Challenges and characteristics of the South American grain and oilseed postharvest system

Bartosik, R.*#
National Institute of Agricultural Technologies, Balcarce Experimental Station, Balcarce (7620), Buenos Aires Province, Argentina. Email: rbartosik@balcarce.inta.gov.ar

* Corresponding author
# Presenting author

DOI: 10.5073/jka.2010.425.302

Abstract

Concerning grain production, South America is divided in two main regions: 1) the Mercosur region (Argentina, Brazil, Uruguay and Paraguay) which produces more than 250 million tonnes of grains and oilseeds, and 2) the Andes Mountain region countries, which are net importers of these products. The main challenges related to grain postharvest that South America is facing are to minimize the quality and quantity losses; improve the food safety; enhance the capability for segregation and traceability of identity preserved (IP) grains; and incorporate technology to maintain the overall efficiency of the postharvest system. Among the critical points affecting the efficiency of the system are the shortage of permanent storage capacity; large storage structures which affects the segregation of IP grains; deficient transportation system (roads and railroads); poor management of integrated pest control system; and unsatisfied demand of formal and informal education in suitable grain postharvest technologies and practices. However, the region remains highly competitive in producing and delivering food for the rest of the world and it has demonstrated high capacity for incorporating cost efficient grain handling technologies. As a result, one of the main changes in the region was the appearance of the silobag system for temporary storage of dry grain and oilseeds. Each silobag can hold approximately 200 tonnes of wheat and with the available handling equipment is quite simple to load and unload. During the 2008 harvest season, more than 33 million tonnes of grain were stored in these plastic bags in Argentina (including corn, soybean, wheat, sunflower, malting barley, canola, cotton seed, rice, lentils, sorghum, beans and even fertilizers). The silobag technology is also being adopted not only in neighbor countries, but also in countries around the world such as the USA, Mexico, South Africa, Australia, Russia and Ukraine, among others.

Keywords: Logistic, Transportation, Storage Capacity, Hermetic Storage

1. Introduction

South America is one of the most productive regions of food for the world. The top six commodities produced in South America are soybean, rice, wheat, maize, dry beans and sunflower seeds. In 2007, the total production of these six commodities was higher than 250 million tonnes (FAO, 2010). The grain production in South America is mostly located in the countries conforming the economic block called "Mercosur" (Argentina, Brazil, Uruguay and Paraguay). These countries produce more than 230 million tonnes of the mentioned commodities, which represents about 92% of the total production of South America, and 10% of the world production (Table 1). The rest of the South American countries are net importers of these products, although in some of them, grain production is a fairly common practice.

Table 1 World, South America and Mercosur (Argentina, Brazil, Uruguay and Paraguay) production of soybean, rice, wheat maize, beans and sunflower seeds and percentage of the share for Mercosur production in South America and in the world (FAO, 2010).

Commodity	**World**	**South America**	**Mercosur**		
	(million tonnes)	**(million tonnes)**	**(million tonnes)**	**% of World**	**% of South America**
Soybeans	220	114	112	51	98
Rice, paddy	657	22	13	2	61
Wheat	611	24	22	4	94
Maize	788	85	76	10	90
Beans, dry	20	4	4	18	91
Sunflower seed	26	4	4	14	92
Total	2322	252	231	10	92

Brazil and Argentina, the two main countries in the Mercosur, contribute 56 and 39% of the total production of the common market, respectively. Both countries produce soybean in similar proportions (52 and 42% for Brazil and Argentina, respectively). Brazil is the main producer in the region for rice, maize and dry beans, while Argentina is the main producer for wheat and sunflower seeds. Paraguay and Uruguay contribute 4 and 1% of the total production of the economic block, soybean being the main product in Paraguay and rice in Uruguay (Table 2).

Table 2 Production and percentage of participation of soybean, rice, wheat, maize, beans and sunflower seeds of the four member countries of the Mercosur (Argentina, Brazil, Uruguay and Paraguay) (FAO, 2010).

Commodity	Brazil (million tonnes)	Brazil (%)	Argentina (million tonnes)	Argentina (%)	Paraguay (million tonnes)	Paraguay (%)	Uruguay (million tonnes)	Uruguay (%)
Soybean	57.9	52	47.5	42	6.0	5	0.8	1
Rice, paddy	11.1	82	1.1	8	0.1	1	1.1	9
Wheat	4.1	19	16.5	75	0.8	4	0.7	3
Maize	52.1	68	21.7	29	1.9	2	0.3	0
Beans, dry	3.2	89	0.3	9	0.1	2	-	0
Sunflower seed	-	0	3.5	94	0.2	5	0.1	1
Total	128.3	56	90.6	39	9.1	4	3. 0	1

The predicted population of the Mercosur countries and all of South America in 2010 is about 244 and 392 million people, respectively (UN, 2010). This implies that South America, and the Mercosur in particular, have one of the highest rates of food production per capita (0.64 and 0.95 tonnes, respectively, (Table 1)). Table 3 shows a list of nine grains and agricultural products derived from grain produced in South America. The sub-continent, through the Mercosur countries, export 30% of the total world trade of these commodities (about 129 million tonnes), being soybean and its related products (cake of soybean and soybean oil) the commodities in which South America participate with the highest percentage. In terms of total tonnes exported, maize and wheat also are important products (Table 3). This manuscript will focus on maize and wheat, especially in Argentina and Brazil, due to the higher importance of these grains in the Mercosur countries

Table 3 Total world trade (tonnes) and South American participation (tonnes and percentage) of the main exporting commodities of South American countries (FAO, 2010).

Commodity	World tonnes	South America tonnes	South America %
Wheat	132.8	10.1	8
Soybeans	74.4	39.9	54
Maize	109.7	28.2	26
Cake of Soybeans	61.4	40.4	66
Rice Milled	27.4	1.0	4
Soybean oil	12.4	9.2	74
Sunflower Cake	4.0	1.0	24
Sunflower oil	4.7	1. 0	21
Sunflower seed	3.1	0.1	4
Total	429.0	128.9	30

2. Main challenges of the postharvest system

2.1. Shortage of storage capacity

In Argentina, a report from National Institute of Agricultural Technologies (INTA PRECOP, 2008) indicated that the total permanent storage capacity in Argentina can be estimated at 73 million tonnes, of which 25% are on farm, 11% in ports, and 64% in commercial elevators, cooperatives and industry. Almost 100% of the storage capacity is for handling grain as bulk.

The 2007-2008 harvest season had an historic peak of production of more than 95 million tonnes. This implies a shortage of permanent storage capacity of about 22 million tonnes (storage capacity/production ratio: 0.77). This gap between the total production and the permanent storage capacity is partially covered with temporary storage capacity (silobags). The expectation is that Argentina will continue to increase the production beyond the 100 million tonnes in the near future, thus, it will be a challenge for the country to catch up with the investment in permanent storage capacity.

According to the National Supply Company (CONAB), the permanent storage capacity for grains in Brazil in 2008 was 128.5 million tonnes, of which 80% are for bulk storage and 20% for bagged product. Most of the new investment in permanent storage capacity is for handling grain as bulk (Deckers, 2009). Brazil used to have a balanced ratio between storage capacity and production (storage capacity/production ratio: 1). However, in the last 15 years the production started to increase at a higher pace than the investment in new storage capacity. Today, the total grain production in Brazil is 140 million tonnes, which results in a deficit of 12% for the storage of grains, not including coffee and sugar (Deckers, 2009).

A document from the Brazilian government indicates that the expectation for Brazil is to increase the production to 180 million tonnes by 2018. This will create some pressure in the system to incorporate extra permanent storage capacity. Another characteristic of the Brazilian grain storage system is that only 15% of the permanent storage capacity is located on-farm. A significantly lower proportion, compared with other important grain producing countries (Deckers, 2009).

2.2. Postharvest losses

Even when there was not a rigorous study for South American countries, the postharvest losses were estimated in Argentina at about 10% of the total grain production (INTA PRECOP, 2008). According to the Ministry of Agriculture of Brazil in the process of grain storage the losses are around 10% of the Brazilian crop. These numbers seems to be higher than reasonable, especially for Argentina where the temperate weather should reduce the impact of pests. However, every year both countries have to face higher than acceptable losses according to the current technology available for the grain postharvest operations.

In Uruguay, the level of losses should be similar to Argentina, whereas in Paraguay and Bolivia, due to the warmer weather conditions and the lower level of technology applied, the losses should be higher.

2.3. Grain segregation capacity

The great expansion of agriculture in South America was related to the rapid increase in production of the soybean. As shown in Table 2, almost half of the grain production in Brazil and more than half in Argentina is soybean.

The soybean production does not require segregation since it is mostly commercialized as grade number 2. As a result, the postharvest system was oriented towards prioritizing the low cost-high efficient handling of few grains. The recently installed storage units have rather large storage capacity, making them not suitable for segregation of small amounts of different grains. Additionally, the amount of on-farm storage capacity is much lower than in countries that have well established segregation programs, such as Canada, Australia and USA.

2.4. Transportation and logistics

Recently, the Inter-American Development Bank made a study that concluded that in general, for Latin American and Caribbean countries, the impacts of the inefficiency of transportation costs on exports are much more significant than the protectionist surcharges in major markets. A survey, conducted by the National Confederation of Industry (CNI) of Brazil with the exporters, identified the high costs of freight transport and logistics services as the main obstacle to be overcome by companies (Deckers, 2009). A study performed by the Rosario Board of Trade reached similar conclusions for Argentina (Bernasconi, 2009).

One distinctive characteristic of South America is that most of the grain is transported by truck, although the region has one of the most extended waterways of the planet (Amazon, Paraná and Paraguay, San Francisco and Tietê-Paraná and Uruguay). It seems reasonable that in the future South American countries should increase the transportation through the waterway system, since it is substantially more efficient and less expensive compared to the highway system.

The railroad system is highly efficient in transporting grain and other goods when the distances are large. However, the total railroad system for Argentina is only 28 000 km, and 29 706 km for Brazil, almost the same size it was 80 years ago.

In South America the rural road system is not paved, creating logistic problems during harvest time due to the poor maintenance of the roads, delaying the harvest and the transportation of the grain from the farm to the elevator.

The direct consequences for the critical situation of the South American road system are the low productivity, low average speed, high fuel consumption, accelerated wear of the fleet and high rate of accidents involving deaths. Another characteristic is that the truck fleet is rather old, increasing the inefficiency of the system.

There are some distinctive characteristics regarding to the logistics in the different South American countries, especially regarding to the distance between the production regions and the ports (Table 4).

Table 4 Transportation matrix for Brazil, Argentina and the USA, and average distance from production area to the port.

Mode	Movement of grain by mode (%)		
	Brazil	**Argentine**	**USA**
Waterway (%)	5	2	61
Railroad (%)	28	16	23
Highway (%)	67	82	16
Average distance to port (km)	900 to 1000	250 to 300	1000

Argentina has its main exporting ports located on the Parana River, close to Rosario city, where the ocean-going vessels are loaded. Along the ports are also located the most important oil crushing complexes of the country. This area is the heart of the most productive region of Argentina (soybean and corn), so a large proportion of the production is transported only a few kilometers from the farms to the final destination (ports or processing factories).

Brazil has 30 sea ports and 10 river ports (interior), operated by private companies. However, the productive regions are located far away from most of the important ports, with the average travel distance between the production areas and the ports being large (900 to 1000 km on average) (Deckers, 2009).

Uruguay exports most of its grains through Nueva Palmira port located on the Uruguay River (245 km west of Montevideo) or the ports in the south of Brazil. The average transportation distance in Uruguay for exporting grain is relatively short. On the other hand, Paraguay and Bolivia need to transport the grain considerably further distances from the production areas to the exporting ports located on the Parana River, close to Rosario city in Argentina. There is a barge system in the Parana River, that transports the grain from the North of Argentina to the ports in Rosario area. This barge system is also used for transporting the grain (mostly soybean) from Paraguay and Bolivia. However, a significant proportion of the distance is covered by truck, increasing transportation costs.

2.5. Technology applied to postharvest operations

The technological level of the grain postharvest system in the Mercosur countries (especially in Argentina, Brazil and Uruguay) is considerably higher than in the rest of the South American countries. Brazil and Argentina have a competitive and traditional industry that manufactures equipment for grain handling, drying, storing, monitoring and processing. This industry not only satisfies the internal demand of equipment, but also exports cost competitive technology to the rest of the world. However, it can be appreciated there is a non-uniform incorporation of technology across the postharvest system. Usually, farmers have a lower level of technology in the postharvest system in Mercosur countries, when compared to farmers in more developed countries. This difference is less noticeable when comparing large grain elevators, the grain processing industry or exporting ports.

In the out-lying areas of Mercosur countries the level of technology in the grain postharvest operations is rather poor, with the exception, in some cases, of the grain-processing industry (i.e. wheat milling).

In general, the poor management regarding to pest control leads to a non-appropriate and inefficient use of pesticides, with phosphine fumigation being the main tool for insect control. IPM programs should be more widely implemented in the South American grain postharvest system in the near future.

2.6. Education of personnel

An important limitation in the South American countries is the poor education of the personnel related to grain handling operations. In most cases, the personnel have to acquire expertise at work, where the experience is transmitted from generation to generation in an informal fashion. With the exception of Argentina and Brazil, there are few possibilities for formal professional education in grain handling, storing and processing operations. In Brazil, the EMBRAPA (Brazilian Consortium of Agricultural Research) and some universities have programs for professional education in grain postharvest operations. In Argentina, the professional education is covered by INTA and APOSGRAN (Argentine Grain Postharvest Association), which recently launched a distance learning program (entirely in Spanish) for grain handling in the postharvest system, especially designed to make up for this lack of knowledge in this area in Latin American countries.

In Argentina and Brazil, a few universities offer a graduate degree in grain postharvest operations, a sort of "specialization" type of title.

3. Distinctive characteristics

3.1. Expanding agricultural frontier

The Mercosur countries have undeveloped land areas for agriculture, so the agricultural frontier is moving far away from ports and traditional urban areas. The FAO statistics (FAO, 2010) shows that Argentina only has 30% of its arable land under production, Brazil 9.2%, Paraguay 10.5% and Uruguay 9.2% (Table 5). Although it is unreasonable that all the potentially arable land could be turned into production because of practical, political and ecological reasons, it is clear that the Mercosur countries can substantially increase their production in the near future by incorporating new areas for agriculture. However, the lack of infrastructure such as roads, communication, storage capacity and the large distance to the ports and urban areas makes the production and marketing cost increase compared to traditional agricultural areas. Another important limitation is the lack of personnel with experience in grain handling, since there was not a tradition of that kind of activities in the new agricultural areas.

Table 5 Total area of the country, potential arable land and percentage of potential arable land in use for the Mercosur countries (Argentina, Brazil, Uruguay and Paraguay) (FAO, 2010).

Country	Total area (1000 km²)	Potential arable land (1000 ha)	Potential arable land actually in use (%)
Argentina	2780	90571	30.0
Brazil	8563	549389	9.2
Paraguay	400	21589	10.5
Uruguay	179	14245	9.2

3.2. Storage in hermetic plastic bags: silobags

As mentioned before, Argentina has a permanent shortage in storage capacity that, according to the harvest, could be from 20 to 35 million tonnes. Due to this insufficient storage capacity, an important proportion of the Argentine grain production had to be delivered directly from the field to the regional grain elevators and from there to the terminal ports.

To overcome these unfavorable circumstances, a new storage technique has gained popularity among farmers. It consists of storing dry grain in hermetically sealed plastic bags (silobags). Each bag can hold approximately 200 tonnes of grain and with the available handling equipment is very easy to fill. Local companies also developed machineries to unload the plastic bag transferring the grain directly to the truck or wagon. The new generation of high capacity combines found in the silobag system the ideal partner, since the loading capacity of the bagging machine is basically limited to the transportation capacity between the combine and the place where the bag is filled. Another advantage of the silobags is that they can be easily incorporated into a grain identity preservation (IP) programs. Silobags can be set up in the field, right next to the crop, reducing contamination risks of the specialty grain with other commodities.

In the 2008 harvest season, more than 33 million tonnes of grain were stored in these plastic bags in Argentina (including corn, soybean, wheat, sunflower, malting barley, canola, cotton seed, rice, lentils, sorghum, beans and even fertilizers). The silobag technology is also being adopted not only in neighboring countries (Uruguay, Paraguay, Bolivia, Brazil and Chile) but also in countries around the world such as the USA, Mexico, South Africa, Australia, Russia and Ukraine among others.

The INTA has been conducting research on storage of grain and oilseed in hermetic plastic bags since the year 2000. The system has proven to work efficiently for storing quality corn, wheat, soybean and sunflower during at least six months (Bartosik et al., 2008a). Currently, research is being conducted storing rapeseed, malting barley, cotton seed, paddy rice and dry beans in hermetic plastic bags (INTA PRECOP, 2009).

A novel grain quality monitoring system was also developed for the silobags and implemented by farmers, grain elevators and the industry. The system measures the CO2 concentration inside the bag and relates it to the biological activity, allowing sorting the bags according to a storage risk factor (Bartosik et al., 2008b). This technology will help in the adoption of this novel storage system.

Acknowledgments

The author wants to thank the following friends and colleagues for their help reviewing or providing information for this manuscript: Leandro Cardoso, Diego de la Torre, Denise Deckers, Mauricio Rodriguez, Pablo Abraham and Juan Pablo Martinez.

References

Bartosik, R., Rodríguez, J., Cardoso, L., 2008a. Storage of corn, wheat soybean and sunflower in hermetic plastic bags. In: Maier, D., Goldsmith, P. (Eds), Proceedings of the International Grain Quality and Technology Congress, 15-18 July 2008, Chicago, Illinois, USA.

Bartosik, R., Cardoso, L. Rodríguez, J., 2008b. Early detection of spoiled grain stored in hermetic plastic bags (silobags) using CO2 Monitoring. In: Guo, D.L., Navarro, S., Jian, Y., Cheng, T., Zuxun, J., Yue, L., Yang, L., Haipeng, W. (Eds), Proceedings of the 8th International Conference on Controlled Atmospheres and Fumigation in Stored Products, 21-26 September 2008, Chengdu, China, Sichuan Publishing House of Science and Technology, Chengdu, China, pp. 550-554.

Bernasconi, J., 2009. Infrastructura del sistema de comercialización de granos (Infrastructure for the grain trade system). Report from the Transportation Commission of the Rosario Board of Trade.

Deckers, D., 2009. Brazilian agribusiness: An overview. 2009 GEAPS Exchange Meeting, Saint Louis, Missouri, USA.

FAO, 2010. Agricultural statistics. Available at: http://faostat.fao.org. Accessed on: January 2010.

INTA PRECOP, 2008. Eficiencia de poscosecha: generación, desarrollo y diffusion de tecnologías para incrementar la eficiencia de acondicionamiento, secado y almacenamiento de cereals, oleaginosas y cultivos industrials (Postharvest efficiency: generation, development and dissemination of technologies to increase the conditioning, drying and storing efficiency of grains, oilseeds and industrial crops of Argentina). INTA National Project Report. Available at: http://www.inta.gov.ar/balcarce/precop/2008/efic.htm. Accessed on: December 2009.

INTA PRECOP, 2009. Almacenamiento de granos en bolsas plásticas: resultados de investigación (Storage of grains in plastic bags: Research Report). INTA. February 2009. 180 pp, Available at: http://www.cosechaypostcosecha.org/data/articulos/postcosecha/ConvenioAsistenciaTecnicaAnio3.pdf. Accessed on: December 2009.

UN, 2010. United Nations Population Division. World population prospect: the 2008 revision. Available at: http://esa.un.org/unpp/. Accessed on January 2010.