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Transportation and logistics in Brazilian agriculture

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TRANSPORTATION CHALLENGES IN BRAZILIAN AGRICULTURE[1]

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Transportation infrastructure can determine the competitive success of an agricultural enterprise or an entire agricultural sector. The Brazilian Government has proposed investment in large projects to improve the transportation infrastructure of the country's Center-West and North regions. These projects intend explicitly to develop the commodity delivery system in those regions, which should stimulate the expansion of soybean cultivation into northern areas. The highway freight market is not under government control, meaning that freight prices are formed through free negotiation determined by supply and demand for the transport service. Carriers have to stay current on changes in every shipping cost variable to negotiate efficiently with shippers. Shippers, except under certain very specific circumstances, have the negotiation power to exert strong pressure on carriers to obtain freight transport discounts. The new deregulated railway system shows good potential, especially for the shipment of grains. Transportation using inland waterway systems, considered to be the most economical one for bulk volumes, has generated much expectation due to projects such as the Madeira waterway system. It is hoped that this waterway system will efficiently reduce the transportation costs for grains produced in Brazil's Center-West region. The ports of Santos and Paranaguá are still the preferred embarkation points, but the ports of Itaqui, Vitoria, Ilhéus, São Francisco do Sul and Rio Grande can be considered very good alternatives.

Introduction

One of the most striking phenomena observed in Brazilian agricultural economics in the past decades, and in an accelerated way in recent years, is the transformation in Brazil's spatial arrangement. Agricultural businesses have occupied new frontier areas such as the North and Center-North, in addition to large areas in the Northeast, usually through activities combining modern production technologies. Similarly, input suppliers, storage and processing industries have clustered around production zones, focusing especially on minimizing the transportation costs involved.

The basic motivation for such an optimization is the need for augmenting the competitiveness of national products. This has already resulted in a clear reduction of costs in exporting operations.

Recent development plans of the last Brazilian Federal Governments have resulted in the identification and financing of a series of projects in the transport infrastructure. These projects,

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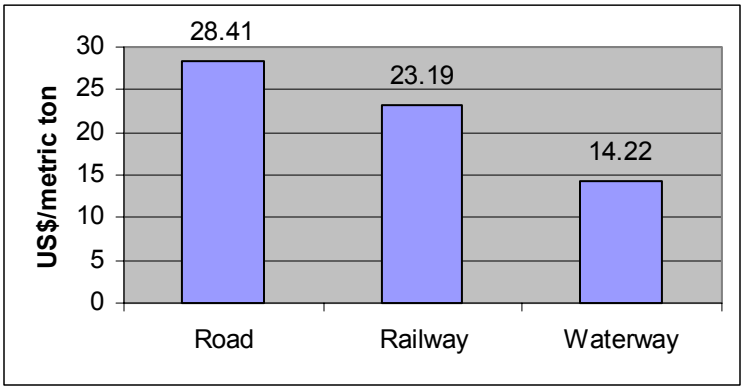
basically, focus on four aspects: the intermodal model, the decentralization of the federal highway network, the continental integration and privatization of the port operations.

Several examples are noteworthy: the successful ending of the Federal Railway Network concessions; the privatization of a number of highways; the public and private investments to expand navigability in several water basins of the country; the modernization policy of the national port system; the advance of the coastal navigation (cabotage); and incentives to increase the frequency of ground transportation of containers.

The use of the rail and waterway modes, in a unimodal way or combined with the road mode, demonstrates the competitiveness-related advantages. As shown in Fig. 1, to move soybeans long distances, the railway unit freight (US$/ metric ton) was 19 percent lower than the road one, while the waterway represented savings of 39 percent in relation to the railway mode.

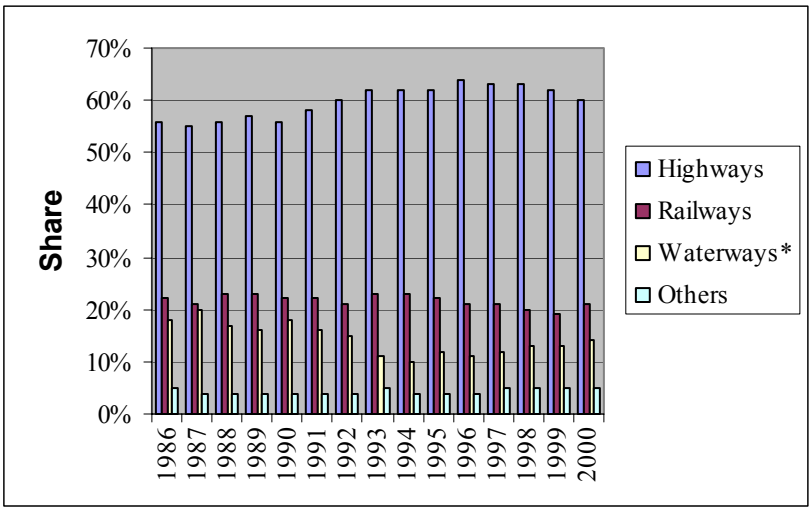
Figure 1–Mean values of freights (US$/metric ton) for soybeans, 620-930 miles, Feb-2001 to Mar-2004



Source: SIFRECA

Trucks account for approximately 60 percent of the general cargo transportation in Brazil while rail and barge account for 20 and 15 percent, respectively (figure 2). Predominance of the road mode (see Fig. 3) can be explained by the larger number of highways built and extended (increasing 160,000 km of paved roads *versus* decreasing 28,000 km of railways), as well as by the difficulties that the other transport categories face in order to efficiently meet increasing demands in outlying areas in the country. Remote areas are not necessarily provided with rail or waterways.

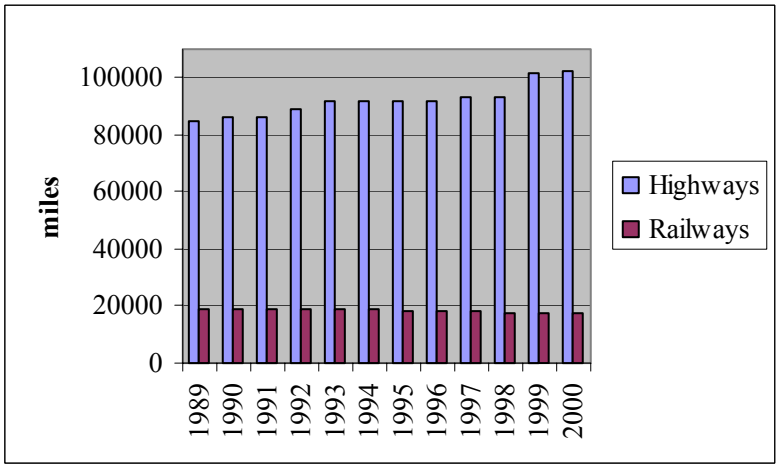
Figure 2–General cargo transported, in tons-miles, per transportation mode



* Waterways = coastal + river transportation

Source: Brazilian Ministry of Transportation

Figure 3–Magnitude of the Brazilian transportation system



Source: Brazilian Ministry of Transportation

This paper summarizes the main characteristics of the Brazilian cargo transportation, detailing aspects of the country's agricultural freight market. A discussion about the new transportation corridors (including the ones in the Amazon region) is also included.

Motor carrier transportation

Despite an increasing number of roads in Brazil, the transportation density indicators are very conservative compared with other countries (Brazilian Ministry of Transportation, 2001). In 2000 Brazil average 30.51 miles of paved roads[2] per 1,000 square miles *versus* an average of 658.38 miles of paved roads per 1,000 square miles in the United States (U.S. Department of Transportation, 2004). The State of São Paulo has the highest density of paved roads in the country, as shown in Table 1: 170.23 miles per 1,000 square miles.

Table 1–Highway densities in selected Brazilian regions, 2000

	miles of paved roads / 1,000 square miles of area
North	5.14
Center-West	20.71
North-East	46.62
South	90.04
South-East	93.89
São Paulo State	170.23

Source: Brazilian Ministry of Transportation

According to data from SIFRECA (Information System for Agricultural Freights, of ESALQ/USP), the road distances traveled by agricultural bulk solids can be relatively high (table 2). This is especially true for grains, which have to cross nearly the entire country from the concentrated areas of production to the various consumption markets.

Table 2–Examples of highway routes traveled in Brazil, per product

Product	Origin	Destination	Distance (miles)
soybean	Campo Novo (RS)	Porto Velho (RO)	2,035
corn	Nova Mutum (MT)	Maraú (RS)	1,263
sugar	Barra do Bugres (MT)	Santos (SP)	1,117
rice	Bagé (RS)	Ilhéus (BA)	1,871
beef	Itaporã (MS)	Recife (PE)	2,229
cotton	Diamantino (MT)	Natal (RN)	2,242
fertilizer	Paranaguá (PR)	Nova Olímpia (MT)	1,248

Source: SIFRECA

[2] Paved roads can include local, minor collector roads, major collector roads, minor arterials, major arterials, and/or interstate highways. Data obtained from Brazilian Ministry of Transportation.

The truck freight market is not under government control; hence, freight prices are determined by supply and demand for the transport service. To negotiate efficiently, carriers and shippers must be aware of current shipping cost variables. These demanders, particularly when trading large volumes of grains, have the negotiation power to exert strong pressure on carriers to obtain freight transport discounts.

More specifically, the increase in soybean production in Brazil, primarily destined to export, has resulted in an increased demand for freight from the central regions of Brazil up to the main ports.

Data from SIFRECA (Information System for Agricultural Freights, of ESALQ/USP) for the freight rates[3] practiced in the movement of bulk soybean help illustrate a number of interesting situations. For instance, on Table 3, freight values of a few representative road routes for soybean, in the past years, are presented.

Table 3–Variation of the road freight rate (US$/metric ton) for bulk soybean in selected routes (they comprehend mostly State owned roads)

Origin	Destination	miles	2001	2002	2003	2004
Sorriso (MT)	Paranaguá (PR)	1,351	40.09	39.90	50.01	53.96
Rio Verde (GO)	Paranaguá (PR)	771	24.26	23.29	23.44	30.38
Balsas (MA)	São Luís (MA)	626	16.64	17.26	16.28	21.87
Cascavel (PR)	Paranaguá (PR)	345	13.75	11.61	16.63	18.09
Primavera do Leste (MT)	Santos (SP)	960	35.15	33.38	42.00	47.89

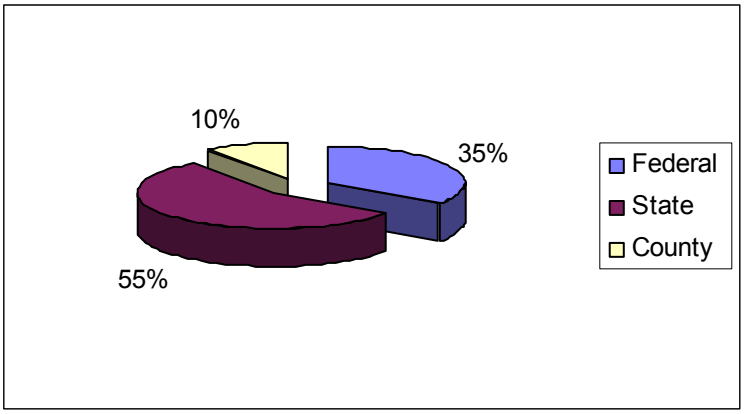
Source: SIFRECA

Freight rates basically depend on the travel distance, type of cargo shipped, as well as the quality of the roads. In that sense, the quality of the recently privatized roads has been clearly superior to the roads still owned by the State.

Figure 4 illustrates that more than half of the Federal highway system is currently passing through a process of privatization. Approximately 6,200 miles under the Federal level and more than 1,860 miles under the State level has been privatized.

[3] The road freight values from SIFRECA take into account the land costs from some specific origin to a specific destination, at a trucking company level, including toll rates but not considering expenses with insurances and taxes.

Figure 4–Brazilian highway system: government level jurisdiction, 2004



Source: Brazilian Ministry of Transportation

Normally, independent on the ownership or type of management (private or public) of the road, for most of the cargoes and particularly for grains, there is no type of regulation for the movement of such goods in terms of restrictions on working-hours (e.g., the toll and/or scaling gates are open 24 hours a day).

In terms of predominant type of vehicles on the roads, a number of strategies viewing the optimization of both in-bound and out-bound logistics have been observed and go from designing new vehicles that have already become a reference to the transportation of bulk solids (e.g., double-trailers with a capacity to carry 40 mt) up to the facilitation of hiring back-hauling operations.

Increased demand for freights to deliver grains, starting in the Center-West region of Brazil (mainly Mato Grosso) has provided greater back-hauling opportunities. Motor carriers are hauling fertilizer back from the ports up to the interior of the country.

Railroad transportation

Railroad transport in Brazil accounts for more than 17,360 miles of extension and is concentrated on the southern States of the country. Historically, the rail system in Brazil has different types of gauges according to the region (see Figure 5 and Table 4).

A specific type of gauge influences the dimensions involved in the railroad transportation. For instance, on a 5.25 feet gauge it is possible to have a train convoy with 70 cars, with an average of 70 metric tons of capacity per wagon; the weight of the rail that is used for this type of rail line is around 38 pounds/foot and the maximum train speed can reach 37 miles/h, what can mean a transit time that surpass 4 days from a soybean production region to a exporting port (distance traveled of 868 miles). On the other hand, for a 3.28 feet gauge, a typical train convoy can

involve 35 cars, with an average of 50 metric tons of capacity per wagon; the most common weight of the rail, used for this type of gauge, is about 30 pounds/foot and a maximum train speed of 50 miles/h, with a transit time that surpass 4.5 days for a trip of 806 miles (these numbers can vary according to the railway company policy and also can be function of the cargo to be shipped).

Even considering the problems in the connections between different types of gauges, it is unusual to transload cargo during the transportation process. An alternative for that type of operation is the transshipment of the cargo to a warehouse or similar type of storage structure.

Nevertheless, the deregulation of the Brazilian railway system, occurred between 1996 and 1999, brought a new enthusiasm to the market, showing good results, especially for the shipment of grains, which can effectively increase the railway share in the transportation market.

Figure 5–Brazilian railway system

Source: Associação Nacional dos Transportadores Ferroviários (www.antf.org.br)

Table 4-Main figures of the Brazilian railway system.

Railway	Region	Federal states crossed by the railway	Extension (miles)	Gauge (feet)	Connection of the railway with (maritime or riverine) ports
ALL - América Latina Logística do Brasil S/A	South	RS / SC / PR	6,586	3.28	Paranaguá-PR São Francisco do Sul-SC Porto Alegre-RS Rio Grande-RS Estrela-RS
Carajás	North	PA / MA	892	5.25	Terminal da Ponta da Madeira-MA Itaqui-MA
CFN - Companhia Ferroviária do Nordeste	Northeast	MA / PI / CE / RN / PB / PE / AL	4,238	3.28	Mucuripe-CE Recife-PE Natal-RN Suape-PE Cabedelo-PB Pecém-CE
FCA - Ferrovia Centro Atlântica S/A	Southeast, Center-West and Northeast	MG / GO / DF / BA / SE / ES / RJ / SP	7,080	3.28 (4,277 miles) 3.28 / 5.25 (113 miles) 3.28 (1,502 miles) 5.25 (938 miles)	Rio de Janeiro-RJ Angra dos Reis-RJ Vitória-ES Aracaju-SE Salvador-BA Aratu-BA Santos-SP Pederneiras-SP
FERROBAN - Ferrovia Bandeirantes S/A	Southeast	SP / MG	4,236	3.28 / 5.25 (187 miles)	Panorama-SP Presidente Epitácio-SP
FERROESTE - Estrada de Ferro Paraná Oeste S.A.	South	PR	248	3.28	Paranaguá-PR
FERRONORTE S/A - Ferrovias Norte Brasil	Center-West	MT / MS	512	5.25	-

				5.25 (1,012 miles)	Rio de Janeiro-RJ
				3.28 / 5.25 (26 miles)	Sepetiba-RJ
MRS	Southeast	MG / RJ / SP	1,674		Santos-SP
Norte-Sul	North	MA	226	5.25	Itaqui-MA
	Southeast and				Porto Esperança-MS
Novoeste	Center-West	SP / MS	1,621	3.28	Ladário-MS
Tereza Cristina	South	SC	164	3.28	Imbituba-SC
Vitória - Minas	Southeast	ES / MG	898	3.28	Tubarão-ES

Source: http://www.antt.gov.br/concessaofer/concessionarias.asp, related to the status observed in 31/12/2004.

Inland waterway transportation

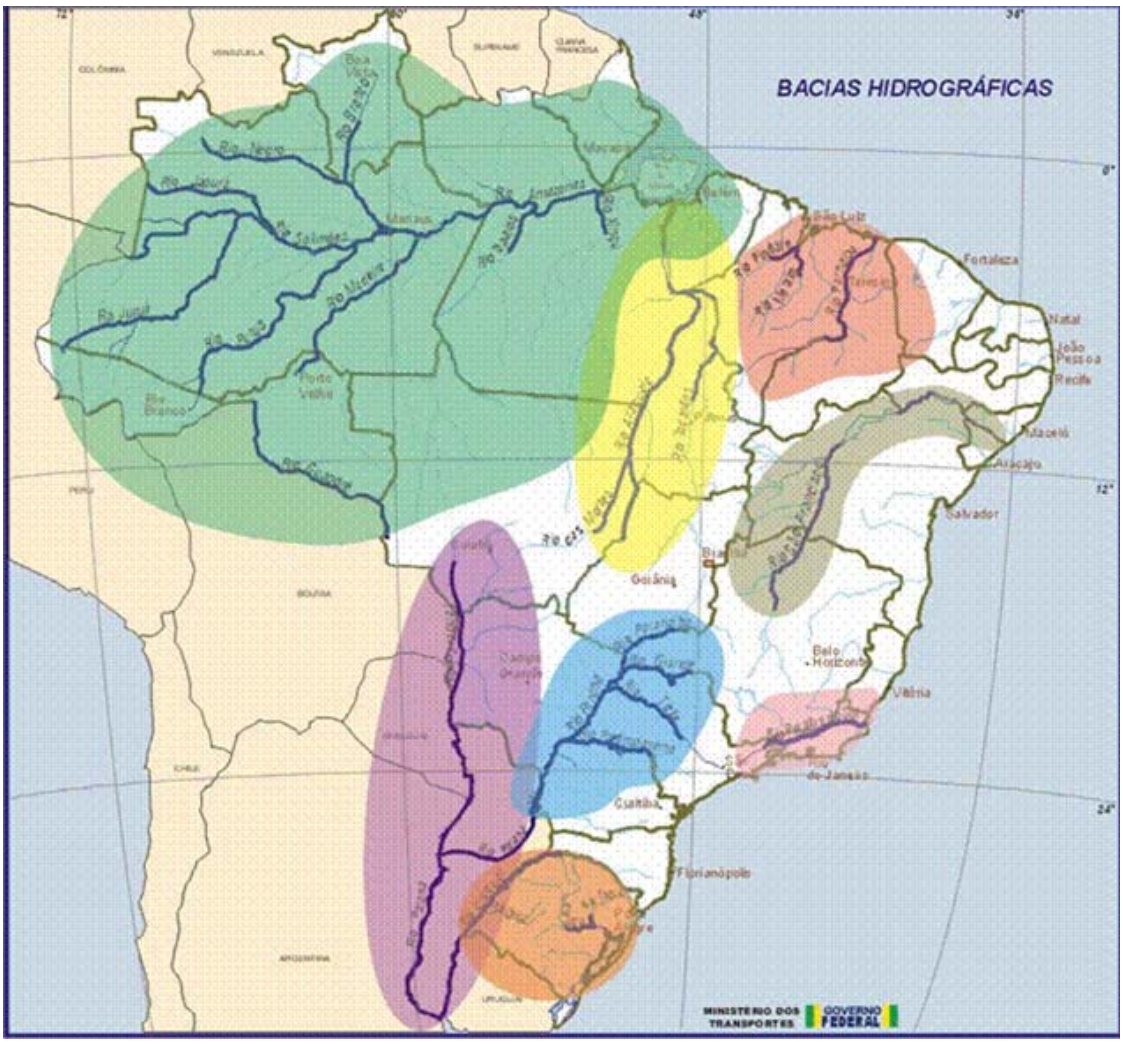
The total extension of navigable rivers in Brazil accounts for more than 16,740 miles. Table 5 and Figure 6 show the main navigable rivers in Brazil.

Table-5-Main Brazilian waterways

Water basin	Federal States	Waterway: extension
Paraguay - Paraná	MT / MS	Paraguay - Paraná: 2,134 miles
Tocantins - Araguaia	GO / MT / PA / MA / TO	Tocantins: 260 miles Araguaia: 762 miles Mortes: 360 miles
Amazônia Oriental	AC / RR / RO / AM / MT / PA	Amazonas: 1,020 miles Guamá-Capim: 468 miles
Amazônia Ocidental	AM / AC / RO / RR	Madeira: 657 miles Solimões: 1,010 miles
São Francisco	MG / GO / DF / BA / PE / AL / SE	São Francisco: 979 miles
Nordeste	MA / PI	Parnaíba: 729 miles Itapecuru: 378 miles Mearim: 400 miles Pindaré: 407 miles
Sul	RS / SC	Jacuí - Taquari: 385 miles
Tietê - Paraná	GO / MG / MS / SP / PR	Tietê - Paraná: 1,488 miles

Source: Brazilian Ministry of Transportation

Figure 6–Brazilian waterway system



Source: Brazilian Ministry of Transportation

Transportation using inland waterway systems is considered to be the most economical for bulk shipments. It has generated much enthusiasm and expectations by carriers, shippers and traders, mainly due to projects such as the Madeira and the Tietê-Paraná waterway systems. It is anticipated that these waterway systems will consistently reduce the transportation costs for grains produced in Brazil's Center-West region. It is estimated that the Madeira-Amazon Waterway lowered transportation cost for west-central Mato Grosso soybean production by 25 percent (Lazzarini and Faveret Filho, 1997).

The main reason preventing Brazil from having an inland waterway system capable of efficiently shipping products from major production centers to the ports, as occurs in the United States, is the fact that there are no navigable rivers that provide adequate passage for commercial traffic. The Brazilian rivers, except for the Tietê-Paraná system, do not make connections between important economic centers. This requires several transshipment operations so that the product

can reach the final destination. These operations incur additional costs and losses that discourage the use of the waterway. Therefore, it is most rational for decision-makers to place the cargo on a truck with no transshipments.

Maritime transportation

Brazil has a comprehensive set of maritime ports. Itaqui, Santos and Paranaguá are the most used for the movement of bulk cargoes (table 6). Despite the increased demand for bulk grain towards the port of Itaqui, that port still has predominance in the movement of bulk ore, especially that extracted from the Carajás mine.

Table 6-Movement of bulk cargoes (mt) in selected Brazilian maritime ports, 2000.

Port	In-Bound	Out-Bound	Total
Itaqui-MA	49,921,618	3,646,640	53,568,258
Santos-SP	8,075,375	11,128,845	19,204,220
Paranaguá-PR	9,585,434	4,347,947	13,933,381
São Francisco do Sul-SC	1,616,712	918,375	2,535,087
Recife-PE	286,355	1,441,816	1,728,171
Maceió-AL	828,953	370,927	1,199,880
Imbituba-SC	-	958,258	958,258
Ilhéus-BA	585,932	58,936	644,868
Salvador-BA	37,979	457,634	495,613
São Sebastião-SP	-	444,396	444,396

Source: Brazilian Ministry of Transportation

The ports of Santos, Paranaguá, Rio Grande and Vitória accounted for more than 67 percent of the 19,258,372 mt of soybeans exported in 2004 (table 7).

Table 7-Brazilian maritime ports: exports of bulk soybean, 2004.

Port	Exports (mt)	Market share
Santos (SP)	5,629,004	29.23%
Paranaguá (PR)	5,156,021	26.77%
Rio Grande (RS)	2,312,534	12.01%
Vitória (ES)	2,203,261	11.44%
Itaqui (MA)	1,162,964	6.04%
São Francisco do Sul (SC)	1,134,642	5.89%

Source: Aliceweb

The ongoing privatization process of several Brazilian maritime terminals has resulted in a noticeable increase in the efficiency operation of bulk and container cargoes. This is a result of investments in the ports, via acquisition of new equipment, and the implementation of a new labor management model at the maritime terminals.

The main expectation of the market is related to competitive handling charges on the specialized terminals; particularly in the ones considered as the preferred embarkation points for soybeans (see examples of current handling charges for some selected ports in Table 8).

Table 8–Handling charge rates to move bulk solids in selected Brazilian ports, 2005

Port	US$/mt
Ilhéus (BA)	8.00
Itaqui (MA)	6.50
Paranaguá (PR)	5.00
Rio Grande (RS)	4.00
Santos (SP)	7.00
São Francisco do Sul (SC)	5.50
Vitoria (ES)	4.00

Source: Brazilian trading companies

Future transportation infrastructure developments by mode

With the consolidation of the *cerrado* (virgin savannah land) border in the 1990s, agricultural expansion has entered the last Brazilian frontier, the Amazonian region. These new areas have been rapidly incorporated into the productive process, especially when taking into account the improved transportation infrastructure. This has not only increased competitiveness among the already producing regions but has also made viable, areas once considered economically inaccessible for grain production.

As soybean production expands to regions further away from consumption centers and exporting ports of the South and Southeast, the development of corridors towards the North of the country has become necessary. These corridors are not new and have been used for quite a long time for the regional commerce of northern States. However, they have only recently been given added attention, mainly due to the private investments carried out.

In regions where the transportation infrastructure allows grain exports through the North, this has effectively been achieved, as it is the case of the Carajás railway and Madeira river waterway. Otherwise, the production follows its traditional flow up to the ports of the South and Southeast or up to the closest agroindustries. At the 2002 season, 1.850 million tons were delivered through these two corridors, of which 1.200 million went by the Madeira River and 650 thousand by the Itaqui port (MA).

There is a clear interdependence between transportation and agricultural production. Reductions in transportation costs denote growth of production. Helfand and Rezende (1998), while analyzing the agricultural price differentials in selected regions of Brazil, suggest that a considerable reduction in costs of production could occur as a result of shifting the animal production from the Southeast to the Center-West. According to the same authors, however, this could not be said about shifting the animal production from the South to the Center-West. Especially in the case of the South, the reduction of feed cost is not enough to make up for the higher transportation cost between the Center-West and the consumption markets in the Southeast.

The main multimodal transportation corridors are according to Lício and Corbucci (1996), and Lima et al. (2000):

— Center-West and North Regions:

- Madeira waterway corridor, to carry out the transportation of grains from Mato Grosso by highway until Porto Velho (RO), then by the Madeira river up to the city of Itacoatiara, in the Amazon river, and then by ocean ships to the rest of the world;
- Ferronorte railway corridor, to carry out the transportation of grains from Mato Grosso by the Ferronorte up to the southeastern ports, mainly to the port of Santos. The railway is already operating in the city of Alto Taquari (MT), with an on-going expansion of the network up to the city of Cuiabá, the State capital;

- Multimodal Center-North corridor, to carry out the transportation of grains from Goiás, from Tocantins, from Pará, and part of northeastern Mato Grosso by the Araguaia river up to the city of Xambioá (TO), and then, by road, going up to the city of Estreito (MA). From Estreito, the grains would follow by the North-South and Carajás railways up to the port of Itaqui, in São Luiz, the capital of Maranhão (MA). Furthermore, the use of the Tocantins river between Miracema (TO) and Estreito (MA), and North-South and Carajás railways for grain transportation from eastern Tocantins and southern Maranhão are predicted;
- Cuiabá-Santarém highway corridor, to carry out the transportation of grains from Pará and, additionally, from northern Mato Grosso up to the port of Santarém;
- Teles Pires/Tapajós waterway corridor, to transport grains from Mato Grosso by highway up to the border with Pará, then by the Teles Pires and Tapajós rivers up to the city of Santarém (PA), source of the Tapajós river into the Amazon river, and then by ocean ships to the rest of the world;
- Paraná-Paraguay waterway corridor, to carry out the transportation of grains from Mato Grosso by waterway starting in Cáceres (MT) through the Pantanal region up to the Argentine and Paraguayan ports, where soybeans could be crushed before proceeding by ocean ships to the rest of the world.

— Northeast Region:

- São Francisco waterway corridor, to carry out the transport of grains up to Juazeiro (BA), then proceeding by train up to the port of Salvador (BA) or Petrolina (PE), and by train (Transnordestina railway) up to the ports of Suape (PE) or Pecém (CE). Likewise, this corridor would carry out the transportation of grains for domestic consumption to the Northeast region.

— South and Southeast Regions:

- For these regions, the projects usually entail the renovation of existing railways, highways, and port terminals.

Figure 7 illustrates most of those corridors.

Figure 7-Main multimodal transportation corridors in Brazil

Source: Brazilian Ministry of Transportation

It should be noted that the polarization around Santarém, will help to establish a new axis for the movement of soybeans in the country. Since the North region has had a very modest participation as an exporting zone among the five physical-political Brazilian regions, this would also contribute to a better balancing among the different destination regions of agricultural bulk solids in Brazil.

This new bordering region presents unique characteristics in terms of transportation infrastructure. For instance, it holds the waterway basin with the largest navigable extension in the country. Recently it has drawn attention in the movement of agricultural cargoes.

With regard to the Amazonian States, Mato Grosso has established itself as the main soybean producer not only of the region but also of Brazil. Following Mato Grosso are Pará, Maranhão and Tocantins which have similar production levels. Pará represents an important producing region in the axis along highway BR 163.

The paving of highway BR 163, which link Central Mato Grosso to the Amazon River of Satarem has made a significant impact on the advance of soybeans over the forest land. It will allow access to little developed areas of Mato Grosso, Pará and Amazonas.

In the future there is much expectation regarding the technological advances in the transportation sector. Assuming the highway network will still be fundamental for the delivery of commodities - even at medium term in Brazil, measures regarding transportation cost reduction must deal with increased number of trucks as well as increase in cargo load. Accordingly, consideration should

be given to the loading and unloading process, as well as the safety and management of back-hauling operations.

A higher professionalism of the highway sector should also be encouraged through measures favoring the release of specific banking credit lines and the implementation of better strategies for a systematic maintenance of the highways.

In regard to the latter, a definitive (and not merely palliative) solution is urgently required for road maintenance, since the problem's cycle is well known by authorities and agents involved; trucks come and go with visible cargo excess on highways with extremely deficient inspection and without a minimum number of scales. They deteriorate the highways with this excessive weight. This results in more fuel being consumed, more worn out tires and higher consumption of lubricants. The implementation of tolls would increase the carrier's costs and cause them to avoid well-conserved highways, using vicinal ones with an inadequate capacity.

As to the railway sector, it is essential to provide: effective measures viewing the systematic follow-up of operational and financial performance indicators of railway companies; specific credit lines for the modernization of vehicles and infrastructure; as well as support towards easier articulation among distinct railway systems and between railways and ports.

With respect to the waterway transportation, its effectiveness and viability should be slower than that of other modes. Brazil has to go through a process of waterway "acculturation", which will involve, among other measures: suitable location and better operational capacity of waterway terminals; evaluation and redefinition of what has been so far considered within the scope of the 'waterway-viable cargoes', usually of low value added; evaluation and redesign of lock systems.

Measures reinforcing the modernization of marine ports and stimulating their increase in capacity and efficiency are expected. This would also entail the expansion of activities related to the coastal navigation. In this sense, the enforcement of the Port Modernization Law has to prevail, including the staff's schedule to move the cargoes according to the Hand Labor Managing Organ (OGMO), and no longer exclusively by the unions.

Another important paradigm is the role to be exerted by a coordinating agent of the transportation sector. The management of transport systems in Brazil, especially cargoes, has always been characterized by a generalized diversity of responsibilities. This might be the result of the flexibility prevailing in the highway transportation, which is not necessarily (and it does not have to be) under any sort of centralized coordination. In addition, the managerial authorities lack in large part of integration and common strategic policy

It is essential to design and properly implement the National Transportation Agency with the objective of regulating the transport whole sector. Currently, this agency is split into the National Terrestrial Transports Agency (ANTT), and the National Aquatic Transports Agency (ANTAQ). However, regulating policies must not impose excessive costs. Examples of important regulations include safety and environmental rules, as well as specific and clear rules regarding service taxation such as (VAT (value added taxes) in intra- and interstate movements.

The main goal of shippers is to deliver cargo in good condition, at the destination stipulated, within the scheduled deadline, and at a competitive price. For the grain market, particularly, one expects that lower railway and waterway freight values will actually appear when making the transportation decision.

Therefore, in general, a competitive and efficient transport sector is fundamental to the Brazilian economic growth, so strategies to integrate the transport modes are vital to increase the efficiency of the movement of agricultural cargoes.

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