/ton in South.

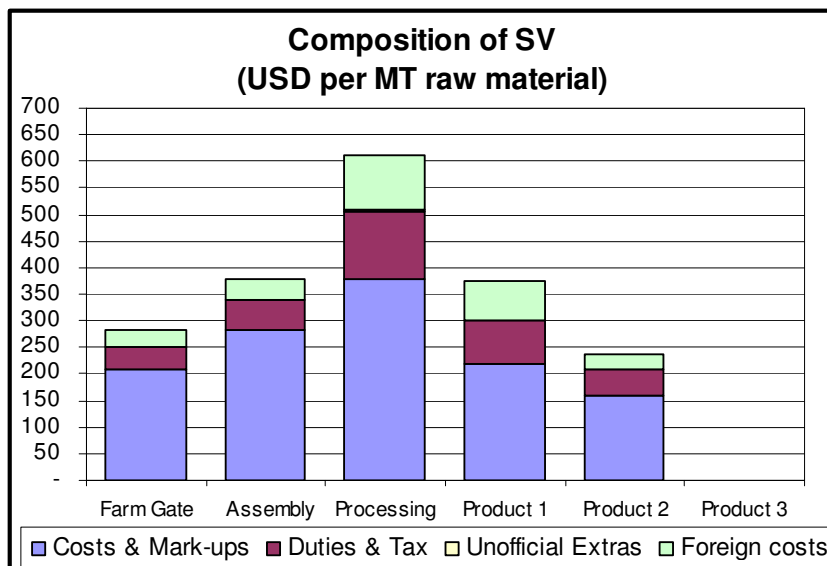
According to table 10, variable cost is R\$314 in the Cerrado and R\$350 in the South a 11% difference. Investment cost (interest plus depreciation on fixed capital) per soybean ton is 180 in the Cerrado and 400 in the South (an 122% difference). Total per ton cost is R\$494 in the Cerrado and R\$750 in the South. Considering regional output prices, the Southern farmer makes a positive net revenue (over variable cost) of R\$100 per ton, while in the Cerrado he makes only R\$55 per ton. Total net revenue (over total cost) is negative in both cases, but it is better in the Cerrado (-R\$125 per ton) than in the South (-R\$300). What explains these results. The smashing difference in favor of the Cerrado is investment cost. In large farms more economical use of machinery is possible: indivisibilities are important in the sense that smaller farms in the South may have to use tractors and other equipments larger than the most economic size. Larger tractors are not proportionally more expensive than smaller ones. Other relevant observations are: in the Cerrado (a) fertilizer costs are higher because soils are poorer; (b) chemicals and machinery variable costs are cheaper because larger farmers get better buying deals; (c) hired labor are cheaper because labor opportunity cost is lower .

**Table 10. Cost Composition (R\$/ton) for Typical Farms in Center-Western and Southern Brazil, 2006**

<b>COST</b>	<b>CERRADO(A)</b>	<b>SOUTH(B)</b>	<b>B/A</b>
<b>Variable</b>	314	350	1.11
seed	27	29	1.07
fertilizer	119	66	0.55
chemicals	71	109	1.54
spraying	15	34	2.27
machinery	68	86	1.26
selling	5	13	2.60
labor	9	13	1.44
<b>Investment</b>	180	400	2.22
<b>TOTAL</b>	494	750	1.52
<b>REVENUE</b>	369	450	1.22
<b>NET REVENUE</b>	55	100	1.82
<b>TOTAL NET REVENUE</b>	-125	-300	2.40

Source: CEPEA-ESALQ/USP

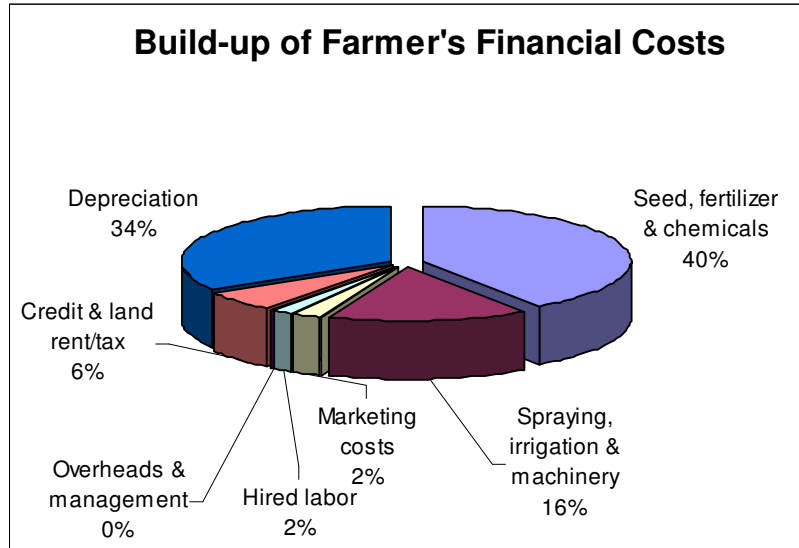
**Figure 12. Composition of Soybean Shipment Value**



Source: CEPEA

Obs: Product 1 = oil; Product 2 = meal.

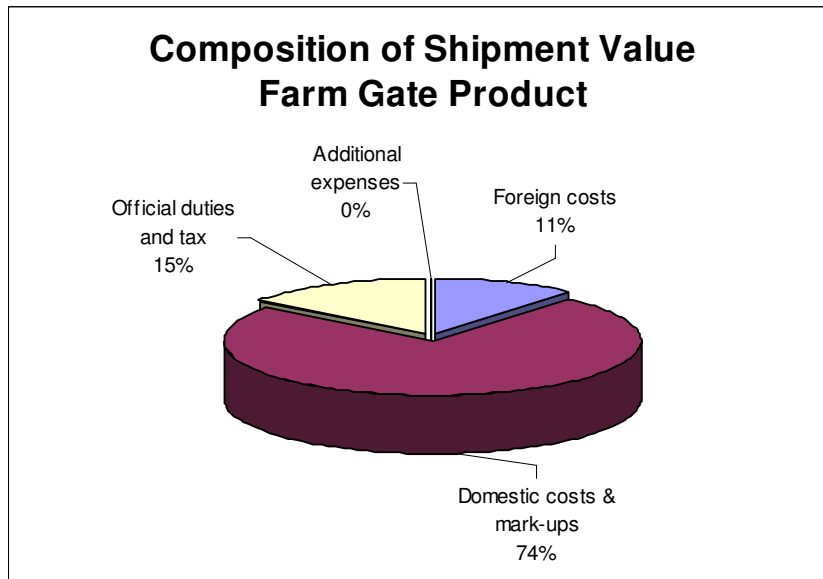
**Figure 13. Input composition of the soybean farm costs**



Source: CEPEA

Figure 12 indicates that total farm shipment soybean value is around US\$280 per ton. That means that the farmer experiences a loss of US\$111 per ton. Land costs take up 6% of the shipment value according to figure 13. Foreign costs represent 11% due mainly to fertilizer and chemical imports and taxes take up 15% (figure 14).

**Figure 14. Domestic private, taxes and foreign composition of the soybean farm costs**



Source: CEPEA

As for the remaining of the soybean value chain, one notices that most of the valued function is performed at the processing level but in a rather awkward fashion: most of the value added are taxes (21%) and foreign export-related expenses (17%).

### **1.5.2. Cotton**

The development of the cotton sector has been historically attached to the possibility of exporting, according to Alves<sup>32</sup> (R). As part of a general industrialization strategy, in seventies the government forbade plume exports so as to promote value added textile products. The state of São Paulo moved faster in the industrialization process. The effect, however, was, as expected, to lower farm price to different degrees up to 1988. In addition, the cotton crop has been subject to plenty of pests and diseases leading to high costs of production. As a result for many years cotton output had been decreasing. Market liberalization only occurred in the nineties. But it took several years – up to 1997/98, before the sector reacted positively with a system based on large mechanized commercial farms. The production, that used to occur mainly in the South and Southeast based on intensive labor use, moves mainly to the Center-West with consequent reduction in the importance of small and medium farmers in the sector. Two major changes were observed: fiber quality improved and yields jumped above the highest worldwide values.

EMBRAPA had an important role in that changing process: in association to other institutions it conducted research that permitted to expand the area planted to cotton improving the fiber quality at internationally competitive costs. Especially in the nineties EMBRAPA began to do research on new cultivars adapted to the Cerrado. In 1992 the distribution of one of those cultivars contributed to the consolidation of the crop in the region. Since 1997 one to three Cerrado cultivars have been released to farmers. Half the Cerrado cotton area is planted with EMBRAPA varieties.

Currently in the Cerrado, as shown in table 11, most of the farm costs are due to modern inputs: chemicals, machinery maintenance, and fertilizers. Farmers typically experienced a small loss ( per ton total cost = R\$1172 and sale's price =R\$1133) in 2006.

As for the value chain analysis, farm shipment value reaches US\$545 per ton of raw

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<sup>32</sup> Alves, L.R.A 2006.

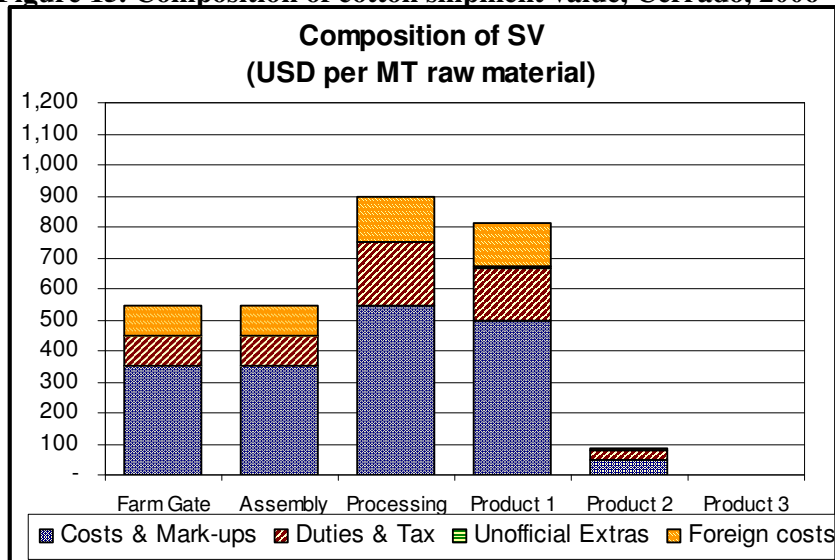
material , of which taxes take up 18% and foreign costs 17%. At the processing level shipment value adds up to US\$904, with taxes representing 22.4% and foreign costs 16%. See figure 15.

**Table 11. Cotton Farm Costs (R\$/ton), Cerrado/Brazil,2006**

	Total per ton SV farm gate	% of total SV
<b>Variable Costs</b>		
Seed	28	2.4%
Fertilizer	194	16.6%
Chemicals	346	29.5%
Spraying costs	-	0.0%
Irrigation costs	-	0.0%
Machinery O&M	218	18.6%
Packing materials	-	0.0%
Selling expenses	-	0.0%
Hired labor	63	5.4%
Family labor	-	0.0%
Overheads & management	4	0.3%
Seasonal credit	90	7.7%
Land rent/tax	70	6.0%
<b>Total Variable Costs</b>	<b>1,013</b>	<b>86.5%</b>
<b>Fixed Investments</b>	<b>159</b>	<b>13.5%</b>
<b>TOTAL</b>	<b>1,172</b>	<b>100.0%</b>
Totals in USD	545.13	100.0%

Source: CEPEA-ESALQ/USP

**Figure 15. Composition of cotton shipment value, Cerrado, 2006**



Source: CEPEA-ESALQ/USP

### 1.5.3. Bovine cattle

Twenty one percent of the Cerrado area is occupied by planted pasture and 37% by native pasture. It is relevant to notice that only between 1990 and 2000 the national milk production expanded by 37% while the production in the Center-West increased by 81%. In Goiás the milk production increased by 105%. As for Center-West bovine livestock in general, the number of animal increased from 40 million to 56 million in the decade to 1995.

EMBRAPA's work from the beginning focused on high productivity forage cultivars that could adapt to the Cerrado conditions. In 1980 the *Andropogon* cultivar (cv. Planaltina) grass was released. It was adapted to low fertility soils and resistant to spittlebug ("cigarrinha da pastagem"), one of main pests in the region. In 1983 the Marandu grass was launched, the only *Brachiaria* resistant to the spittlebug. In a joint work with CIAT the "Vencedor" grass was distributed in 1990 with good nutritional quality and well adapted to mean fertility soils. Currently nine commercial *Brachiaria*'s cultivars for cattle feeding. EMBRAPA launched six cultivars over the last 25 years.

Beef cattle feeding in the Cerrado depends almost exclusively on pasture. During dry season forage production are not enough for the animal feeding needs so EMBRAPA developed the multiple mixture or energetic salt: mineral salts, urea, and natural sources of protein and energy. The energetic salt is to be used in substitution for the mineral salt during the dry season.

The crop-cattle integration is an alternative to revert the pasture degradation process. Diversification, rotation or association of crop activities and beef and milk production is seen as a sustainable alternative of increasing production without occupying additional Cerrado lands. This technique is also available to family farmers.

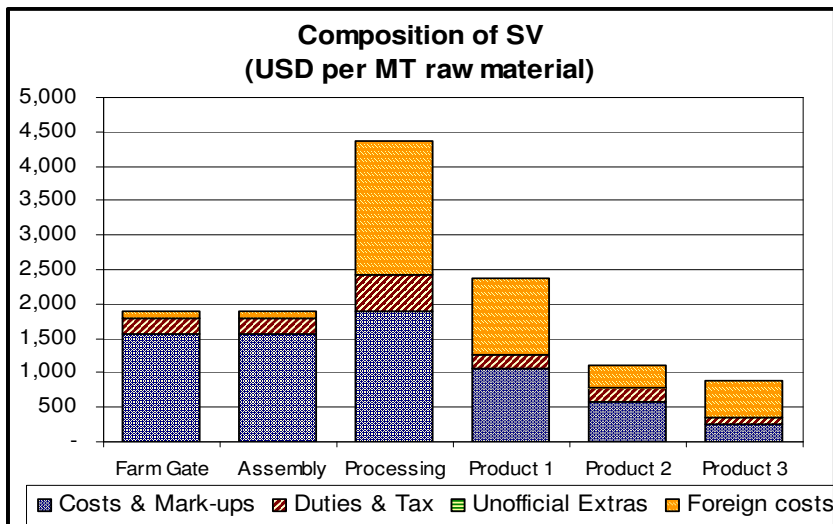
Looking now to the economic performance of cattle ranching in the Cerrado, figure 16 reports that shipment value at the farm gate reaches US\$1890 per ton, of which 8.1% are land costs, 6.3% are labor costs and 6% are feed costs (table 12). That shipment embodies 12% of taxes and 5% of foreign currency expenditure on inputs imports. Processed beef shipment value (figure 13) at the importing country adds up to US\$4365, of which 45% are foreign currency transportation costs.

**Table 12. Beef Cattle Shipment Value (R\$/ton) and Composition at the Cerrado's Farm Gate**

	Total per ton SV farm gate	% of total SV
<b>Variable Costs</b>		
Animals	32	0.8%
Supplemental	228	5.6%
Medicine/Vaccine	66	1.6%
Others	3	0.1%
Irrigation costs	-	0.0%
Machinery O&M	125	3.1%
Packing materials	-	0.0%
Selling expenses	30	0.7%
Hired labor	255	6.3%
Family labor	-	0.0%
Overheads & management	54	1.3%
Seasonal credit	-	0.0%
Land rent/tax	329	8.1%
<b>Total Variable Costs</b>	<b>1,121</b>	<b>27.6%</b>
<b>Fixed Investments</b>	<b>2,945</b>	<b>72.4%</b>
<b>TOTAL</b>	<b>4,067</b>	<b>100.0%</b>
Totals in USD	1,891.50	100.0%

Source: CEPEA-ESALQ/USP

**Figure 16. Composition of Beef Shipment Value, Cerrado, 2006**



Source: CEPEA-ESALQ/USP

#### 1.5.4. Pasture Development in Brazil

Since the nineteen-eighties – as the availability of new land reduced - Brazilian cattle ranchers began to consider pasture as a crop activity as opposed to the traditional view that saw pasture as natural vegetation. In the state of São Paulo the fierce competition with expanding sugar-cane and orange crops on land previously occupied by pasture indicate that productivity had to be increased – with land fertilization - if beef production was to remain in the state. While milk production counts on feed supplementation, for beef production grass improvement is vital for competitiveness.

As Zilmer<sup>33</sup> (S) indicates, while natural pasture bears an output of 8.8 kg of meat per hectare, it is possible to obtain as much as 16.5 kg per hectare of cultivated pasture based on minimum cropping. Most of the Brazil's cultivated pasture is formed with African grass brought in slave ships in the 19<sup>th</sup> century and since cattle ranching in general follows the opening of previously forested areas it counts heavily on natural fertility to grow.

Commercially the “capim gordura” (*Melinis minutiflora*) was the first to be cultivated in Brazil for its easy propagation. As land became more expensive, and technology evolved, ranchers moved to other grass species looking for higher productivity and resistance to dry and/or cold weather. The “capim Jaraguá” (*Hyparrhenia rufa*) represented an alternative in the early seventies with those properties despite of its slower propagation capacity. Then “Capim colômbio” (*Panicum maximum*) expanded in the state of São Paulo because of its organic material contents and high productivity in rich soils. However, it tended to degrade as use of land extended (not much) over time. The use of these types of grass was not accompanied by better pasture management: ranchers limited to cast seeds on the field using no fertilizer. When soil exhausted and productivity fell, they chose to move to another variety instead of fertilizing the soil.

In the early seventies “Brachiaria” (*Brachiaria Decumbens*) – a rustic grass that propagates through seeds - began to be planted for its low demand on fertility and adaptation to acid soils like those in the Cerrado. Productivity is low compared to other grass types, but, its ability to grow on poor lands was the dominant decision factor for extensive ranching, when the animal growth process until slaughtering age took as many as five years. Only in the nineties as price of land surged pasture management techniques began to be applied.

According to EMBRAPA (2006), today 80–90% of the cultivated pasture in Brazil are

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<sup>33</sup> Zimmer, A.H.; 1993.

planted with Brachiaria of which the species *B. decumbens*, *B. humidicola* and *B. ruziziensis*, have been planted for about 30 years. *B. brizantha* was launched in 1984<sup>34</sup>. The *decumbens*, that represents more than half the brachiaria's total, presents a good adaptation to low fertility soils thanks to a deep and intense root system and high springing-up capacity after fire, frost or occurrence of pests. Abundant seed production is also a significant characteristic.

Despite its importance for the cerrado development, when pasture degradation comes up, many ranchers consider the substitution of brachiaria by crops (corn, soybean or rice) or other grass species. Because of the seed abundance the elimination of brachiaria is no easy task and demands both mechanical and chemical controls complemented with crop planting for two to three years before another grass like “colonião” is introduced.

### **1.5.5. Rice, the Supporting Actor**

In the early twentieth century irrigated rice production began in Rio Grande do Sul and played an important role as a wage-good during the urbanization process in Brazil. Highland rice begins to have some importance only in the forties<sup>35</sup> (T). At first highland rice was preferred by consumers, but later in the seventies irrigated rice won the consumers' preference and the best market prices. At that time the Cerrado occupation was peaking up so that rice was a leading crop (in acreage terms) during the eighties. Still in the eighties, as the Cerrado occupation reduced intensity, rice production fell because of its supporting role as a “land taming” or land recovering (in degrade areas) instrument (rather than being a long term activity capable of settling down in a given region) became less relevant. The crop was carried out for at most three years and then yielded space for pasture or other crops.

In most of the Cerrado, the initial clearing is done by dragging the area with a steel cable or chain pulled by two tractors<sup>36</sup>. That is done during the rainy seasons so that most of the trees' and shrubs' roots are pulled out of the humid soil. Lumbermen collect large trees for firewood, pile them up and set fire in the remaining forest. After vegetation is removed, with a heavy disk the soil is opened up and any remaining roots are removed. Two to three tons of lime are spread to the area and then heavy disk is once more applied. Then a light disk, a cultivator and grid leave the land ready for planting rice. In addition to lime application, fertilization with macro and

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<sup>34</sup> <http://www.cnpqc.embrapa.br/publicacoes/divulga/GCD05.html>

<sup>35</sup> Ferreira, C.M. et al (edit.). 2005.

<sup>36</sup> [http://agbrazil.com/p/opening\\_virgin\\_cerrado\\_land.htm](http://agbrazil.com/p/opening_virgin_cerrado_land.htm)

micronutrients is necessary. The whole process may take as many as nine months. High land rice productivity is enhanced when soybean is planted in recently opened land between the second and fifth year. Most of the highland Cerrado soils reach high productivity levels after five or six harvests. Double or triple harvests reduce the time period to reach high fertility. Soil fertility is good enough for corn to be planted after five years.

In the nineties, as the government reduced its role in supporting price to farmers – especially to those in the south, highland rice gained favorable prospects: despite the reduction in acreage, yield increase has been able to sustain production in the Center-West where 19% of national production originates. However, since rice per capita consumption is decreasing in Brazil as a result of consumers' option for less caloric food, a lower pressure upon production is perceived by policy makers. As to the rice production, it is recognized that still few farmers employ the same (high) level of technology for rice as they do for other crops. They argue that rice output response to technology is lower and variable. Indeed part of Brazil's excess demand for rice is met by imports from Argentina and Uruguay. This seems to be the prospect for rice in the short and medium term in Brazil.

### **1.5.6. Sugar**

The sugar sector, as indicated by CEPEA's data, is extremely important for Brazil farm sector: cane shipment value makes up to 18% of the crop sector revenue. Only in 2006, cane real price rose by 21% followed by orange price (16%); these were the only two crops whose prices did not fall in real terms. At the industry level, sugar and alcohol have been the few segments to significantly grow in recent years: 9% for sugar and 7% for alcohol. Regarding exports, the sugar and alcohol sector had a foreign sale of almost US\$8 billion, second only to the soybean sector with more than US\$9 billion.

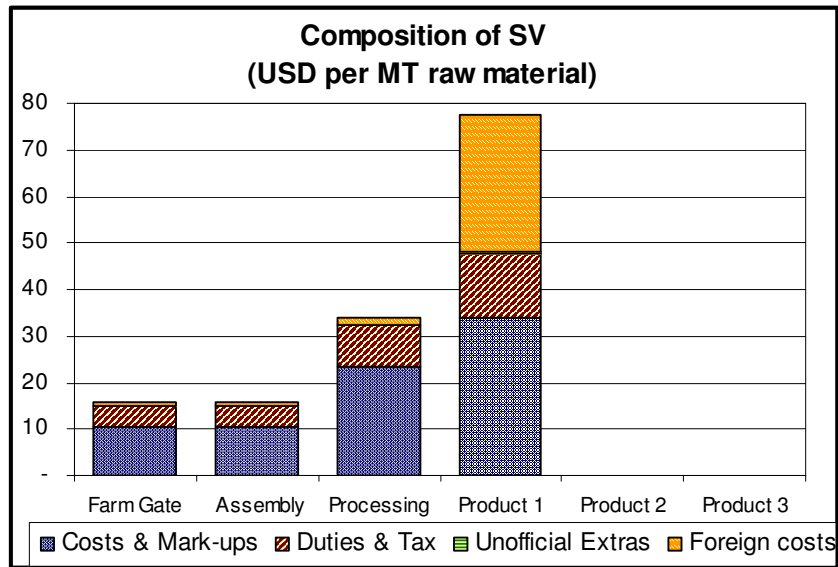
The Center West rapidly approaches the 10% share of Brazil's cane production and Goiás is the leading states as far as yields are concerned, with an average of 80 tons per hectare. Shipment value at the Cerrado's farm gate reaches US\$15.7 per ton. Machinery operation and maintenance takes up 32%, hired labor 20%, land 19% and fertilizer 13%. Along the supply chain the shipment value goes up to almost US\$60 per ton of processed raw material, of which taxes take up 23% and foreign currency related costs almost 50%.

**Table 13. Sugar cane Shipment Value and Composition at the Cerrado Farm Gate**

	Total per ton SV farm gate	% of total SV
<b>Variable Costs</b>		
Seed	-	0,0%
Fertilizer	4	12,1%
Chemicals	1	3,7%
Spraying costs	-	0,0%
Irrigation costs	-	0,0%
Machinery O&M	10	32,1%
Packing materials	-	0,0%
Selling expenses	-	0,0%
Hired labor	7	20,9%
Family labor	-	0,0%
Overheads & management	0	0,2%
Seasonal credit	2	7,7%
Land rent/tax	6	18,4%
<b>Total Variable Costs</b>	<b>30</b>	<b>95,3%</b>
<b>Fixed Investments</b>	<b>1</b>	<b>4,7%</b>
<b>TOTAL</b>	<b>31</b>	<b>100,0%</b>
Totals in USD	14,62	100,0%

Source: CEPEA/ESALQ/USP

**Figure 17. Composition of Sugar Shipment Value, Cerrado, 2006**



Source: CEPEA-ESALQ/USP

### 1.5.6.1. Constructing a market

The sugar and alcohol sector had been subject to more than forty years of state control when it was liberalized in the nineties. The Sugar and Alcohol Institute (IAA) was created by Getúlio Vargas after the 1929 crisis to control production and keep prices at adequate level thus protecting the national product in the world market<sup>37</sup>. The domestic sugar market has ever since been marked by endless series of conflicts between farmers on one side, farm workers on another and industry on a third one. In other words, the political system constantly failed to resolve the distribution of income between the supply chain agents.

When in the end of the nineties the whole chain was liberalized, the CEPEA (Center for Applied Economics Studies)<sup>38</sup> of the University of São Paulo was invited to supply technical support to the CONSECANA – the Cane, Sugar and Alcohol Producers Council - formed by São Paulo's farmers and industry representatives established the cane delivery process and payment rules according to technical and political criteria. CEPEA was in charge of collecting and processing daily sugar and alcohol prices to inform the council that in turn would calculate sugar-cane prices to be paid to individual farmers. An end-of-the-year balance adjustment takes care of possible compensations due to market oscillations. No serious conflict between the parts have arisen since the creation of the Council. Today the sugar and alcohol business is the most prosperous segment in Brazil's agribusiness. The activity is expanding to other states where in the Cerrado area as the agro-energy market grows. There and in the traditional Northeastern areas the CEPEA has been the institution in charge of the information system.

The CEPEA's experience in supporting market formation began in the early nineties when the São Paulo's Commodities and Futures Exchange (BM&F) needed a price index to be used in cash settlements of live cattle contracts. A special survey process was delineated in such a way that farmers and agro-industry participates in a information community. Farmers and industry are individually contacted to inform (sale and purchase) prices so that both sides of the market are represented. On a daily basis data are processed into regional averages and results are sent back to farmers and industry. Today information systems are formed by many agribusiness supply chains so that daily negotiations almost all over Brazil begin by consulting previous day's CEPEA's data. Several daily bulletins are also released by internet, newspapers, radio and TV. Agestado, the major national economic news agency releases data domestically and Bloomberg

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<sup>37</sup> [http://www.copersucar.com.br/institucional/por/academia/moderna\\_agroind.asp](http://www.copersucar.com.br/institucional/por/academia/moderna_agroind.asp)

<sup>38</sup> <http://www.cepea.esalq.usp.br/>

does it also to the international public. The two agencies help plus BM&F help in financing CEPEA's activity. Many farmers choose to contract sales for future delivery at prices to be informed by CEPEA when the delivery occurs. They think that this way they are receiving the market price free of industry oligopsonistic influences.

### **1.5.7. EMBRAPA's Funds**

Although it is not the only agricultural research institution in Brazil, EMBRAPA is certainly the most technology-oriented particularly to the Cerrado area. Table 14 shows the public budget funds allocated to EMBRAPA since 1975 to 2003. During the seventies these funds clearly tended to increase reaching around US\$300 millions per year. In the eighties some oscillation around US\$325 millions was observed. In the nineties the funds exceeded US\$340 millions or R\$1 billion. In the 2003 a 20% reduction occurred compared to 1999.

As a share of agriculture's GDP the highest values occurred in the 1990/92 triennium: 1.18%. Along the nineties and twenties a continuous fall in technology investment for agriculture took place. Clearly these investments tended to lag behind the economic importance that agriculture reached in Brazil.

## **1.6. Production and Productivity in the Cerrado**

In the last 15 years input relative prices have changed markedly in Brazil. See figure 18. A major change relates to real wage: in the rural sector it experienced a rise of some 70% right after the 1994 Real Plan, which stopped high inflation. That meant that an additional factor – besides the well known payroll cost that heavily taxes employment in Brazil - favoring mechanization was at work. Prices of agro-chemicals and fertilizer have remained stable, while fuel prices rose in the early twenties. Regarding land prices, figure 19 shows during the nineties they fell in real terms in Brazil as a whole, except in the Center-West as land demand kept strong over that decade.

**Table 14. EMBRAPA Budget – R\$ Million of 2004 and Percent of Agriculture GDP**

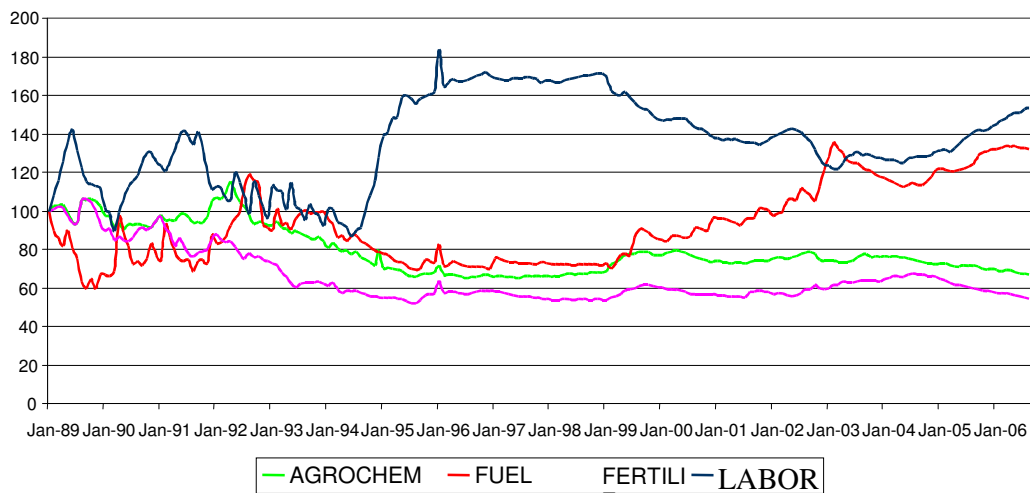
<b>Year</b>	<b>EMBRAPA BUDGET</b>	<b>% AGRICULTURE GDP</b>
1975	268	0,35
1976	419	0,49
1977	548	0,52
1978	697	0,77
1979	809	0,86
1980	897	0,85
1981	994	0,97
1982	977	1,09
1983	934	0,84
1984	858	0,65
1985	902	0,70
1986	987	0,76
1987	965	0,79
1988	935	0,72
1989	925	0,80
1990	1017	1,17
1991	1014	1,18
1992	1008	1,18
1993	914	1,03
1994	966	0,80
1995	1073	0,93
1996	1163	1,05
1997	1189	1,08
1998	1090	0,96
1999	1030	0,90
2000	980	0,85
2001	932	0,76
2002	855	0,66
2003	823	0,55

Source: SGE and DAF/EMBRAPA<sup>39</sup>  
 In 2004 the exchange rate was US\$1 = R\$2.92

<sup>39</sup> Alves, E. , A.J. Oliveira. 2005. “O Orçamento da Embrapa”. *Revista de Política Agrícola* XIV(4)

Putting input costs and output prices (see below) together one is led to conclude that unless substantial productivity was under way, Brazil's farm sector was under serious survival threat. Fortunately that was precisely what was happening. An study by IPEA and USP<sup>40</sup> (U) estimated that the farm total factor productivity in Brazil's crop and livestock sector increased close to 100% over the last 30 years and by 72% just after 1994. See figure 20.

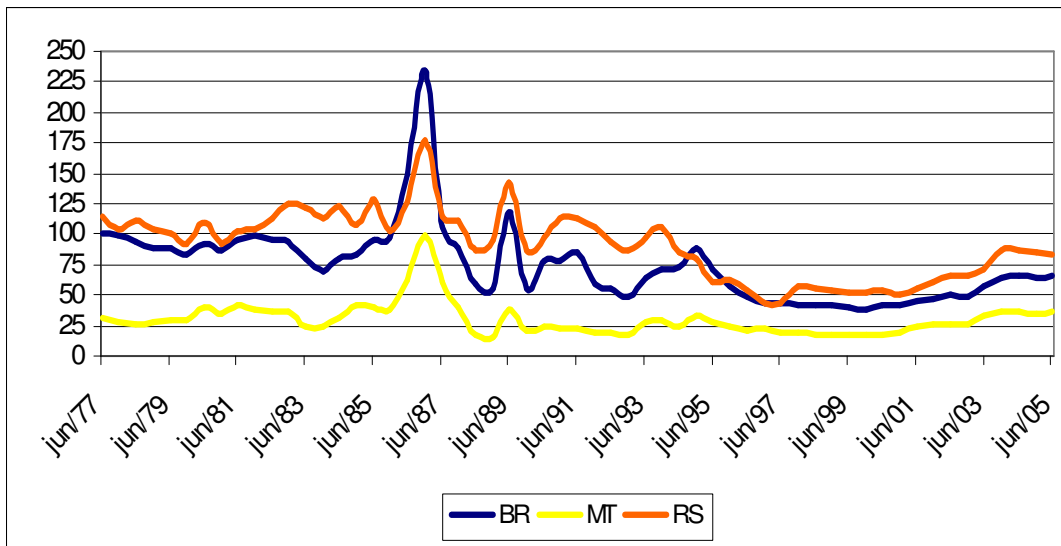
**Figure 18. Labor and input real costs, Brazil, 1989/2006**



Source: FGV

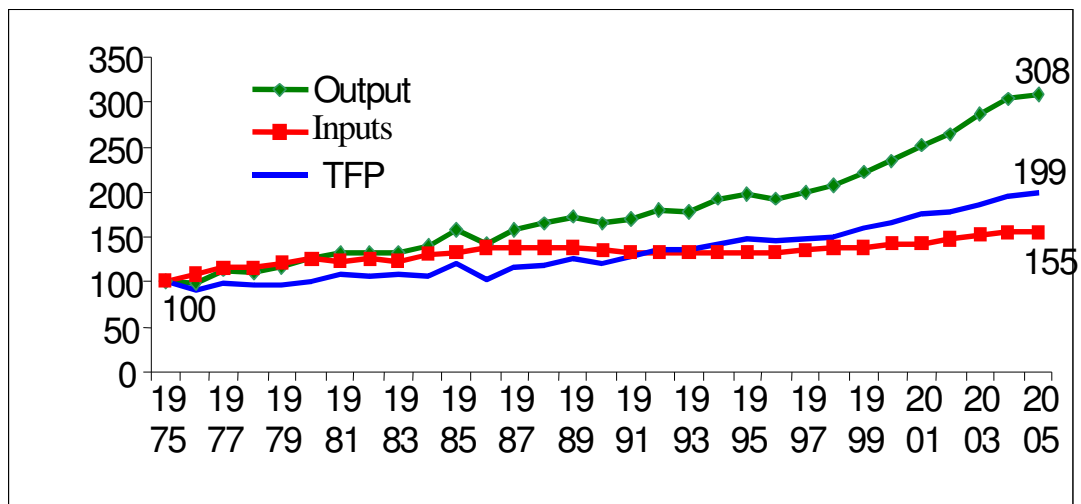
<sup>40</sup> GASQUES, J.G.; BASTOS, E.T.; BACCHI, M. P. R.; CONCEIÇÃO, J.C.P.R. 2004.

**Figure 19. Land Prices, Indices, Brazil (BR), Mato Grosso (MT) and Rio Grande do Sul (RS), 1977/2006**



Sources: FIPE, FGV, elaboration -CEPEA

**Figure 20. Total factor productivity of Brazil's farm sector – 1994 to 2004**



Source: Gasques et al

### 1.6.1. Output Performance

Crop production in Brazil has increased substantially over the last 40 years. See table 15. From 1965 to 1975 crop growth concentrated in soybeans (1791% in the decade), wheat (205%), orange (176%), cocoa (75%). At the same time peanuts (-40%), cotton (-33%) and some food crops like rice, beans and cassava fell a lot behind. From 1975/1985 changes were still expressive: cane (170%), wheat (142%), orange (125%), cotton (101%). Except for peanuts food crops expanded though at much slower rates. In the decade from 1985 to 1995, maize (65%) and soybeans (41%) and orange (40%) productions increased significantly while cotton and peanuts retracted. Food output again expanded moderately. Finally from 1995 to 2005 wheat (204%), cotton (154%), soybeans (99%), peanuts (85%) and cane (39%) were the leading crop activities.

It is quite clear that tradable crops – soybeans, orange, cane, wheat and tobacco increased expressively over the last 40 years. Traditional food crops like rice, beans and cassava did not increased very much. Peanuts ended up with a 58% lower level of output compared with 40 years ago. Coffee did not do well either: output shrank 42% in the same time period. Tomato (and to a lower extent, potato) production expanded reasonably.

**Table 15. Brazilian Crop Production – Volume (tons) and Rate of Growth – 1965/2005**

Crops	1965 (tons)	% 1965/1975	% 1975/1985	%1985/1995	%1995/2005	2005(tons)	%1965/2005
Cotton	1986313	-33	101	-46	154	3666160	85
Peanuts	742686	-40	-23	-50	85	315239	-58
Paddy Rice	7579649	3	16	24	18	13192863	74
Potatoes	1245857	28	22	38	16	3130174	151
Cocoa	160823	75	53	-31	-30	208620	30
Coffee	3663587	-31	50	-51	15	2140169	-42
Cane	75852866	21	170	23	39	422956646	458
Beans	2289796	0	12	16	3	3021641	32
Tobacco	248182	15	44	11	95	889426	258
Orange	1793258	176	125	40	15	17853443	896
Castor bean	355026	0	18	-92	409	168802	-52
Cassava	24992579	5	-11	10	2	25872015	4
Maize	12111921	35	35	65	-3	35113312	190
Soybeans	523176	1791	85	41	99	51182074	9683
Tomato	579839	81	84	40	27	3452973	496
Wheat	585384	205	142	-64	204	4658790	696
Grapes	550892	5	23	17	47	1232564	124

Source: IBGE.

As for livestock, table 16 indicates that the Brazilian bovine stock increased 95% from 1970 to 1995/96 (latest Census Year). The largest expansion occurred in the poultry stock (240%). The swine stock, decreased 12%. Table 17, however, reports that the swine slaughtering increased faster than bovine's from 1977 to 1996: 135% versus 51%. The highest rate was observed for poultry (410%).

**Table 16. Brazilian Livestock Inventory (number of animals and growth rates) – 1970/1995**

<b>ANIMALS</b>	<b>1970</b>	<b>%1970/1980</b>	<b>1980</b>	<b>%1980/1995</b>	<b>1995</b>	<b>%1970/1995</b>
Bovine	78547905	50	118085608	30	153058275	95
Swine	31510008	10	34661683	-20	27811244	-12
Poultry	211303000	96	413180000	74	718538029	240

Source: IBGE

The carcass weight also increased during the 1977/1996 period particularly for poultry (19%). For bovine animals the carcass weight increased more slowly (7%) and for swine still slower (3%). See Table 18. These data suggest that there was a quantitative increase in stock and in the production turnover, as indicated in table 19, particularly in the cases of swine and poultry.

**Table 17. Slaughtered Animals – Numbers – 1978/1996**

<b>Year</b>	<b>Bovine</b>	<b>Index</b>	<b>Swine</b>	<b>Index</b>	<b>Poultry</b>	<b>Index</b>
1977	12274135	100	7387930	100	339409600	100
1978	11427325	93	8185984	111	397755892	117
1979	10047869	82	8920129	121	478011831	141
1980	9572534	78	10270866	139	615627024	181
1981	9955970	81	10339202	140	723566509	213
1982	11658642	95	9171135	124	798415753	235
1983	11546282	94	9643351	131	795462358	234
1984	10215596	83	8204224	111	715198254	211
1985	10605566	86	8571007	116	745774355	220
1986	8732677	71	9029200	122	755137685	222
1987	10590894	86	10927656	148	832031033	245
1988	12542075	102	10608758	144	820060464	242
1989	13461870	110	9694712	131	844477842	249
1990	13374663	109	10993264	149	962029422	283
1991	13933582	114	12176642	165	1055061597	311
1992	14563130	119	13122406	178	1119624770	330
1993	14951359	122	13305932	180	1232978796	363
1994	15512452	126	14574656	197	1447525030	426
1995	17056108	139	16538105	224	1607970033	474
1996	18488855	151	17397813	235	1731672166	510

Source: IBGE

**Table 18. Carcass Weight per Animal, Brazil- 1977/1976.**

<i>Year</i>	<i>Bovine Index</i>	<i>Swine Index</i>	<i>Poultry Index</i>
1977	199,2	100	69
1978	203	102	69,2
1979	210,4	106	68,5
1980	217,7	109	68,1
1981	212,4	107	68,6
1982	205,6	103	68,3
1983	204,8	103	67,1
1984	205,2	103	68,1
1985	209,6	105	67,4
1986	214,2	108	66,4
1987	213,6	107	67,3
1988	205,8	103	65,9
1989	206,4	104	66,4
1990	207,5	104	66,1
1991	209,9	105	66,7
1992	210,2	106	68
1993	208,9	105	66,5
1994	214,9	108	67
1995	216,1	108	69,7
1996	214,2	107	71,1

Source IBGE

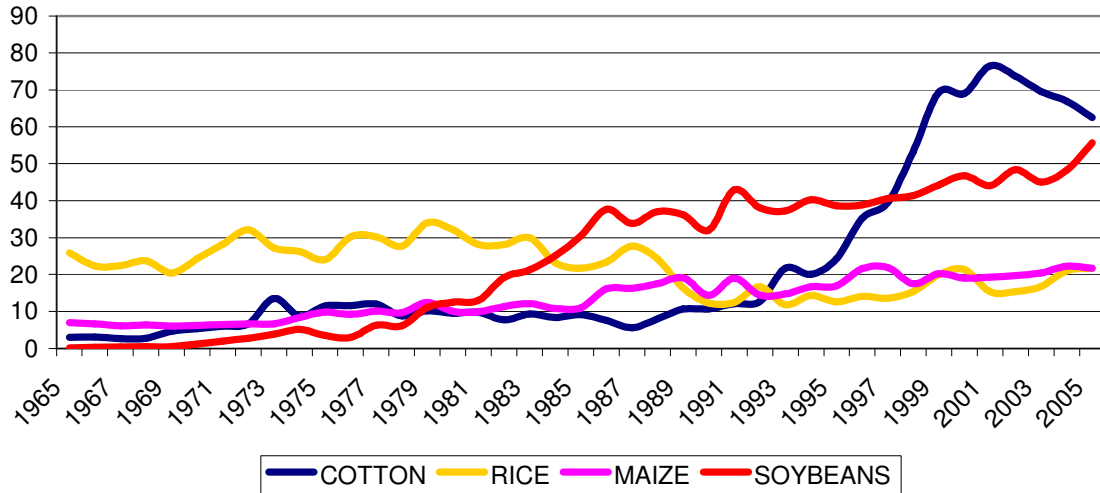
**Table 19. Production Turnover (Percent of Livestock Inventory), Brazil 1980/1996**

	<i>1980 (a)</i>	<i>1996 (b)</i>	<i>(b/a)</i>
Swine	30	63	2.1
Poultry	149	241	1.6

Source: IBGE

Considering the performance of the Center-West, in figure 21 it is shown that, over the last 40 years, the Cerrado expanded its share of national output of soybeans (to more than 50%), maize (to 20%) and recently of cotton (to 60-70%). At the same time the share of rice fell from 30% to around 20%.

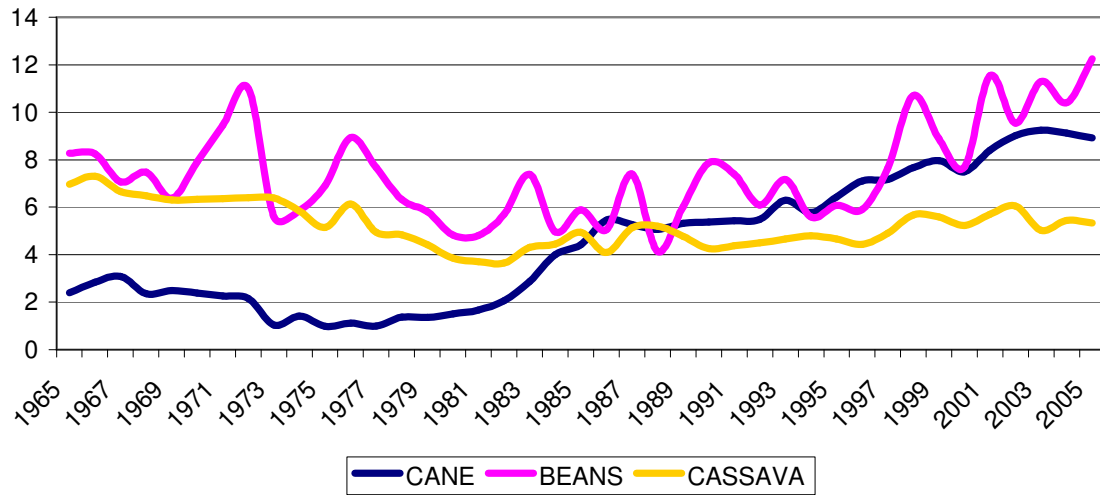
**Figure 21. Share (%) of the Center-West in National Production – Cotton, Rice, Maize and Soybeans, 1965/2005**



Source: IBGE

In figure 22 the shares of the other important regional crops are presented. The cassava share has been falling (to 5-6%), beans presented a swing and now is around 12%, while the share of sugar-cane reached 9% in 2005.

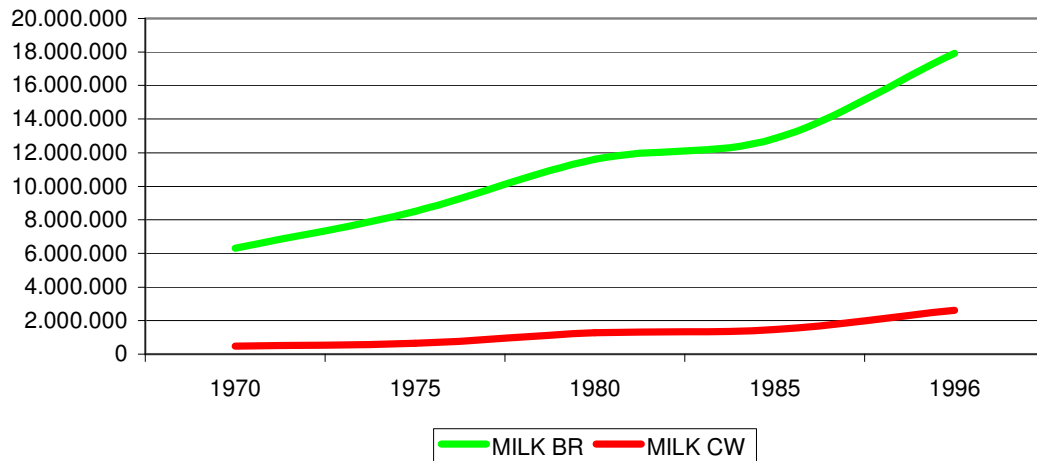
**Figure 22. Share of the Center-West in National Production – Cane, Beans and Cassava, 1965/2005**



Source: IBGE

As for livestock production, figure 23 shows that the Center-West milk production is increasing; in fact the regional share has evolved from 7.8% to 14.6% of the country production, during the 1970 – 1996 period (for which census data are available).

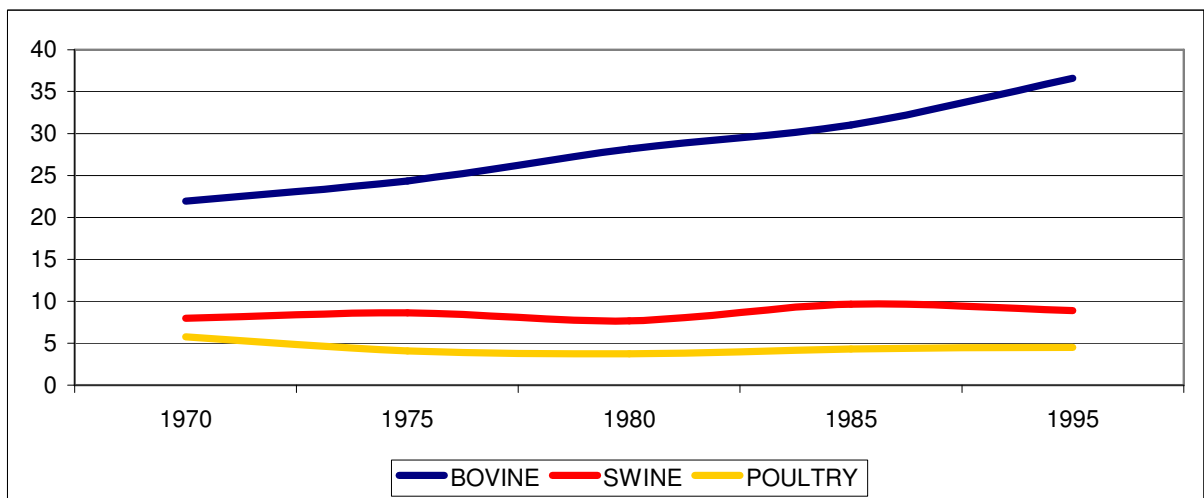
**Figure 23. Milk production (1000 liters), Brazil and Center-West region – 1970/1996**



Source: IBGE

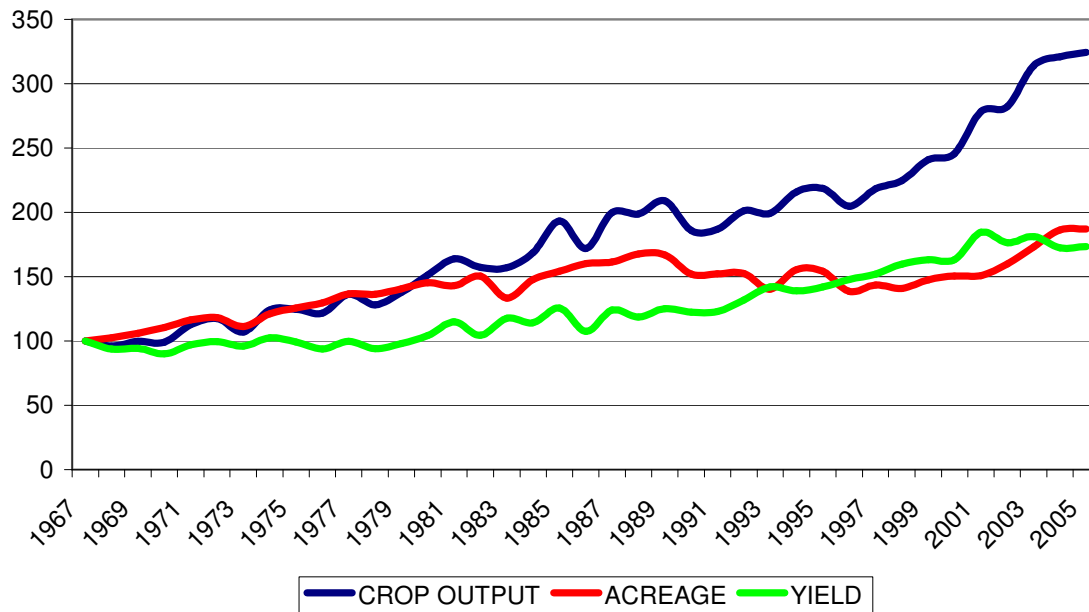
The Center-West bovine inventory share increased from 22% to 37%. For swine and poultry the shares changed very little over the 25-year period considered. See figure 24.

**Figure 24. Livestock Inventory Center-West Shares – Bovine, Swine and Poultry, 1970/1995**



Source: IBGE

**Figure 25. Aggregate Crop Yield, Acreage and Output**



Source: IBGE, elaboration CEPEA

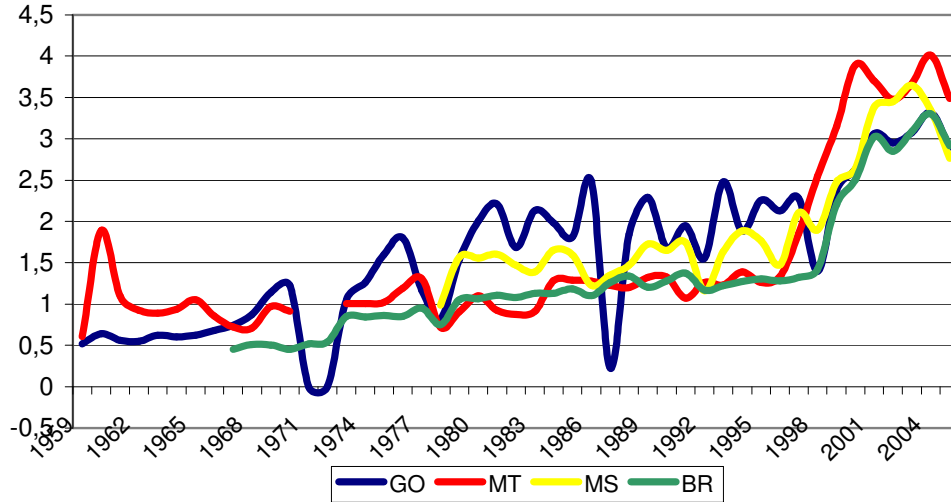
With respect to yields, figure 25 reports the aggregate evolution of crop land productivity since 1967<sup>41</sup>. It is possible to notice that crop output has increased continuously in that period. However, until 1980, yields were almost constant, so that output growth was due to acreage expansion. From 1980 on yield increase – specially in the nineties- is the dominant force behind output growth. In the last couple of years, however, yield has stabilized and acreage began to rise again. In the last year both remained almost unchanged.

### 1.6.2. Individual crops yields

Looking at individual crops, in figure 26, cotton yields for the Center-West states (Mato Grosso = MT, Mato Grosso do Sul = MS and Goiás = GO) are compared to Brazil's average. Historically regional cotton yields have been above the national average. An acceleration in yields is observed since the end of the nineties for both the region and Brazil as a whole. In Mato Grosso (MT) yields increased from 1.3 ton per hectare to 4 tons per hectare within a 6-7 year period. Notice that the growth starts in the eighties.

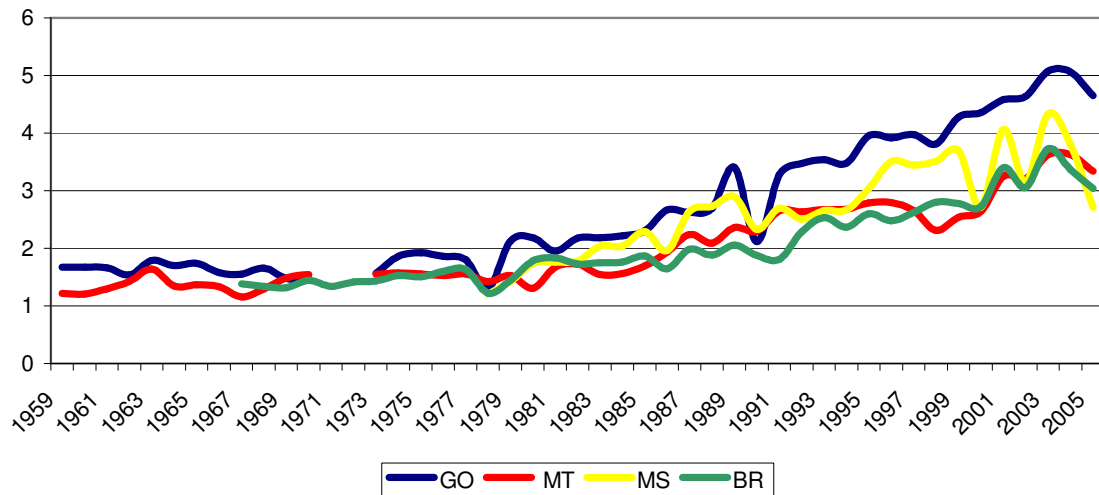
<sup>41</sup> To compute aggregate yield, individual crops were evaluated by the 38-year real price average.

**Figure 26. Cotton Yields (tons/ha), Brazil and Center-West States, 1973/2005**



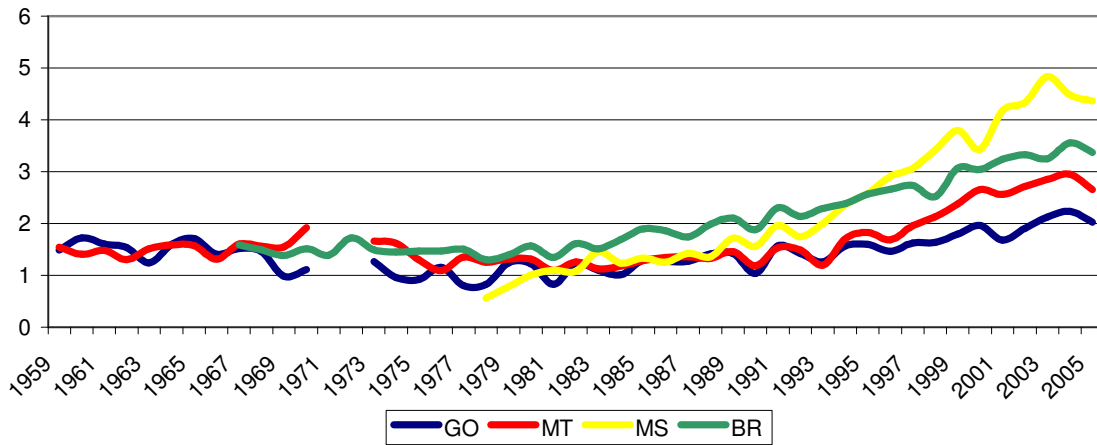
Maize yields – shown in figure 27 – has changed from 1 to 2 tons per hectare to 3 to 5 tons over the last 46 years. Mato Grosso and Mato Grosso do Sul (MS) corn yields are above national average. Most of the growth takes place after the eighties.

**Figure 27. Maize Yields (tons/ha), Brazil and Center-West States, 1959/2005**



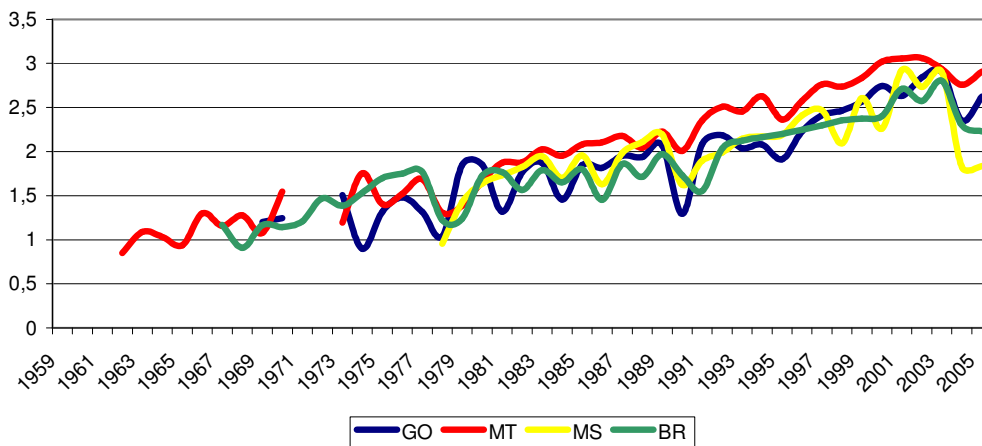
As for rice (figure 28) yields have increased more intensively since the nineties. In Mato Grosso do Sul yields grew from 1.7 ton per hectare to 4.8 tons per hectares from 1991 to 2005.

**Figure 28. Rice Yields (tons/ha), Brazil and Center-West States, 1959/2005**



Soybeans yields (figure 29) have increased significantly since the mid-seventies. In Mato Grosso yields rose from 1.5 ton per hectare to 3 ton per hectares in that period. A fall in yields is perceived in the last couple of years, possibly due excessive fall in output prices that followed the recent exchange rate appreciation.

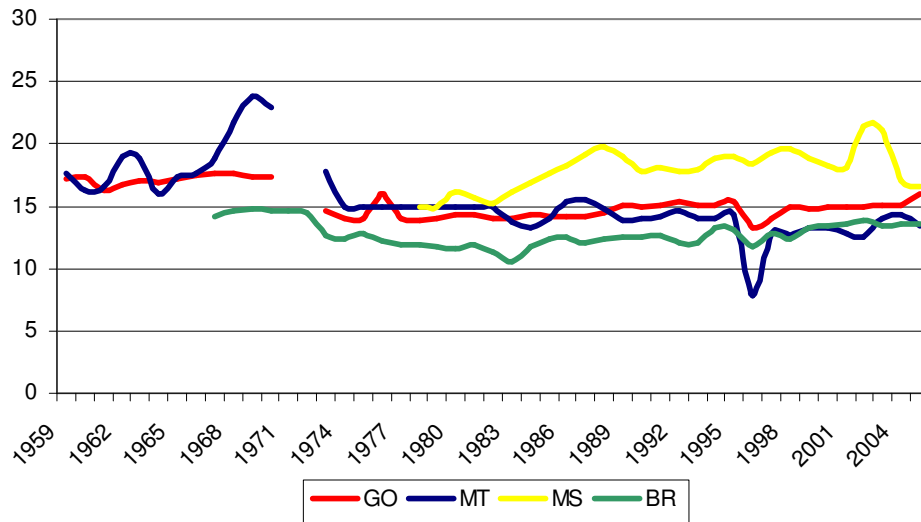
**Figure 29. Soybeans Yields (tons/ha), Brazil and Center-West States, 1959/2005**



Source: IBGE

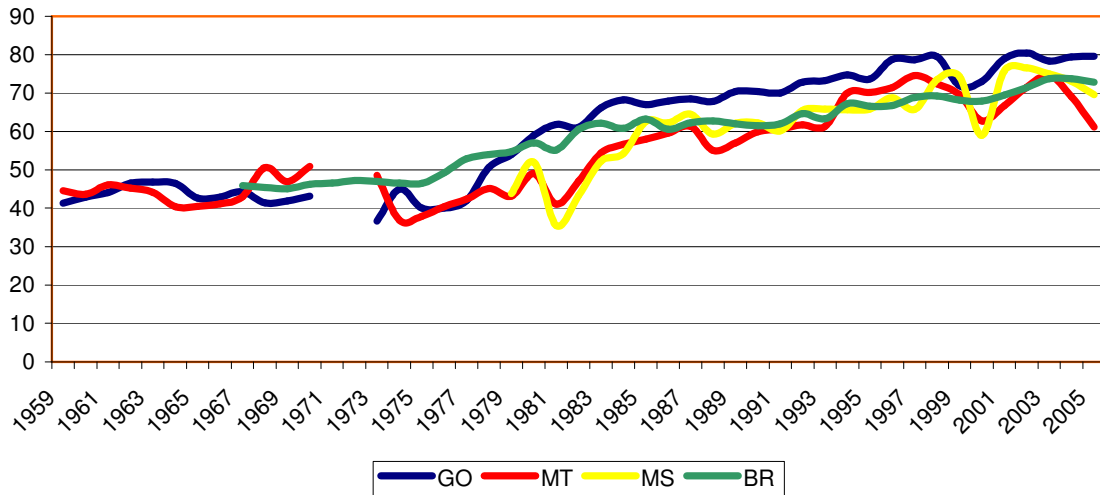
Cassava yields – figure 30 - have not changed very much over the last 45 years, except in Mato Grosso do Sul where a jump was observed in the late eighties. The Center-West cassava yield is higher than the national average (12-13 tons per hectare). In Mato Grosso do Sul recent years' average has been 18-20 tons per hectare.

**Figure 30. Cassava Yields (tons/ha), Brazil and Center-West States, 1959/2005**



In figure 31 sugar-cane yields are presented. Yields have been increasing since the mid-seventies. Goiás experienced the fastest growth from the seventies to the eighties and has kept yield levels above the national levels ever since. Yields have stabilized around 70-80 tons per hectare since the mid-nineties.

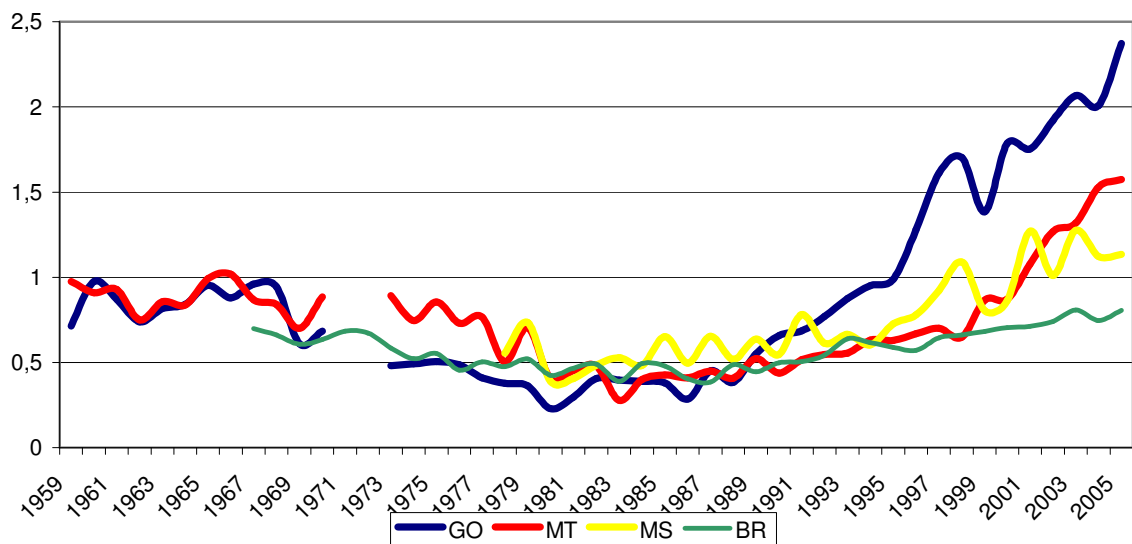
**Figure 31. Sugar-cane Yields (tons/ha), Brazil and Center-West States, 1959/2005**



Source: IBGE

Beans yields (figure 32) experienced a falling trend from the sixties to the late eighties. In the nineties national yields rose from 500 kilos per hectare to around 800 kilos. The Goiás beans yield, however reached 2.4 tons per hectare.

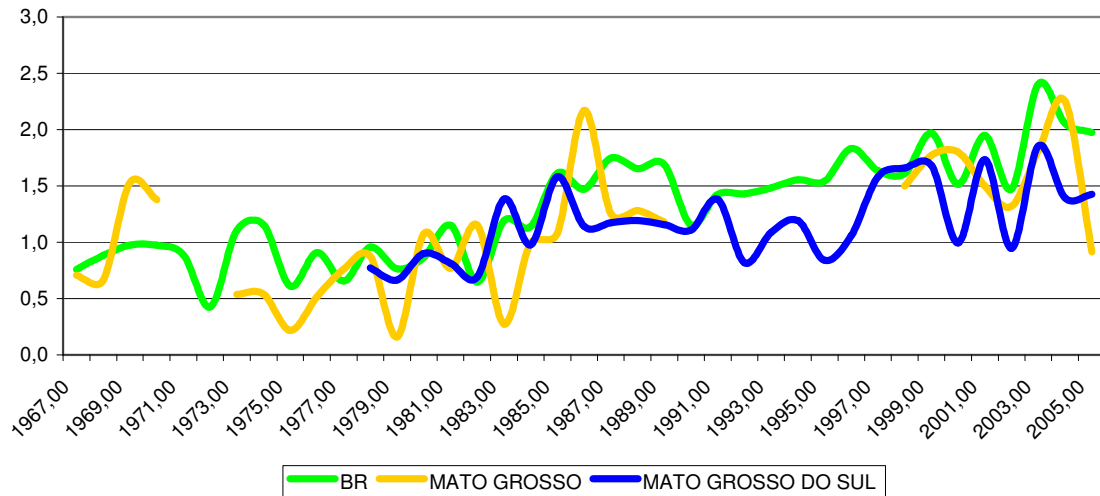
**Figure 32. Beans Yields (tons/ha), Brazil and Center-West States, 1959/2005**



Source: IBGE

Brazil has always been dependent on wheat imports. In the Center-West, Mato Grosso do Sul and Mato Grosso have been able to keep themselves close to national yields. See figure 33.

**Figure 33. Wheat Yields (tons/ha), Brazil and Center-West States, 1959/2005**



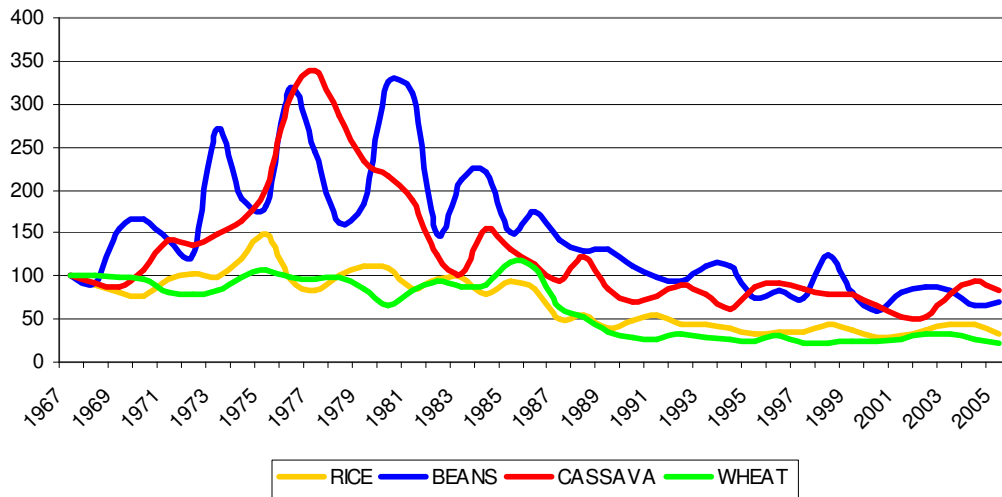
### 1.6.3. The reflection on Prices

Figure 34 shows the evolution of farm prices for four food crops. From the early seventies to early nineties beans and cassava prices were very high – reaching levels 200% higher than in the sixties. Beans and cassava yields were very low at that time and that may explain at least part of behavior of farm prices. Rice and wheat presented only moderate oscillation with no rising trend. All four prices present strong downward trend starting either in the mid-eighties or early nineties. These were periods of strong growth in yields for rice and beans but not for cassava.

Still regarding food prices, figure 35 reports farm prices for animal products. Poultry prices presented a steady fall trend from the mid-seventies to the mid-nineties, when they stabilized. Swine, beef cattle and milk tended to present high prices from the mid-seventies to the late eighties. Thereafter a strong fall in prices is observed until stabilization is reached in the mid-nineties.

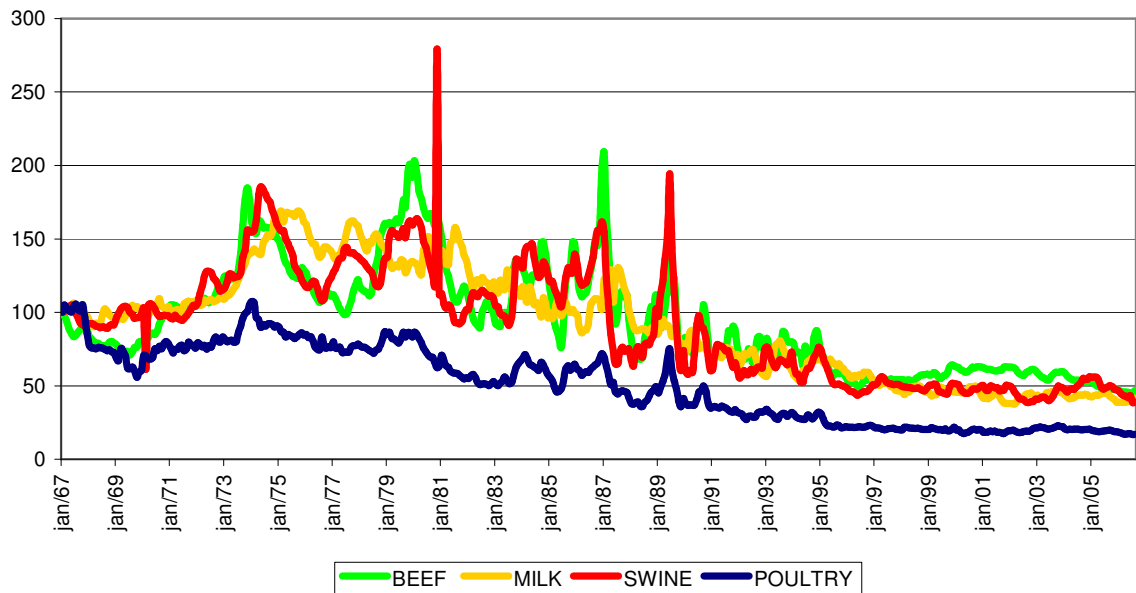
One may conclude that food prices have fallen since the mid-eighties both for vegetal and animal products. Special highlight should be given to rice and wheat whose prices experienced a 50% fall beginning with low prices in the seventies. Beans and cassava have had price reductions of about 70% since the eighties (when prices were quite high). Currently cassava and beans prices are around 20 to 30% below their levels in the sixties.

**Figure 34. Farm prices for food crops: rice, beans, cassava and wheat. Brazil. 1967/2005**



Source: FGV.

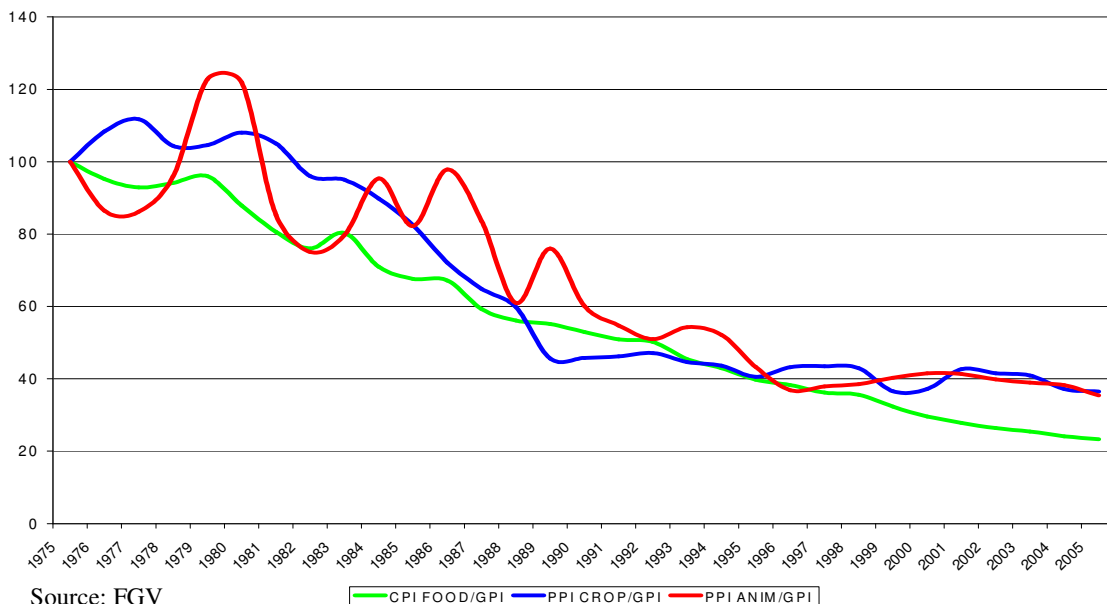
**Figure 35. Farm prices for animal products: beef cattle, swine, poultry and milk. Brazil. 1967/2005**



Source: FGV.

Figure 36 summarizes the trends in farm and consumer food prices. In the last 30 years farm prices, both of crops and livestock, fell little more than 60% in real terms. Consumer food prices fell almost 80%. This is doubtless a major contribution of agriculture and the cerrado experience to society as a whole.

**Figure 36. Farm Crop and Livestock Prices and Food Consumer Prices, 1975/2005.**

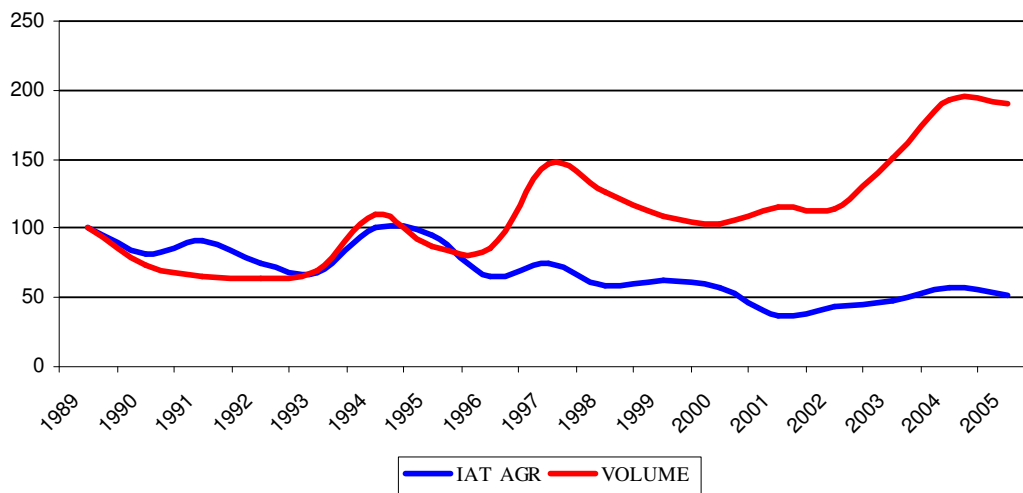


Source: FGV

#### 1.6.4. The external front

A complete understanding of agricultural sector in Brazil requires an examination of the performance of its in the external market<sup>42</sup>. Figure 37 relates crop products exports and the domestic currency value of exported units (IAT: external dollar price times domestic currency effective dollar exchange rate). In the sixteen-year period to 2005 the export volume doubled while the export price decreased 50%. In figure 38 the same information is presented for the livestock products. In this case exports multiplied eightfold ( with the major adjustments after 2003) while unit prices almost doubled. These performance are compatible with the observation that productivity – either total or partial – have gone through substantial increase. The same seem to have happened in terms of efficiency.

**Figure 37. Crop Products Exports and Domestic Currency Unit Value of Exports 1989/2005.**

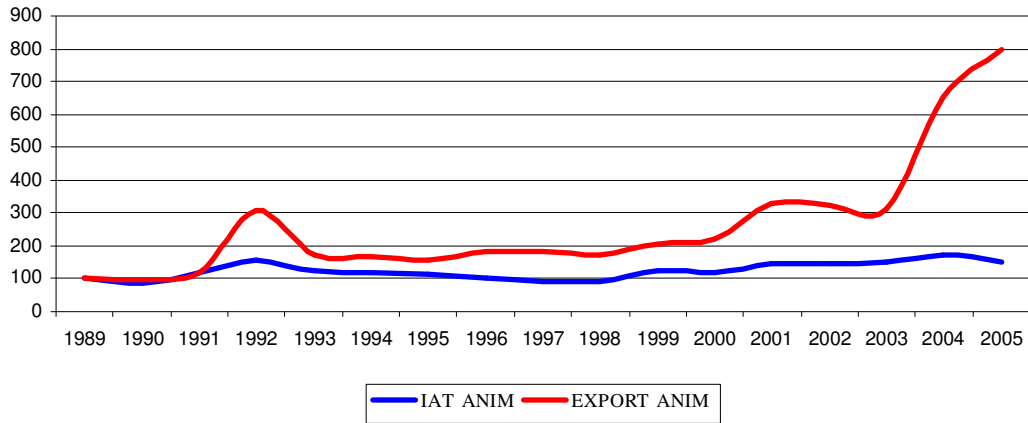


Source: FGV

<sup>42</sup> The external trade performance of individual crops and animal products is presented in table 23. Over the last 10 years, the soybean complex has been by far the most important foreign currency generator in Brazil's agribusiness (around US\$9 billions/ year). The second in the line is the sugar and alcohol sector which approached US\$8 billions in 2006 side by side with the meat (beef, poultry and pork) sector. Inside the meat sector the beef industry leads with almost half the exports revenue. Then comes the coffee sector (US\$ 3 billions) followed by orange juice and tobacco.

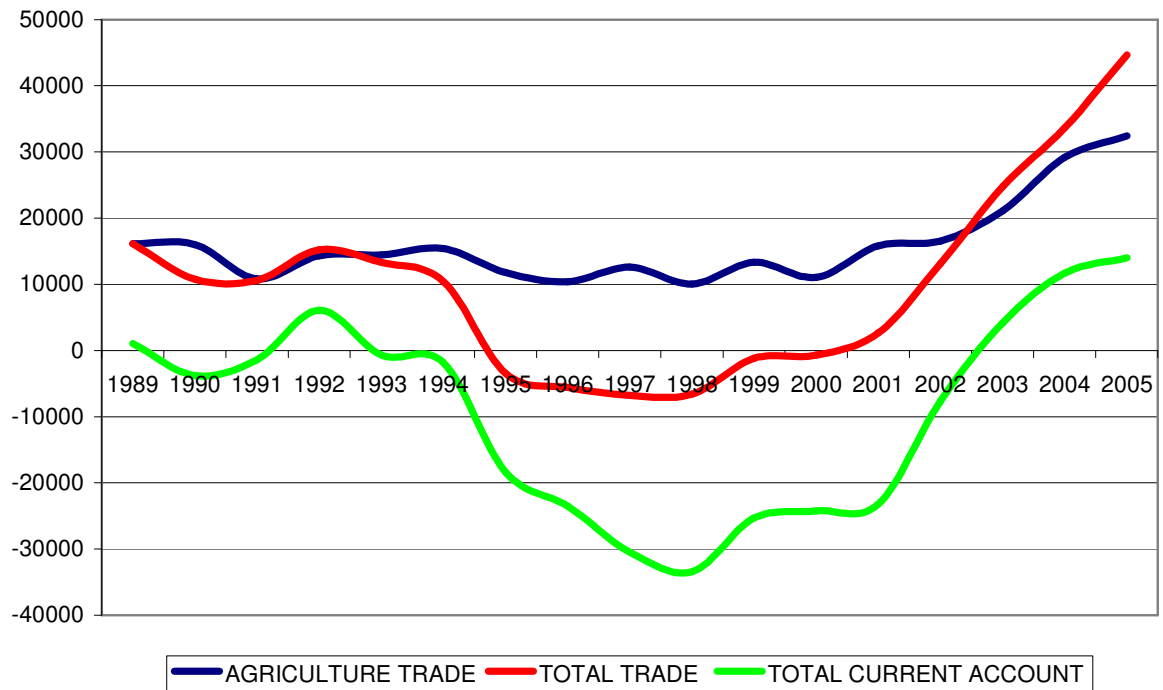
**Figure 38. Animal Products Exports and Domestic Currency Unit Value of Exports 1989/2005.**

Source: FGV



The role of agriculture in Brazil's international finances cannot be overlooked. During the nineties the inflation fighting strategy relied heavily on high interest rates and overvalued currency. This combination drove the country towards escalating trade and current account deficits. See figure 39. Agriculture's trade balance – around 10 billion dollars per year - played a key role in keeping Brazil's solvency. When finally the currency market was liberalized and devaluation occurred, agriculture's trade jumped fourfold to the US\$40 billion level thus leading to surplus to both the trade and current accounts after a 10-year period of persistent deficits.

**Figure 39. Brazil's Current Account, Total Trade and Agriculture's Trade Balances, 1989/2005**



Source: IPEA & CEPEA

The external trade performance of individual crops and livestock is presented in table 20. Over the last 10 years, the soybean complex has been by far the most important foreign currency generator in Brazil's agribusiness (around US\$9 billions/ year). The second in the line is the sugar and alcohol sector which approached US\$8 billions in 2006 side by side with the meat (beef, poultry and pork) sector. Inside the meat sector the beef industry leads with almost half the exports revenue. Then comes the coffee sector (US\$ 3 billions) followed by orange juice and tobacco.

**Table 20 (a) Dollar Value of Agricultural Exports , 1997/2007(april)**

	<b>Soybean and Byproducts</b>	<b>Beef</b>	<b>Poultry meat</b>	<b>Pork</b>	<b>Sugar and Alcohol</b>	<b>Tobacco</b>
1997	5,563,786,330	462,054,145	883,629,687	166,076,108	1,826,582,868	1,664,806,336
1998	4,732,660,098	615,696,818	752,678,856	171,498,349	1,978,953,905	1,558,989,645
1999	3,760,985,495	815,227,512	892,813,307	133,604,091	1,976,541,316	961,237,046
2000	4,194,428,525	813,563,314	828,746,524	182,832,277	1,233,896,537	841,473,613
2001	5,290,978,401	1,048,721,027	1,333,800,109	374,984,486	2,371,204,044	944,315,843
2002	6,006,189,775	1,143,825,040	1,392,816,054	486,118,679	2,262,789,661	1,008,168,629
2003	8,122,102,071	1,589,679,391	1,798,952,693	551,107,919	2,297,964,502	1,090,259,057
2004	10,041,488,282	2,525,404,759	2,594,882,933	774,749,439	3,137,967,628	1,425,762,500
2005	9,473,584,923	3,059,910,731	3,508,548,024	1,165,346,849	4,684,357,423	1,706,520,228
2006	9,308,112,223	3,923,314,417	3,203,413,957	1,036,304,971	7,771,690,404	1,751,726,280
2007	2,864,783,408	1,423,139,499	1,346,838,633	341,423,581	2,046,465,313	422,296,194

**Table 20 (b) Dollar Value of Agricultural Exports , 1997/2007(april)**

	<b>Orange juice</b>	<b>Cotton and textiles</b>	<b>Corn and byproducts</b>	<b>Cocoa</b>	<b>Coffee</b>
1997	1,006,660,930	640,132,440	46,307,353	7,865,247	2,748,974,501
1998	1,266,424,346	575,306,018	5,164,385	9,272,940	2,335,133,090
1999	1,239,033,843	534,602,715	5,196,022	4,757,753	2,232,900,556
2000	1,033,646,269	705,294,802	5,119,753	2,003,792	1,562,418,613
2001	845,094,498	875,960,553	496,866,986	3,784,964	1,212,510,879
2002	1,040,753,100	753,161,492	267,233,177	6,999,938	1,201,261,395
2003	1,192,979,783	1,037,598,543	380,154,923	3,073,701	1,315,582,739
2004	1,058,090,916	1,303,547,792	592,651,169	1,874,915	1,758,432,048
2005	1,110,499,732	1,381,550,118	119,326,049	1,783,408	2,533,204,942
2006	1,468,748,466	1,217,384,469	482,701,607	828,662	2,953,077,405
2007	734,196,071	358,803,715	267,887,572	193,140	1,105,322,972

### **1.7. The Cerrado Development – The role of the private sector and domestic market**

The occupation of the Cerrado area took place both spontaneously and induced by public programs. Both were not well organized and free of social conflicts, particularly over land ownership. The point to be emphasized here is the availability of entrepreneurs willing to move from the South and Southeast to distant regions and invest in production in poor lands located far from main consumer centers and from export ports.

The volume of private investments - or the existing amount of private physical capital - in the Center-West region in the most relevant regional supply chains (beef cattle, soybeans and maize, cotton and sunflower) was recently evaluated by CEPEA to be around US\$ 110 billion. That would be the volume of capital currently applied as farms (land, machinery, facilities), warehouses, slaughterhouses and grain processing industries. For next ten years from 2006 the expectation is that volume of capital will grow 130% or US\$ 136 billion<sup>43</sup> (V). If the South and Southeast are included the amount of private physical capital in use currently adds up to US\$360 billion.

The agribusiness sector is today quite well developed particularly in the Center-West, Southeast and South. In Brazil, it represents around 28% of Brazil's GDP, while the farm sector stands for around 9% (CEPEA<sup>44</sup>). If it is true that farm size has been escalating, it is more so that agroindustry and distribution are growingly concentrating. Today in the food industry 12 companies hold a 50% share of the market. In the farm inputs sector, 7 companies represent 50% of the total market sales. 50% of the respective markets are also held by the 4 largest farm machinery companies and 3 largest supermarket chains<sup>45</sup> (W). Most of the agribusiness companies are multinationals as the participation of foreign capital is rapidly increasing in Brazil. That indicates that although substantial capital investments are demanded for the coming years, the prospects are that those companies are willing to support the agribusiness development in Brazil.

Brazil has a sizable domestic market of around 190 million people. However up to few years back the growth potential of that market was limited by poverty and income distribution concentration. In addition the growth of Brazil's GDP has been very modest over the last 20

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<sup>43</sup> Barros, GSAC et al. 2007.

<sup>44</sup> <http://cepea.esalq.usp.br>.

<sup>45</sup> Barros, G. S. C. et al. 2007.

years, with an annual average of 2,5%<sup>46</sup>.

In conclusion it can be said that, in spite of having a large domestic market, poverty, income concentration and low growth did not help much in terms of the performance of the Cerrado area counting on a dynamic domestic market. What helped in assuring a viable agriculture in the region was the possibility of exporting to a growing external market. Productivity gains would soon become unprofitable if the increases in output were all dropped in the domestic stagnated market; thanks to exports agricultural prices did not fall at the same – or at higher, as might be expected - proportion as productivity grew. In addition, it cannot be overlooked that agroindustry and retail concentration was not a factor restraining the transmission of falling farm prices to consumers<sup>47</sup> (X). Instead as concentration surge and private investments increase, a fierce competition and an obsession for efficiency dominated the market relations among retailers and processors. So consumers prices fell for sure as productivity increased: the Brazilian poor benefited from technology, processing, retailing and farm efficiency as the government took effective steps to distribute nominal income (as with the Family Grant Program); the Cerrado contribution was to make the nominal distribution turn into real income redistribution and not an inflationary process as used to happen in the many prior experiences of redistributing income in Brazil. The result was that for the first time in Brazil's history, the Gini Index is in a process of substantial reduction since 2001<sup>48</sup> (Y): from 2001 to 2005, the Gini Index fell from 0.593 to 0.566.

## 1.8. Concluding Comments

The occupation of Brazil's CENTER-WEST region – with the dominant role of the Cerrado area – was the result a political decision from the beginning of the twentieth century, as a part of a national development program. This program had as its main objective to develop Brazil into an industrialized country. Since the public sector was the driving force behind the program, it was necessary to impose priorities as to the way and order projects would be carried out. The then highly accepted strategy to follow was import substitution. The agricultural sector entered the program both as a food and foreign currency supplier and as a consumer of some of

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<sup>46</sup> IBGE in <http://ipea.gov.br/ipeadata>.

<sup>47</sup> Barros, G.S.C. 2005..

<sup>48</sup> Paes de Barros, R. 2006.

industrialized goods to be now produced domestically.

Since most of the traditional agricultural lands was already taken, it became necessary to incorporate the Center-West “empty space”, a step also useful from the geopolitical point of view. Infrastructure was needed and investment capital raised from the public sector and foreign investors. Regional population was small and unprepared for the task of development new, unfertile land. Therefore it became necessary to promote migration from the South where experienced and trained human resources were available. That was successfully done, because southern farmer found it profitable to go after cheap land with the financial support of the public sector. At the same time migration from the poor northeast was being stimulated as well for purpose of redistributing land in the Center-West and Northern regions. These two human flows met in the region in a conflicting way.

Southern farmers, as expected, were better able to successfully establish in the region. Besides infrastructure, credit and price support, these farmers counted on a technological generating process headed by EMBRAPA since the seventies. Although the techniques for soil correction was already known at the time, much effort was needed to produce the adapted variety to the region, be it pasture or crops. It was essential also that farmers were able to correctly use the new inputs and techniques in a efficient way so as to make them profitable.

When the official side of the occupation process ended in the eighties the big question was: will the Center-West farm system stay in place with much less help from the government? The answer, later learned, was yes. In the early nineties – thirty years later the beginning of the process – the fruits from the investments were ripe to be harvested. Although some relevant objectives – like forming a small-family farm system, thus improving land and income distribution – were not satisfactorily reached, Brazilian society certainly gained from the Cerrado occupation in two ways: abundant and cheap food – which opened the way or better nutrition and health of the poor, widening at the same time their range of consumption items – and abundant foreign currency to clear the way for economic growth, practically without any external constraint.

# THE BRAZILIAN CERRADO EXPERIENCE WITH COMPETITIVE COMMERCIAL AGRICULTURE<sup>49</sup>

## A Critical Review

### Part 2. ENVIRONMENTAL ANALYSIS OF THE CERRADO

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*Simone Fioritti Silva*<sup>3</sup>

#### 2.1. Introduction

As the use of land for agriculture approached its limits in the South and Southeast in the 1950s, the Cerrado region became strategic for the needed supply growth of agricultural products related to the industrialization and urbanization processes. A flat topography – adequate for mechanization – and low price of land attracted farmers capable of applying the principles of the “green revolution” to large-size farms. That became also the time to worry about environment and natural resources.

It is quite usual that environment aggressions begin as a byproduct of official initiatives designed to develop a region. In the area to the east of the Xingu Indian Park in the Northeastern Mato Grosso and in the South of the Amazon, for instance, as Barreto et al.<sup>52</sup> (Z) indicate, the environmental problems began with the 1966 SUDAM (Amazon Development Superintendency) projects, and the INCRA (National Institute for Colonization and Agrarian Reform) colonization projects, not to mention the private initiatives.

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<sup>52</sup> BARRETO, R. et al. 2003.

Interestingly enough, contrary to what happened in the United States, as pointed out by Barreto Filho<sup>53</sup> (AA), where the first reservation areas were created in the far west frontier lands, in Brazil national reservations began to be created in the urban areas of the Southeastern region. The first “Parque Nacional” in the Center-West was established only in 1959, just one year before the inauguration of Brasilia. As the Vargas’ “Marcha para o Oeste” progressed, most of the conservation units were being created: 13 between 1959 and 1961. In 1961 9 forest reservation areas were established leading to what Barreto Filho identified as a real boom of conservation units of integral protection. Geopolitics and strategic reasons are behind these initiatives designed to follow the movement of the occupation of land. The presence of Indians was perceived as an exotic special touch and as “a part” of the natural environment to be preserved.

According to Silva<sup>54</sup> (BB) the occupation of the Cerrado really began with *Pinus* and *Eucaliptus* based reforestation to supply the needs of the paper and cellulose industries, which were developing as a result of the fiscal incentives related to the 1966’s Law 5.106<sup>55</sup>. Then agriculture followed with soybeans, cotton, coffee, maize, beans, and peas. This was a marked change in land use: Shiki<sup>56</sup> (CC) indicates that until the sixties the Cerrado land contributed to the supply of basic food products, such as rice and beans, produced by family farms in hardly found and specially selected fertile areas.

The change towards modernization was possible thanks to two state companies: EMBRAPA (Brazilian Company for Agricultural and Livestock Research), which came up with Cerrado’s adapted varieties and other technologies, which reached farmers through the extension service EMBRATER (Brazilian Rural Extension Company). Abundant and cheap credit and price support programs offered by the government institutions were also instrumental. In the seventies the National Development Plan (PND) provided credit and promoted research focused on correction of acid and poor soils through application of lime and fertilizers, machinery, improved seeds, herbicides and insecticides (organophosphates and carbamates).

In 1975 the POLOCENTRO – the major program of the II PND (Second National Development Plan) – directed funds to research and infrastructure (transport, storage, energy and rural electrification) in addition to extension and subsidized credit for Center-West and Minas

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<sup>53</sup> Barreto Filho, H.T. 2005.

<sup>54</sup> Silva, L.L. 2000.

<sup>55</sup> According to this law, companies could reduce up to 50% of income tax to be paid by using this value to foresting or reforesting.

<sup>56</sup> SHIKI, S. 1997.

Gerais medium and large farmers. As a result, Silva mentions that as the “Chapadas” (plateaus) land became growingly expensive, small farmers were displaced to poorer lands where production was based on subsistence cropping.

Special attention was to be given by POLOCENTRO to food production. Indeed 60% of the farms’ land was to be allocated to crops and the rest to pasture. In practice, however, the opposite occurred: cropland was largely overcome by pasture. According to Diniz<sup>57</sup> (DD), the POLOCENTRO’s goal was to occupy 600 thousands hectares per year involving 202 municipalities and 4.2 million inhabitants. The concept of growth “poles” was adopted so that 12 Cerrado areas were selected to receive investment funds for infrastructure.

The achievements of the POLOCENTRO are subject to controversies. As mentioned by Silva, around 2400 projects were approved between 1975 and 1982, with the incorporation of 3.7 million hectares: 1.8 million allocated to crops, 1.2 million to pasture and 700 thousand to forestation and reforestation. Another evaluation, mentioned by Diniz, indicates that POLOCENTRO incorporated 2 million hectares or 31.5% of the change in the cerrado area. Goiás was the most affected state (42.3%) followed by Mato Grosso do Sul (31.3%) and Mato Grosso (30.5%). Shiki indicates, however, that 8.2 million hectares were incorporated by POLOCENTRO between 1975 and 1980, with 70% used for planted pastures and only 23% for crops. Cattle herd would have increased by 128% between 1970 and 1985.

According to information provided by Silva, as the POLOCENTRO was discontinued in 1979, the PRODECER was introduced with the participation of the Japan International Cooperation Agency – JICA. The program was coordinated by the Agricultural Promotion Company – CAMPO, formed by public and private capital with the primary objective of producing grains for exports. The “chapadas” were chosen to be occupied mainly by high technology grain production closely linked to the expected agro-industrial growth.

Diniz points out that subsidized credit and the minimum price support program were key factors to stimulate colonization and expansion of the agricultural frontier, not to mention a whole bunch of other important special programs: Program for the Development of the Pantanal – PRODEPAN; Special Program for the Development of the Grande Dourados – PRODEGRAN; Special Program for the Brasilia Geo-economic Region – GEOECONÔMICA; Program of Agriculture and Livestock and Mineral Poles of the Amazon – POLOAMAZÔNIA (which affected Mato Grosso and the North of Goiás) and Integrated Program for the

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<sup>57</sup> DINIZ, B.P.C. 2006.

## Development of the Northwest of Brazil - POLONOROESTE.

Despite its magnificent natural endowment, the Cerrado has been and actually is under continuous threat as the agricultural frontier expands. Soybean, beef cattle and charcoal kiln are pointed out as major activities that could harm the Cerrado soil, fauna and flora, according to ISA<sup>58</sup> (EE). In addition, contrary to what happens to the Amazon, Atlantic Forest and the Pantanal, the Cerrado lacks a legal apparatus for its protection. The Cerrado is not a constitutional National Patrimony. ISA also reports that only 1.7% of its area or 2.14% of its bioma is protected in integral-protection-conservation-unities.

More recent information from ISA<sup>59</sup> (FF) indicates that up to October, 2006, 3% of the Cerrado was protected under Integral Protection Conservation Unities. Indian Lands represented 4% of the territory. If Environment Protection Areas are added, a total of 10% of the Cerrado is somehow protected. Specialists urge the government to expand this protection, particularly through Integral Protection Unities, which are seen as effective biodiversity protectors due to their large continuous territorial size.

In the Cerrado there exist National Parks, Ecological Stations and Environment Protection Areas designed to preserve species and the ecosystem. Some of those areas are useful as laboratories for the development scientific research.

**National Parks** – These parks are designed to preserve ecosystems and scenic beauty, besides creating conditions for research and development of environment educational activities, close-to-nature recreation and eco-tourism. State and Municipal Parks fulfill the same functions. AmbienteBrasil<sup>60</sup> reports the existence of 13 national parks as of 2007. These parks were created between 1959 and 2002.

**Ecological Stations** - The stations are intended to preserve nature and conduct research. Ecosystem changes within the station are allowed only to restore modified ecosystems, to manage species to preserve biodiversity, to gather ecosystem components for scientific purposes. The first ecological station was created on 1984; currently there are seventeen ecological stations located in the Cerrado according to AmbienteBrasil.

**Environment Protection Areas** – These are large areas occupied by men up to some degree and endowed by biotical, aesthetical or cultural attributes. They intend to discipline the

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<sup>58</sup> Instituto Socioambiental – ISA. 2005.

<sup>59</sup> Instituto Socioambiental ISA.2007.

<sup>60</sup> AmbienteBrasil, “Unidades de Conservação do Brasil.”  
<<http://www.ambientebrasil.com.br/composer.php3?base=/.snuc/index.html&conteudo=/.snuc/categorias1.html>>

occupation, protect biodiversity and assure sustainable use of natural resources. It encompasses both public and private lands. Under constitutional limits private properties may locate in the area subject to norms and restrictions. Scientific research and public visitation are permitted. AmbienteBrasil reports eight environment protection located in the Cerrado; the first one was created on 1989.

The current federal administration informs that from 2003 to 2007 19.4 million hectares of conservation unities were created, a 63 increase in the previous availability<sup>61</sup>.

There are not in the literature evaluations of the effectiveness of the parks, stations and protection areas in terms of in preserving natural resources and collaborating for Cerrado's research.

## 2.2 The Characteristics of the Cerrado

### 2.2.1 Size

The Brazilian Cerrado area is estimated to encompass 204 million hectares of which 125 million – counting only the latosols (46% of the cerrado) and alluvial soils (15.2%) - are suitable for agriculture activities as mentioned by Resck<sup>62</sup> (GG). According to Reis et al.<sup>63</sup> (HH) the Cerrado encompasses the “Planalto Central” (Central Uplands), although its soil combination is observed since the state of Paraná up to northern regions like the Marajó Island and the states of Roraima and Amapá. Of the cerrado agricultural area (estimated to be 1,3 million square kilometers or 125 million hectares), 80% are located in Minas Gerais, Goiás and Mato Grosso. Tocantins, Bahia, Maranhão, Mato Grosso do Sul, Piauí, São Paulo, Rondônia and the Federal District also have cerrado areas. See Figure 40.

There are controversies regarding the Cerrado area size mainly because of the unsettled issue of classifying or not as Cerrado the transition areas in the borders of the bioma central area, as dealt with by Machado et al.<sup>64</sup> (II). Coutinho<sup>65</sup> (JJ), for instance, estimates the Cerrado

<sup>61</sup> [http://www.mma.gov.br/estruturas/imprensa/\\_arquivos/relat\\_desmat\\_amazonia\\_2006\\_2007.pdf](http://www.mma.gov.br/estruturas/imprensa/_arquivos/relat_desmat_amazonia_2006_2007.pdf)

<sup>62</sup> Resck, D.V.S. 2002.

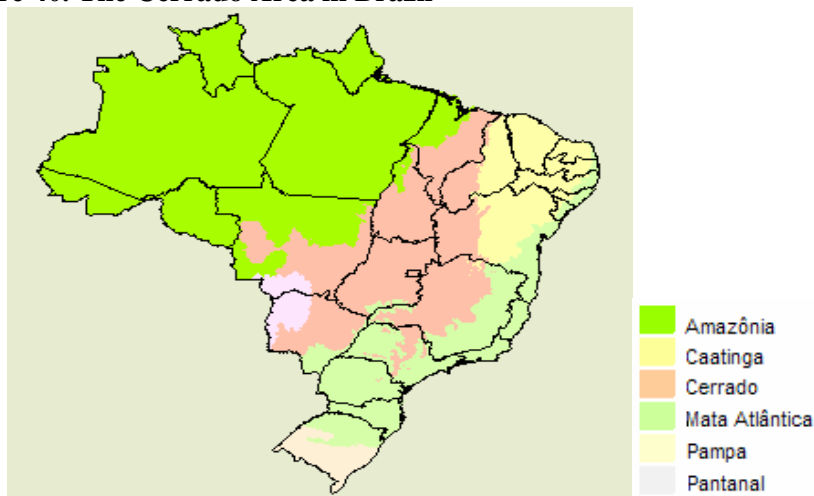
<sup>63</sup> Reis, M.R.; Da Cruz, C.A.; Paiva, R.M.; Patrick, G.F. 1973.

<sup>64</sup> Machado, R.B.; Ramos Neto, M.B.; Pereira, P.G.P.; Calda E.F.; Gonçalves, D.A.; Santos, N.S.; Tabor, K.; Steininger, M. 2004.

<sup>65</sup> Coutinho, L.M. 2006.

Dominium area as approximately 1.5 million square kilometers or 2 million square kilometers if considered transition strips, adding up to 23% of Brazil's territory. The Environment Ministry<sup>66</sup> estimates the Cerrado area to be 2.047 million square kilometers (2.047 millions hectares), following the Coutinho's second criterion.

**Figure 40. The Cerrado Area in Brazil**



Source: IBGE, 2005<sup>67</sup>.

### 2.2.2. Geology, topography and soil

According to Coutinho, half the Cerrado area is located between altitudes of 300m and 600m above the sea level; only 5.5% reach beyond 900m. The highest points are the Itacolomi Peak (1797m) of the Espinhaço Mountain (2070m) and the Sol Peak (2070 m) of the Caraça Mountain. Most of the bioma does not go beyond 1100 meters.

According to Reis et al., in Minas Gerais, Mato Grosso and Goiás topography is mostly plain with little undulation (ancient basaltic sediments or Pre-Cambian crystalline rocks). Technical recommendation was that the Cerrado area could be submitted to intensive mechanization thanks to its non-restrictive topography and soil physical characteristics. Around a hundred million hectares (half the cerrado's area) have these characteristics and, therefore, are

<sup>66</sup> Ministério do Meio Ambiente. Mapa de Cobertura Vegetal dos Biomas Brasileiros: Cerrado (versão preliminar). <<http://www.mma.gov.br/index.php?ido=conteudo.monta&idEstrutura=72&idMenu=2338&idConteudo=4472>>.

<sup>67</sup> Instituto Brasileiro de Geografia e Estatística – IBGE. (<http://www.ibge.gov.br/home/>).

indicated for agriculture (PNUD<sup>68</sup> (KK)). See Figure 21.

For Coutinho, deep Latosols dominate the Cerrado fields; coloration varies from red to yellow and soils are friable and porous. The soil grain structure permits high permeability. Other soil characteristics include: very leached, poor in absorbable phosphorus, low to medium nitrogen and changeable potassium availability and low or very low changeable calcium and magnesium. Water retention capacity is low and organic-matter content is between 3% and 5%. Clay and silte dominate the soil texture.

The Cerrado soils are very acid - pH between less than 4 and little above 5 – and improper for agriculture unless when corrected by lime and fertilizer (micro and macronutrients) application. Then grains like soybeans, corn, beans, and fruits like mangoes, avocado, pineapple, orange can be produced successfully.

Table 21 presents a detailed classification of the principal Cerrado soils with emphasis on the latosol type that is present in almost half the Cerrado area and most relevant for agriculture. These latosols are acid (pH between between 4.0 and 5.5), their fertility is low, and are poor in phosphorus. However, it is easily corrected by agricultural techniques, like fertilization. Diniz mentions that red latosol (Oxisol) is best suited for agriculture.

The Acrisol soil, found in 15% of the Cerrado, is proper for agriculture as well, but its fertility is too variable. This soil is spread over many small areas far apart from each other what makes it improper for mechanization. The Entisol is not recommended for agriculture because it is susceptible to erosion and presents low fertility, loss of organic matter and low water retention.

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<sup>68</sup> Programa das Nações Unidas para o desenvolvimento – PNUD, 1999.

**Table 21 – Cerrado Soil Classes**

Embrapa's Classes	Estimated Occurrence (%)
<b>Latosols</b>	<b>45.7</b>
• <i>Oxisol</i>	22.1
• <i>Ultisol</i>	21.6
• <i>Yellow</i>	2.0
<b>Entisol</b>	<b>15.2</b>
<b>Acrisol</b>	<b>15.1</b>
• <i>Loamy Acrisol</i>	6.9
• <i>Oxisol</i>	8.2
<b>Plinthite</b>	<b>9.0</b>
• <i>Argiluvic and Haplic</i>	6.0
• <i>Petroplinthite</i>	3.0
<b>Typical Endoaqualf</b>	<b>2.5</b>
<b>Gley</b>	2.1
• Low Humic Gley	0.2
• Humic Gley	< 0.1
• Alluvial Soil	< 0.1
• <i>Bog Organossolo Mésico</i>	
<b>Litolic</b>	<b>7.3</b>
<b>Others</b>	<b>5.2</b>
<b>Total</b>	<b>100</b>

Source: Correia et al., (2004), citado por Diniz (2006).

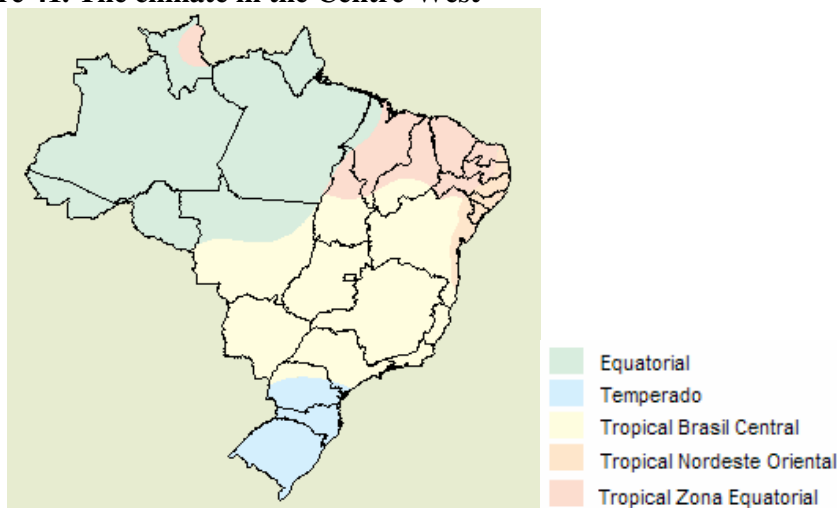
### 2.2.3. Climate and meteorology

Atmospheric conditions in the Cerrado are determined by inter-reaction of the (a) Equatorial Continental mass from the Amazon, (b) Tropical Atlantic mass from the high pressure area of the South Atlantic Ocean and (c) cold air mass from the Antarctic Continent. See figure 41. The Tropical climatic region is the most important one, extending from Minas Gerais to Mato Grosso and Goiás. It includes two subdivisions: Warm Tropical region (temperature in the coolest month above 14°C) and Mild Tropical (temperature in the coolest month under 15°C).

The tropical climate presents two well-defined seasons: humid summer (October to March) and dry winter (when spontaneous fire tend to occur).

As Coutinho indicates the average annual temperature lies within 22°C and 23°C. Monthly maximum temperatures do not oscillate much along the year and can get above 40°C. The minimum temperatures, however, present wide oscillation reaching below zero levels between May and July.

**Figure 41. The climate in the Centre-West**



Source: IBGE, 2005.

Rainfall is concentrated in the spring and summer (October to March) but short dry periods may occur during these seasons with harmful effects on agriculture. From May to September rainfall decreases severely approaching zero.

Barreto et al refer to a study indicating that the substitution of pasture for forest changes the soil-plant atmosphere interactions affecting the local microclimate. Data collected over a 10-year-period in the Amazon showed that rain occurrence in forest area is 28% higher than in pasture lands. He also refers to researches detecting an increase in soil surface temperature, a reduction in total rainfall and evaporation and longer dry seasons resulting from deforestation.

## 2.2.4 Vegetation

For Diniz the Cerrado term is too generic to characterize the vegetation; it really emphasizes soil and climate conditions. Nevertheless the Cerrado presents some peculiar characteristics that make its vegetation different from those of other types of soils (especially those of the forest). Most of the vegetation is similar to the savannah, with grass, shrubs and sparse trees. These trees are relatively short (less than 20 meters high), with twisted stems and branches and deep roots, which allow access to water below two meters depth even in the dry season.

Coutinho points to two antagonist vegetation strata: trees and shrubs, on the one side, and herbs and sub-shrubs, on the other. Though incompletely known, the Cerrado flora is enormously rich: 3000 species, - 1000 of them in the trees and shrubs stratum and 2000 in the herbs and sub-shrubs stratum. There is a strong competition between these strata for the limited available space. In addition, they differ not only with respect to biological spectrum but also regarding their flora, root depth, soil exploration, behavior towards drought, fire, etc. Between these two strata, there are a variety of intermediary forms with savannah physiognomy. Herbaceous and sub-shrubs have underground subsistence organs that warrant survival to drought and fire. Roots are superficial, less than 30 centimeters deep. Branches are annual, drying out and dying in the dry season resulting in tons of easily flammable straw each year.

In 2006 the Environment Ministry started to release preliminary results of a research on the remnant vegetation of the Cerrado. Landsat (ETM+) satellite 1:250000 scale images were used.<sup>69</sup> (LL). According to this research, the Cerrado remnant vegetation corresponds to 61.1% of the original one, a percent higher than reported by previous studies, like the 45% of the International Conservation by Machado et al. Spatial resolutions may explain different results according to the ministry's study. However, it is worth mentioning that the difference between studies may be the result of including 28 millions hectares of native pasture as Cerrado remnant: if this area were considered as submitted to anthropic use the remnant area would fall to 48%.

Table 22 reports the percents of Cerrado remnant areas by state: São Paulo, Paraná e Mato Grosso do Sul presented the lowest indices<sup>70</sup>. Northeastern and Northern states presented the highest indices.

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<sup>69</sup> Ministério do Meio Ambiente, dez. 2006.

<sup>70</sup> Kronka reports a 14% remnant área index for São Paulo.

**Table 22 - Percent of Cerrado Remnant Area - 2006**

<b>State</b>	<b>Original covering of bioma (%)</b>	<b>Remnant Área (%)</b>
São Paulo	33	15
Paraná	2	31
Mato Grosso do Sul	61	32
Goiás	97	46
Distrito Federal	100	51
Minas Gerais	57	53
Mato Grosso	40	66
Bahia	27	73
Tocantins	91	82
Maranhão	65	89
Piauí	37	92
Total		61,1

Source: Ministério do Meio Ambiente

Figure 42 shows Cerrado remnant areas according to hydrographic basins. The Paraná basin presents a low level of Cerrado remnant bioma (33%) while the Atlantic Basin presents the highest preservation level (91%).

**Figure 42 - Percent of Cerrado Remnant Area according to Hydrographic Basins**



Source: Ministério do Meio Ambiente

### 2.2.5. Fauna

Data from ISA indicate that around one third of Brazil's biodiversity and 5% of the world fauna (837 bird species, 161 mammal genders, 150 amphibious species e 120 de reptiles) live in the Cerrado. It stands as the fourth world birds' diversity area and the eighth in amphibian species.

According to AmbienteBrasil<sup>71</sup> (MM) the Cerrado's fauna is little known, however. Only recently scientific work on this matter has begun to be done. The high variety of environments permits a large diversity of species and a real abundance of individuals, some with specialized adaptations to specific habitats. AmbienteBrasil reports that currently 1575 animal species are known in the Cerrado, forming the second largest animal set in the world.

Due to intense human action the Cerrado suffered large changes in the habitats putting – according to AmbienteBrasil - some species under the threat of extinction: great anteater (tamanduá-bandeira), monkey, tapir, Brazilian wolf (lobo-guará), Brazilian Merganser (pato-mergulhão) and falcon (falcão-de-peito-vermelho), Brazilian three-banded armadillo (tatu-bola),

<sup>71</sup> AmbienteBrasil, 2007.

giant armadillo (tatu-canastra), Pantanal's deer (cervo), vinegar dog (cachorro-vinagre), spotted jaguar (onça-pintada), Brazilian otter (ariranha) and river otter (lontra).

### **2.3. Impacts of Agriculture on the Environment**

Diniz emphasizes that the Cerrado's production expands in the direction of better suited lands conditioned to the transport and infrastructure availability so production can be shipped out to urban centers and export ports.

As discussed by Barreto et al the system of extending the agriculture frontier is based on the same thirty-year-old methods. In general the wood products business opens the area selecting economically valuable species for special uses. The machine work, the three falls and extraction result in soil movements and eliminate most of the vegetation. Then comes the so-called "correntão" (large chain): two parallel tractors linked by a 20- meter chain or steel-cable pull the threes with the roots out of the woods. Next, fire is set to free the area for pasture seeding or cropping.

Large scale and high technology farming became the dominant Cerrado model since the seventies. Negative environment impacts of intensive soil operations and high use of chemical have been observed in the soil, water, biodiversity and in the forest.

#### **2.3.1. Deforestation**

Programs designed to promote agricultural development have generated expressive environment degradation. INPE (National Space Research Institute), as reported by Barreto et al, indicates that deforested area in Mato Grosso increased from 920000 hectares in 1975 to 6 million hectares in 1983, the period of heaviest effort to develop the state.

In 2003, the Xingu Indian Land Association (ATIX)<sup>72</sup> carried out a checking expedition to evaluate the soybean area in the neighborhood of that Indian reservation, according to which most of the deforestation – especially of the Cerrado-Amazon transition forest – was related to the expansion of the soybean production either directly or indirectly, that is, after cattle ranching. However, cattle ranching really dominates the occupation of the lands in the east Mato Grosso

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<sup>72</sup> More details in Barreto et al.

according to EMPAER- Mato Grosso Rural Assistance Enterprise (Empresa de Assistência Rural do Estado do Mato Grosso).<sup>73</sup> From 1994 to 2000, deforestation in that state (excluding the Xingu Park) increased by 40% from 23800 square kilometers to 33700 square kilometers. As a consequence one third of the natural vegetation disappeared. In addition INPE's data, presented by Barreto et al, show that the Xingu basin deforestation reached 2.9 million hectares in year 2000, falling to 238000 hectares in 2001 and keeping a decreasing trend thereafter.

As soils degrade beef cattle profitability falls; farmers will then probably decide to move to soybean production if the market conditions are favorable.

Recently the environment ministry released new data on deforestation in the Legal Amazon (Northern Region plus Mato Grosso and a large portion of Maranhão, a northeastern state)<sup>74</sup>. See figure 43. In the twenties, after reaching a peak in 2003/04 (27,400 km<sup>2</sup>), deforestation has been falling, reaching 11,200 km<sup>2</sup> in 2006/07. These welcome results are attributed to better monitoring and control. Since 2003, one million m<sup>3</sup> of timber have been apprehended, fines of R\$3 billion (US\$ 1.5 billion) have been applied, 650 people (20% of which public servants) have been arrested, 1500 companies were closed and hundreds of trucks, tractors and tree-saws were apprehended. Current number of conservation unities reached an area of 4990 km<sup>2</sup> in 2007 (39% after 2003). Interestingly, deforestation in Mato Grosso which peaked in 2003 (14,400 km<sup>2</sup>) was reduced to 2,500 km<sup>2</sup> in 2007.

### **2.3.2. Soil degradation**

Study cited by PNUD reports that an important environment impact is the soil degradation. According to study, areas appropriate for agriculture were inadequately explored, resulting in soil degradation and erosion.

Specifically related to soil degradation, available literature presents different estimates. It should be emphasized, however, that impacts on the soil depend on crop practices. As reported by Barreto et al, the no-tillage system losses of soil are close to 40% less than the conventional system losses. Rodrigues<sup>75</sup> (NN) estimated that the conventional system generates erosion 300% higher than the no-tillage system. In addition, since little crop rotation – as in the case

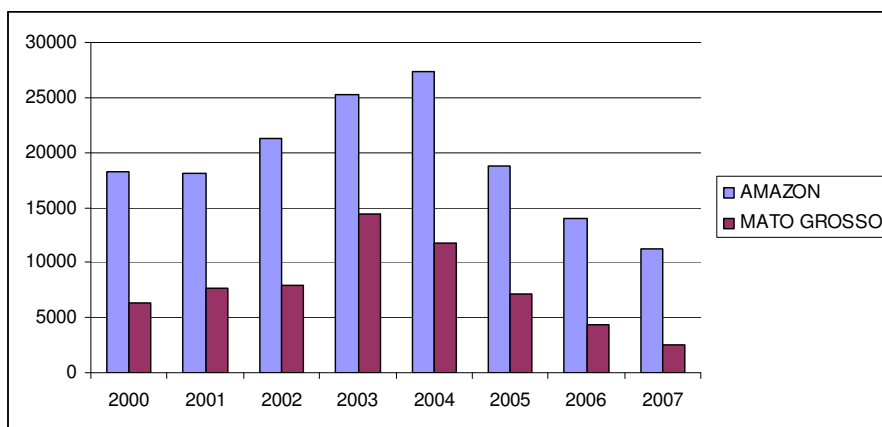
<sup>73</sup> [www.socioambiental.org/esp/soja/](http://www.socioambiental.org/esp/soja/)

<sup>74</sup> [http://www.mma.gov.br/estruturas/imprensa/arquivos/relat\\_desmat\\_amazonia\\_2006\\_2007.pdf](http://www.mma.gov.br/estruturas/imprensa/arquivos/relat_desmat_amazonia_2006_2007.pdf). The measurement goes from August of previous year to August of current year.

<sup>75</sup> Rodrigues, W. 2005.

monocultures – demands more agrochemicals, it is associated with large water contamination and biodiversity losses.

**Figure 43. Deforestation in Mato Grosso and Legal Amazon (km<sup>2</sup>)**



Source:MMA

The Conservation International presents estimates that soybean traditionally cultivated causes soil losses of 25 ton/hectare/ year<sup>76</sup> (OO). If minimum tilling were applied losses would be reduced to 3 tons/hectare/year. An Environment Ministry study<sup>77</sup> (PP) indicates land use in the Cerrado – mainly with soybeans – has caused soil loss of 20 tons/hectare/year or 1 billion tons per year. A PNUD study indicates that each kilo of soybeans corresponds to a loss of 10 kilos of soil; for cotton, each output kilo implies a loss of 12 kilos of soil<sup>78</sup> (QQ). WWF estimates reported by ISA indicate that each kilo of grain produced leads to a soil loss between 6 and 10 kilos.

A study cited by PNUD reports that the conventional system provokes carbon loss, CO<sub>2</sub> emissions and land surface warming by the exposition to solar radiation, contributing to the global warming.

<sup>76</sup> Conservation International. 1995.

<sup>77</sup> Ribemboin, J. 1997.

<sup>78</sup> PNUD, 1996.

### 2.3.3. Water Resources

The relevance of the Cerrado as far as water is concerned can be evaluated by the fact that three important hydrographic basins – Amazon, São Francisco and Paraná - have their sources in that area<sup>79</sup> (RR).

The predatory management of the natural resources and deforestation, according to Barreto et al, are causing river sedimentary deposits, provoking water scarcity and reduction of water quality. Since the seventies and up to the nineties impacts on water were associated to livestock production in area surrounding the Xingu Indian Park accompanied by forest loss and destruction of riparian vegetation. No hard data on these phenomena are available to permit any generalization, however.

As soybean production expanded the presence of agrochemical in water is cause of major concern because water quality changes are difficult to be measured due to scarcity of research on contamination: there is need for laboratories equipped with specific resources. Barreto et al also mention the absence of surveys on the presence of chemical in regional rivers, so that much of this matter is really unknown so far.

Water contamination by agrochemicals may take two forms. In the Cerrado areas - dominated by soils of high erosion and lixiviation potentials - agrochemicals that contaminate their upper layers are carried by the rain showers into the rivers. In the so-called transition forests with Red-Yellow Latosol (Ultisoil) the rain takes the agrochemicals down the soil so that accumulation occurs in the groundwater. Once again it should be reminded that no hard evidence is available on the real extent of water contamination in the Cerrado.

Last, but not least, high consumption of water for irrigation is leading to conflicts among users as water supply gets critical in low rain seasons. The agricultural sector is in fact the largest consumer of water in Brazil: 59% versus 22% in urban structures and 19% in industries<sup>80</sup> (SS). According to Resck, total Brazil's irrigated area adds up to 2.95 million hectares – 7% of the country's agricultural area. The Cerrado contains 40% of national irrigated area, followed by the Southeast (35%), South (15%) and Northeast (10%). So far there is no extensive evaluation of the impact of farming upon water availability in the Cerrado.

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<sup>79</sup> Instituto Brasileiro De Geografia E Estatística – IBGE.2006.

<sup>80</sup> Pádua, J.A., 1999.

### 2.3.4. Air Quality

According to Ribeiro & Assunção<sup>81</sup> (TT) the impacts of gas emissions due the combustion of biomass are still to be well evaluated, especially in Brazil. It is a fact that a significant number of people are affected particularly in developing countries, where forest and “Cerrado” burning is a usual agricultural practice. In addition, involuntary forest and cerrado fire is quite frequent in low-rain seasons. Among the typical consequences they mention: drastic reduction of visibility with airports and schools being eventually closed, increase in the occurrence of accidents, destruction of the biota, higher incidence of diseases, reduction of productivity, restriction both to leisure and work and other economic costs.

During biomass burning several classical pollutants are emitted: Nitrogen oxide (NOx), CO, HC and particulated matter, in addition to other highly toxic substances. It should be mentioned, however, that the concentration of classic pollutants – with the exception of particulated matter - has been below the limits recommended by the International Health Association and adopted in Brazil.

EMBRAPA<sup>82</sup> (UU) verified that beef cattle were responsible for 82% of methane emission from intestinal fermentation by ruminants in 1994. The milk cattle’s figure is 14%. With regard to methane emission related to deject disposal, beef cattle was responsible for 53% and milk cattle for 17%. Mato Grosso do Sul and Minas Gerais are by far the largest sources of the emissions.

To analyze emissions of CO<sub>2</sub> the Science & Technology Ministry<sup>83</sup> (VV) evaluated the net emissions related to land use change (conversion of forest into cropland and pasture) from 1988-1994. The Amazon bioma was indicated to be responsible for 59% of the emissions, while the Cerrado bioma was responsible for 26%.

### 2.3.5. Intended and Accidental Fire

As reported by an IPEA study<sup>84</sup> (WW), the use of fire is a traditional supposedly private cost-reducing practice in the Amazon. Farmers apply this practice every year by the end of the dry season as a means either to convert forest land into crop or pasture land or yet to control proliferation of undesired plants. Fire is commonly used to stimulate the growth of grass and to

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<sup>81</sup> Ribeiro, H., J. V Assunção. 2002.

<sup>82</sup> Embrapa. 2006.

<sup>83</sup> Ministério de Ciência e Tecnologia – MCT. 2006.

<sup>84</sup> Motta, RS.and others 2002.

burn shrubs that invade pasture. In addition to its usual controlled expansion, accidental fire is quite frequent in the dry season with consequent losses in terms of crops, pastures, farm facilities – especially fences - as well as harm to human respiratory system plus carbon emissions.

In addition to its usual controlled expansion, accidental fire is quite frequent in the dry season with consequent losses in terms of crops, pastures, farm facilities – especially fences - as well as harm to human respiratory system plus carbon emissions. IPEA reports that 16% of the area hit by fire in Amazon frontier was affected by fire intended to burn the forest. The remaining is due to fire intended or accidental that hit crops and pastures. Accidental fire is responsible for a total annual farm loss of US\$27 million to US\$68 million, according to IPEA.

Forest fire has been increasing over the last 15 years as the forest is subject to occupation. The “El Niño” climatic phenomenon is associated with occurrence of fire in the forest: the loss in marketable wood value was estimated in US\$13 million in 1998 (an “El Niño” year) and in US1 million in 1995, when the phenomenon was not observed.

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IPEA estimated that annual costs from accidental or intended fire in the Mato Grosso region are around US\$ 102 million. This value can be 45 times higher, depending on how it is calculated.

Carbon (CO<sub>2</sub>) emission of around 200 million tons takes place each year as a result of Amazon deforestation representing 2.5% of the global emission. In 1998, 26200 square kilometers of forest were burned in the Amazon compared to 1800 square kilometers in 1995. CO<sub>2</sub> emission was estimated between 36 million tons and 472 million ton in 1998 and 3 million tons and 29 million tons in 1995. The monetary costs of these emissions were estimated between US\$126 million and US\$9.4 billion in 1998. In 1995 the values were between US\$10 million and US\$572 million.

In terms of impacts on human health it was estimated that 6% of the hospitalization cases

– 9300 people - were attributed to farm and forest fire. This is a conservative estimate since it refers only to respiratory problems.

In summary, the IPEA study finds that economic costs of fire in the Amazon total from US\$102 million to US\$5 billion including farm and forest losses plus respiratory diseases and carbon emissions.

Other costs should be taken into account as well. Land and air transportation both are affected negatively by smoke produced by in farms fire. Fire is also associated with vegetation loss and exposure of the soil to erosion and river sedimentation besides increasing the occurrence of floods.

The interaction of each farm activity with the Cerrado environment is discussed below.

### **2.3.6. Beef Cattle**

Shiki notes that beef production was one of the first activities to occupy the Cerrado. Particularly the native fields and shrubs areas were used – after setting fire – with extremely low rate of animal density. Planted pasture expanded in the seventies with the introduction and expansion of *Brachiaria* grass, in general following a rice crop as part of the clearing process of Cerrado natural vegetation. The rice revenue helped to finance the clearing and grass planting activities.

According to ISA, beef cattle production is the major cause of new deforestation. Although this line of causation has been put into question by recent analysis, ISA argues that in Goiás, for example, 87.4% of deforestation authorized by the state environment agency in 2001 was for cattle ranching. Diniz points out that usually cattle ranching spreads over wide areas because, unlike agriculture, it can be developed in less fertile lands with lower infrastructure availability. Usually cattle ranching was seen as a means to open new areas, before the agricultural use or yet to rotate activities to avoid falls in productivity.

Shiki mentions reports informing that through adoption of planted pasture animal density has risen from 0.2 Animal Unity /ha/year to 1.2 AU/ha/year. Productivity has increased by 20 kg/ha/year to reach 200 kg/ha/year despite the fact that the production system has remained extensive and highly dependent on natural fertility. However, Shiki also presents indications that beef cattle production may be getting into a productivity-related crisis because of soil exhaustion and degradation. He presents estimates showing that – at the current pasture degradation stage – sustainable animal density would not be higher than 0.8 AU/ha/year with productivity of 40

kg/ha/year. The productivity of large degraded pasture areas would be comparable to the level obtained in natural pastures (0.2 AU/ha/year); at this phase soils would present desertification signs, with ravine, gullies (voçorocas), high occurrence of termites and infesting plants. Pest infestation such as the spittlebug (cigarrinha das pastagens) is aggravated by soil degradation.

In addition, forage scarcity forces expansion of the pasture into gallery forests, palm savannahs (veredas), micro-relieves (covoais) truly water deposits thereby affecting the cerrados' water system.

To analyze the important subject of whether cattle growing is a profitable business by itself or an accessory activity to follow deforestation and antecede soybean cropping the Center for Advanced Study on Applied Economics (CEPEA)<sup>85</sup> (XX) of the University of São Paulo proceeded to an Amazon field survey to gather farm data. The results of an optimization analysis<sup>86</sup> (YY) indicate that beef cattle production is a profitable activity independent of previous deforestation revenues. Indeed in the Mato Grosso “Deforestation Arc” a 14.5% rate of return on beef cattle growing was estimated. See table 23. Rates of return on beef cattle tended to be higher in the Amazon and nearby regions because it occupies rocky and undulated area where crops do not do well. In addition, beef cattle are relatively low risk business and warrant a stable cash flow to farmers.

**Table 23. Internal Rate of Return on Beef Cattle Investment –2002**

Municipality/State	IRT
Paragominas –Pará	11.0
Redenção – Pará	9.1
Alta Floresta – Mato Grosso	14.5
Ji-Paraná – Rondônia	11.5
Tupã – São Paulo	6.4

Source: Cepea

Optimization was applied only to the Paragominas region where - because of the level of farm development and favorable weather and soil conditions – interaction between annual crop activities (maize, soybean and rice) and cattle growing was observed. The typical farm can be

<sup>85</sup> Zen, S, S.M. Ichihara, G.S.A.C. Barros, M.R.P.Bacchi. 2002.

<sup>86</sup> Cepea. 2002.

associated with net income of R\$900,000. The optimized farm had: 528 ha for rice, 1185 ha for soybean, 547 for maize, and 1124 for pasture. The remaining 11,163 ha of forest were not explored.

To estimate the value of forest to farmers, successively increasing values per hectare of forest were simulated until the forest area begins to expand into the other activities areas. In the model where risk is not considered, that value was found to be R\$200 or US\$96 per hectare. When risk is considered, the value falls to R\$45 or US\$22. Under risky condition, cattle are preferred because of its low risk profile. In other words, the beef production activity is capable of paying market prices for the land it uses.

This study leads to the conclusion that beef production is an economic activity that is profitable by itself. The direct association between cattle ranching and deforestation rests on the hypothesis that the first was not profitable and that the sale of products from the forest were necessary to make the combined business viable. Therefore deforestation are primarily motivated by the revenue from timber sale while beef production is part of a profitable portfolio of activities that include several crops.

### **2.3.7. Soybean-Corn**

Soybean production has been growing vertiginously. As indicated by Diniz, between 1961 and 2003, world soybean land productivity rose from the average of 1.1ton/ha to 2.3 ton/ha. In Brazil, the productivity gain was even higher: from 1.6 t/ha in 1975 to 2.8 t/ha in 2003. Corn production already was expressive in 1975 and spatially it followed the soybean expansion profiting from soils best suited for agriculture.

The soy-corn system – according to Shiki - was intensive from its beginning in the Cerrado as it imported genetic and nutrition technical advances from the South and Southeast. Tractor mechanization - from planting to harvest, including pulverization, fertilization and other cropping practices - leads to high labor productivity. The technological process is based on continuous generation of new seeds highly responsive to chemical fertilizer but very susceptible to pests and diseases to be controlled by genetics and chemicals. It is a high energy-consuming system, which is compatible with medium and large farms developed in the latosoils of the Cerrado plateau.

Small farmers in many cases are pushed into less fertile lands with undulated and hilly

topography and, therefore, improper for mechanization. It should be noticed that small farmers also contribute to environment deterioration. Pádua, for instance, mentions the deforestation carried out by the official land settlements. He is very critical of what he calls the “insistence” in settling farmers in the Amazon region. Viana<sup>87</sup> (<sup>ZZ</sup>) estimates that up to 1997 88.4% of the distributed land was located in that region. Pádua concludes that “it would be hypocritical to think that workers settled on areas with large forest coverage would not carry out deforestation”.

More recently a new system - based on the corn crop production following the soy production – is being used. The corn “safrinha” (small harvest – an improper term as the crop tends to strongly increase over time - or “second crop”) is the cultivation of that product off the normal season, that is, from January to April after the spring-summer (soybean) crop season. Tsunehiro et al<sup>88</sup> (<sup>AAA</sup>) show that the Brazil’s “second crop” corn output increased by 269% in the 10-year period to 2005. In that period yields rose by 66% nationwide. In Mato Grosso the output growth almost reached 1000% and yield 97% (table 24).

For Shiki the second harvest is of course a significant intensification of the use of land. The consequences for the soil obviously are compactation and surface and ravine erosion. The response to these new challenges was the introduction of the no-tillage system also imported from the South. This system had been tried before early in the eighties, as mentioned by Rodrigues<sup>89</sup> (<sup>BBB</sup>), but then it was found economically unviable. Latter in the nineties as the herbicide prices went down, the no-tillage system costs became closer to conventional system costs.

The system expanded rapidly in Brazil, having reached 22 million hectares in 2004, according to the No-Till Federation<sup>90</sup> (<sup>CCC</sup>). Available research points to a substantial reduction of erosion to 2ton/ha/year under the no-tillage system for a soil declivity of 5.5%. Maybe the more attractive advantage of the system to farmers is the cost reduction it brings: less tractor use and lighter equipments. Fossil fuel use is reduced although the herbicide use is increased. To make no-tillage planting systems work, special consideration must be given to controlling weeds and insects, fertilizer placement, monitoring soil temperatures and moisture, machine management and other factors, all in a slightly different way than when tillage is also a part of the crop production system<sup>91</sup> (<sup>DDD</sup>). Still another move towards crop intensification – with the

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<sup>87</sup> Viana, G., 1998.

<sup>88</sup> Tsunehiro, A., Ferreira, C. R. R. P.2005.

<sup>89</sup> Rodrigues, W. 2005.

<sup>90</sup> Federação Brasileira de Plantio Direto na Palha. 2004.

<sup>91</sup> University of Missouri Extension. 1997.

central pivot system - came up with the introduction of irrigation to produce beans, peas or other short-cycle crop in the reserve area during the long dry season<sup>92</sup> (EEE).

**Table 24. Planted Area, yield, and production: “Second Crop Corn” 1992-95 e 2002-05**

State	Period	Area	Yield	Production
		1.000ha	kg/ha	1000t
Paraná	1992-95	537,5	1.910	983,3
	2002-05	1.002,7	2.867	2.946,5
	Var. %	86,5	50,1	199,7
Mato Grosso	1992-95	120,9	1.695	219,9
	2002-05	718,7	3.338	2.398,6
	Var. %	494,7	96,9	990,8
Mato Grosso do Sul	1992-95	168,2	1.396	223,5
	2002-05	476,0	2.673	1.314,8
	Var. %	182,9	91,4	488,3
Goiás	1992-95	69,4	2.313	160,6
	2002-05	225,6	3.878	874,7
	Var. %	225,1	67,7	444,5
São Paulo	1992-95	347,4	2.075	719,3
	2002-05	329,4	2.618	864,1
	Var. %	-5,2	26,1	20,1
Brazil	1992-95	1.423,9	1.692	2.408,0
	2002-05	3.123,8	2.815	8.882,0
	Var. %	119,4	66,4	268,9

Source: IBGE.

Rodrigues estimates that the no-tillage system raises soybean production costs by 0.5%, but, at the same time, reduces environmental costs by 81%. For corn production costs fall by 5.9% when no-till system is used while environmental costs reduce by 29%. This information suggests that for corn no-tillage system is recommendable not only for economic efficiency reasons but also from the sustainability standing point.

Table 25 shows the expressive growth of the no-till system in Brazil and specifically in the Cerrado. Since 1990 to 2000, the no-tillage area grew 13.5 times to 13.5 million hectares in Brazil, while in the Cerrado it increased 22 times to 4 million hectares. So, in 2000, 30% of Brazil's no-tillage area was in the Cerrado.

<sup>92</sup> Landers, J.N. 2005.

**Table 25. No-Till Area in Cerrado and in Brazil, 1974-2000**

<i>Year</i>	<i>Cerrados(a)</i> <i>(ha)</i>	<i>Brazil(b)</i> <i>(ha)</i>	<i>a/b</i> <i>(%)</i>
1974/75	-	8000	-
1976/77	-	57000	-
1978/79	-	54000	-
1980/81	-	205000	-
1982/83	500	260000	0.2
1984/85	2000	500000	0.4
1986/87	9000	n.d.	nd
1988/89	35000	n.d.	nd
1990/91	87000	1000000	87
1991/92	180000	1350000	13.3
1992/93	270000	nd	nd
1993/94	420000	3000000	14.0
1994/95	930000	3800000	24.5
1995/96	1500000	4500000	33.3
1996/97	1938000	7900000	24.5
1997/98	2670000	10100000	26.4
1998/99	3402000	12100000	28.1
1999/00	4000000	13470000	29.7

Source: Landers and FEBRAPD

On the negative side, as production is intensified, the new system brings about a homogeneous and simplified ecosystem that could permit the surge of opportunistic species: usual insects may turn into economically important pests; or bacteria, viruses or fungi normally present may become recurrent diseases. The intense use of chemicals for pests and diseases would tend to demand ever-increasing doses as resistance augments. In addition. Hard evidences on these points are not available, however. But it is a fact, as reported by Embrapa<sup>93</sup> (FFF), that the “second crop” corn is harming the soybean Asian rust control, not only increasing the risk intensity of incidence but also turning the controlling procedures hard to implement. As the process advances the risk of soil, water and produce contamination increases resulting in additional ecological disequilibria.

Table 26 indicates that in 24 years to 1994 the Cerrado cropland increased from 4.1 million hectares to 11.5 million hectares. Planted pasture evolved from 8.7 million hectares to 46.4 million hectares. At the same time unused land already incorporated into farms grew from 7.5 million hectares to 11.6 million hectares - more than the area of the state of Paraná.

<sup>93</sup> VII Conferência Mundial de Soja, IV Conferência Internacional de Processamento de Soja e III Congresso Brasileiro de Soja. 2004.

**Table 26 – Occupation of Cerrado Areas (million hectares)**

	1970	1980	1994
Crops	4,1	7,9	11,5
Planted Pasture	8,7	21,7	46,4
Unused Occupied Land	7,5	9,6	11,6
Total Occupied	20,3	39,2	69,4

Source: Shiki

### 2.3.8 Milk and Staples

The focus here is upon family farming. According to Shiki, as land became scarce in the South and Southeast, family farmers have headed to the Cerrado since the 1960s looking for sparse spots of lands minimally suited for food production. Many times they were involved in violent conflicts with either “grileiros” or “posseiros” or Indians.

The family production system has been the big pioneering force in opening up and occupying new areas. A significant part of milk, rice and beans supply to large urban centers originates from that system: first a small area is cleared for the production of food grain taking advantage of natural land fertility for both self-consumption and money income through sale of the excess over consumption. As a rule soil fertility is exhausted after a three-to-five-year period when cropping is no longer viable so the land is turned into pasture.

At first, the core business becomes the sale of grain and male animals with increasing importance of the latter, as the farm soils loses fertility. Milk production may appear at the mature phase specially when the farm is located close to urban areas with minimum infrastructure. In general these farms have degraded pasture, unless resources are provided for upgrading the system: rotational grazing, fertilization, chopped fresh forage and silages, genetics improvements with the Girolando (holstein and gir crossbreds). According to Shiki the actual system presents low resilience capacity and the challenge of how to progress to another system remains unsolved.

## 2.4. Concluding Remarks on Environmental Issues

According to several authors, extending the agriculture frontier in the Cerrado anchored on Green Revolution practices and stimulated by fiscal incentives and cheap credit provoked a series of negative environmental impacts. But most of effects reported have no ground on hard evidences neither permit generalization for the whole Cerrado area; that is, data are missing in most of the cases discussed in the literature.

Although it is an unproved matter that deforestation, for instance, is caused by crop or beef cattle activities, there evidences that both may carried out in the Center West in economically sound basis. It is estimated that about 17 percent of the opened area (half the size of the state of Paraná) is currently abandoned. This illustrates the lack of concern of farmers as to the maintenance of the soil quality: land (the major asset to many farmers) is used up to exhaustion and that does not take a long time. There is available technology to circumvent these problems through no-tillage systems and pasture-crop integration/rotation.

It is true that there are the environmental risks in the Cerrado: illegal deforestation, unwanted and intentional burning, river sedimentary deposits, provoking water scarcity and reduction of water quality, air pollution (nitrogen oxide (NO<sub>x</sub>), CO, HC and particulated matter, in addition to other highly toxic substances). However, many studies have to be done before conclusive statements can be made.

IPEA estimated that annual costs from accidental or intended fire only in Mato Grosso are around US\$ 102 million, a very conservative figure. In terms of impacts on human health it was estimated that 6% of the hospitalization cases – 9300 people in 1998 - were attributed to farm and forest fire. This is also a conservative estimate since it refers only to respiratory problems. In addition, studies warn for the high level of the CO<sub>2</sub> emissions and role of the Cerrado in this matter.

Beef cattle and soybean are taken by many analysts as the villains in the Cerrado story. Nonetheless beef cattle have been shown to be a profitable activity apart from deforestation revenues. There evidences that beef cattle alone are yet responsible for 82% of methane emission from intestinal fermentation by ruminants and milk cattle for 14%. With regard to methane emission related to deject disposal, beef cattle was responsible for 53% and milk cattle for 17%. However, it should be kept in mind that these livestock effects are not related to the Cerrado occupation properly, but occurs wherever these activities takes place.

As for crops, soybean and corn in successive activities have permitted to use the same land tract twice. That is a highly intensive use of land with possible harmful environment consequences. On the positive side the accelerated expansion of the no-tillage system is a significant case of success of an environment-friendly practice. High intensity in land use is also a substitute for deforestation.

The family production – usually a socially sympathetic production system - has been the big pioneering force in opening up and occupying new areas. In reality it is viable while natural land fertility maintains. However, as a rule soil fertility is exhausted after a three-to-five-year period when cropping is no longer viable. The survival rule is to go after new land with the well-known consequences.

The increase of the number of National Parks, Ecological Stations and Environment Protection Areas, mainly in the two last decades, demonstrates that preserve the native fauna and the flora of Cerrado is receiving support of the public sector. The forest and environment laws and the monitoring of their enforcement – so as to internalize these externality costs - are important instruments to guarantee the sustainable production and protection of the remnant areas of the Cerrado. Studies of the effectiveness of these initiatives are in order. Recent reductions in deforestation are good news and set a new trend in the Brazil's malady.

### Part 3. SOCIAL ANALYSIS OF THE BRAZILIAN CERRADO'S OCCUPATION<sup>94</sup>

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#### 3.1 Introduction

The Center-West Region of Brazil, commonly referred to as the Cerrado area, comprises 18.8% of the national territory, 7.6% of the national GDP and a population of 11.6 million (IBGE, 2000). Authors devoted to study the region diverge with respect to the dates in which the several stages of the occupation of region took place. In most cases, the development of the region is related to two occupation phases: the first by the end of the 17th century, during the gold exploration cycle; the second along the 1950-70 period, associated with the industrialization and urbanization processes<sup>97</sup> (GGG).

Diniz<sup>98</sup> (HHH) indicates the Spanish – still under the 1494 Portugal-Spain Tordesilhas Treaty - as the first migrants to arrive in the territory that, currently, is part of the states of Mato Grosso do Sul and Mato Grosso. The Spanish did not settle down in the region not only because gold and silver deposits were not found as expected, but also because of the Indian resistance to the occupation. In addition, the deposits of silver found in Bolivia and Peru were more attractive.

A new effort to occupy the region was made by the Portuguese in middle of 17th century, when the sugar business in the Southeast went through a sever crisis. The goal was to look for gold and silver. In fact in the 18th century gold deposits were discovered in Goiás and Mato Grosso. But the relative scarcity of the metals compared with their abundance in Minas Gerais discouraged major efforts to populate of the Brazilian West until the 20th century. Thus during that period of time the economic activity that was maintained in the region was the cattle ranching. The expansion of the railroad system during the first years of the 20th century really was a great booster to the economy of the region. Dourados, in the current state of Mato Grosso do Sul, received many settlers from the northeast region through the Northwest Railroad

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<sup>97</sup> Pedroso, I.L.B. & A.R.P. da Silva. 2005.

<sup>98</sup> Diniz. Bernardo Palhares Campolina. 2006.

(Bauru/SP to Corumbá/MS) built in the second decade of 20th Century. Still according to Diniz, in 1913 Goiás and Minas Gerais are connected by the Goiás Railroad and the so-called “Rede Mineira de Viação”, a railroad that reaches Anápolis (Goiás) in 1935.

The population growth of the region was irregular until the beginning of the 20th century. In 1872, for example, the population of the states of Goiás and Mato Grosso (which then included Mato Grosso do Sul, Tocantins and Rondônia ) was less than 2% of the total in Brazil. In 1906 Marshal Cândido Rondon created a commission for the settling of the Brazilian West. The telegraph service construction and the pacification and incorporation of the Indian tribes were two of the accomplishments of the Rondon Commission.

The South Mato Grosso was a primary entrance door to the Center West, as pointed out by Batista et al<sup>99</sup> (III). Regions such as Bataguassú, Batayporã, Nova Andradina and Anaurilândia, were traditionally occupied by Indians groups like the Xavante, Kaiowá and Ofaié, who experienced conflicts first with the Spaniards in the 18th century. In the 20th century conflicts were intensified particularly in the ninety-fifties in the second Vargas era. In 1943 the Dourados Colony appears. In 1953 the Vera Cruz Company began colonization attracting coffee growers from São Paulo. In 1957 the Curupáí Colony opens up with farmers from both São Paulo and Minas Gerais.

Table 27 shows the population growth of that region until the decade of 1950. From 1920 on the share of the Center-West started to increase compared to the Brazilian population.

**Table 27. The Population in the Cerrado Region and Brazil – 1872 to 1950 (thousands)**

Territory	1872	1890	1900	1920	1940	1950
Cerrado*	221	320	373	759	1259	1774
Brazil	9930	14334	17438	30636	41236	51944
Cerrado/Brazil(%)	2.2	2.2	2.1	2.5	3.1	3.4

Source: Diniz (2006)

\*Territory that today corresponds to the present states of Goiás, Mato Grosso, Mato Grosso do Sul, Tocantins and Rondônia.

As Diniz points out, railroads generated a new dynamics in the Center-West region along the three decades of the 20th Century leading to increased food production, rising land prices and urbanization. Small urban centers tended to locate on the sides of the railroads. The First World

<sup>99</sup> Batista, L.C., C.MartinsJr., J.C. Ziliani. (Jan 3rd 2007).

War stimulated economic growth in the region as demand for domestic products expanded.

According to Batista et al, in the fifties land sales in Mato Grosso do Sul exploded so that a certain piece of land could be sold many times to different people. Poor farmers in general were left no other option besides taking over a small tract of land as a “posseiro” (land grabber). As the occupation process evolved over Indian territory, large portion of these peoples were exterminated. In the fifties this cleaning operation reached alarming proportions.

Diniz presents reports that the construction of Brasília was the critical decision that made Brazil a highway-oriented country as far as transportation is concerned. Brasília became the nodal point in the Brazilian highway system leading to integration of the Northern and Center-Western regions to rest of the country. The linkages departing from Brasília - Belém-Brasília, Brasília-Cuiabá, Brasília-São Paulo, Brasília-Belo Horizonte, Brasília-Barreiras and Brasília-Corumbá – articulated the region to almost all the national territory.

According to Bezerra & Cleps Jr<sup>100</sup> (JJJ), the agricultural growth of the region was intensified already in the 1930s with the goal of meeting the rapid growth of demand for agricultural products in the Southeast, where industrialization was accelerating. According to Diniz, in order to repress rural oligarchies - that opposed him in the 1930 Revolution - and to maintain national territory unity, Getúlio Vargas established the “Marcha para o Oeste” – an inter-regional integration program to amplify the domestic market and promote migration - as a national goal, which led the consolidation of the occupation of the region between 1940 and 1950. The foundation of Brasília and the construction two highways: BR-153 (Belém-Brasília) and BR-364 (Cuiabá-Porto Velho) played significant role in the occupation process.

Muller<sup>101</sup> (KKK) indicates, however, that up to 1960, most of the agricultural expansion took place spontaneously (facilitated, we should say, by infrastructure made available by the government); the role of the public sector as an inductor of economic reallocation was relatively minor. As a rule, the public sector action lagged behind private initiatives, being executed only when infrastructure deficiencies threatened the viability of the commercial agriculture.

Already in the 1950's, as the Belém-Brasília highway was under construction, migrants from the Northeast, mainly from Piauí and Maranhão, were arriving to Goiás and Mato Grosso, as pointed out by Martins<sup>102</sup> (LLL). While poor northeastern migrants, most of them itinerant-agriculture farmers, moved westward after the so-called “terras-livres” (free lands) to become

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<sup>100</sup> Bezerra, L.M.C. & J. Cleps Jr. 2004.

<sup>101</sup> Muller, C.C. 1990.

<sup>102</sup> Martins, J.S. 1989.

“posseiros” (informal landholders or tenants), well experienced “grileiros” (land grabbers) from Paraná – previously involved with the 1957 “Revolta Camponesa” (Peasant Uprising)<sup>103</sup> related with the colonization of the southwest of that state, which began in the early 1940s - were in the process of moving to Mato Grosso in the fifties and sixties. These two migrant flows would meet each other in the Cerrado area.

Northeastern farmers came in general from rural communities where the collective use of land was a cultural characteristic well adjusted to itinerant-agriculture – after two or three years, cropping activities had to move to new virgin land or else a reserved area until the land tracts left behind recovered their fertility. This land use pattern clearly conflicted with a well-defined concept of individual land property. At the same time, larger land buyers/investors from the South and Southeast were purchasing property titles frequently lacking any legal value. The same tract of land may have been sold by “grileiros” to several different buyers, resulting in substantial gains to the sellers. As a result, in the fifties Goiás, for instance, was deeply taken by bloody conflicts between “grileiros” and “posseiros” and large landowners, as pointed out by Martins.

Another relevant factor related to the labor market was the new rural legislation approved by the military government in the 1960s. The Estatuto do Trabalhador Rural (Rural Worker Statute), which extended the urban labor legislation to the agricultural sector and the Estatuto da Terra (Land Statute) established the rules governing labor relations and the process of agrarian reform. According to Rezende<sup>104</sup> (MMM), following this legislation, rural employers reacted by reducing employment – by increasing subsidized mechanization - and avoiding informal hiring procedures, like sharecroppers and the so-called “colonos”, who lived in the farm and were granted pieces of land for substance cropping. As a matter of fact, the Estatuto da Terra was based on the conception that land leasing and sharecropping were not desirable forms of land access. From then on most of rural workforce would be paid a wage rate and be hired either by a certain period of time – most on daily basis - and would live in urban areas.

At the same time, many were the hurdles faced by the newcomers. Soil and climatic conditions were very peculiar: the annual occurrence of a dry season, some years of very scarce rain showers even in the rainy season, soil acidity, high inputs prices due the distance to producing unities and so on. These were instrumental to lobby for a pool of policies designed to

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<sup>103</sup> On October 10<sup>th</sup>, 1975, after a fight with “jagunços”, thousands of armed peasant tenants occupied several municipalities and surrendered the local authorities demanding land regularization. See Wachowicz, R. 1987. Paraná, Sudoeste: ocupação e colonização. Ed. Vicentina.

<sup>104</sup> Rezende, G.C. 2005.

subsidize agriculture in the region when the urban and external demands for agricultural products increased.

### **3.2. The occupation of Goiás – misleading propaganda leads to social conflicts**

The colonization of part of Goiás was studied by Alves<sup>105</sup> (NNN) and illustrates the conflicting characteristics and severe consequences of the process. In the forties several government institutions were in charge of attracting to Brazil experienced and trained foreign families – farmers and cattle growers. According to Alves frequently that was not more than misleading propaganda. The land settlements carried out by the government institutions in general did not absorb the migrants properly – in a dignified manner – so that they tend to failure and produce social conflict.

The Colonia Agricola de Goiás, for instance, was officially intended to allocate small farmers into 20 to 50 hectares plots. What really was expected from the migrants, according to Alves, was that they occupied the lands and prepared them for later transference to big capital owners. When in 1948 the Rodovia Transbrasiliana (Transbrasilian Highway)<sup>106</sup> began to be constructed, illegal occupation by “grileiros” and large farmers accelerated. In Formoso and Trombas (Medium North Goiás), as land values tended to grow, large farmers - in conjunction with the local judge and the register officer – manage to acquire the lands at insignificant prices. As a reaction, migrant peasants surrounded these lands, occupied, deforested and started cropping activities. Large farmers with the help of “jagunços”(gunmen) reacted back and a real warfare established in the region. Given the omission of the government authorities, the “posseiros” looked for the support of political leaders – including from the by then illegal Communist Party. In some cases, peasant farmers succeeded with the creation of cooperatives. But with the military regime installed in 1964, the army occupied the region and peasant leaders were arrested, tortured and killed. It was the end of the so-called Formoso-Trombas Movement.

The Land Statute of 1964, and the related “usucapião” institute<sup>107</sup> - conceding property of land to long-term occupants, led large farmers to accelerate the expelling of peasants from

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<sup>105</sup> Alves, M.M.2002.

<sup>106</sup> Transbrasiliana highway is the extension of the Belém-Brasília, going through many Brazilain territories: Pará, Tocantins, Goiás, Distrito Federal, Minas Gerais, São Paulo, Paraná, Santa Catarina, ending in Rio Grande do Sul.

<sup>107</sup> “Usucapião” derives from the latin word *usucapere*, meaning “acquiring by usage”. It is an ancient principle (450 BC) that secures the tenant - who in fact used the land - the ownership of that land after an established period of uncontested tenure (Gonçalves, R.A, <http://www1.folha.uol.com.br/folha/cotidiano>).

frontier lands. Peasants in response looked for help from the so-called “Ligas Camponesas”<sup>108</sup>, rural labor unions and associations and from the Catholic Church to fight for their rights. Usually lands were bought and sold with no regard to tenure rights, that is, whether the land had been used by others (with possible rights over that land) or not. As a result land owners had to expel occupants by force – with the help of militias - and looking for support from the judicial system.

### 3.3. The Occupation of Mato Grosso – The role of the “gaúcho”

Rocha<sup>109</sup> (2006) developed a study of the role of the so-called “gaúcho” in the colonization of Mato Grosso and the so-called Amazônia Legal<sup>110</sup>. This territory was taken since the times of Getúlio Vargas in the early 1930s and up to the mid-seventies as a “demographically empty space” waiting for directed colonization projects. The “emptiness” permitted ample choice with respect to (a) land distribution pattern to be created, (b) cropping activities to explore and (c) the “ideal” worker to be employed. Even the colonization model – cooperative-oriented – was possible to choose.

In 1976, as part of the National Integration Program (PIN) the BR163 highway was constructed linking Cuiabá (MT) to Santarém (Pará)<sup>111</sup>. A 10km strip on each side of the highway was reserved for colonization, including Lucas do Rio Verde and the Araguaia Basin. The methodologically named “gaúcho”, here under quotation to refer to all migrants from the Southern Brazil (Rio Grande do Sul (RS) – birthplace of the gaúcho properly said -, Santa Catarina (SC) e Paraná (PR)), was especially attracted to the region. Traditionally the “gaúcho” has been praised for possessing a triple profile: explorer, pioneer and entrepreneur.

Lucas do Rio Verde encompasses 270,000 hectares. Occupation accelerated in the nineties when population tripled from 6,693 in 1991 to 19,322 in 2000 to reach 27,224 in 2005. “Posseiros” (land tenants), “parceiros” and cooperative settlers were the main social actors in the region. The first group (27 families) – the pioneers - arrived spontaneously from the South in the late seventies. These were small farmers that sold their lands in the South and bought large

<sup>108</sup> The “Ligas Camponesas” were rural workers’ associations - directed mainly to claiming for land reform - originally created in Pernambuco and later extended to Paraíba, Rio de Janeiro, Goiás and other regions of Brazil. Their activities were very intense from 1955 to the fall of the Goulart government in 1964. (<http://www.cpdoc.fgv.br/dhbb/verbetes.htm>).

<sup>109</sup> Rocha, B.N. 2006.

<sup>110</sup> The 1953 Law-Decree no. 1806 included in the “Amazônia Legal” the states of Amazonas, Acre, Pará, Rondônia, Roraima, Acre and the east of Maranhão and the north of Mato Grosso.

<sup>111</sup> The construction was carried out by the Army’s 9<sup>th</sup> Battalion of Engineering and Construction.

land tracts in Lucas. Although they held large extensions of land, ownership was not official, that is why they were called “posseiros”. In 1982 INCRA (Brazilian Institute of Colonization and Agrarian Reform) regularize the land ownership of the “posseiros”.

The second group to acquire land in Lucas came from Ronda Alta (Rio Grande do Sul) where it was associated with the social movement known as MST (Movement of Landless Rural Workers). According to some researchers, the federal government promoted the migration of these “parceiros”<sup>112</sup> to the settlement in Mato Grosso with the intension of weakening the social movement in 1981. The group of 71 initial families tended to grow so that eventually it reached 203 families in the Projeto de Assentamento Conjunto - PAC (Joint Settlement Project) in 1982. “Posseiros” and “parceiros” are both affiliated to the Rio Verde Cooperative (COOPERLUCAS), supported by the PRODECER.

The third group was related with the PRODECER and was operated by the COOPERLUCAS. The group – mainly from the South - had financial and logistical support from PRODECER. These “assentados da cooperativa”(cooperative’s settlers) were selected according to previous experience and financial resources to partially fund the agricultural activity. This warranted a entrepreneurial profile and a special social status to the group, commonly referred to as “elite”.

Based on a set of self-applied values – courage, entrepreneurship, cooperation, solidarity, union – “posseiros” and “assentados da cooperativa” as a group assumed the local leadership and took in their hands the challenge of developing the area. The “parceiros”, on the other hand, are referred to by the first group as “inapt to work, disorder promoters and uncourageous”.

The Brazilian “Marcha para o Oeste” by the “gaúchos” is sometimes associated with the North American experience of conquering the West focusing the figure of the “pioneiro” or pioneer. Moog<sup>113</sup> (PPP) points out several analogies: (a) migration having the family as the dynamic factor based on the values of entrepreneurship and hard work; (b) collective effort and solidarity to create a urban nucleus with houses, schools, hospitals, churches, public offices, and eventually expand industrial activities; (c) the European (German and Italian) origin of “gaúchos” and the pioneers.

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<sup>112</sup> Parceiros”, not to be confused with “parceiros” (sharecroppers), is a denomination given to the group of landless workers from Ronda Alta for having acquired a “parcel” of land through the cooperatives of the colonization program.

<sup>113</sup> Moog, Viana. 1981.

### 3.4. Impacts of the Induced Occupation on Agriculture

Diniz accepts the division of the transformation process of the Cerrado into three phases: (i) the first at the end of the sixties, when the soybean pioneers arrive to Mato Grosso to adapt the species locally and to begin the processing of the grain in Goiás; (ii) the second takes place in the eighties with the consolidation of the intensive soybean and maize cropping under the coordination of trading companies; and (iii) the third beginning in 1985, when industrial conglomerates move to the Center-West and consolidates the grain-meat complex.

During the military governments, several national development programs were implemented to achieve that transformation. First came, in 1967, the PROTERRA (Land Distribution and Agro-industrial Development Program) and, in 1970, the PIN (National Integration Program). Then during the seventies, the Center-West region was submitted to important economic occupation programs: POLOCENTRO (Program for the Development of the Cerrado) in 1974, and later in 1979 the PRODECER (Nippon-Brazilian Cooperative Program for the Development of the Cerrado). Official support was granted to private colonization programs thereby accelerating the occupation process.

As a consequence of the official programs, some authors say that the effective advance over the agriculture frontier occurred, therefore, in the seventies. By then the dominant technical strategy was to have rice introduced after the area was cleaned; then soybean - on soil properly corrected for acidity and infertility - was cultivated. Cattle ranching was propelled by pasture planting - instead of native grass feeding - with substantial growth in productivity<sup>114</sup> (QQQ).

Meanwhile, according to Martins, many of the activities of the “grileiros” continued and are believed to have been - to some degree - interrelated with the colonization projects that had preference for the formation of huge farms in the region. Anyway, by the end of the seventies even many small farmers from the south were migrating to the Center-West attracted by the soybean business that was peaking.

Native farmers, familiar with and pegged to the traditional low productivity methods of exploiting the cerrado land, were willing to sell their farms at low prices compared to the levels observed in the Southeast and South. The modern and productive use of those lands by the new owners was taken as real “miracles” by native farmers, beyond the reach of their abilities and knowledge (Mendonça et al).

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<sup>114</sup> Mendonça, M.R., D.D. Ribeiro, A Thomaz Jr. 2002.

As the exploration of the Cerrado progressed the agrarian structure changed. In Goiás the number of farms increased by 8% (from 145 thousands to 157 thousands) from 1970 to 1995. See table 28. Farm ownership increased by 26%, leasing reduced by 28%, sharecropping fell by 10% and the number of “posseiros” fell by 57%. In 1995, 89% of the farms were operated by their owners.

**Table 28. Status of Farm Operator - Goiás – 1970/ 1995/96**

	1970	1975	1980	1995/96 <sup>1</sup>
Owner	111,014	113,108	122,767	139,775
Leaser	6,106	7,688	7,595	4,393
Sharecropper	1,337	4,579	3,644	1,207
Tenant	26,658	28,160	19,764	11,329
Total	145,115	153,535	153,770	156,704

Source: IBGE, Censos Agropecuários.

1. Data include the state of Tocantins, part of Goiás in previous surveys.

In Mato Grosso do Sul, on the other hand, land ownership increased 28%, so that currently 83% of the farms belong to the operator (table 29). Leasing fell by 68% and currently represents only 6% of the farms. Sharecropping almost disappeared (fall of more than 92%). The number of farms reduced by 15%.

**Table 29. Status of Farm Operator –Mato Grosso do Sul – 1975/ 1995/96**

	1975	1980	1985	1995-1996
Owner	32,276	33,147	38,485	41,395
Leaser	8,945	5,719	6,511	2,874
Sharecropper	5,904	3,114	2,745	458
Tenant	10,728	5,963	6,890	4,696
Total	57,853	47,943	54,631	49,423

Source: IBGE, Censo Agropecuário.

In Mato Grosso, like in Mato Grosso do Sul and Goiás, land ownership grew, while other types of land tenancy decreased (table 30). The growth of land ownership, however, was much higher in Mato Grosso: 185%. The number of farms increased by 37%.

**Table 30. Status of Farm Operator – Mato Grosso – 1970/ 1995/96**

	1975	1980	1985	1995-1996
Owner	23,980	35,737	48,832	68,214
Leaser	13,158	9,820	10,332	1,641
Sharecropper	2,066	3,887	5,002	968
Tenant	16,914	13,939	13,755	7,940
Total	56,118	63,383	77,921	78,763

Source: IBGE, Censo Agropecuário.

It should be observed that in all 3 states, although the presence of “posseiros” fell, it still represents 5% to 10% of the total number of farms. This is an indication that despite of reduction of precarious land tenancy, it still is a source of possible conflicts. In addition, land ownership is by far the dominant form of farm operation probably because of the relatively low price of land. It suggests also that this might be a relevant condition – probably to have access to credit - for farming and ranching in that region.

It could be expected that the pattern of use of available land would affect the tenure pattern in each state. However, aside from the substantial expansion in farmland in Mato Grosso, there is not a perceivable difference in land use pattern among the states in the Center-West.

Table 31 shows an increasing trend in total farmland in Goiás, particularly up to 1980. Pasture – both natural and planted – is the dominant (around 70%) type of use of land in that state, while crop activity takes less than 7.5%. Natural pasture is losing its share to planted pasture (55% x 12% in 1970 to 26% x 46% in 1995). The share of productive but unused land fell from 11% to 4.4%.

**Table 31. Land Use in Goiás , 1970 to 1995/96**

	1970	1975	1980	1985 <sup>1</sup>	1995-96 <sup>1</sup>
Total (m ha)	35.1	40.3	45.2	44.8	42.3
			(%)		
Permanent Crop	0,22	0,19	0,03	0,26	0,19
Temporary Crop	7,07	3,86	6,87	7,73	5,59
Reserved área	-	0,26	1,54	1,96	1,46
Natural pasture	55,25	53,83	45,56	37,72	25,87
Planted pasture	12,41	18,48	24,01	32,59	46,23
Natural Forest	13,97	15,79	15,25	12,80	16,11
Planted Forest	0,07	0,06	0,17	0,19	0,17
Unused Productive	11,01	7,53	6,56	6,74	4,38

Source IBGE, Censos Agropecuários

1. Data include the state of Tocantins

In Mato Grosso do Sul (table 32), farmland is almost stable around 31 million hectares. Pasture absorbs more than 70% of available land, but the shares of planted and natural pasture that were 57% and 19% inverted to 21% and 53%. Cropping activity use stays around 5% to 7%.

**Table 32. Land Use in Mato Grosso do Sul , 1970 to 1995-1996**

	1975	1980	1985	1995-96
Total Area (m ha)	28.7	30.7	31.1	30.9
		(%)		
Permanent Crop	0,24	0,18	0,10	0,06
Temporary Crop	4,43	5,56	6,47	4,65
Reserved area	0,14	0,49	0,69	0,40
Natural pasture	57,05	42,88	33,82	20,67
Planted pasture	19,09	31,70	42,53	53,44
Natural Forest	14,49	14,71	14,60	19,36
Planted Forest	0,67	1,55	1,59	0,06
Unused Productive	3,89	2,94	0,20	1,37

Source IBGE, Censos Agropecuários

In Mato Grosso (table 33) farmland is increasing; indeed it more than doubled in the last 20 years with available data. Pasture takes between 40% and 50% of the total farmland. Planted pasture expanded sixfold. An increasing share of farmland is represented by natural forest (the cerrado itself). The cropping area increased fivefold in 20 year-period in the table. Unused productive land share reduced from 10% to 3%.

Apparently the huge expansion in Mato Grosso farm land took place though land ownership. That means the expansion in farm land represented no opportunity for other type of land tenure like “posseiros” as was the case in the earlier times of occupation of the states.

**Table 33. Land Use in Mato Grosso , 1970 to 1995-1996**

	1975	1980	1985	1995-96
Total Area (m ha)	21.1	32.4	35.3	47.9
	(%)			
Permanent Crop	0,20	0,00	0,39	0,35
Temporary Crop	2,17	4,39	5,65	5,81
Reserved Area	0,16	0,92	1,21	1,03
Natural Pasture	40,91	31,11	27,45	12,93
Planted Pastures	12,32	14,47	19,04	31,87
Natural Forest	33,62	41,26	40,03	44,85
Planted Forests	0,11	0,15	0,07	0,14
Unused Productive	10,51	7,69	6,17	3,02

Source: IBGE, Censos Agropecuários

Another relevant point is that the average farm size has been changing over time, mostly in Mato Grosso (table 34). In this state, average farm size grew by 62% over the 20 year-time period. In Mato Grosso do Sul, a 26% growth occurred. In Goiás average farm size increased by only 3%. Notice, however, that average farm size is presently similar in Mato and Mato Grosso do Sul (a little above 600 hectares).

**Table 34. Average Farm Size in the Cerrado Area (ha) , 1975 and 1995/96**

	1975 (a)	1995/96 (b)	(b/a)
Goiás	262	270	1.03
Mato Grosso do Sul	497	626	1.26
Mato Grosso	376	609	1.62

Source: IBGE, Agricultural Census

As farm size increased and capital intensive technology was increasingly used, farm employment presented a decreasing trend in the Cerrado area since 1980 (table 35). From a maximum of 1330 thousands workers in that year, the region's farm employment fell by 25% to 1004 thousands in 1995/96.

**Table 35. Number of Farm Workers in the Cerrado Area– 1970 to 1995-1996**

	1970	1975	1980	1985	1995-1996
Mato Grosso do Sul	-	257,132	230,983	253,993	202,709
Mato Grosso	373,039	263,179	318,570	359,221	329,798
Goiás	547,647	688,033	780,749	616,336	471,657
Total	920,686	1,208,344	1,330,302	1,229,550	1,004,164

Source: IBGE, Censo Agropecuário

Table 30 clearly shows the fall in the employment of labor per hectare of planted land. Although Mato Grosso do Sul – a major livestock producer – has a lower labor/land ratio than the other two states, the fact is that labor this ratio fell by around 70% in all states since 1975.

**Table 36. Number of Workers per 1000 hectares of planted land<sup>1</sup> – 1970 to 1995/96**

	1970	1975	1980	1985	1995/96
Goiás	78,9	75,6	55,6	33,7	21,4
Mato Grosso do Sul	-	36,7	19,3	16,1	11,3
Mato Grosso	-	84,3	51,7	40,5	18,0

Source: IBGE, Censo Agropecuário

1. Planted area: permanent and temporary crops, planted pasture and planted forest

Another relevant aspect is the level of mechanization adopted in the process of expansion of Cerrado occupation. Table 37 shows that after the increase in tractor usage in the seventies, the ratio stabilized at 2 tractors per 1000 hectares of planted area in the whole Cerrado region. There is no trend of intensification of mechanization in the region as far as the number of tractors is concerned.

**Table 37. Tractor-Planted Area Ratios (Tractor units/1000ha)<sup>1</sup> – 1970 to 1995/96**

	1970	1975	1980	1985	1995/96
Goiás	0,8	1,5	2,0	1,8	2,0
Mato Grosso do Sul		1,8	1,9	2,0	2,0
Mato Grosso		0,8	1,8	2,2	1,8

Source: IBGE, Censo Agropecuário

1. Planted area: permanent and temporary crops, planted pasture and planted forest

The ratio of workers per tractor (table 38), though, has been falling markedly since the seventies. This is compatible with the well known fact that the power of tractors has been increasing. In addition, and perhaps more importantly, other types of mechanization also have been put into increasing use, mainly in the harvest operations.

**Table 38. Workers/Tractor Ratios – 1970 to 1995/96**

	1970	1975	1980	1985	1995/96
Goiás	96,2	50,5	28,3	18,4	10,9
Mato Grosso do Sul		20,9	10,0	8,2	5,6
Mato Grosso		99,6	28,6	18,4	10,1

Source: IBGE, Censo Agropecuário

### 3.5. General Impacts on the Cerrado Region

Between 1960 and 2000, the Cerrado region exhibited the highest demographic growth in Brazil: its population more than quadrupled while the total Brazilian population almost doubled (table 39). This is an evidence of substantial geographical mobility in the country: the percent of the population in the Cerrado region evolved from 3.2% to 6.9%.

**Table 39. The Population of Cerrado and Brazil – 1970 to 2000 – (thousands)**

Territory	1960	1970	1980	1991	2000
Cerrado*	2,678	5,072	7,545	9,427	11,636
Brazil	70,992	93,134	119,011	146,825	169,799
Cerrado/Brazil(%)	3.8	5.5	6.3	6.4	6.9

Source: IBGE

\* Goiás, Mato Grosso e Mato Grosso do Sul

The population diversity, according to ethnic characteristics, shows the predominance of whites in the previous phase to the official occupation. However, the group of the population classified as “pardos” (brown) presented the biggest growth up to 2000. In 1950, for example, the whites represented 64.8% of the population, and browns 20.8%. Fifty years later, the whites were 49.73% of the population, and browns 43.68%. Table 40 shows the evolution of the population of the Cerrado (region Center-West) according to ethnic characteristics. The share of blacks reduced significantly, while the share of yellows remained practically the same since the beginning of the induced occupation.

Table 41 shows the evolution of the population of the Cerrado (region Center-West) according to ethnic characteristics. The share of black reduced significantly, while the share of yellow remained practically the same since the beginning of the induced occupation.

The Indian population was not surveyed in the censuses before 1996. The demographic census of 2000 reports only 0.9% of the population as being Indian. It can be assumed that this ratio was well above that before the implementation the official occupation programs.

**Table 40. Ethnic Population Ratios in the Cerrado (%) – 1950 to 2000.**

	1950	1960	1980	1991	1996	2000
White	64.80	56.57	49.47	50.44	48.20	49.73
Black	14.03	7.26	4.17	3.09	2.64	4.62
Yellow	0.28	0.45	0.32	0.33	0.18	0.40
Brown	20.81	35.71	45.61	46.14	48.68	43.68
Indian	-	-	-	-	0.30	0.90
Not declared	0.08	0.01	0.44	-	0.00	0.68
Total	100	100	100	100	100	100

Search: IBGE, Censo Demográfico

The demographic census of 1970 does not inform statistics of the population according to ethnic characteristics. The 1996 Census contains information about Indian population

In general the economy of the Center-West increased faster than the rest of the nation, so that its share of the country's GDP doubled over the last 35 years (table 41). Most of the growth concentrated in Mato Grosso. Distrito Federal and Goiás followed somewhat behind and Mato Grosso do Sul practically kept the same share of around 1% of Brazil's GDP.

**Table 41. Regional and States' Share in Brazil' GDP (%) – 1970/2004.**

	1970	1980	1990	1999	2000	2001	2002	2003	2004
Center-West	3.72	4.99	5.16	6.44	7.00	7.20	7.4	7.6	7.6
Mato G. do Sul	-	1.12	0.96	1.12	1.10	1.10	1.1	1.2	1.1
Mato Grosso	-	0.61	0.83	1.20	1.20	1.20	1.3	1.6	1.6
Goiás	-	1.73	1.75	1.84	2.00	2.10	2.3	2.4	2.3
Distrito Federal	1.03	1.53	1.61	2.28	2.70	2.80	2.7	2.4	2.6

Source: IBGE and <http://www.ai.com.br/pessoal/indices/PIBREG.HTM> (11/16/2006)

Table 42 shows that from 1940 to 1996, but specially after 1970, the per capita GDP of the Center-West grew faster than in the rest of the country. In 1940, it was 68.8% of the national average and in 1996 it was 6% higher than that average.

**Table 42. Relative GDP per capita (Brazil =1.00)**

	1940	1970	1996
North	0.733	0.568	0.640
Northeast	0.477	0.397	0.470
Southeast	1.422	1.521	1.350
South	1.100	0.959	1.155
Center-West	0.688	0.679	1.062

Source: Camerano & Beltrão<sup>115</sup> (RRR)

Although the occupation of the Cerrado is generally taken as primarily focused on the agricultural sector, it is a fact that this sector GDP has been falling over time. Table 43 shows that in 1950 57% of the regional GDP originated from agriculture, while the share for Brazil was almost 31%. Currently this share is around 13% in the region while at the national level it is only 7%. Nonetheless, that share for the Cerrado is relatively small if one compares it with the 12% share of agriculture in the South.

**Table 43. Share of Agriculture in Regional and Brazil's GDP (%), 1950 - 2000**

	1950	1960	1970	1980	1990	2000
Center West	57,0	52,5	24,0	20,2	11,7	13,0
North	30,1	25,1	23,6	17,3	18,7	11,7
Northeast	42,5	41,3	22,4	16,7	11,8	8,7
South	42,1	43,8	25,1	17,8	11,8	12,0
Southeast	24,6	18,9	6,5	5,7	4,8	3,9
Brazil	30,8	27,6	12,5	10,2	8,0	7,0

Source: IBGE

<sup>115</sup> Camerano, A.A.; Beltrão, K.I. 2000.

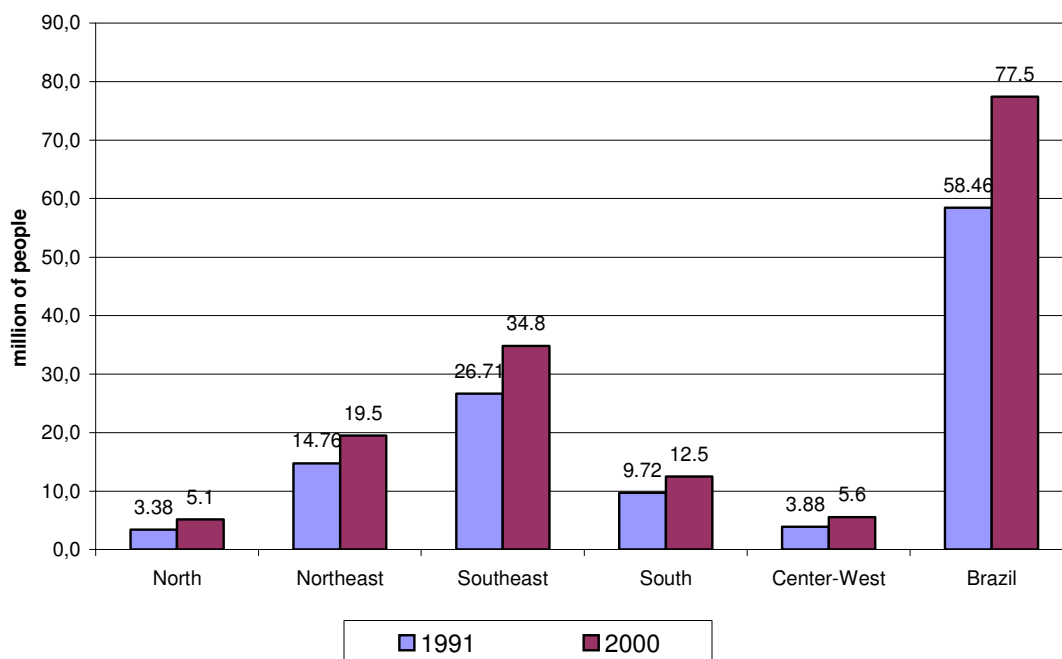
As economic growth expanded in the Center-West the distribution of employment opportunities changed in Brazil. Table 44 presents some evidence on this matter by referring to the number of “carteiras de trabalho” (work-register book) issued by the labor Ministry. The “carteiras” are assigned only to those workers holding a formal job. So they grossly underestimate the level of employment for the country as whole and especially so for interior regions like the Center-West. Although the data show that regional formal work retrograded in the 1970s, the overall trend suggest a firm increase in the share of formal work over the past 60 years.

**Table 44. Number of Worker’s Register Books – Brazil and Center-West Region, 1940/2000**

	Brazil (a)	Center-West (b)	b/a (%)
1940	278,215	2,422	0.87
1950	304,883	3,109	1.02
1960	639,148	40,230	6.29
1970	2,785,740	90,878	3.26
1980	4,963,800	281,700	5.68
1990	7,200,852	462,930	6.43
2000	6,636,289	613,394	9.24

Source: IBGE

In addition, Figure 44 shows that the economically active population (PEA) of the Cerrado had the second higher growth rate (43%) in Brazil, second only the North (52%), just between 1991 and 2000.

**Figure 44. Economically Active Population (10 years and older)– 1991 to 2000**

Source: IBGE

Given the slow growth of agriculture compared to others sectors of the economy and the labor-saving technological changes that took place in agriculture, it should be expected that urbanization should have increased significantly in that region from the sixties to 2000. As a matter of fact, the rate of urbanization was surprisingly high for most standards: table 45 shows that since 1980 the Center West has had an urbanization ratio higher than that of the South and the Northeast— regions of origin of most of the migrants to the region - and second only to the Southeast.

**Table 45. Regional Urbanization Ratios in Brazil, 1960/2000**

Region	1950	1960	1970	1980	1991	2000
Brazil	36.2	44.7	55.9	67.6	75.5	81.2
North	31.5	37.4	45.1	51.7	59.2	69.9
Northeast	26.4	33.9	41.8	50.5	60.6	69.1
Southeast	47.5	57.0	72.7	82.8	88.0	90.5
South	29.5	37.1	44.3	62.4	74.1	80.9
Center-West	24.4	34.2	48.0	67.8	81.3	86.9

Sources: IBGE, Censos Demográficos <sup>116</sup> (SSS).

A measure of the degree to which urbanization has harmed the welfare of the population is the percent of homes located within favelas (slums)<sup>117</sup>. Interestingly enough the percent of favela homes in the Center-West region is very low compared to rest of Brazil (table 46). It was 0.58% and fell to 0.44% in 2000 while in Brazil as a whole the proportion rose from 1.62% to 3.04%. This information suggests that people that left the farms probably did not expressively move to “favelas” in the Cerrado area.

**Table 46. Regional and Brazil's Percent of “favela” homes – 1980-2000**

	1980	1991	2000
NORTH	1.04	4.11	5.32
NORTHEAST	0.87	2.62	2.20
SOUTHEAST	2.60	3.59	4.20
SOUTH	0.62	1.11	1.30
CENTER WEST	0.58	0.42	0.44
BRAZIL	1.62	2.76	3.04

Source: IBGE, Censos Demográficos .

<http://worldbank.org/urban/symposium2005/presentations/pasternak.pdf>

<sup>116</sup> Cunha J.M.P. 2003.

<sup>117</sup> IBGE defines favela as a set of at least 51 homes located in alien properties in disordered disposition lacking the basic utilities services. (<http://worldbank.org/urban/symposium2005/presentations/pasternak.pdf>).

Table 50 shows how the net immigration flow to the Center-West and its states behaved over the last 30 years. There is still an acceleration of the flow of people to the state of Goiás. Mato Grosso do Sul always tended to attract a low net flow of migrants. Mato Grosso, on the other hand is decelerating the immigration flow in the nineties. That Goiás be the leading state regarding the attraction of migrants suggests that it may not be the occupation of frontier land the motive behind the migration movements, but business and job opportunities outside agriculture.

**Table 47. Net Immigration to the Center West and States (thousand people)– 1970-2000.**

Region	1970-80	1981-91	1990-2000
Center West <sup>1</sup>	218.2	495.5	617.7
M.G. Sul	67.9	25.2	29.9
Mato Grosso	175.1	297.3	170.8
Goiás	-24.8	173.0	417.0

Source: IBGE. Censos Demográficos <sup>118</sup> (<sup>111</sup>)  
Data exclude Brasília.

The occupation of the Cerrado tended to reproduce the general undesirable social and economic conditions observed in the South and Southeast Brazil.

Consider the behavior of agricultural income and its distribution. Hoffmann informs that the mean income of farm people in Brazil as a whole doubled from 1970 to 1980, but in a highly concentrated form: the Gini index changed from 0.424 to 0.554<sup>119</sup> (<sup>UUU</sup>). Inequality increased much more in agriculture than in the secondary sector. In Goiás, income growth and concentration were more intense: the mean grew 138% and the Gini index changed from 0.439 to 0.582. At the same time, absolute poverty (per capita income less than the minimum wage) reduced significantly in Goiás: from 82.2% to 52.1%. During the eighties, mean income continue to grow in Goiás' agriculture (37%) while poverty ratio rose to almost 60%. Two factors are singled out to explain these changes (growth with income distribution concentration): land tenure concentration and the policy-induced labor-saving modernization.

Correa & Hoffmann<sup>120</sup> (<sup>VVV</sup>) also report increase in Brazil's farm people income

<sup>118</sup> Cunha J.M.P. 2003.

<sup>119</sup> Hoffmann, R. 1994.

<sup>120</sup> Corrêa. A. M. C. J. ; Hoffmann. R. 1997.

concentration and in poverty during the eighties, particularly in the Center-West. Access to land ownership is a key factor explaining income distribution alongside educational level.

As the Cerrado's economy increased with growing urbanization and income concentration, the demand for public services – such as health and education – tended to grow as well. As far as health is concerned, one observes that as the occupation of the Center-West evolved the public sector invested on the creation of health facilities – especially in seventies - as table 48 indicates. The Center-West share of health facilities grew up to the eighties to reach 7% in 2000.

**Table 48. Health Facilities in Brazil e and the Center-West Region – 1940 to 2000.**

Year	Brazil (a)	Center-West (b)	b/a(%)
1940	2,362	59	2.50
1950	4,330	111	2.56
1960	2,433	99	4.07
1970	5,411	182	3.36
1980	18,489	1,185	6.41
1990	35,701	2,195	6.15
2000	56,133	3,921	6.99

Source: IBGE

In order to better evaluate the change in the health facilities supply, Table 49 reports the ratio of inhabitants per facility<sup>121</sup>. Again, most of the increase in that supply occurs in the seventies, so that presently that ratio is approximately equal for the Center-West and the country's average (3000 inhabitants per facility).

<sup>121</sup> Data on size of health facilities are not available; the data used in tables 48 and 49 refer to number of facilities regardless of their capacities. This is a clear approximation, so the comments that follow should be properly considered.

**Table 49. Inhabitants per health facility– Brazil and Center-West Region – 1940 to 2000.**

Year	Brazil	Center-West
1940	17,458	18,534
1950	11,996	13,810
1960	29,179	27,054
1970	17,212	27,871
1980	6,437	6,368
1990	4,113	4,295
2000	3,025	2,968

Source: IBGE

Regarding education, table 50 presents the number of elementary schools available in Brazil and specifically in the Center-West<sup>122</sup>. Major attention to the region was given in sixties and in the eighties. In the nineties the region's number of schools lagged behind other regions of Brazil.

**Table 50. Elementary Schools in Brazil and in Center-West Region – 1950 to 2000.**

Year	Brazil (a)	Center-West (b)	B/a(%)
1950	46,315	993	2.14
1960	89,999	3,380	3.76
1970	134,909	6,526	4.84
1980	186,009	10,260	5.52
1990	201,541	12,760	6.33
2000	293,413	13,048	4.45

Source: IBGE

The relative availability of schools (inhabitants per school) is presented in table 51. That a major investment took place in the sixties is confirmed. Since then investments have been made to keep up relative supply close or somewhat behind national average.

<sup>122</sup> Here again, as in the of health facilities, data on capacity of schools are not available and, accordingly, the comments related to tables 50 and 51 should be properly considered.

**Table 51. Inhabitants per Elementary School in Brazil and in Center-West Region – 1950 to 2000.**

Year	Brazil	Center-West
1950	1,122	1,544
1960	789	792
1970	690	777
1980	640	735
1990	729	739
2000	579	892

Source: IBGE

It is possible to observe between - 1985 and 2000 - a significant increase of the alphabetized people with age of 5 years or more, in the Center-West (table 52). At the beginning of the induced occupation (1960) less than half of that population group was alphabetized. In 1985, 75% of the population was alphabetized. In 2000, the ratio increased to 87%.

**Table 52. Literacy of Population 5 years or more.– Center-West Region – 1985 to 2000.**

	Total (a)	Literate (b)	Illiterate	B/a (%)
1960	2,450,376	1,202,918	1,247,072	49.09
1970	4,237,423	2,413,731	1,780,899	56.96
1980	6,421,312	4,317,213	2,094,408	67.23
1985	7,545,321	5,657,048	1,887,809	74.97
1990	8,683,069	6,729,519	1,953,083	77.50
1995	8,857,291	7,334,357	1,519,660	82.81
2000	10,180,354	8,879,366	1,300,988	87.22

Search: IBGE, Censo Demográfico

More detailed data on literacy are presented in table 53. The rate of literacy in the Center-West is pretty much comparable to Brazil's average in most of the period. Currently, the rate is well above national average.

Looking into the data on the evolution of health and education it is possible to conclude that the Cerrado region followed the overall trend observed in Brazil as a whole. That does not mean that health and education conditions in the region are satisfactory, but simply that they are

comparable to the patterns ordinarily observed in Brazil.

**Table 53. Literacy Rates (%) – Brazil and Center-West States – 1960/2000**

	BRAZIL	GOIÁS	MATO GROSSO	M. G. DO SUL
1960	53	45	56	-
1970	60	54	57	-
1980	68	64	61	69
1990	75	78	76	79
2000	84	89	89	90

Source: IBGE - Obs.: Up to 1990 refers to population 5 years and older; in 2000, 10 years and older.

Table 54 sums up the general development picture of the Cerrado area compared to other selected states of Brazil. São Paulo is taken as the most economically developed state in Brazil, while Alagoas is considered one of the least developed states. Rio Grande do Sul was selected for having been the state from which a large portion of the migration to the Center West originated. The PNUD's Human Development Index (HDI) for 1996 indicates that the HDI for Mato Grosso do Sul (MS) is close to the ones for São Paulo and Rio Grande do Sul and above the Brazil's index. Mato Grosso (MT) and Goiás (GO) lie somewhat behind, in the "average interval" for the index (0.5 to 0.8), but well above the HDI for Alagoas. Which are the factors that lead MS to perform better than the other two region's states? In fact it does better in the 3 indicators of economic development that enter the HDI: per capita GDP in MS is 28% higher than in MT, illiteracy 16% lower and life expectation is 1.8% longer.

**Table 54. Social and Economic Indices – Center West and Other Selected States- 1996**

STATE	GDP <i>per capita</i> (US\$)	Illiteracy (%)	Infant Mortality (%)	LIFE EXPECTATION (YEARS)	HDI
GOIAS	5238	13.7	20.7	68.6	0,786
M. GROSSO DO SUL	6393	11.9	19.2	69.2	0,848
MATO GROSSO	5003	13.8	21.5	68.0	0,767
SÃO PAULO	6511	6.9	17.4	69.4	0,868
ALAGOAS	2496	34.7	57.7	61.9	0,538
RIO G. DO SUL	6446	7.1	15.4	70.8	0.869
BRASIL	6403	14.8	27.8	67.6	0.830

Source: IPEA, FPI, IBGE, PNUD.1998. Desenvolvimento Humano e Condições de Vida: Indicadores Brasileiros.

As a result of the poor performance of the Brazilian economy as far as the reduction of poverty is concerned, the government has been implementing a number of programs to alleviate this deficiency. O Programa Bolsa Família (Family Grant Program) officially reached 11.2 million families in June 2006. Subject to some conditionalities, (a) extremely poor families (per capita family income up to R\$60 per month) are granted from R\$50 to R\$95 monthly; poor families (per capita family income from R\$60 up to R\$120 per month) are granted from R\$15 to R\$45 per month.

Figure 45 relates information from IBGE and the Ministry for Social Development and the Hunger Fighting Program. Blue columns indicate whether the state has a larger or smaller proportion of poor compared to its population share in Brazil. The red columns indicate whether the state has Family Grant assistance proportional to its share of poor in the country. For instance, São Paulo has 22% of Brazil's population and 10.3% of the Brazilian poor, so its blue column is assigned a value of 0.47. In addition, having 10.3% of the poor, the state receives 10% of the number of family grants; so its red column is assigned a value of 0.97. If the share of poor of given state was equal to its share in national population, its blue column would be assigned a value of one; analogously if a state received the same share of grants as the share of poor families, its red column would be assigned the value of one as well.

Regarding the Center-West region their share of poor is lower than its share in national population: MT (0.85), MS (0.81) and GO (0.92). All were assigned blue columns with less than one value. These results certainly favor a positive evaluation of the social performance of the region. With respect to Family Grant assistance the region MS is getting 10% more grants than

the share of poor, while MT is getting a share just right, and GO is being under benefited by 14%<sup>123</sup>. Again it is worth mentioning the case of Mato Grosso do Sul that performed well regarding the social indices of table 54, presented a lower percent of poor families and is being over benefited by the government assistance.

Recent data, however, indicate that Brazil income distribution moved towards more equality after 2001, a historical happening. Figure 46 indicates that the Gini Index fell from 0.593 to 0.566 – a 4.6% fall - from 2001 to 2005. This reduced poverty by 4.5% and extreme poverty by might have taken 7 million people off the extreme poverty by 4.2%<sup>124</sup>.

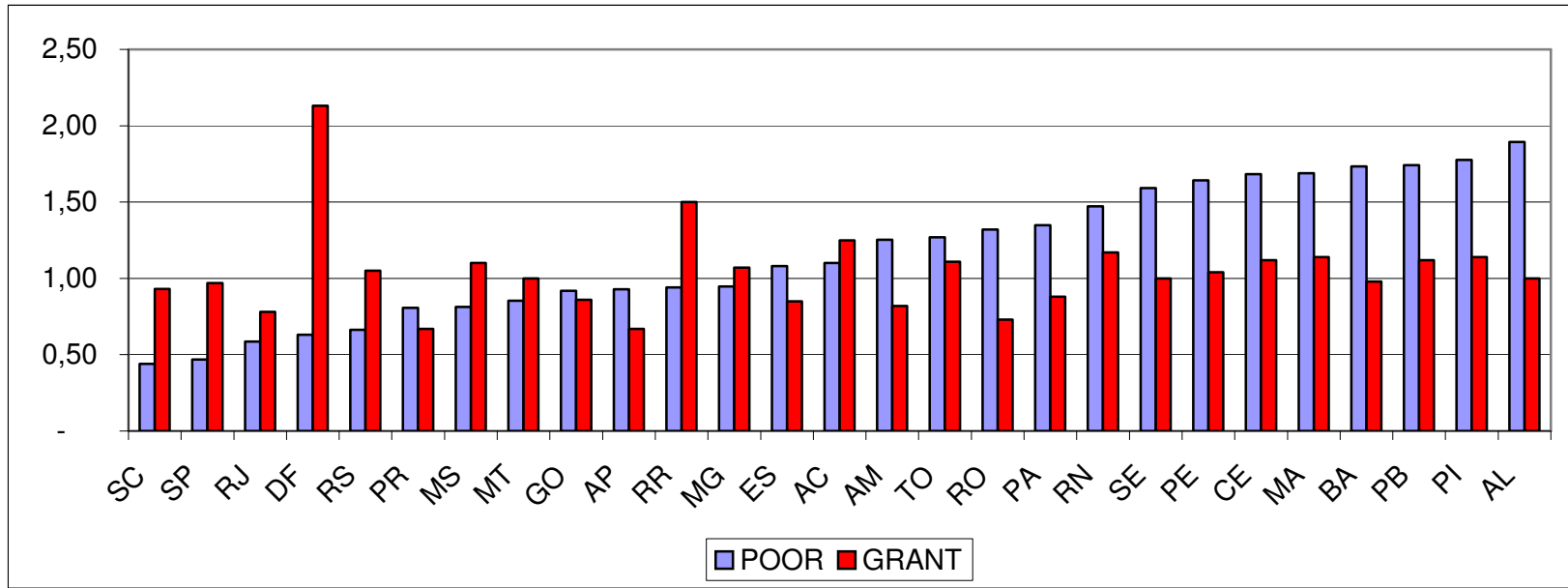
The Family Grant program currently benefits 11.2 million families; each family may have its income increased by at least 21% (if it has no child) or 40% (if it has three or more children). That makes up to US\$3.7 billion income increase for the poor (at most one minimum wage) population. Hoffmann estimates the income elasticity for food in that income stratum to be 0.74. That means that about  $\frac{3}{4}$  of the income increase would be spent in food. Taking US\$3.7 billion as the income increase due to the program and US\$5.1 billion the previous expenditure on food by the program's families, it is possible to conclude that that expenditure can increase by 38% as a result of the program. Under normal condition food prices should rise substantially due that demand increase. The amazing fact is that that did not happen. Indeed as has been shown agricultural prices have been falling for two decades. Certainly agriculture, and the Center-West in particular, have a lot to do with thi historical change.

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<sup>123</sup> It is impressing how well the Federal District is being well served by the program: with one of the lowest share of poor, it is receiving more than twice as many grants as it should according to the program rules.

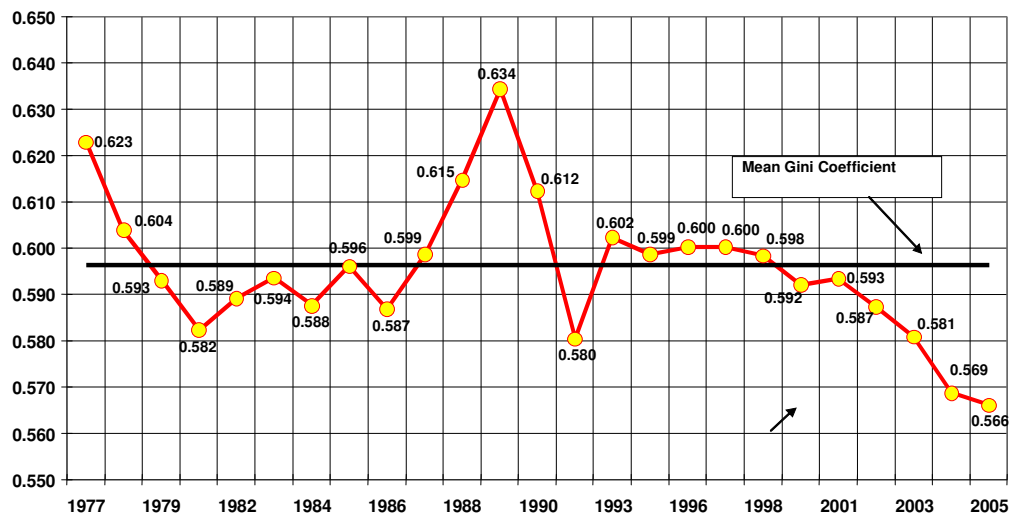
<sup>124</sup> Paes de Barros, R. 2006. "A Recente Queda na Desigualdade no Brasil: magnitude, determinantes e conseqüências". IPEA, DF.

**Figure 45. Ratios of Percent of Poor to Percent of State Population versus Ratio of Percent of State Family Grants to Percent of Poor**



Obs: If, for example, the blue column is equal to 1.0 then the state has the same share of poor families in Brazil as the share of population; if the blue column is 0.5 then its proportion of poor is half its proportion of the national population. If the red column is 1.0 then 100% of the poor families are receiving the grant  
 Source: Ministério do Desenvolvimento Social e Combate à Fome; IBGE

**Figure 46. Gini coefficient of the per capita family income – Brazil, 1977/2005**



Source: Paes de Barros

### 3.6. Concluding Remarks on Social Issues

Critical sociological views of the Center-West occupation process focus on the deterioration of the living standards of native population as a major result: many farmers became landless and jobless as the new capital-intensive technologies were typically labor-saving and based on large scale exploration. As an aggravating factor, it turned out that these new technologies were predominantly used not only in farming itself but also all along the new supply chains that substituted for the traditional means of marketing, processing and transporting. Thus not just native farmers were harmed, but also many other native participants of farm related or dependent activities.

The major criticism from the social standpoint relies upon the lack of focus on the objective of having the native population as the ultimate beneficiary of the occupation and modernization. Rather than creating development opportunities for the native population, the option was to increase production - for the Brazilian growing urban population and for external markets – in a then “empty space” through new farmers brought from other regions and new capital-intensive, labor-saving and human capital-intensive technology out of the reach of native farmers.

According to that view, conservative as it was, the modernization aggravated social inequalities, particularly those related to the agrarian structure: land distribution became even more concentrated. No offsetting policy was implemented to enhance the development opportunities of the native population: only a minority of the native population benefited from the whole changing process. Thousands of farm families were displaced to the urban areas or else had to move to the Center-North and ultimately to the Amazon.

As farmers were expelled from rural areas, unplanned urban growth took place with the surge of many new towns with few development perspectives. That was a byproduct of the so-called “conservative modernization”, a name with negative connotation given to the “green-revolution” in Brazil, for having kept unchanged agrarian structure and favored the regional oligarchies. Diniz emphasizes that that was a model suggested by American institutions (Ford and Rockefeller Foundations, World Bank and USAID) to overcome technological obstacles in developing countries. Lacking capital, knowledge and enough land, small farmers were left out of the modernization process.

At the present stage, it can be said the Center-West occupation resulted in a extension of

the general Brazilian social conditions to that region for almost any criteria considered: urbanization, health, education, poverty, income distribution. As were the cases the of remaining regions of Brazil, Center West State and federal governments reacted with programs designed simply to make supportable the social situation of the growing urban population: donation of food and other basic goods baskets, cooking gas, urban plots and even housing. As Mendonça et al point out these are measures that tend to alleviate – but to perpetuate as well – poverty, and that ultimately makes the agricultural modernization process tolerable from the political point of view.

It is agreed by many analysts that a substantial of share native and immigrated Center-West population may have lost an (or the) opportunity to greatly benefit from the regions natural resources when the occupation process took place. Indeed it seems that most of region's population stands close to the remaining of Brazilians as far as welfare is concerned. It cannot be overlooked, nonetheless, the benefits the whole Brazil's population (including the local one) experienced as agricultural output (specially food) supply increased at decreasing prices. Food supply has been enough to warrant concrete improvements in income distribution and alleviate poverty.

## MAP OF BRAZIL



## ACRONYMS

AGF - Federal Government Purchases (for minimum price program)  
 ATIX - Xingu Indian Land Association  
 BBM – Brazilian Commodity Exchange  
 BM&F – Commodities and Futures Exchange  
 CAMPO - Agricultural Promotion Company (public and private company to produce grains for exports)  
 CEPEA – Center for Advanced Studies in Applied Economics  
 CFP – Production Financing Company (a state company, extinct)  
 CIBRAZEM – Brazilian Storage Company (a state company, extinct)  
 COBAL – Brazilian Food Company (a state company, extinct)  
 CONAB – Brazilian Supply Company (a state company replacing CFP, COBAL and CIBRAZEM)  
 CONSECANA - Cane, Sugar and Alcohol Producers Council  
 COOPERLUCAS - Rio Verde Cooperative (Goiás state)  
 CPR – Rural Product Note  
 EGF – Federal Government Loans (for minimum price program)  
 EMBRAPA – Brazilian Agricultural Research Company (a state company)  
 EMBRATER – Brazilian Rural Extension Company (a state company, extinct)  
 EMPAER - Mato Grosso State Rural Assistance Company  
 ESALQ/USP – Luiz de Queiroz College of Agriculture/ University of São Paulo  
 FEBRAPD – Brazilian No-Till Planting Federation  
 FGV – Getúlio Vargas Foundation  
 FIPE – Economic Research Institute Foundation  
 IAC – Campinas Agronomic Institute  
 IBGE – Brazilian Geographic and Statistics Institute  
 INCRA – National Settlement and Agrarian Reform Institute  
 INPC – National Consumer Price Index  
 INPE – National Spatial Research Institute  
 IPEA – Applied Economics Research Institute (of the federal government)  
 JICA - Japan International Cooperation Agency  
 MCT – Science and Technology Ministry  
 MDA – Agrarian Development Ministry  
 MMA – Environment Ministry  
 PEP – Product Shipment Program (minimum price program)  
 PIN – National Integration Program  
 PND – National Development Program  
 POLAMAZONIA - Program of Agriculture and Livestock and Mineral Poles of the Amazon (1975)  
 POLOCENTRO Program for the Development of the Cerrado (1974)  
 POLONOROESTE - Program for the Development of the Northwest of Brazil (1982)  
 PRODECER - Japan-Brazilian Cooperation Program for the Development of the Cerrado (1979)  
 PRODEGRAN - Special Program for the Development of the Grande Dourados  
 PRODEPAN - Program for the Development of the Pantanal  
 GEOECONÔMICA - Special Program for the Brasília Geo-economic Region  
 PROMAT – Program for Development of Mato Grosso  
 PROSUL - Program for Development of Mato Grosso do Sul  
 PROTERRA – Program for Land Redistribution and Stimulus to North and Northeast Agro-industry  
 SUDAM – Amazon Development Superintendency

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