Chapter 7

PERSPECTIVES AND CHALLENGES FOR DEVELOPMENT OF CERRADOS REGION

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As we have seen in the previous chapters, the great increase of agricultural production in the Cerrados region causes strong impacts on the Country's agriculture and on agribusiness as a whole.
For the sustainable development of this region, the increase of its competitive capacity is fundamental, based on the reduction of production and transport costs as well as on a higher interaction and awareness of the tendencies in the WTO negotiations sphere. These facts are emphasized in the guidelines of the PPA – PLURIANNUAL PLAN of the Brazilian Federal Government for the years 2000 ~ 2003.

In this Chapter, we will try to explain the productive potential of grains in the Cerrados region. Then, a specific analysis for soybean that is the impeller of this development process is carried out, approaching the main challenges for its international competitiveness. Aspects of the production and its potential are analyzed, as well as aspects of agro-industrialization, biomass production, and competitiveness of other products which are increasing in the region: maize, cotton, coffee, fruits, sugar cane, silviculture species, poultry and swine. Furthermore, the necessity of a higher commitment with ecosystem protection is identified, for preservation of the environment and for development of an agricultural technology with the objective of concretizing sustainable agriculture.

7.1 POTENTIAL OF GRAIN PRODUCTION

According to studies carried out by EMBRAPA Cerrados, it is possible to produce approximately 236 million tons of grains through the opening of new areas and from the increase of productivity in the Cerrados region. This data is shown in Table 7.1.1. This volume equals 1.4 times the current grain production in Brazil: that is, 98 million tons (2000/2001).

Table 7.1.1 Potential of the Agricultural Production in the Cerrados Region

	Area (1,000 ha)	Productivity (ton / ha / year)	Production (1,000 ton)
Grains production (upland)	55,000	3.2	176,000
Grains production (irrigated)	10,000	6.0	60,000
Production of meat cattle	55,000 (Pastures)	0.2	11,000
Fruits production	7,000	15.0	105,000
Total	127,000	-	352,000

Source: EMBRAPA CERRADOS – Lecture presented by the Director

The frontier of grain production is distributed in the Cerrados region located in: the State of Mato Grosso, in the Center-West Region, in the States of Tocantins and Roraima, in the North Region, and in the States of Maranhão and Piauí, in the Northeast Region. The possibility of grain production expansion is still high in these regions.

However, in order to materialize this grain productive potential, a considerable investment is necessary for the opening of new areas and for the implementation of production infrastructure (such as irrigation equipment and structures for the production

channeling) in addition to basic infrastructure for rural routines. There is also a concern with the environment, and many economic and technical challenges need to be faced. The challenges and possibilities of production and export of agricultural products (such as soybean, maize, cotton and sugar cane) and of livestock products (such as poultry and swine) are analyzed below.

7.2 POTENTIAL OF SOYBEAN PRODUCTS PRODUCTION EXPANSION AND EXPORT

7.2.1 Possibility of soybean products export

The value of agricultural product exports in 2000 was US$16.6 billion, equivalent to 24% of the total export value of Brazil. The value of the soybean complex exports was US$4.1 billion, equivalent to 25% of the agricultural exports value.

The soybean complex exports value was approximately US$4.1 billions in 2000. The forecast of soybean production for 2006 is 50 million tons, and for the soybean complex exports, US$7.3 billion (ABIOVE, 2001). There is a strong domestic demand in the livestock husbandry sector (mainly poultry and swine), and the expansion of exports is expected due to the following international market factors.

(1) Increase of soybean production due to increase of soybean oil consumption volume

Among the more than ten different types of existing vegetal oils, soybean oil stands out due to its higher consumption growth rate. Besides soybean oil, there is also vegetal oil extracted from maize, sunflower, cotton, etc. However, in the last 10 years soybean oil was the one presenting the higher consumption growth rate. For its production, soybean demand increased from 136.5 million tons in 1997, to 169.5 million tons in 2001. This increase of 33 million tons that was observed in the 4 years period is impressive considering that it is equal to Brazil's soybean production volume.

(2) Growth of vegetal protein source demand with emphasis on soybean bran due to the influence of mad cow disease

The occurrence of mad cow disease in Europe caused expansion of the vegetal bran market of soybean, maize, wheat, etc., as substitution of animal protein source to avoid disease propagation. Among the vegetal protein sources, soybean one is the most utilized due to its low cost. It currently represents 60% of the world's bran consumption, with forecast for demand increase.

(3) Influence due to change in EU common policy for agriculture

The EU are planning to reduce 38% of the subsidy granted to oleaginous plants, which would decrease prices from US$429/ton in 1999/2000 to US$268/ton. With the reduction of this subsidy, a drop in European product competitiveness is expected, favoring the export of Brazilian products.

(4) Possibility of new export market with China in WTO

China started to import 10 million tons of soybean per year since 1990, for oil production thus becoming a large importing country. The customs taxes are 3% for soybean in grains, 122% for oil, and 5% for bran.

With China's participation in WTO, the quota regime will be applied for the import of soybean oil. The import volume will be 1.7 million tons for the first year, then rise to 3.3 million tons in 2005, with the total extinction of the quota from 2006 onwards. Thus an increase of export for the China domestic market can be expected.

7.2.2 Challenges for soybean export of processed products

(1) Present situation of export of soybean processed products

The soybean complex export volume increased from 16 million tons in 1996 to 26 million tons in 2001, which was a spectacular increase in this period as shown in Figure 7.2.1. However, the increase of export was of soybean in grains, with stagnation of oil and bran exports.

Argentina and USA are recently adopting an incentive policy to industry, giving priority to the export of processed products, with disadvantage to the export of soybean in grains.

Argentina exported in 2000, 14.4 million tons of bran and 3.1 million tons of oil, replacing Brazil as the major soybean bran exporter.

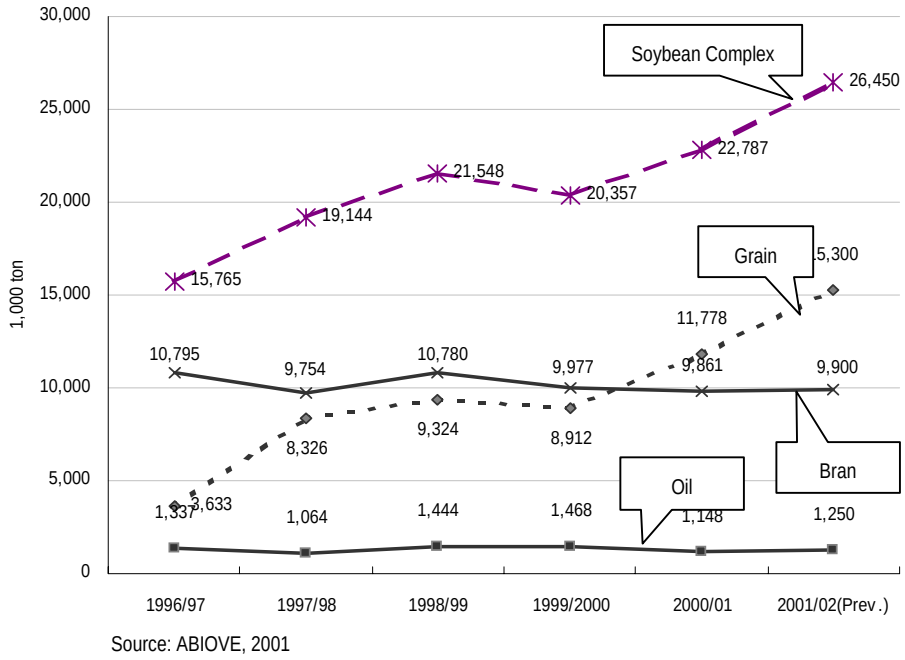


Fig. 7.2.1 Evolution of Soybean Complex Export - Brazil

(2) Necessity of commercial (channeling) cost reduction for products

As described in Section 5.1.2, soybean produced in the Cerrados region, located in the country's inland, faces an enormous disadvantage in relation to USA soybean due to the high transport cost to the port. This cost is a fundamental bottleneck for the increase of competitiveness.

Apart from this, the average tax for port utilization for export in Brazil is US$7/ton, while in the USA this value is US$4/ton. Hypothetically speaking, considering an FOB value of US$180/ton at the port, the price for the Brazilian producer would be US$149 while the American producer would receive US$161.

In Argentina, the average transport distance from the production region to the port is 300 km, and 82% of this is through railway, which is cheaper than through highway. Consequently, the transport cost in Argentina, considering an equal distance, is US$16/ton, almost the same as in the USA. The port utilization tax is US$3/ton, which is cheaper than in the USA.

These differences in the product commercial (channeling) costs, including the transport, storage and port utilization costs, are reducing the competitiveness of Brazilian soybean.

Figure 7.2.2 compares the prices to the Brazilian and Argentinean soybean producers, based on the 1999/2000 harvest data. The average price to the Argentinean producer in the reference year was US$179.50/ton, while in Brazil the price paid was

US$170.47/ton for producers in Paraná, at the South of the Country, and US$145.68/ton for the producers in Mato Grosso State (Municipality of Rondonópolis). The difference between the price paid to the Argentinean producers and to those from Paraná State was US$9.03 per ton, while the difference for Mato Grosso State producers, at the Center-West region, more distant to the port, increased to US$33.82 (ABIOVE, 2001).

In the PPA - Pluri-annual Plan of the Federal Government (2000~2003), the implementation of multi-modal transport systems is considered as a priority project. The execution of these projects to implement and improve commercial/export corridors, mainly those that benefit the Cerrados region, is fundamental for the reduction of transport costs, for the strengthening of competitiveness and for the improvement of the price paid to the Brazilian producer.

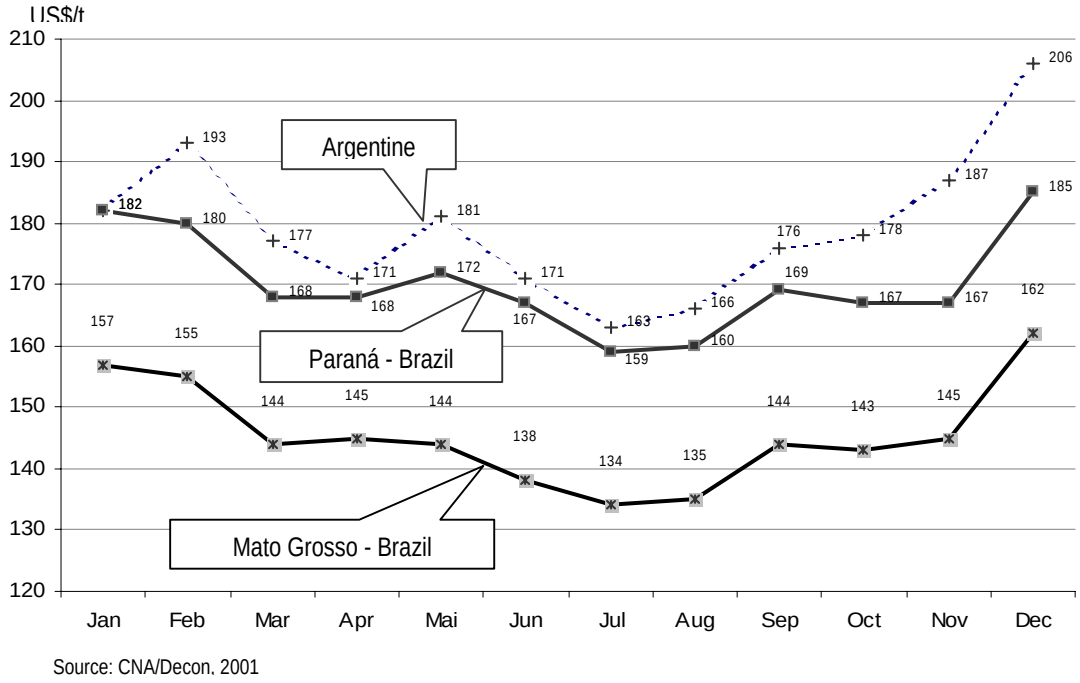


Fig. 7.2.2 Difference of Price Paid to Brazilian and Argentinean producers

(3) Influence of the tax system

The stagnation of soybean oil and bran exportation is caused, on one side, by the increase of domestic demand, and on the other side, by the influence of the tax system that became the bottleneck for the increase of the Brazilian products international competitiveness.

The Brazilian government issued in September 1996 a Complementary Law known as Kandir Law with the objective to relieve the export of primary products from taxes, similarly to what already happened to processed products, thus promoting higher

production and export. As a consequence of this Law, soybean production increased from 24 million tons in 1996, to 31.7 million tons in 2000, and probably will reach 38.2 million tons in 2001. Apart from this, as shown in Figure 7.3.1, the export of soybean in grains, among the soybean complex products, increased from 3.6 million tons to 15.3 million tons in the same period.

This Law had great influence on the current trend of soybean in grains export expansion. However, it harmed the export of oil and bran by creating a difference between the soybean exported in grains and the soybean utilized as raw material, by exempting the first and taxing the second in inter-state operations even if the processed product is for export. As a consequence, the export of soybean oil and bran had a small increase from 20 million tons in 1996, to 22 million tons in 2000. The Brazilian tax system is complex, as described below, in a way that harms the competitiveness and capacity of processing industries as well as of producers.

1) Besides the State tax ICMS (Tax on the Circulation of Products and Services), there are PIS and COFINS (federal taxes). The impact of the first one on production cost is 8.9% in the State of Mato Grosso, 8.5% in the State of Goiás, 7.5% in the State of Paraná, and 8.8% in the State of Mato Grosso do Sul.
2) There is also 2% as the “Contribution to the Rural Security” on the value of soybean revenue. This contribution is paid by the soybean purchaser, but in the last analysis, it becomes a burden for the producer.
3) In the State of Mato Grosso, the biggest soybean producing area in Brazil, there is a tax called FETHAB (State Fund of Transportation and Housing) corresponding to 1.3% of revenue. In the State of Mato Grosso do Sul, there is FUNDERSUL (Fund for the Highway System Development) corresponding to 1.0% of revenue.
4) When a crushing factory purchases soybean in another State, 4% of the value is charged as ICMS and PIS/COFINS.
5) ICMS is charged on inter-State soybean purchases. Thus, it is not profitable for crushing factories to purchase soybean in a neighbor region if this region is located in another State. Consequently, factories prefer to purchase from another region, even with some additional freight cost, if this region is located in the same State.

In Brazil, according to ABIOVE, the elasticity of production response to the taxes reduction is 1.2%. Thus, according to the calculation of the same organization, if there were exemption to ICMS, PIS/COFINS and the Contribution to the Rural Security, the increase in soybean production would be of 11.6 million tons (Plan of Support to the Soybean Complex Exportation, ABIOVE, 2000).

Currently, 15% of the installed capacity of soybean crushing factories in Brazil is

unused. In Argentina, due to export policy incentives for processed products, approximately US$1 billion were invested between 1996 and 2000 in the modernization of the crushing factories, doubling the production capacity from the beginning of the 90's (ABIOVE). Thus it can be said that multinational companies are purchasing and increasing the export of soybean grain in Brazil while investing in a higher value-added production in Argentina due to the complexity of the Brazilian tax system.

(4) Influence of North American agricultural policy (Subsidy)

In order to discuss the competitiveness of the Brazilian soybean exports, it is necessary to look at US agricultural policy trends. This country is the biggest competitor to Brazil in terms of soybean. In the USA, a special subsidy regime called *marketing loan* is utilized to protect agricultural producers, mainly soybean producers. This regime assures to the producer payment of the difference in value whenever the international market price is below to the *loan rate* (in case of soybean, it is equal to US$5.26/bushel) established by the Government based on criteria such as production cost.

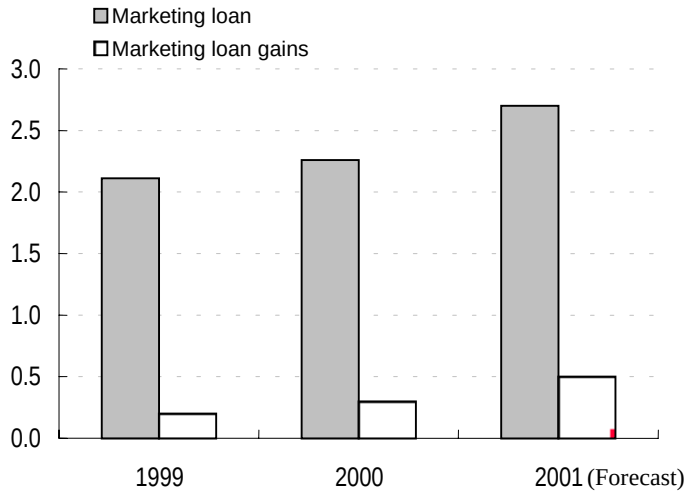
Furthermore, "Agricultural Law of 1996" (applicable to agricultural products produced from 1996 to 2002) assured production freedom. Until then, each farmer was obliged to produce a determined crop according to the cultivation history of the respective agricultural region. If the producer didn't plant according to the determination, the producer could not receive the subsidy if the market price dropped. However, since the harvest of 1996, farmers became free to plant on any land any desired crop, except for fruits and greenery. Thus, producers started to plant crops with higher economic returns. In this manner, the US Government is trying to increase productivity to increase even more the international competitiveness of its agricultural products.

With this freedom to expand production protected by subsidy, the cultivated area of soybean amazingly increased from 1996 onwards. The cultivation area reached a peak in 1979, with 28.5 million ha. After that, reduction and stagnation took place in turns, until the year 1990 when it reached 22.9 million ha. However, since 1996, there was again a growth trend. The cultivation area, which was 25 million ha in 1995, surpassed the historic landmark of 1979 in 1998, then each year it surpassed the previous year figure, finally reaching 30 million ha in 2001. This represented an increment of 20% in the cultivation area in the last six years. In the same period, as shown in Table 5.5.7 of Section 5.5, the market price dropped, with a small peak at the end of 1997 when it temporarily reached US$8/*bushel*. After this, the dropping trend continued, with the price going below the "loan rate" in the second half of 1998.

Despite of this, the soybean cultivation area in the US continued to increase as shown in Figure 5.5.5 of Section 5.5. The price continued to drop without sign of recuperation,

reaching approximately US$4.30/*bushel* (as of October, 2001. *USDA: World Agricultural Supply and Demand Estimates, October 12, 2001*) for the harvest of 2001. This price is lower than the US$ 4.55/bushel recorded in 2000.

The payment of the *marketing loan* to the soybean producers considerably increased since 1999. The paid value, as shown in Figure 7.2.3 below, was 2.1 billion in 1999, 2.3 billion in 2000, and in 2001 this value will be even higher due to the forecast of a more acute drop in the market price.



Source: USDA/FSA, November 6, 2001(http://www.fsa.usda.gov/dafp/psd/reports.htm)

Fig. 7.2.3 "Marketing Loan Gains" and "Marketing Loan" of Soybean in the USA

As shown in Figure 7.2.4, the payment of "marketing loan" per *bushel* was US$0.91 in 1999, and US$0.93 in 2000. Since there is a forecast of a new drop in soybean price, it is possible that, for the year 2001, the average value of this payment will surpass US$1.00.

In the report published by the U.S. Department of Agriculture called "Analysis of the U.S. Commodity Loan Program with Marketing Loan Provisions (by P.C. Westcott and J.M. Price, ERS Agricultural Economic Report No. 801, April 2001), an analysis concludes that if there was no "marketing loan" program, the cultivation area in 2001 would be at least 5% smaller. This analysis also concludes that if this "marketing loan" were stopped, the market price would raise to US$5.50 by the year 2005. This fact contradicts the WTO policy according to which the subsidy regime that stimulates production shall be eliminated.

Hence, while this "marketing loan" regime continues in the current fashion, an even higher increase of soybean production in the USA is expected. As a result, the market price will also continue to drop. This fact is favorable to the importing countries, such as Japan, but represents a difficulty to the Brazilian producers who, without subsidy,

compete with the highly subsidized American soybean. In the next US Agricultural Law, which probably will come into force in 2002, the "marketing loan" may continue although in another form.

Table 7.2.1 was prepared to analyze how the situation would change if the American "marketing loan" subsidy were stopped. The production cost of the American soybean in 1999 divulged by the U.S. Department of Agriculture is of US$249 per acre (approximately 0.4 hectares), as shown below.

Table 7.2.1 Soybean Production Cost in the USA (1998~1999)

Item	1998	1999
Gross value of production:		
Primary product: Soybean	223.17	171.31
Total, gross value of production	**223.17**	**171.31**
Operating costs:		
Seed	20.46	19.25
Fertilizer	8.00	7.96
Soil conditioners	0.10	0.10
Manure	0.80	0.79
Chemicals	26.65	24.88
Custom operations	5.84	5.86
Fuel, lube and electricity	5.97	5.90
Repairs	5.59	9.79
Purchased irrigation water	0.05	0.05
Interest on operating capital	1.86	1.75
Total, operating costs	**79.32**	**76.33**
Allocated overhead:		
Hired labor	1.98	2.01
Opportunity cost of unpaid labor	18.11	18.46
Capital recovery of machinery and equipment	50.66	51.58
Opportunity cost of land (rental rate)	77.66	79.74
Taxes and insurance	6.89	6.77
General farm overhead	12.94	14.13
Total, allocated overhead	**168.24**	**172.69**
Total costs listed	**247.56**	**249.02**
Value of production less total costs listed	-24.39	-77.71
Value of production less operating costs	143.85	94.98
Supporting information:		
Yield (bushels per planted acre)	43	37
Price (dollars per bushel at harvest)	5.19	4.63
Enterprise size (planted acres) 1/	220	220
Production practices: 1/		
Irrigated (percent)	5	5
Dry land (percent)	95	95

1/ Developed from survey base year, 1997.
Source: USDA/http:www.ers.usda.gov/data/costsandreturns/car/DATA/copest99/soybean.xls November 6, 2001

The productivity of 1999 was 36.6 *bushels* per hectare, which means that the production cost per *bushel* was US$6.72. For the case of 2001, if the production cost of one hectare is US$250.00 and a productivity of 39.2 *bushels* is expected, the production cost of a

bushel will be US$6.38. This cost is very high even in relation to the US$5.26 of the "loan rate".

However, such production cost is practically very small. Even in the values presumed so far, the production cost divulged by the U.S. Department of Agriculture is overestimated. Surely there are countless producers very competent in reducing the costs, and thus most of the soybean produced in that country is produced with a production cost smaller than the "loan rate".

That is why the production is being expanded through the "marketing loan" subsidy that considers the "loan rate" as a guarantee unit. Converting the "loan rate" of US$5.26/bushel into 60 kg bags, the value will be US$11.60. The production cost in the State of Goiás (one of the soybean producing regions in the Brazil), based on a productivity of 2.9 to 3.0 tons/ha, a 60 kg bag would cost approximately US$8 (more exactly US$ 7.88~8.22) (FNP: Agrianual 2001, p.480), or approximately US$3 cheaper than the American production cost.

The competitiveness is also measured by the transport cost. In the USA, this cost from the producing farm to the port is US$6.60/ton. In the case of Brazil, this cost is of approximately US$50.00 to 60.00/ton, in addition to which the port costs are higher. These US$50.00/ton converted into 60 kg units exactly equals to US$3.00. Thus at present, the FOB prices of the soybean produced in Brazil and in the USA are equal. However, as already mentioned, the actual production cost of several US producers is below the "loan rate". Thus, even if the "marketing loan" would be hypothetically stopped, the various representatives of the agribusiness sectors in the US would join their strength to search for new ways to reduce costs. Therefore, analyzing the soybean export competition between Brazil and the USA, and even the international competition with other countries, it can be concluded that this competition will continue to be harsh.

(5) Product quality and sanitary measures of WTO

The WTO Agricultural Agreement basically covers three main points which are: access to markets, domestic support (domestic subsidy), and subsidy for export. In regard to the last two points, the excess of product supply, such as grains and dairy products, at worldwide level could be avoided through the prohibition or reduction of subsidy of exports and of the subsidy to agricultural production in the USA and in EU countries. This can be interpreted as a positive change that would help the expansion of the export opportunity to the world market, for countries such as Brazil where there are no subsidies to the producers.

Brazil, as one of the members of the Keans Group, is standing in the position of demanding fulfillment of the current WTO rules. However, there is a problem that

Brazil will inevitably have to face in the negotiations carried out within the WTO sphere. This problem is the elaboration of rules related to sanitary measures (animal, vegetal and food health) and the problem of product quality. The "HACCP"[1], strict rule in US that regulates the processing stage of agricultural products, is being introduced in countries such as Brazil, Argentina, Southeast Asian countries and developed countries. Apart from this, the soybean processing and commercial (channeling) sectors have to bear in mind the terms of ISO series. There is still the possibility of substitution of the three main points of the WTO Agricultural Agreement for a "new international order" based on rules related to sanitary issues. [2]

If this becomes reality, the Brazilian advantage of the WTO Agricultural Agreement disappears. Therefore, until technology of vegetal sanitary protection is introduced, it will not be possible to strengthen export competitiveness in the world market.

(6) Challenges from introduction of transgenic soybean

1) Basic challenges of transgenics

The great advantage of transgenics to producers is the reduction of production cost due to the reduction in volume of agricultural pesticides. On the other hand, the advantages for the consumers are still not clear, raising doubts in regard to the safety of these products for consumption. The degree of preoccupation with this theme is shown through the debate about the need for labeling genetically modified products. Exporting countries such as the US and Argentina are for "no labeling", while importing countries such as Japan and the EU countries are for "labeling".

This problem will become one of the main debate themes in WTO negotiations. The course of the agreements to be signed is still uncertain. However, there are no doubts that the position of the importing countries will influence the production and export volumes of these products.

2) Positions of USA and Argentina and future challenges

In the USA, transgenic soybean represented, in 1996, 7.4% of the total cultivated area. In 2001, this percent rose to 63% (USDA-NASS, 2001). Argentina also produced transgenic soybean since 1996, reaching a cultivation area that represented 80% of the total area of soybean cultivation in the 1999/2000 harvest (ALIC/WEEKLY, 2001, http://www.lin.go.jp). Since the transgenic cultivation area in Argentina in 1997/98

1) *Hazard Analysis Critical Control Point*: Management systems search for the safe production of food through the control of the whole processing stage, from the raw material until the final product. Through the elaboration of a work manual, the understanding of the sanitary control is made available for everyone.

2) This point of view is presented in the information of the following internet *site*: http://lanic.utexs.edu/sela/engdocs/spdredi22-984.htm(1999)

represented only 13% of the total, expansion has been increasing at a fast pace in these last two years.

The recent discussions about the safety of such consumption have raised the following questions:

a) To what degree has expansion of the transgenic soybean cultivation area happened so far?
b) If the importing countries start to demand labeling of transgenic products or to demand a different commercial channeling in relation to the conventional soybean, what would be the additional cost to bear?

3) Transgenic soybean in Brazil and future challenges

In Brazil, the transgenic soybean is still not officially released for commercial scale production. However, researches about genetically modified products are being carried out by official research organizations and by the multinational companies, mainly those dealing with grains. The Government of Brazil is getting prepared to rapidly and adequately react to a new situation in case the transgenic product is worldwide accepted and released commercially in world markets.

Brazil exports to the EU countries that are against the commerce of transgenic soybean, and to the US, where these products are already sold. At present, while there is still not a definite conclusion about the possible problems for the human consumption of this type of product, Brazilian companies and producers are divided into two big groups: those who are getting prepared for the future release of transgenic products, developing varieties that are resistant to diseases and blight, and those who intend to enter a new market opportunity, exclusively working with non transgenic products.

Among the Japanese trading companies that work with soybean imports, there are those which are showing signs of strengthening soybean acquisition channels from Brazil in order to meet the demand of non transgenic soybean. This trend is within a context in which Brazil is not producing transgenic soybean. In the case of the US, the products are separate, but at the commercial stage, when they go through the silo elevators, they get mixed. To import only non transgenic soybean, it is necessary to assemble a new transport structure, starting at the producer farm, and separating the desired soybean during the whole channeling process. In case of Brazil, considering that there is no transgenic soybean yet, for now there is the advantage of not needing a new structure for separate commerce.

However, there are examples in the USA such as one big seed sales company that at the same time sells transgenic soybean seeds, also consolidates the know-how for the separate channeling of soybean. This shows the possibility in the future of increasing

differential channeling practice. However, as mentioned before, there will be additional cost for this. If this additional cost is transferred to the soybean price, there are new possibilities for trading companies that now purchase from the USA to start to purchase the Brazilian soybean.

Thus, Brazil will have to face new challenges such as to develop products which are in accordance to the final consumer demand, to calculate the cost for the consolidation of new commercial relationships, and to analyze new measures after comparing the increase of the necessary cost to assure a stable supply of products which are either transgenic or not.

7.3 POTENTIAL AND TRENDS OF MAIZE PRODUCTION

7.3.1 Trends of production and consumption

World maize production is approximately 586 million tons (2001). The biggest world producers are the USA, with 238 million tons (40.6% of the world's production), China with 105 million tons (17.8%), and Brazil with 36.6 million tons (6.2%). In regard to productivity, Brazil, with its 2.5 tons/ha, is however still far away from the 9 tons/ha attained by France, which is first in productivity ranking.

World consumption is estimated at 525.4 million tons. The USA is both the biggest consumer and exporter of maize. Their consumption is estimated in 176.8 million tons (33.6% of the world's consumption).

Maize cultivation is a very important activity in Brazil considering its geographic size, cultivated area, labor-force occupation and participation in the production of roughage; thus the cultivation area and the production volume present possibilities for expansion.

Maize is cultivated over the whole national territory, and the main producer States are Paraná (7.7 million tons), Rio Grande do Sul (4.2 million tons), Minas Gerais (4.1 million tons), São Paulo (3.9 million tons), Goiás (3.7 million tons) and Santa Catarina (3.6 million tons). Only the State of Paraná accounts for more than 20% of the national production. When we take into account the six biggest producer States mentioned, this participation accounts for approximately 80%. This participation, that in the beginning of the 80's was 90%, suffered a reduction partially explained by the fast growth of the maize production in that period in the State of Mato Grosso. It is worthy to mention that, in the period from 1980 till now, the growth of the Paraná State production was only a little smaller than that of São Paulo, Rio Grande do Sul and Goiás States, but was considerably higher than that of the States of Minas Gerais and Santa Catarina. The States of Mato Grosso and Mato Grosso do Sul were those that presented the highest

growth rates, although they had started from a much smaller base. Another fact to be pointed out is that the expansion of production towards the Center-West region has been carried out using advanced technological standards. In 1997, Goiás State recorded a yield of approximately 4 tons/ha, the highest among the Brazilian States. In Goiás, there is an important potential of maize supply, represented by the municipality of Rio Verde. The region's productivity is approximately 6 tons/ha.

7.3.2 Possibility of production expansion

As for consumption, the maize for animal feed (poultry and swine) represents the biggest part, representing two thirds of the maize produced in Brazil.

From these two thirds, it is estimated that 45% are for poultry production, 23% for eggs production, and 32% for swine production. The increase of maize consumption in the last two decades was closely related to the increase of demand in these categories. Focusing only on the poultry production, responsible for the largest consumption of maize, the biggest stock (45% of the national herd) is in the South region. The Southeast Region, that at the beginning of the 80's had around 42% of the herd, reached the 90's with only 29%. In this period, the activity was transferred from the Southwest Region to the South, and more recently to the Center-West region.

Cerrados region participation in the national scenario is increasing, mainly during the last years, reaching 45% of the total production. The regional productivity is higher than the national average, and will increase with the expansion of the irrigated cultivation.

The Cerrados region is becoming an important frontier for maize, with capacity to absorb and to utilize high technology.

Most of the maize is produced during the rainy season (November to April), through a great number of cultivation systems, but with the predominance of subsistence systems (small areas, usually in consortium with cassava, feijão bean and coffee) and of the commercial cultivation in large areas after the improvement of the soil fertility. This last system tends to expand through rotation with other crops, especially soybean. Irrigated maize cultivation will also increase with the search for higher productivity.

In commercial systems, there is predominance of hybrid cultivation produced by private companies. Recently, there have been increasing numbers of efforts to obtain better quality material also better adapted to the region environmental conditions and with high protein quality.

The maize consumption will increase as a response from the roughage industries for animals raised and/or slaughtered in a confinement system. Additionally, an increasing

utilization of maize in the bread industry and in the vegetal oils production is expected. Depending on price policy and on the improvement of transport infrastructure, maize can become an export product.

The maize cultivation area will increase mainly aiming at composing a crop rotation system. But the major increase will be the result of productivity improvement, with the amelioration of production technology, including irrigation. The region has potential to double its current productivity, reaching levels close to those obtained in the US. Due to these conditions, Brazil managed to export maize for 2 consecutive years: 5.8 million tons in 2000, and approximately 2 million tons in 2001 (CONAB, 2001), with forecast for future export increase.

7.4 POTENTIAL OF COTTON PRODUCTION

7.4.1 Expansion of cotton cultivation through the development of appropriate varieties

The State of Mato Grosso is the main cotton producer in Brazil with 53.4% of the production. For this reason, the analysis of this crop will focus on this State's performance.

One of the remarkable examples of the research contribution for the sustainability of the textile chain was the generation and transference of technology for the consolidation of cotton in the Brazilian Cerrados region, starting in Mato Grosso in 1989, with the formal partnership between EMBRAPA and the Itamarati Group. At that time, economic alternatives were sought for crop rotation with soybean as strategy to assure return on the high investment carried out for the opening of Cerrados region in the Mato Grosso, threatened by a sequence of low yield soybean harvests, as well as by the increase of phyto-sanitary problems, especially stem cancer and the nematocyst of soybean.

Initially, the Itamarati Group imported technology and seeds from Israel, USA and Australia, without success considering that the imported varieties were adapted to irrigated production systems in semi-arid environments, and the climatic conditions of Mato Grosso (high altitudes with high temperatures, humidity and precipitation) resulted in high incidence of foliar diseases (bacteria, fungus) and virosis.

Once the partnership with Embrapa in 1989 was established, the evaluation of the vast germ plasma bank of cotton was prioritized, as well as the development of varieties in the Cerrados of the Chapadão dos Parecis (Campos Novos dos Parecis – MT) and the amelioration of the production system in use. The diseases and pests with economic importance were identified, as well as the varieties resistant to the main diseases, when

implementing the integrated management of the crop pests and ameliorating the production system for cultivation time, spacing, cultivation density and seeds treatment. A partnership network was established aggregating Empaer – MT (1991), Embrapa-Rondônia and Empaer – MS (1994), and since 1995, the MT Foundation, IAC, IAPAR, COODETEC, Cooperatives, Cotton companies, entrepreneurial producers of the Cerrados, Fetagri, Secretariat of Agriculture and Agrarian issues and Producers Associations. The research results started to show up in reports, technical and scientific publications, and since 1992, Field Days began to be held for the transference of technology that became known as the high technology cotton production system in the Cerrados region. After this first Field Day carried out by Embrapa and Itanorte, in Campo Novo dos Parecis in 1992, others followed, culminating in the harvest of 1998/99, with 20 Field Days carried out by all the concerned institutions in Mato Grosso. The cotton producers in the Mato Grosso Cerrados evolved from only two in 1989 to 725 in the harvest of 2000/2001. In this State, the organization of cotton producers was sought through AMPA – Mato Grosso State Association of Cotton Producers – at the State level, and AMBRAPA – Brazilian Association of Cotton Producers – at federal level, and PROALMAT (Program of incentive to cotton in Mato Grosso) was created, together with FACUL (Fund of support to the cotton crop). The creation of the Fund and of the cotton incentive Program facilitated great improvement of the quality and competitiveness of the Mato Grosso State cotton.

7.4.2 Possibility of cotton production increase

Cotton cultivation technology and the development/diffusion of appropriate varieties for the Cerrados region in the Mato Grosso State allowed the increase of productivity and of the cultivation area in this State, as shown in Table 7.4.1. Currently, the State of Mato Grosso is the major producing State with cotton representing 53.4% of the national production. The engagement of all the State sectors in cotton cultivation is shown in the high quality of products and production stability, thus allowing the increase of Cerrados' cotton producers credibility with the national textile industrial park, that in turn started to purchase in advance part of the production, thus playing an important role in the production financing.

Table 7.4.1 Expansion of the Cotton Cultivation Area in Mato Grosso and Participation of CNPAITA 90 in harvests from 97/98 to 2000/2001

ITEM	HARVEST **97/98**	HARVEST **98/99**	HARVEST **99/00**	HARVEST **00/01**
Area MT-1,000 ha	109.9	203.3	268.4	362.3
Production MT-1,000 ton (plume)	94.2	224.1	335.8	460.3
Productivity – kg/ha	2,450	2,940	3,250	3,300
Plume production in MT in relation to Brazil - %	22.9	41.8	47.9	53.4
Cultivated area with the Variety CNPA ITA 90 in MT - %	80.0	79.9	66.5	64.5

The following social benefits of this program can be pointed out: generation of 83,930 jobs, implementation of 140 cotton gins. The total revenue from cotton cultivation in Mato Grosso reached R$839.1 million just in the harvest of 99/00, with a total tax collection (ICMS, taxes from industries) corresponding to R$ 307.9 million. Goiás, Bahia, Minas Gerais, Mato Grosso do Sul and Maranhão States are implementing similar models to that adopted by Mato Grosso, as strategy for the expansion of cotton cultivation in their Cerrado areas, also counting on the direct participation of EMBRAPA in each of these States.

This successful example already reverberates in other countries through visits of entrepreneurs and importers from Europe and Asia who resumed the import of Brazilian cotton, purchasing 30,000 tons of plumes during 2000 from Mato Grosso producers. There are prospects of attaining 150,000 tons of exports in 2001, out of which 120,000 tons are already negotiated for future delivery. In Cerrados, the increase of cultivation area for one million hectares in the next three harvests is expected, including 600,000 hectares to be cultivated only in Mato Grosso. However, for expansion of the cultivation area, the development/diffusion of new varieties with multiple resistance to diseases in order to replace CNPAITA 90 is becoming indispensable. For the increase of exports, the major challenges are product quality improvement through the reduction of agro-chemicals utilization and modernization of cotton processing plants, besides the reduction of production cost.

7.5 POTENTIAL OF THE COFFEE PRODUCTION

7.5.1 Tendencies of production

The coffee product chain moves around the world approximately US$35 billion per year. In 1997, the world supply of coffee was around 130 million 60 kg bags, and the demand was for 110.5 million bags. Brazil is the major coffee producer in the world, with 22.4% of the world production and 23.1% of world exports in 1998. USA, Germany, Japan,

France and Italy are the major importers, in that order.

Coffee that in the beginning of the century represented 80% of Brazilian exports, but in 1980 contributed only 13.8% of the total exports revenue, in 1985 10.22%, dropping to levels around 3% in the beginning of the 90's. In 1998, coffee presented a total export value of US$2.6 billion, corresponding to 5.11% of global export revenues (Coffee Statistics information, 1998).

Due to climatic factors (hoarfrost), political-economic factors, influences of the foreign markets, emergence of producing countries, as well as due to discontinuity of coffee research programs, the annual production in the 70's, 80's and 90's was very unstable, oscillating between 10 to 38 million bags.

In 2000, the States of Minas Gerais (51%), Espírito Santo (22%), São Paulo (12%), Paraná (6%), Rondônia (4%) and Bahia (4%) were the major producers, contributing 99% of the Brazilian coffee production. (Table 7.5.1).

Table 7.5.1 Characteristics of the Brazilian Coffee Cultivation – Harvest 2000/2001

States	Coffee Park December 1999		Production Estimate December 2000 (thousands of processed bags)	Productivity 2000 (bags/ha)	%
	Area (thousand ha)	Coffee Population (millions of holes)			
Minas Gerais	829.0	2,039	15,900	19.20	51.0
Espírito Santo	508.7	984	6,700	13.17	22.0
São Paulo	200.4	374	3,600	23.10	12.0
Paraná	145.2	298	1,900	13.24	6.0
Rondônia	160.0	187	1,400	8.75	4.0
Bahia	89.0	145	1,200	14.50	4.0
Others	48.0	83	400	8.30	1.0
Total of Brazil	1,980.3	4,110	31,100	15.70	100

Source: Agreement MAPA/Embrapa (December 2000)

7.5.2 Challenges for coffee production

The State of Minas Gerais, from 1969 on, consolidated its participation in national coffee production with the Plan of Crop Renovation planting 1.28 billion holes, multiplying by five its coffee plants that increased from 332 million in 1969 to 1.7 billion in 1998. In 2000, the number of plants amounted to approximately 2.87 billion. The great number of new coffee producers is an indication of the continuity of the Minas Gerais distinguished position, compared to other producer States.

In the 70's, coffee started to be planted in the Cerrados ecosystem, starting in the State of Minas Gerais. Today, its expansion occurs in other States, mainly in Bahia.

Together with the technological level, the low relative humidity caused by the absence of rain during the harvest – May to September –allows the production of high quality coffee in the region, with international acceptance. In the Paracatu and Patrocínio regions, where Prodecer projects were implemented, coffee known by the brand name "CERRADO COFFEE" is expanding its production, mainly by the Nikkei coffee producers (Japanese descendents).

In the course of coffee cultivation, traditionally agricultural research had a great influence on the adaptation of the crop at several locations in Brazilian territory. Only in the recent past did coffee researches lose their importance, mainly after the closing of the Brazilian Institute of Coffee – IBC, in 1990, with clear negative effects on national coffee cultivation.

With the aim of carrying out research and development activities which were able to give technological and economic support to the coffee agribusiness, the Brazilian Consortium of Coffee Research and Development – CBP&D/Coffee – was created in March 1997, and today integrates 40 Research & Development institutions plus other components of the coffee productive chain, under the coordination of EMBRAPA.

Although promising, coffee cultivation is experiencing technical problems that are being targeted by the research. Productivity varies between 6 to 27 bags (60 kg) per ha. To compensate for this deficiency, lineages and varieties with higher productivity, production stability and resistance to coffee rust were selected. The obtained results allow the indication of lineages with average yields between 45 and 55 bags (60 kg) per ha. These yields correspond to a superiority of 13 and 25% in relation to the varieties "Mundo Novo" and "Catuaí," respectively, which have been traditionally cultivated.

7.6 POULTRY POTENTIAL

The chicken meat production volume of Brazil increased from 217,000 tons in 1970 to 6 million tons in 2000. The growth in the last 10 years was amazing, with a growth rate of 164%. In 2001, 6.4 million tons were produced, equivalent to 14% of the world's production, ranking Brazil in the second position only behind the USA that produced 13.73 million tons. In 2000, poultry meat husbandry started to have 27.5 million of installed matrixes, while for eggs production there were 970,000 matrixes. Brazil is the 8th largest world producer of eggs.

In terms of productivity, in 1970, 70 days were necessary for the growth and fattening of a meat chicken, which consumed around 2.0 kg of roughage for 1.0 kg gain in weight, and 80% of this live weight could be considered edible. With fast modernization, Brazilian poultry husbandry reached high levels of productivity, considering that

currently a meat chicken is ready for slaughter with 2.4 kg of live weight, at 44 days, with a conversion rate of 1.78 kg of roughage/kg gain in weight. In the same period, hens increased from approximately 255 eggs to more than 330 eggs in the first cycle and improved the conversion rate from 1.77 to less than 1.40 kg of roughage/dozen eggs produced.

In regard to chicken meat consumption per capita, it increased from 5.1 kg in 1975 to 24.1 kg in 1998 (FAOSTAT, 2000). The eggs consumption per capita increased from 2.3 kg in 1970 to 30 kg in 2001, an amazing expansion. The country with the highest eggs consumption per capita in the world is Hong Kong with 62 kg, followed by Kuwait and USA (42 kg), Saudi Arabia and Arab Emirates (33 kg), and then Brazil.

The increase of soybean and maize production in the Cerrados region, which are raw material for the production of animal roughage, greatly contributes to the increase in chicken meat and eggs demand.

In Brazil, the importation of highly productive specialized lineages in the 60's greatly contributed to the fast evolution of Brazilian poultry husbandry.

In 1965, the import of commercial matrixes and small chicken was forbidden, and only the import of reproducers belonging to the last two generations in relation to commercial generation was allowed. This situation created the conditions for a genetic improvement program in Brazil that started the selection of lineages in mid 70's.

Thus, in 1972 the first three entirely national commercial lineages were launched.

Similarly, the results of EMBRAPA works such as raising method, improvement of roughage chemical composition and improvement of lineages allowed the consolidation of a modern productive process, integrating production through processing. This productive process was initially introduced in the South Region, and was afterwards diffused to the States of Goiás and Mato Grosso. These two States have a great comparative and competitive advantage in relation to other regions in terms of facilities in preparing roughage and reducing its cost due to the production of soybean and maize in the Cerrados region itself.

7.7 THE POTENTIAL OF SWINE HUSBANDRY

7.7.1 Tendencies of production and consumption

In Brazil, the swine production rapidly increased since the 70's. In 1970, 8.52 million heads of swine were slaughtered; in 2000, 26.827 million heads were slaughtered, and in 2001, approximately 28.5 million heads were slaughtered, with a higher growth trend in the last years.

In regional terms, since the 70's, swine husbandry strongly expanded in the South Region, especially in the West of Santa Catarina State, cradle of the major agro-industries of this sector in Brazil. In 1970, the South region participated with 89.34% of the total number of slaughtered swine in Brazil, though this participation diminished to around 49.96% in 2000. This was due to the growth of swine husbandry in the Southeast and Center-West Regions that accounted for 9.4% and 18.1% of the national herd, respectively. The current national herd accounts to 37.3 million heads, and these Regions present a strong trend to occupy the leading position of swine production in the country.

The Brazilian participation in world production of swine meat increased from 1.71% in 1973 to 2.2% in 2000. Currently, Brazil occupies the seventh position in the ranking as a major swine producer countries, of which China and the USA, with around 45% and 10% of the production, occupy the first and second positions, respectively.

Canada is the current world leader in swine meat exportation (750,000 tons in 2000). Brazil, thanks to the opening of the Russian market, is exporting each time more, and in 2001 may have occupied the fourth position in the exporters ranking, with approximately 160,000 tons.

The swine meat consumption is high in Europe, North America and Asia. Belgium presents the highest consumption per capita per year, 77.2 kg in 2000. It is followed by Spain with 64.2 kg, and then come the Czech Republic, Germany, Australia and Hong Kong. The huge markets of China and USA recorded, in 2000, a consumption of 33 kg and 30.7 kg, respectively. In the case of Brazil, the domestic consumption per capita increased from 6.9 kg in 1975 to 9.2 kg in 1998, with a tendency for gradual growth.

7.7.2 Production potential and increase of exports

In the period from 1975 to 2000, Embrapa developed products and technology in several fields of the swine husbandry activity, for example the high productivity reproducer through the food chemical composition table, besides achieving progress in the sanitary field. Furthermore, the genetic improvement sector generated the swine MS

58 known as “light swine”, which for its development work received an award in the USA from the *Smithsonian Institute.* These raising and genetic improvement methods highly contributed to the increase of productivity, with a reproductive efficiency obtained in technical raising systems of small- and medium-scale, in the South of Brazil, of approximately 10.5 swine per delivery and around 2.2 deliveries/female swine/year.

Brazilian swine exports are still concentrated, efforts and actions being necessary for its diversification. The production cost in Brazil is around 20% lower than in Western Europe. This cost reduction is possible due to factors such as the consolidation of the production structure integrating production through the final processing, the possibility of having cheap and good quality raw material for roughage from the Cerrados region, and also thanks to the productivity increase recently observed in the sector.

Another significant gain obtained by Brazil in the swine husbandry activity was in the field of animals sanitation, considering that the 13 States located in the Center-West, Southeast and South regions, where 90% of the national production is concentrated, are free from two of the most harmful diseases which can even close the doors of the international market: FMD and Classic Swine Fever. Based on these factors, the Brazilian government intends to increase the swine meat export volume to 1 million tons, in a near future.

The Cerrados region, due to the already mentioned factors, stands out as a promising region for the efficient and effective development of swine husbandry. There are already expansion plans that count on the increase of the number of installed matrixes to something around 100,000 heads in the next five years.

7.8 POTENTIAL OF FORESTRY EXPLOITATION

The Cerrados region of Brazil has a great potential for the full development of silviculture, with special distinction for the utilization of fast growth species such as *pinus* and *eucalyptus*.

In average, each seven hectares planted with forest species generates one direct job and three indirect jobs. Each job created in the forestry sector costs approximately US$ 600. Consequently, the forestry sector created, in 2000, 2 million direct and indirect jobs, assuring a tax revenue of R$3 million.

The forests planted in Brazil represent around 0.5% of the total Brazilian territory, corresponding to 2.9 million ha of area reforested with eucalyptus and 1.7 million ha reforested with pinus.

The industrial consumption of wood, in 1999, was 166,310,000 m^3, out of which 62% (102,460,000 m^3) came from planted forests and 38% (63,850,000 m^3) from native forests.

The destination of the planted forest production in the Country has been the paper and cellulose sector (51%), lumber, plywood and reconstructed panels (16.5%) and charcoal (29.3%).

In Brazil, a scarcity of wood is expected already for 2002, that will harm the development of the silviculture-industrial complex. An average annual growth rate of 4.6% for the sawmills, fabrication of wooden objects and furniture is expected until 2004.

Official information reports the existence of imbalance between supply and demand of wood in Brazil. The consumption equals to the annual production of 450,000 ha, while meeting the demand only 150,000 ha are being replanted annually. This confirms the annual deficit of 300,000 ha to supply all the industrial branches of the forestry based sector in Brazil. The reduction of the Fiscal Incentive Policy of the Federal Government had an influence on the sector, causing the reduction of the reforestation area. The silviculture development potential in the Cerrados region is approximately 2 million ha. The silviculture development in Cerrados, with emphasis on the environmental preservation, can significantly contribute to reduce the lack of forestry resources, mainly of cellulose in the country.

7.9 POTENTIAL OF FRUITS PRODUCTION

In Brazil, the soils under Cerrados conditions occupy an area of approximately 204 million ha. Out of this total, around 2 million ha are viable for agribusiness with perennial crops and forests.

The Brazilian Cerrados are spread out on a huge area starting in the Center-West region, thus allowing the production of a varied range of fruits such as banana, pineapple, grape, mango, melon, passion fruit, graviola, lemon, orange, cashew, guava, etc.

In general, Brazil is the second biggest world producer of fruits, with approximately 34 million tons (year 2000), while China occupies the first position in the ranking. According to FAO, in 1997, Brazilian exports reached US$77.741million, while USA, Equator, Spain, France and Italy surpassed US$1 billion and Chile, Holland, and Colombia exported more than US$500 million.

In 2000, the international fruit market circulated approximately US$22 billion. Brazil

increased its exports in relation to 1997 even though attaining only 0.8% of this market, corresponding to US$170 million.

The most exported fruit is mango with US$36 million, out of which 80% come from the São Francisco River Valley in the Northeast Region of Brazil.

Furthermore, Brazil is the biggest world producer of orange and orange juice. Currently, the country exports more than 1.1 million tons of juice, out of which 65% goes to the European Union (basically to Germany and England), and 20% to the USA.

The cashew crop is becoming very important for the Northeast Region, mainly for the States of Ceará, Piauí and Rio Grande do Norte, particularly after the development of excellent appropriate technology such as the genetic improvement and the creation of precocious dwarf cashew trees.

Many other fruits have a great export potential, such as the native fruits from the Amazon and Center-West regions, this last one with high conditions to become a great fruits producer in Brazil.

In order to assure the fruits quality for the domestic and international markets consumption, Brazil is implementing and developing a project for the survey of the fruits production activity in the Country, giving priority to those more exported, and with the objective to follow up the requirements of international quality production. The APPCC System (Analysis of Dangers and Control Critical Points) must be mentioned, through which the Country searches for production amelioration through the integrated system of fruits production.

7.10 POTENTIAL OF SUGAR CANE PRODUCTION

Sugar cane exploitation in Brazil is, socio-economically and strategically speaking, the most important crop to the country in terms of energy. The sugar cane importance gained notoriety in the last 20 years with the creation of the National Program of Alcohol /PROALCOOL, through the utilization of alcohol as fuel.

Currently, Brazil is the largest major world producer of sugar cane, with more than 300 million tons, produced on 5 million ha and that are transformed into more than 15 million tons of sugar, out of which 80% are for the domestic consumption and 20% for export. 15 billion liters of alcohol are domestically consumed. The main producers Brazilian States of sugar cane are, in order of importance, São Paulo, Alagoas, Paraná, Pernambuco, Minas Gerais and Rio de Janeiro. In the Northeast region, this crop occupies approximately 1.1 million ha in the year 2000. The State of Alagoas, with

around 400,000 ha of cultivated area is the first producer in this region. In the the 95/96 harvest, the State produced approximately 20 million tons of sugar cane, 600,000 cubic meters of alcohol and 31 million bags (50 kg) of sugar.

This activity mobilizes 350 industries in the whole Country, around 50,000 producers and around 1.4 million direct workers and another 3.6 million indirect workers, according to Copersucar data as of 2000.

The use of one sugar cane by-products, fuel alcohol, is directly related to the environmental aspects of this crop. This fuel is able to reduce the emissions of carbon by 57%, of hydrocarbon by 64% and of nitrogen oxides by around 13%, when compared to cars fueled with gasoline. With ProAlcool, Brazil started to reduce the import of petroleum in the 80's, equivalent to 200,000 barrels per day, which in socio-economic terms represents around 1 million jobs and R$1.5 billion per year in the economy of exchange value. In 1998, only taking into consideration the international prices of petroleum, we could say that the price of the energy unit in the form of alcohol was relatively expensive, but this price did not consider the environmental impact. Alcohol is considered one of the cleanest renewable bio-combustibles.

The Cerrados region has a large agricultural frontier, allowing economy of scale gains for sugar cane production that requires a large area. From now on, this region will call attention to itself as having an important production potential for biomass.

7.11 CHALLENGES, FROM AGRICULTURAL TECHNOLOGY, ENVIRONMENTAL PRESERVATION AND ECOSYSTEM PROTECTION VIEWPOINTS FOR THE DEVELOPMENT OF A SUSTAINABLE AGRICULTURE

7.11.1 Challenges for the development of agricultural technology

EMBRAPA is carrying out experimental researches about technological development appropriate to the region's characteristics, for the areas where the Prodecer projects are located. The technical consolidation of an appropriate crop to the site allows the practice of a sustainable and environmentally friendly agriculture, without high financial burden.

EMBRABA is engaged in the development of technology aiming at the practice of a sustainable agriculture in the Cerrados region (see next Figure). Experimental researches were already carried out and several of them are already being applied. The future challenge is the continuity of appropriate technology research development and its diffusion.

TECHNOLOGICAL CHALLENGES IN THE AGRICULTURAL DEVELOPMENT PROCESS OF CERRADOS REGION

- Knowledge about the volume of natural resources stock.
- Protection against erosion, increase of organic matter, improvement of the soil physical conditions through the sod seeding and contour lines cultivation practices. With these measures, the soils are invigorated, increasing their resistance against pests and diseases.
- Minimization of agricultural pesticides utilization through the selective use with small effect on the insects which are not the target-pest. Consolidation of diseases and pests biological control technology through the use of natural enemies without using pesticides. This practice avoids the contamination of soil and water, minimizing damage to the ecosystem.
- Incentive for the small-scale agriculture and for organic agriculture with the utilization of organic fertilizers, minimizing the use of chemical fertilizers.
- Crop rotation between grains and pastures, or between grains, avoiding the damage caused by the practice of monoculture and soil degradation.
- Protection of water resources to avoid their depletion, giving priority to the use of micro-sprinkling or dripping irrigation equipment instead of the central pivot system.
- Consolidation of agricultural production technology in the Cerrados region that aims at economic and environmental sustainability.

The pasture area in the Cerrados region is equal to four times the grain cultivation area. The consolidation of a production system with the rotation between grains and pastures (agriculture/livestock husbandry rotation) is one of the current major challenges. The crops utilized for rotation of crops and/or with livestock husbandry are selected bearing in mind their utility as raw material, besides their obvious use as grains and roughage. The rotation between soybean-maize is the most common, due to the availability of technology, market demand and competitive prices. According to EMBRAPA, in a cultivation system where several crops such as peanuts, millet, sorghum, sunflower, etc. are introduced, there are several positive aspects such as the better utilization of nutrients, reduction of diseases and pests, environmental protection, etc., which results in the increase of productivity and a better harvest. As shown in Table 7.11.1, in both the crops rotation and rotation with pastures, the cost of pulverization against diseases and pests and the cost of chemical fertilizers are smaller than in a monoculture, in addition to the benefits to rural administration, increase of productivity and environmental protection.

Table 7.11.1 Comparison of Costs between Crops Rotation, Rotation of Crops/Pastures and Monoculture

Production System	Production Cost (R$/ha)	Selling Price (R$/ha)	Net Revenue (R$/ha)
Monoculture of Soybean	400	530	130
Monoculture of Maize	450	590	140
Rotation Soybean - Maize	430	580	150
Rotation Soybean – Maize - Pasture	380	620	240

* The productivity is considered as 3ton/ha for soybean, 7.2ton/ha for maize and 360kg/ha for meat cattle.

Source: Biodiversity and Sustainable Production of Food and Fibers in the Tropical Savannas, 1st International Symposium on Tropical Savannas, Brasília-DF, 1996

The development of the described technology is already being carried out within the Japanese-Brazilian projects of joint research and technical cooperation. Technical cooperation projects between JICA and EMBRAPA were carried out, and now projects with JIRCAS such as the "PROJECT OF AGRICULTURE / LIVESTOCK HUSBANDRY ROTATION" and "PROJECTS OF SOYBEAN IN SOUTH AMERICA" are being executed, obtaining good results. However, the agriculture/livestock husbandry system still presents some technical problems. For instance: (1) the depletion of the soil organic matter due to the introduction of high productivity and high nutrients demanding pastures, due to the transformation of pastures into cultivation areas and due to the economy of fertilizers, (2) speeding up the decline of productivity of leguminous crops, in addition to the need of intensive use of herbicides due to the re-sprouting of remaining pasture that, acting as weeds, competes with the soybean, etc. In order to make this system sustainable, it is necessary to continue the development of agricultural technology, including techniques of fertilization management.

7.11.2 Environmental Protection

(1) Structure for environmental monitoring and public policies

In order to continue sustainable agriculture development, in addition to measures such as the introduction of appropriate agricultural technology, soil conservation, increase of productivity, solution of social problems, etc., environmental protection activities are also necessary.

The organizational structure of the Federal and the State Governments for environmental protection, mainly in regard to monitoring, is not considered sufficient.

IBAMA (Brazilian Institute of Environment and of Renewable Natural Resources) is responsible for the environmental monitoring of areas protected by law, which is carried out with relationships among the research institutes and organizations. For instance:

"University of Brasília and UNESCO (with an office in the Federal District)"; "INPE (National Institute of Spatial Research) and Biodiversitas Foundation". Another alternative of action is the contracting of university researchers by cooperatives, and the surveys carried out on a regional basis, such as in the State of Goiás, about the water contamination, etc.

Environmental monitoring was carried out in Prodecer projects, by CAMPO and with the JICA support, through a technical cooperation project. The main objective of this monitoring was to understand the influence of Prodecer execution on the environment.

Through the obtained data, the viability of the adoption of measures that result in the Cerrados ecosystem protection was confirmed, as well as the appropriate use of soil in harmony with the nature, recuperation of degraded soils, etc. For this purpose, the consolidation of an organization structure is necessary.

On the other hand, together with the environmental monitoring, the Federal and States Governments policies are also important. Through the design of the Economic Zoning, Economic and Environmental Zoning, Land Use Policy, Ecological Zoning, etc., by these governments, the harmony between the development process and the environmental protection will be possible.

(2) Environmental problems caused by implementation of channel/export corridors

In the PPA – Pluri-Annual Plan of the Federal Government, the implementation of a transport multi-modal integration system for the channeling of agricultural products in the Cerrados region is included as a priority program. In the implementation of export corridors from the Cerrados region, efforts are being made to increase the transport rate through waterways. However, the construction of ports, storehouses and silos at the margins of rivers influences, by itself, the region's environment, besides the possibility of the silting of the river to change of its depth. There is also the possibility of ecosystem destruction caused by dredging works in the riverbed carried out to correct its depth in order to make it navigable both during the dry and rainy seasons.

The channel/export corridors that can have environmental problems during their implementation are as follows:

- In the hydrographic basin of the Amazon river, currently under implementation for the channeling of soybean from the Cerrados region, and

- In the hydrographic basin of Paraná River that crosses the Pantanal region, a rare nature habitat in the world.

For the implementation of new waterways or ports, from now on, as a prerequisite, a detailed Feasibility Study, including environmental aspects, will be necessary.

ENVIRONMENTAL MONITORING FOR WATERWAYS AND ADMINISTRATION WITH ENVIRONMENTAL CONCERN

HERMASA is the company responsible for the sector of grain transport of the MAGGI Group. This company transports soybean produced in the Cerrados region, in the States of Mato Grosso, Rondônia, etc., through the Madeira River waterway, one of the tributaries of the Amazon River, and then transships the grains to bigger ships.

To carry out waterway transport, a license is necessary. The license is given by IBAMA for the Ministry of Transport, that in turn authorizes HERMASA's navigation. In order to obtain this license, environmental monitoring of the river is necessary, which is carried out by consultants contracted by the Ministry of Transport. The license is annually renewed. Thus, the monitoring is periodically carried out following strict criteria.

The HERMASA waterway transportis carried out using barges, more intensely in the period between February-August (during 7 months), when the river water level is high due to the rainy season. In order to avoid damage to the environment caused by the running aground of barges on sandbank, the GPS (*Geographic Positioning System*) and satellite connection are utilized for understanding of navigation conditions and for the safe navigation of barges within the pre-established route.

This company also carries out a global monitoring, including the production monitoring, aiming at achievement of ISO 14000. It carries out an entrepreneurial administration with sufficient environmental concern.

(3) Environmental protection by producers and awareness raising activities

There are environmental rules and legislation that regulate agricultural production activities. In regard to the legal preserves that aim to protect the native forests, the law establishes 20% of preservation (at national level) up to the maximum of 80% in the forests of the Amazon region. There are also rules that aim to protect ancillary forests along brooks, rivers and lakes. There are rules about the management of chemical fertilizers and agricultural pesticides, about the installation of irrigation equipment, etc., all of them aiming at soil conservation and at the preservation of water quality and volume.

However, if the producer actually does not become aware about the importance of environmental protection and of following the rules, there won't be concrete results. Producer awareness raising activities are being carried out by various organizations such as EMBRAPA-Cerrados and the cooperatives, together with rural extension activities. The pursuit of these actions is extremely important.

ENVIRONMENTAL PROTECTION IN PRODECER AND ACTIVITIES OF ENVIRONMENTAL AWARENESS RAISING FOR PRODUCERS

CAMPO carried out, with the technical cooperation support from JICA and EMBRAPA-Cerrados, the environmental monitoring of the Gerais de Balsas Project areas, Prodecer III, in the State of Maranhão, in the period between 1995~99 (see Section 5.3.3). Through the preservation of Cerrados with a strip of land of 100 meters from the river margin, a separation belt between the planted area is formed. This measure is aimed at avoiding the silting up of the river, the erosion of sloped soils, the water contamination due to runoff of soils contaminated with chemical fertilizers and agricultural pesticides, etc. However, after 5 years of Prodecer agricultural activities, although alterations in the water quality were not observed, there was a reduction in volume, causing the drying of the soil and the invasion of bushes in an area before exclusively of gramineous vegetation. This is an example where the modification of vegetation is a sign of an alteration in the environment.

Since most of the producers came from the South of the Country, they had perceptions of “Cerrados = grass”, being little sensitive and aware about the effects of pulverization with pesticides and the excessive use of chemical fertilizers, about the role of natural preserves in the preservation of water sources, etc. Therefore, awareness raising activities were necessary to show that, with the preservation of environment and soils, the idea of a sustainable agriculture is possible. In this Prodecer project, where environmental monitoring was carried out, these activities were carried out through meetings and debates with the producers. At the school located within the project, environmental education practices are adopted, demonstrating the importance of the environment protection to the children.

7.11.3 Commitment to ecology preservation
- Protection through ecological corridors -

The protection in a collective way of the native vegetation allows the genetic preservation of important flora and fauna, besides also allowing a sustainable agricultural production with the protection of water resources through the preservation of springs and groundwater. At the Federal and State government levels, there is the CNUC (National Council of Conservation Units), coordinated by IBAMA, that formalizes the policy concerning to the institution and management of conservation units framed within the SNUC (National System of Conservation Units).

In order to maintain the ecology rich in biodiversity and to allow the ecosystem to work, the connection among the natural preserves, that are isolated as islands, is necessary through an ecological corridor, allowing the movement and communication of the diversified fauna and flora. The concept of “ecological corridor” exists to allow the connection among several ecological reserves, thus aiming at ecological preservation in a global manner.

Ecological corridors are environmental protection areas where the movement of species is possible. According to size, the corridors can be classified as follows:

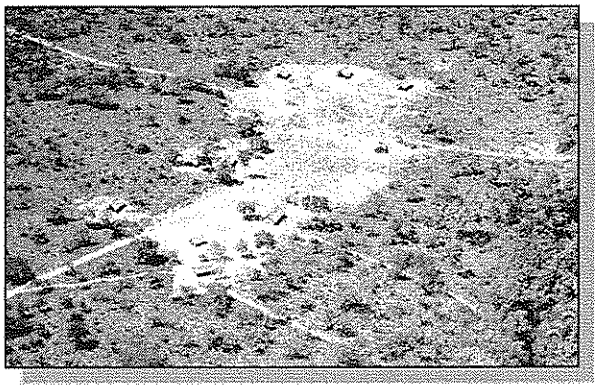
With the macrocorridor, the ecosystems are preserved through the implementation of protection areas, at the macro level, by the Federal and State governments. On the other hand, through the microcorridor, ecosystems at the producer level are preserved. Within the agricultural areas, there are utilization restrictions near small hydrographic basins. In general, river margins are formed of gallery forests, strictly protected by law, due to their function in the protection against erosion and water contamination. In rivers that are less than 50 m wide, both margins are protected in a strip of 30 m, and in rivers that are more than 50 m wide, both margins are protected in a strip of 100 m. Thus, the ecosystem is protected all along the river course. The water sources protection through the microcorridor avoids, at last, the depletion of river water sources at macro level. This is an important measure for sustainable agriculture in the Cerrados region.

Through the combination of these ecological corridors at micro and macro levels, a global structure of environmental preservation is created. With this, the biodiversity is preserved, allowing the functioning of the ecosystem, as well as allowing the preservation not only of the Cerrados ecosystem, but of other regional ecosystems as well.

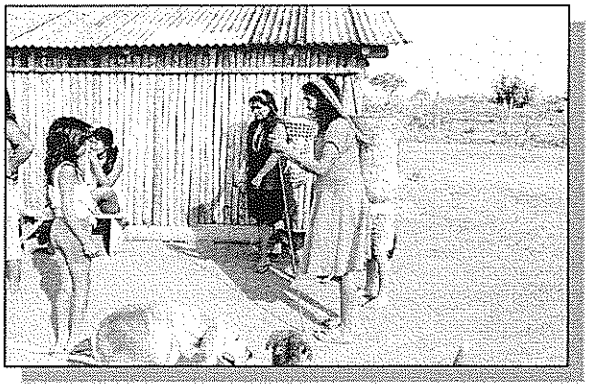
1. MACROCORRIDOR – implemented to connect the large environmental reserves and the national parks, with thousands of hectares, and which are under the jurisdiction of IBAMA and the Ministry of Environment.
2. MICROCORRIDOR – connects small hydrographic basins, at State or municipal levels. The corridor is implemented near rivers where the biodiversity is bigger. In Section 5.3.3, the preservation through a microcorridor in Prodecer was presented.

7.11.4 Protection of the indigenous population

The areas classified as indigenous reserves amount to 559 units distributed in the whole country, with a total area of 84 million ha, equivalent to 9.85% of the Brazilian territory. Only in the Amazon region, there are 358 indigenous reserves, occupied by 160 different tribes. The number of natives is estimated as 328,000 persons, excluding those living in isolated regions but including those that live near the urban centers. In seven States where Prodecer projects were implemented (States of Mato Grosso, Mato Grosso do Sul, Tocantins, Bahia, Maranhão, Minas Gerais and Goiás) approximately 30% of this population live, equivalent to 98,000 persons (Source: FUNAI – National Foundation of the “Índio”, 1997)



Residence distribution of Tribe Xerente in Tocantins

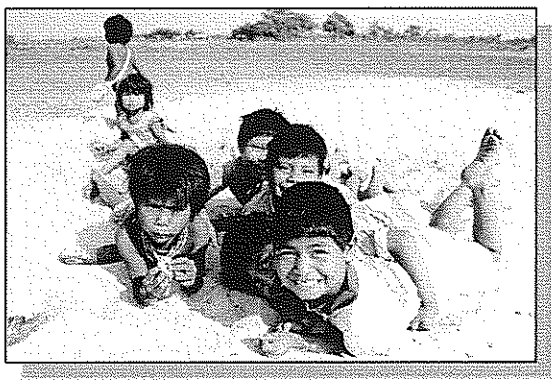


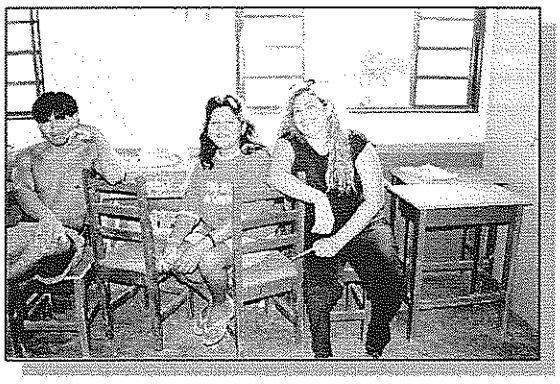
Tribe Nambikwara in Matogrosso

Although these indigenous reserves are not classified as natural preserves as described in the previous section, they are rich in biodiversity and are priority preservation areas. The FUNAI – National Foundation of Indigenous People (Índios) emphasizes that "it is necessary to protect the indigenous reserves together with the natural preserves" due to the fact that:

- The natives have a perfect understanding about the utility of native vegetation;
- They also have a vast traditional knowledge about the utility of vegetal resources for dressing, living and eating, and
- This knowledge is important for the preservation and for the sustainable use of the biodiversity.

However, the protection of natives and of their areas is a complex challenge considering that, besides the problem regarding the dichotomy between preservation and development, other social and human rights problems are also entangled.





Children and teachers of Tribe Nambikwara

7.11.5 Other protection areas and the environmental education

Apart from the environmental protection areas classified in the several categories established by the Federal and State governments, there are also the categories of areas protected and maintained in partnership with the private sector. “RPPNs – Private Reserves of Natural Patrimony” are private areas owned by individuals or companies who spontaneously offer them to be environmentally protected. Once indicated as RPPN, these areas are forever protected, and the owner is exempted from the payment of the Rural Territory Tax. The maintenance is carried out by IBAMA that protects it against fires, deforestation, illegal hunting, etc.

This type of reserve was created in the Brazil in 1992. Until 1998, 150 areas were indicated, amounting to 341,057.34 hectares. (minimum area of 1 hectare and maximum of 104,000 hectares). In Cerrados region, in the seven States where Prodecer projects were implemented, there are 81 such areas, amounting to 178.342.97 hectares, representing 52.3% of the total RPPNs areas (Source: IBAMA/DIREC, 1998). The RPPNs are being intensively utilized as projects’ sites for scientific research, protection programs, eco-tourism, environmental education, etc., by governmental organizations such as IBAMA, EMBRAPA-Cerrados and universities, besides NGOs, etc.

At the States level, there are various governmental organizations that act in the environment protection such as NATURATINS – Nature Institute of Tocantins, FEMA – State Foundation of Environment, etc., through the realization of inspection activities, awareness raising campaigns, environmental education, etc. Furthermore, in the Cerrados RPPNs, the EMBRAPA-Cerrados executes with the support from international cooperation agencies such as DFID (*Department for International Development in UK*) environmental education programs in relationship with IBAMA, Brasília University, and others. The target public is college students and the general public. This program aims at allowing experience of the importance and functioning of the ecosystem, of vegetation, etc., with the spirit of “learning from the beings that live in the environment”.