

A Comparative Analysis of Agricultural Transportation and Logistics Systems in the United States and Argentina

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Thomas J. Goldsby

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Abstract

Interest is high in Argentina as an emerging economic power in the Americas. This paper analyzes issues pertinent to the relative advantages and disadvantages of transportation and logistics systems between the United States and Argentina in the context of distribution to significant global markets. Designed as a tool for agribusiness students and prospective investment and trade partners, it provides a side-by-side analysis of U.S. and Argentine rail, motor, and water transportation systems. Also from a comparative perspective, it examines grain storage capacities and systems.

Key words: global markets, infrastructure, logistics systems, transportation systems, privatization.

Executive Summary

Interest is high in Argentina as an emerging economic power. The five dominant countries in the Americas are the United States, Canada, Mexico, Brazil, and Argentina. This paper analyzes issues pertinent to the relative advantages and disadvantages of transportation and logistics systems between the United States and Argentina in the context of distribution to significant global markets. Also from a comparative perspective, it examines grain storage capacities and systems. This paper is a companion piece to two other MATRIC studies: *The Economic, Financial, and Political Environment in Argentina (Argentina Report 1)* by Sanjeev Agarwal and *A Comparative Marketing Analysis of Major Agricultural Products in the United States and Argentina (Argentina Report 2)* by Sergio H. Lence.

A review of the comparative transportation and logistics systems demonstrates that U.S. shippers maintain a significant advantage over their peers in Argentina. This advantage in movement and storage capacity is substantial enough to create an overall comparative advantage in the serving of common export markets. There is evidence, though, that the gap is closing. While the United States benefited from several decades of substantial public and private investment, yielding perhaps the world's most advanced logistical infrastructure, Argentina languished from nominal development of its own infrastructure. However, the privatization movement in Argentina has achieved great progress in a very short time. An influx of investment from domestic and foreign sources foreign sources is largely responsible for Argentina's recent gain in movement and storage. The rate of change in the Argentine logistics environment is anticipated to remain high well into the foreseeable future.

Among the most significant changes is the controversial development of the river systems in Argentina and neighboring Mercosur nations. The hidrovía ("water highway") projects promise to improve the access of large vessel ships to inland ports of significance, dramatically enhancing the economics of scale achieved by shippers trying to reach export markets. It must be noted that the impact of these developments on the delicate

environment of the region is a topic of great debate. Recent judicial actions indicate that dredging efforts will remain closely scrutinized, though not to the extent desired by many North American action groups.

In addition to the river developments, Argentina's rail network is receiving renewed attention. The privatization of the nation's five rail lines is directing traffic away from motor operations to rail, where larger volumes can move over longer distances more efficiently. In the meantime, railroads in the United States have lost business to competing modes in recent years. Greater use of rail by Argentine shippers and less use by U.S. shippers is creating a convergence, not only in volumes moved, but also in the economics of scale enjoyed by each nation. As economies converge, so will costs, though the magnitude of the current gap is such that neither completes convergence in volumes moved nor costs incurred will transpire in the immediate future.

The single greatest gap that remains between the nations is in storage capacity. Argentina's lack of sufficient storage space for its grain production forces most farmers and many elevators to trade the grains despite prevailing market conditions. The limited capacity at elevators and river terminals is commonly cited as the single greatest bottleneck in the nation's logistics systems. The Argentine agricultural sector has placed far greater emphasis on achieving better productivity in the growing field and improved cycle turn capabilities at the country elevator. Significant investment will have to be temporarily shifted away from production enhancement and directed toward storage facilities to alleviate the problem.

The substantial advantages that U.S. shippers have enjoyed in the global market attributable to greater efficiencies in transportation and logistics are dwindling. The presence of progressive North American firms is, to an extent, responsible for helping Argentina to close the gap. While both nations stand to improve the way they move commodities and value-added goods from sources to consumption points, Argentina has the greatest opportunity for improvement and is seizing these opportunities to become an aggressive competitor in grain markets worldwide. Shippers in both nations face new challenges never before present (e.g. GMO market resistance and segregation). The shippers which best address these challenges as they arise will enjoy significant benefits, and perhaps a foothold in critical export markets.

A COMPARATIVE ANALYSIS OF AGRICULTURAL TRANSPORTATION AND LOGISTICS SYSTEMS IN THE UNITED STATES AND ARGENTINA

This analysis comparing the United States and Argentina demonstrates that differences in market performance can be attributed largely to varying states of transportation and logistics development. The transportation and logistics systems that serve a market are critical, given that transportation costs typically represent more than half of a commodity's total landed cost (Binkley 1999). The analysis indicates that the agricultural sector of the United States enjoys a considerable comparative advantage in grain movement and storage, substantially explaining an overall trade advantage in common export markets. As inflationary pressures settle in Argentina, the significant cost of transportation and logistics for agricultural materials is becoming more apparent. In fact, it is estimated that higher freight rates and inadequate transportation capacity requires South American exports to cost 10 to 20 percent more than those of the United States (*U.S. Grain Shippers Losing their Edge* 1997).

It appears, however, that performance differences are closing. Argentina has made great strides over the past decade that promise to diminish the long-established advantages of the United States. The analysis begins by examining the comparative infrastructures of each nation. The analysis then provides a mode-by-mode analysis of the current state of agricultural transportation and logistics. The impacts of emerging developments in each setting are then discussed.

Overview of Transportation and Logistics Infrastructures

An appropriate starting point for an analysis of comparative transportation and logistics across the two nations is an assessment of the respective infrastructures. The transportation infrastructure of a nation reflects its resource availability and commitment to efficient and effective logistics execution. The comparative transportation and logistics

performance of any nation is constrained by the capacity of its transportation infrastructure.

Of the primary modes of transportation, this report will examine overland and water transportation—those most commonly used for grain transport. Air and pipeline transportation do not factor in significantly with the agricultural commodities and value-added products of interest in this analysis. Motor, rail, and river navigation, therefore, serve as the focus of the analysis. Maritime (high seas) navigation is the primary means of accessing overseas export markets and receives cursory treatment as well.

Table 1 provides basic statistics of the comparative geographies and infrastructures across Argentina and the United States. The highway system over which motor transportation operates is a critical link for the farmer and consolidator (e.g. elevator or processor) in each setting. As later analysis indicates, motor transportation and the highway system are also critical for movement from the consolidation point to the port location for export purposes. Examining the number of paved highway kilometers (km) is largely irrelevant without reference to the landmass over which the infrastructure rests. The raw volume of paved highways is much greater for the United States than Argentina. When the relative landmass is considered, however, the difference becomes less pronounced. The United States has, on average, 0.0275 km of paved highway for every square kilometer (sq km) of land. Argentina has 0.020 km/sq km. As will be discussed later, the quality difference of the roads between the two nations is rather marked.

Table 1. Comparative geography and infrastructure between the U.S. and Argentina

	Argentina	United States
Landmass (sq km)	2.8 million	9.3 million
Paved highways (km)	57,000	255,650
Total rail trackage (km)	34,572	236,035
Navigable waterways (km)	11,000	41,935
Total grain storage (million tons)	53.9 (49 metric)	264 (240 metric)

Sources: Bureau of Transportation Statistics website (www.bts.gov/programs/itt/latin/south), U.S. Department of Transportation (for Argentina); *The Pocket Guide to Transportation 1998*, Bureau of Transportation Statistics, U.S. Department of Transportation (for U.S.)

The differences in railroad coverage are much more pronounced. The United States is the clear leader in total coverage and relative coverage of track given the landmass served with 236,035 km, or 0.025 km/sq km. Argentina has 34,572 km of rail, or 0.012 km/sq km. It should also be noted that a uniform rail gauge is present throughout the United States as opposed to the varying gauges present in Argentina across independently operating lines. Varying gauge sizes force shipments to be transshipped before continuing on a rail line with a different gauge. Railroads, where available, serve as an efficient basis for moving large volumes of bulk grains from consolidation points to distant ports for exporting.

Navigable inland waterways are viewed as a natural resource inherent to the setting. The United States enjoys almost 42,000 km of navigable rivers, or 0.0045 km/sq km. While Argentina enjoys far fewer total kilometers of navigable rivers, the relative difference is much smaller given the nation's 0.0039 km of riverway for each square kilometer. Inland river ports can serve as a shipping point for domestic barge operations and, depth and navigability permitting, as a channel for export shipping over the high seas. Most export shipments originating from river ports in the three settings must be transloaded from barge to ocean vessels for ultimate delivery. Efforts, to be discussed later in greater detail, are underway to increase the inland reach of ocean vessels in Argentina and neighboring South American nations.

The comparative disadvantage Argentina suffers because of an inefficient rail infrastructure is, in many ways, negated by the proximity of the most fertile grain growing regions to ocean and river ports. For instance, the La Pampa region gains easy access to the port of Bahia Blanca on Argentina's Atlantic coast. The port of Buenos Aires serves agricultural shippers near the capital city, while the ports along the Rio Parana serve shippers in the inland growing regions. Midwestern farmers and agricultural shippers in the United States must cover greater distances to access export port locations. These shippers make use of the Mississippi and Ohio Rivers to access export terminals in the lower Mississippi delta. Easy access to these two rivers systems is critical for U.S. shippers. The prime growing region for wheat is more distant from these rivers than those regions dedicated to corn and soybeans, posing a greater geographic disadvantage in the

shipment of wheat to export port locations. Once the shipment reaches the export terminal, however, the subsequent transoceanic distance to the major export markets of Europe and Asia is shorter from the United States than Argentina, favoring U.S. shippers. This somewhat offsets Argentina's advantage of inland proximity to ports.

Significant components of the logistics infrastructure include not only structures to facilitate movement but also storage. Storage capacity is critical for housing and protecting grains while in waiting for transit or improving market conditions. When demand exceeds capacity, grains must either be sold prematurely (before optimal market prices) or be left unprotected in the elements, threatening the integrity of the grain. Problems of undercapacity are obviously more pronounced during high-yield seasons. The United States benefits from a significantly greater storage capacity, with space for 264 million tons of grain (Hajnal 1999). Argentina has capacity for 53.9 million tons (SAGPyA 1998).

A comprehensive analysis must extend beyond basic comparisons of movement and storage capacity, however, and assess the levels of cost, utilization, and service available to agricultural shippers. The next section examines the modal transportation performance levels achieved in each nation.

Analysis of Current Performance by Transportation Mode

This section reviews the current status of transportation and logistics operations across the two national settings. The analysis will examine each of the significant modes of transportation before comparing the relative storage capacities available in Argentina and the United States in the next section.

Motor Transportation

Motor transport almost exclusively serves as the mode for transferring harvested grains from the farm to the next-destination customer, usually either an elevator location or processor. While the relative coverage of paved highways is fairly comparable across the two settings, the quality of U.S. roadways surpasses that of Argentina. While main thoroughfares between major cities in Argentina are generally on par with those of the

U.S. interstate system, side roads serving rural locations are particularly poor. Therefore, connecting roads from the farm gate to the main thoroughfare and from the main road to the consolidator or port location can be extremely rough.

A case in point is the network of roads serving the busy terminal locations along the Rio Parana near Rosario. While the roadway conditions do not directly impede grain transfer, road conditions can lead to more frequent truck and equipment failure, transit time uncertainty, and overall higher costs. Privatization of the roadways in Argentina promises to increase the number of paved roadways and improve the quality of existing roadways, but often at the expense of high tolls. Outlays for tolls can easily exceed fuel expenses on selected routes, making tolls among the highest operating expenses.

It is reported that 80 percent of South American freight is moved over the road despite the fact that trucking costs are approximately 60 percent higher than those in the United States (Berzon 1998). Despite the relatively higher cost across the United States versus Argentina, motor transport is still the cheapest and most reliable mode available to Argentine agricultural shippers.

In addition to high toll expenses, price differences between U.S. and Argentine motor operations can also be attributed to the market settings. Agricultural motor operations in Argentina are characterized by thousands of small service providers that specialize in commodity movement. These carriers typically operate seasonally with the agriculture harvests and experience tremendous demand during the peak harvests. The legal and regulatory environment for these small Argentine carriers is very different from that faced by U.S. carriers. To combat competitive pressures on pricing, particularly during off-peak periods, collusion has become commonplace in certain pockets of the region to maintain an artificially high market price for the movement of materials.

Minimal enforcement of safety regulations permits carriers in the region to operate at much lower costs than their counterparts in the United States despite higher fuel and equipment costs. Many South American governments subsidize diesel fuel, however, significantly lowering the operating cost for carriers (*Brazil Railways Trucks to Trains* 1999). While a lack of regulatory enforcement and the presence of fuel subsidies lower the cost of operation in Argentine trucking, there are instances where government

intervention, or the lack thereof, can prove debilitating. The bureaucracy of the Argentine government has been known to frequently impede the efficiency gains sought by the nation's carrier industry. Of course, the same may be said of U.S. regulatory bodies, though the interest of modern government actions is directed toward preserving a market environment free of regulatory obstacles.

Overall, the general health of motor operations in each setting is relatively sound. Growing congestion within major metropolitan areas and near port locations is a problem in both settings. Continued privatization of roadways in Argentina and intensified competitive pressures among motor carriers will result in continued efficiency gains in agricultural trucking in the South American nations.

Rail Transportation

While motor transportation typically serves as the mode for inbound movement to the consolidation point, it has also historically served as the primary means of moving grain from points of consolidation to export port locations. This is particularly true in Argentina. The movement of bulk grains by truck is far more costly per ton than moving by unit train, where capacity can be almost 400 times that of a single truck/trailer combination. Movement by unit train creates significant economies of volume that dramatically lower costs per unit.

As noted in Table 1, Argentina has only 34,572 km of rail, operated by five companies. The lack of availability and relatively poor service performance of rail transportation in Argentina have limited its preference in these markets. Another difficulty inherent with the rail systems is the problem of varying gauges present among rail lines. In Argentina, there are three gauges (1.000 meters [m], 1.435m, and 1.676m) (Berzon 1998). The reality of having to unload, transship, and reload shipments across rail lines creates prohibitive time consumption and costs. In addition, the independent rail lines first constructed by the British, French, and Germans during the late 1800s through the mid-1900s have languished in under-maintenance over the past several decades. In fact, many key segments are inoperable today. At an expense of \$200,000 per kilometer to build a new line and \$100,000 to repair one kilometer of existing line, the challenge of

revitalizing the several thousand miles of rail in need of replacement or repair becomes apparent (Ferres 1999).

The tide is turning, however, in Argentina as privatization of the rail lines and the infusion of foreign investment more recently have revitalized rail. Argentina privatized its railroads in the early 1990s. Private investment in Argentina's rail network totaled \$750 million from 1995–97 and this level of investment continues (*Argentina Business* 1998). A common strategy since privatization has been for a large industry positioned along the existing rail line to acquire the line for private transport purposes. Capacity that exists beyond the firm's needs is then made available to other shippers. These shipping customers commonly argue that their shipments receive lower priority and poor customer service when compared to the rail operator's own shipments. The prospects of improving service and dramatically lower costs are luring many large shippers to deeply consider rail. In fact, many shippers are building private branch lines to connect the main line railroads to their facility locations (*Brazil Railways Trucks to Trains* 1999).

Significant investment is still required yet to make rail competitive with other modes. While the dilapidated rail lines receive rejuvenation, attention must also turn to equipment. Scheduling equipment is difficult; transit times vary widely and locomotive failures are common. The productivity of locomotives in South America is approximately one-fourth that of locomotives on North American railways. Average rail speed in South America is currently estimated at 20 kilometers per hour, or about one-third the speed of North American trains (*Brazil Railways Trucks to Trains* 1999).

Despite these challenges, Argentina's rail freight traffic rose by 15 percent in 1995 and an additional 12 percent in 1996 (*Argentina Business* 1998). Recent estimates indicate that 20 percent of Argentina's grain production moves by rail at some point (Hajnal 1999). As a result of improved utilization and efficiencies, the cost of rail transportation has dropped by 25 percent in Argentina (Hajnal 1999). One Argentine rail operator expects his business to increase by 40 percent over the years 1997–2002. Significant increases in grain traffic are cited as a primary reason for this growth (Cottrill 1997).

Unlike Argentina, the United States has traditionally relied heavily on its rail network to move grains from consolidation points to processor or export ports. Table 2 illustrates an emerging shift in modal usage for U.S. grain shippers in recent years, however. The table illustrates the average annual share of grains moved by mode in the United States over the years 1981–95. Data are presented in annual averages over five-year increments.

Table 2. Modal share of U.S. grain movements (Annual Averages in thousand tons)

Grains/Years	Motor	Rail	Barge	Total
Corn	41,634.0 (34.0%)	48,677.2 (39.8%)	31,980.0 (26.2%)	122,291.2
Wheat	8,760.2 (12.2%)	48,186.6 (67.4%)	14,574.8 (20.4%)	71,521.6
Soybeans	28,054.0 (49.8%)	11,295.4 (20.1%)	16,973.8 (30.1%)	56,323.2
Other grains	10,724.4 (39.6%)	13,700.0 (50.5%)	2,681.6 (9.9%)	27,106.0
Total, 1981–1985	89,172.6 (32.2%)	121,859.2 (44.0%)	66,210.2 (23.9%)	277,242.0
Corn	66,132.4 (41.1%)	62,601.4 (38.9%)	31,997.4 (19.9%)	160,731.2
Wheat	11,034.4 (16.4%)	44,048.2 (65.4%)	12,231.6 (18.2%)	67,314.2
Soybeans	25,326.4 (45.2%)	14,995.4 (26.8%)	15,722.4 (28.1%)	56,044.2
Other grains	15,543.2 (45.5%)	15,314.6 (44.8%)	3,318.4 (9.7%)	34,176.2
Total, 1986–1990	118,036.4 (37.1%)	136,959.6 (43.0%)	63,269.8 (19.9%)	318,265.8
Corn	84,779.4 (45.9%)	63,351.6 (34.3%)	36,673.6 (19.8%)	184,804.6
Wheat	13,965.8 (19.9%)	42,872.2 (61.2%)	13,188.2 (18.8%)	70,026.2
Soybeans	29,789.0 (47.5%)	15,356.2 (24.5%)	17,632.2 (28.1%)	62,777.4
Other grains	13,516.2 (45.4%)	13,053.0 (43.8%)	3,223.2 (10.8%)	29,792.4
Total, 1991–1995	142,050.4 (40.9%)	134,633.0 (38.8%)	70,717.2 (20.4%)	347,400.6

Source: Eriksen, Ken A., Jerry D. Norton, and Paul J. Bertels (1998), *Transportation of U.S. Grains: A Modal Share Analysis, 1978–1995*, United States Department of Agriculture.

Table 2 illustrates that during the years 1981–85, rail had the greatest share of grain transport relative to motor and barge operations. Soybeans represent the only grain to be shipped predominantly by truck from the consolidation point (grain elevator) to domestic processors or export port over the past two decades. Corn and other grains (e.g., sorghum, oats, barley and rye) have made significant shifts toward truck movement in the years following 1985, such that motor operations have achieved a slight majority over rail. The shift has been so significant that motor operations now represent the greatest share of modal movements, despite wheat shippers' remaining preference for rail transportation (though motor transportation has achieved consistent gains here, too).

It should be noted that the modal share U.S. trucking currently enjoys pales in comparison to Argentina's reliance on trucking for all goods and materials. It was estimated in 1997 that 85 percent of all domestic freight moved by truck in Argentina (*Argentina Business* 1998). Approximately 80 percent of Argentina's grain moves by truck (Hajnal 1999).

There are a variety of reasons cited for the overall shift in U.S. modal share from rail to trucking. Eriksen et al. (1998) report three primary reasons. These reasons include:

- decentralization in the livestock feeding industry has created opportunities for trucking,
- increases in corn processing have created markets for trucking that were once reliant on rail, and
- changes in the rates and services offered by rail operators have sent shippers looking for reasonable alternatives. The latter reason applies to agricultural and finished goods shippers alike. Extensive deregulation of the U.S. motor and rail industries in the early 1980s has brought about the change.

The Staggers Rail Act of 1980 presented rail carriers with new opportunities and challenges. It created an environment of greater pricing flexibility and the freedom to expand (or abandon) service offerings. As a result of these market freedoms, many U.S. farmers and small agricultural shippers are finding rail service less accessible today than two decades ago. Many branch lines, traditionally relied upon by small and rural shippers, have been abandoned. Where service still exists, small shippers often find

themselves captive to a single carrier—a carrier that now has greater freedom to considerably raise prices above those of the once-regulated environment.

Another result of the freer market environment is increased consolidation activity among rail carriers. This trend is currently at its peak with substantial consolidation occurring among the nation's largest Class I railroads. In the past five years, the Burlington Northern has merged with the Santa Fe, Union Pacific has acquired Southern Pacific, and most recently, the Conrail line has been split by CSX and Norfolk Southern. This consolidation activity has created considerable disruption to normal rail operations. The Surface Transportation Board, the nation's judicial governing body for rail and motor operations, maintains a busy schedule of hearings to investigate service complaints from rail shippers. These complaints are primarily rooted in the problems of poor coordination and/or severe congestion on the nation's newly consolidated rail lines.

The sum of the rail analysis across settings indicates that Argentina is making great efforts to rejuvenate its rail systems. It appears as though modernization efforts are resulting in significant performance improvements and a substantial shift in traffic from motor to rail service. The United States, on the other hand, is relying somewhat less on its extensive rail network. Recent figures indicate that motor transportation has supplanted rail as the preferred mode for movements from the elevator to processor or export port locations.

Water Transportation

The significance of motor and rail operations in all three settings has been clearly demonstrated in the preceding discussion. Water transportation should not be overlooked, however. Table 2 illustrated that approximately twenty percent of all U.S. grain movements from the point of consolidation to the processor or export port location were made by way of barge. What was not made clear in that discussion, though, was that more than 90 percent of the U.S. grains moved by barge are ultimately destined for export markets. In addition, barge serves as the primary mode of export movement for U.S. corn and soybeans (while rail maintains a 60 percent share of wheat export

movements) (Eriksen et al. 1998). These phenomena are even more pervasive in South America.

Argentina and Brazil are currently looking to expand their already extensive network of navigable inland waterways. Significant investment has been made in recent years to extend the reach of barge and vessel traffic inland from the deep rivers of the region's major port cities along the Atlantic coast. Perhaps the most ambitious, and certainly the most controversial, of all South American transportation developments in recent years is the creation of the Rio Paraguay-Rio Parana Hidrovia. The Hidrovia, or "water highway," is a multi-national effort to extend the reach of inland navigation from Uruguay's Nueva Palmira to Caceres in the Mato Grosso region of western Brazil (Figure 1). An idea that dates back to the early 1900s, the Paraguay-Parana Hidrovia would trace almost due north a distance of 3,442 km along the Rio Paraguay. The Paraguay-Parana project is a venture that involves all four Mercosur nations (Argentina, Brazil, Paraguay and Uruguay) as well as Bolivia, given the course of the two rivers.

In addition to the multi-national Hidrovia project, Brazil is looking to extend barge access beyond the Rio Parana but deeper into the heart of the nation by way of the Rio Tiete. Thirteen dams, 10 locks, and more than 1,000 navigational buoys have been positioned along the river in recent years to make the movement of cargo down the Tiete more feasible (Fabey 1999). The Tiete project has been referred to as the "backbone of [the] Mercosur river system," uniting 200 million people and a combined gross domestic product (GDP) of more than \$1 trillion (Fabey 1999). The enhanced navigability of the river has resulted in an increase in agricultural development and growing interest in manufacturing along the expanded corridor.

The extensive dredging and realignment among these rivers is anticipated to have a significant economic impact on producers and carriers alike. Some estimate that transportation costs for upstream shippers will be cut in to upwards of 50 percent by using the river system rather than rail or truck (Gooley 1998). A January 1999 report completed by Argentina's Bolsa de Comercio de Rosario (Commercial Grain Board of Rosario) illustrates the cost savings of a barge movement from Sao Simao to Anhemí along the Hidrovia Tiete-Parana, when compared to the same movement by rail or truck.

For the rivers to accommodate large barge tows, the projects call for extensive dredging (with minimal depths of 10 feet), the construction of several dikes and the straightening of curves in the rivers, particularly the winding Parana (Perovic and Kelly 1999). Significant investment is clearly required on behalf of all interested parties to see the Hidrovia projects reach fruition. Cost estimates for the Hidrovia Paraguay-Parana project are said to range from \$560 million to over \$1 billion for construction, with an additional \$1 billion dedicated to maintenance (Perovic and Kelly 1999).

Besides the substantial investment, the projects are controversial on another front. The significant savings in transportation cost and expansion in planted agricultural acreage are thought by many to result in severe degradation of the river corridor's sensitive natural environment. Of particular concern is the Pantanal region, the world's largest remaining wetland that spans western Brazil, eastern Bolivia, and northeastern Paraguay—an area estimated to be 140,000 to 200,000 sq km in size (Perovic and Kelly 1999). The Pantanal is home to more than 150,000 plant and animal species, some of which are on the world's endangered species list (World Wildlife Fund 1999).

A regular cycle of wet and dry seasons helps the Pantanal region to maintain its biological capacity. The region typically experiences flooding during the wet season (October through March) and an extended period of dryness. These regular seasons support an environment for unique plant growth and regular migration patterns among bird species. There is fear that straightening the rivers will increase the speed of water flow, causing extended flooding and a disruption to the normal wet/dry cycle in the area. It is anticipated that such a disruption would interfere with the natural growth and migration as well as the region's climate (Perovic and Kelly 1999). The World Wildlife Fund (WWF) has indicated that the region could lose up to 17 billion cubic meters of water in the Hidrovia's first year of operation—enough freshwater to serve the entire population of Brazil (World Wildlife Fund 1999).

There is also great concern surrounding the clearing of natural vegetation for increased agricultural acreage and positioning of manufacturing facilities along the river corridor. With improved transportation available to regions that were previously inaccessible by rail or truck, the potential for implementing agriculture in the mineral rich

areas along the river becomes abundantly clear. The state of Mato Grosso in Brazil is an area of particular growing interest among many farmers and processors.

Two counterbalanced forces are clearly at odds in the development of the Hidrovia projects. Prospective farmers, processors, and barge operators who stand to profit from the venture obviously favor immediate action. Ecologists and environmental action groups side with the preservation of the river networks in their original state. Among the action groups supporting preservation are Greenpeace, the World Wildlife Fund, and the Environmental Defense Fund (EDF). The federal governments of each nation are positioned in the middle, though their respective interests in increased trade activity have lent support to development of the river system. Given the interests of government, licensing for dredging activity has been issued to begin the process of deepening channels as a first step in implementing the Hidrovia initiative.

Environmentalists have repeatedly called for substantive investigation of the possible ecological impacts of the extensive dredging, straightening, and diking of the various rivers of interest. The Inter-American Development Bank and the United Nations Development Program have invested more than \$8 million to assess the engineering feasibility and environmental impact of hidrovia projects (Environmental Defense Fund 1997). The findings from these studies are only beginning to surface.

A panel formed by the EDF to review the summation of public and private reports found the Paraguay-Parana project to be “fundamentally flawed.” One Harvard environmental economist involved with the panel suggested that the social and environmental costs of the project have been grossly underestimated while the economic benefits have been considerably inflated (Environmental Defense Fund 1997). Findings such as these have led judicial bodies to suspend dredging activities along the corridor. In February of 1999, Brazil’s newly appointed Minister of Environment and Water Resources suspended dredging of the Rio Paraguay in the region of Caceres (Vida 1999). More recently, a federal judge in Brazil withheld the environmental licensing of a firm looking to initiate a hidrovia along the Tocantins-Araguaia corridor (Silveira 1999). Despite these injunctions, development of the river network continues elsewhere, namely throughout Argentina.

Progressive barge carriers in Argentina are already achieving considerable efficiencies within the nation's current network of navigable waterways. Foreign investment has dramatically expanded barge and towing capacity while also improving the navigability of large tows at all hours. An implementation viewed by one barge operator to be "revolutionary" was the recent adoption of satellite tracking and guidance systems that allow for nighttime river navigation (Forciniti 1999). This technology permits navigation at all hours and efficiencies on par with similar operations in the United States. Primary challenges for Argentine barge operators today include: the varying regulations among Mercosur nations, the disruptions of dramatic weather changes, and improved equipment utilization.

Shippers and barge operators in the United States, on the other hand, are concerned about an aging inland waterway infrastructure. After several decades of extensive use and reliance on the river system for efficient bulk materials movement, the rivers are in need of renewed attention. A recent study indicates that by the year 2000, 44 percent of the nation's inland locks and dams will be at least 50 years old (Cottrill 1999). Special concern is directed toward the aging lock system of the Mississippi River. The Mississippi serves as the backbone of an efficient grain movement system in the United States. As noted earlier, the proximity of growing areas for corn and soybeans to the Mississippi and its tributaries make the system imperative for low-cost exporting. The ability to quickly and efficiently access port facilities located at the mouth of the Mississippi River in Louisiana has proven critical to the export success of these U.S. crops. To maintain the comparative advantage that the United States has long enjoyed with inland navigation, it is essential that significant investment be directed toward the aging system. This holds particularly true given the aggressive advances South American shippers are making to their own river system.

In addition to drastic improvements in inland water movement, Argentina is making significant strides in the storage and loading capacity of inland and coastal port locations. Argentine ports have experienced dramatic efficiency improvements as a result of privatization that took place in the early 1990s. Long known for gross inefficiencies, the

ports throughout Argentina are quickly approaching the discharging/loading capacities and performance of their North American peers.

Privatization has allowed for greater port investment from both domestic and foreign sources. Foreign-based firms (e.g., Cargill, Bunge, and ConAgra) are investing substantially in new port facilities along the Rio Parana, particularly in and around Rosario. Rosario is a natural location for these facilities given its common reference as the heart of the fertile Pampas area and its accessibility by Panamax vessels. These firms are implementing many of the same technologies used in North American terminal facilities. In turn, operations are becoming extremely automated in the most recently constructed locations. Argentine river ports can commonly discharge 300 metric tons of grain per hour—taking five hours to completely fill a barge with a 1,500-ton capacity (Forciniti 1999). As a point of reference, one estimate states that operating costs of Argentina’s neighboring ports in Brazil are \$3 more per high ton (Comission de Transporte 1999).

Smaller domestic shippers are also seizing the opportunities of an improving river system. For instance, it is now possible for multiple shippers to merge assets into a cooperative port facility. One such cooperative investment is the much-heralded Terminal 6 (T6) facility located in San Martin, just north of Rosario on the Rio Parana. It consists of a soybean crushing plant, ten “flat” storage facilities with 52,000-ton capacities, nine horizontal silos with 60,000-ton capacities, and two river loading berths. Currently, the facility processes 5,000 metric tons of soybeans each day, producing oil and vegetable proteins for export markets (Terminal 6 1999). The facility offers the latest technology in quality assurance, unloading and discharging, and real-time data sharing with customers. T6 is accessible by truck and train but can also unload barges arriving from upstream. The facility can unload up to 300 railcars and 1,000 trucks per day. With a 32-foot depth guaranteed from its location in San Martin to the Atlantic Ocean, T6 is capable of fully loading vessels up to 275 meters in length. This creates vast opportunity for T6 shareholders to efficiently access export markets from their inland location in Argentina.

Argentine river terminals will experience further efficiency gains as the railroads serving these facilities improve. An existing problem for many river terminals is their

current reliance on trucking for inbound transportation. Many of these facilities anticipate adding rail spurs to their facilities to gain access to the enhanced rail system. This is particularly important for movements from distant source locations where rail can offer significantly greater efficiency than truck transportation.

Analysis of Relative Storage Capacities

Logistical performance is usually measured in terms of the speed and accuracy of order execution. The capacity and skill of material and product movements, therefore, serve as the primary focuses of logistics. Storage capacity, however, is a critical component of any logistics system. This is particularly true of materials and products that experience seasonality in production and/or demand. The storage of agricultural commodities is a valid case in point. It is crucial that commodity materials be adequately protected until demanded by customers.

As noted in the comparison of national infrastructures, the United States enjoys far greater storage capacity than Argentina. In fact, storage capacity on South American farms is virtually non-existent. Rather than building storage facilities on the farm, most Argentine farmers prefer to invest in improved production (Serebrennik 1999). The current state of mind among South American farmers seems to be to produce at maximal levels and rely on quicker access to market rather than on storage. As a result, farmers continue to invest in technologies that improve yield, accelerate harvesting, and facilitate delivery to the elevator.

Given this rush to deliver grains upon harvest, the worst bottleneck in commodity movement and storage throughout Argentina is that which occurs at the country elevators during peak harvest. Literally hundreds of trucks can linger for several days awaiting an opportunity to unload at the elevator. The transportation vehicles themselves serve as an important form of temporary storage. Commodities that cannot be immediately transported must often sit exposed to the elements until a truck is available.

Technologies used to speed up the receiving of grains are becoming more readily available in Argentina. Flat platforms still serve as the primary means of truck or railcar weighing, though port terminals use fully electronic scales for receiving and hopper

scales when loading vessels. Belt weighing has yet to be used for commercial purposes in Argentina (Hajnal 1999). The sampling of grain is still, by and large, a manual process in South America. One estimate indicates that 95 percent of all receiving facilities in Argentina rely on hand sampling though wider use of automation is on the near horizon (Hajnal 1999). Terminal 6, noted earlier, is among a small group of grain receivers that have fully automated the sampling procedure. Virtually no human involvement is required from the sample gathering through analysis and, ultimately, to providing output to the driver upon entering the facility.

Drying capacity can also serve as a constraint during peak harvest. To combat the excessive demand for drying, many operators try to speed up the process by raising the dryer temperature. This typically results in damage to the grain. Subsequent to drying, receivers need to concern themselves with cooling the grain. Poor management of the cooling process can also result in a loss in grain preservation. Argentina is currently investing in dryer and aeration technologies that will allow for quick yet safe grain drying and cooling (Hajnal 1999).

While weighing, sampling, drying, and cooling can prove time-consuming when automation is lacking, the primary cause of delay at the receiving location still tends to be the actual unloading of the grain. Argentina's more progressive elevators and the newer, larger ports and processors now have full hydraulic platforms capable of unloading a truck-trailer combination simultaneously. These platforms can unload grain at a rate of 600 tons per hour. This is much greater than the 120 to 150 tons per hour that can be unloaded by short platforms, where only a truck or trailer may be discharged at one time (Hajnal 1999). These technologies are helping to speed up the transaction though the limited storage capacity at many facilities still proves to be a constraint.

The severity of the shortage in storage capacity remains elusive. By some people's estimates, the problem is not so severe. The rationale given for this position is based on Argentina's two growing seasons. The fact that the climate can allow for two harvests suggests that greater balance in demand exists over the course of the year (Hajnal 1999). While this may be true, peak periods may still be found with each harvest season—generating the typical rush for deliveries from farm to country elevator. The 1997/98

grain harvest in Argentina amounted to almost 59.5 million tons. Meanwhile, storage capacity amounted to approximately 49 million tons—thereby suggesting that production exceeded storage capacity by 22 percent (SAGPyA 1998). What one must keep in mind with this figure, however, is the fact that during the two harvest peaks, the capacity shortage is much greater than the 22 percent figure would suggest. So there are periods when storage demand dramatically exceeds supply, yet over time the problem wanes as grain is sold throughout the year. By contrast, the ratio of capacity to production in the United States is approximately 92 percent. Problems still exist in certain regions of the United States, however, given that there is only a single harvest season for most grains. This single harvest can create a storage crisis at elevators though many farmers in North America have their own storage capacity to alleviate this problem.

A lack of storage capacity throughout the growing regions of Argentina remains a critical problem for farmers in these nations. As a result of insufficient storage, farmers must accept spot market prices, whether favorable or not. The emergence of futures markets in these regions will place even greater emphasis on storage capacity. Closely related is the excessive demand placed on the transportation market during the peaks of harvest. Transportation capacity is strained during these periods, causing transportation rates to be inflated. Greater storage capacity would allow for grain volumes to be spread over the course of the year, resulting in lower average transportation costs.

Recent Developments

Aside from the significant changes in the transportation and logistics environment discussed thus far are developments in the larger market environment that will subsequently affect the agriculture industry. The growing use of genetically modified organisms (GMOs) and influx of North American third-party logistics (3PL) firms will dramatically affect transportation and logistics systems in coming years. Further discussion of these two developments follows.

Genetically Modified Organisms and Identity-Preserved Grains

The emergence and popular adoption of GMOs by grain producers in the United States and Argentina are headline news throughout the developed world. The advantages that farmers enjoy with GMOs make the motivation for their adoption readily apparent. The uncertainty over consumer acceptance of GMO seeds and GMO-fed meats in critical export markets creates a considerable challenge for the transportation and handling systems. The challenge largely rests with the pending requirement of segregating GMO and non-GMO grains and foods.

The segregation of GMO from non-GMO materials will call for new solutions in storage and movement capabilities. The prospect of preserving the identity of grains and foods will further compromise already strained logistics systems, particularly in Argentina. When storage capacity is already at a premium, the responsibility of segmenting GMO from non-GMO will prove almost prohibitive. Bottlenecks that currently pose significant problems at receiving facilities will be exacerbated. The comingling of GMO and non-GMO grains could result in significantly lower acceptance prices for the crops. It has been suggested that grain handling equipment and perhaps entire facilities may become specialized to handle GMO or non-GMO crops solely (Hayes et al. 1999). But even if elevators begin to specialize, the variety of GMO and non-GMO grains are likely to meet at the barge terminal for export delivery. The complications associated with maintaining separation among crops will influence many to bypass consolidation and transfer points altogether (Baumel 1999). This will result in lessened transportation economies and higher costs in movement. Interestingly, Argentine shippers, when compared to U.S. shippers, may not be severely impacted by these influences given that they currently contend with lower transportation volumes and more direct movement reflective of the potential segregated market.

The transportation and logistics environment could be even further complicated if significant brand loyalty begins to develop among specific seed products. This will transpire if domestic and foreign processors develop unique preferences for the characteristics of a given seed provider's genetic modifications. Such an environment would require handlers to test and subsequently verify the identity of a given brand's

crops from the farm to processor, whether domestic or foreign. Should the consuming market prove to be this discriminating, the challenges for intermediaries will be formidable.

The Influx of North American Third-Party Logistics

Another development that will have significant implications on the transportation and logistics environment is the growing presence of North American third-party logistics (3PL) firms to serve the market. While these firms will direct their efforts primarily on the distribution of finished goods (value-added products), their presence will have a dramatic effect on agricultural shippers as well. This is a reflection of the growing sophistication and progressive posture placed upon logistics strategy by North American industry. As a result of massive transportation deregulation in the early 1980s and continued deregulation at the federal and state levels, logistics is no longer viewed as a necessary cost of doing business but rather a strategic element within many North American firms. Given efforts by firms to achieve competitive advantage through superior logistics performance, logistics has gained tremendous interest among business strategists. As a result of this new focus, shipping customers have learned that they can expect better service at competitive prices from their logistics service providers. In turn, logistics service providers have risen to meet this challenge by providing ever-increasing levels of service with an eye on cost containment for competitive pricing.

It could be argued that the greatest opportunities for enhanced value in the delivery process rests most clearly in finished goods distribution. This may be the case given the elevated marketing implications as the end-user is approached. Greater opportunity for cost savings exists when several channel partners and their subsequent margins are considered. Yet, North American agricultural shippers have benefited considerably from the new emphasis on logistics service quality.

Firms that have led the way in this so-called “Logistical Renaissance” in North America have been 3PL providers. These third parties were firms that performed either transportation or warehousing services before deregulation. As a result of the freedoms set forth in the deregulation of the transportation environment, firms that once were

involved solely in transportation are now providing comprehensive logistics services—including warehousing, logistics management, and administration. Likewise, firms that focused solely on warehousing have now expanded their service offerings to include transportation operations and management. Third parties justify their presence in the distribution channel by way of their expertise in logistics operations. Given that logistics is their core competency, 3PLs can usually offer superior service at a lower cost than a shipper could achieve on its own. The consolidation opportunities available to a third party by way of providing service to multiple customers allow it to achieve significantly lower costs through enhanced economies of scale. The number and revenue growth of these third parties has risen dramatically since the early 1990s. It is estimated that more than 60 percent of U.S. Fortune 500 firms employ one or more third parties to fulfill their logistics needs (Lieb and Randall 1996).

Many of the same third parties that been the market leaders in North America are now offering their services in South America, namely in Argentina and Brazil. Among these new market entrants are such prominent names in the 3PL industry as C.H. Robinson Worldwide, Mark VII, Ryder, and UPS (*U.S. Firms Expand in Argentina* 1998). Again, these firms will focus their efforts on the distribution of finished goods. However, their presence alone will have significant implications on activities that take place further back in the supply chain. These firms will place substantial demand, yet also significant investment, in the transportation infrastructure of the respective environments. While these firms mainly operate in trucking and air, they are also substantial users of rail. As a result, they will generate considerable business for the emerging rail carriers and help to enhance existing rail services.

In addition, the presence of these firms will raise the level of sophistication among logistics service customers in South America. Everyone from the end user on back in the supply chain will learn that they can expect improved product availability, better on-time performance, and fewer defects in delivery—all at a competitive price. These competitive pressures will work themselves back in the supply chain such that agricultural shippers that serve processors domestically and overseas will be expected to rise to meet heightened expectations. As logistics becomes a competitive basis in the South American

markets, firms that fail to delivery supplies with adequate service will fall out of favor. Port terminals, grain elevators, transportation providers, and farmers themselves will experience pressure to provide the materials according to these escalating customer expectations.

The natural dynamics of competition will result in a Darwinistic “survival of the fittest” among logistics service providers. Carriers and storage facilities that rise to the occasion to provide competitive services and prices will survive. All others face acquisition, or worse, dissolution. The end result of this natural occurrence of events is a more competitive domestic market where customers enjoy elevated service and competitive pricing while the national economy enjoys greater competitiveness in export markets. As the transportation and logistics system of Argentina begins to achieve parity with that of the United States, it is conceivable that the agricultural producers in this nation can likewise achieve parity, if not superiority, over their North American peers in common export markets.

Summary

A review of the comparative transportation and logistics systems demonstrates that U.S. agricultural shippers maintain a significant advantage over their peers in Argentina. This advantage in movement and storage capacity is substantial enough to create an overall comparative advantage in the serving of common export markets. There is evidence, however, that the gap is closing. While the United States has benefited from several decades of substantial public and private investment, yielding perhaps the world’s most advanced logistical infrastructure, Argentina has languished from nominal development of its own infrastructure. An influx of investment from domestic and foreign sources is largely responsible for Argentina’s diminishing disadvantage in movement and storage. The privatization movement has achieved great progress in a very short time. The rate of change in the Argentine logistics environment is anticipated to remain high well into the foreseeable future.

Among the most significant changes is the controversial development of the river systems in Argentina and neighboring Mercosur nations. The hidrovía projects promise to improve the access of large vessel ships to inland ports of significance, dramatically enhancing the economies of scale achieved by shippers trying to reach export markets.

The impact of these developments on the delicate environment of the region is a topic of great debate. Recent judicial actions indicate that dredging efforts will remain closely scrutinized—though not to the extent desired by many North American action groups concerned with the various hidrovia projects.

In addition to the river developments, Argentina's rail network is receiving renewed attention. The privatization of the nation's five rail lines is directing traffic away from motor operations to rail, where larger volumes can move over longer distances more efficiently. In the meantime, railroads in the United States have lost business to competing modes in recent years. Greater use of rail by Argentine shippers and less use by U.S. shippers is creating a convergence not only in volumes moved but also in the economies of scale enjoyed by each nation's shippers. As these economies converge, so will costs. It should be noted, however, that the magnitude of the current gap is such that complete convergence in volumes moved nor costs incurred will transpire in the immediate future.

The single greatest gap that remains between the two nations is storage capacity. Argentina's lack of sufficient storage space for its grain production forces most farmers and many elevators to trade the grains despite prevailing market conditions. The limited capacity at elevators and river terminals is commonly cited as the single greatest bottleneck in the nation's logistics system. The Argentine agricultural sector has placed far greater emphasis on achieving better productivity in the growing fields and improved cycle turn capabilities at the country elevator. Significant investment will have to be temporarily shifted away from production enhancements and directed toward storage facilities to alleviate the problem.

In summary, the substantial advantages that U.S. shippers have enjoyed in the global market attributable to greater efficiencies in transportation and logistics are dwindling. The presence of progressive North American firms is, to an extent, responsible for helping Argentina to close the gap. While both nations stand to improve the way they move commodities and value-added goods from sources to consumption points, Argentina has the greatest opportunity for improvement and is seizing these opportunities to become an aggressive competitor in grain markets worldwide. As illustrated previously, shippers in both nations do, and will continue to, face challenges never before

present (e.g., GMO market resistance and segregation). The shippers who best address these challenges as they arise will enjoy significant benefits, and perhaps an additional foothold in critical export markets.

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