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Research Article

Information System for Grain Storage in Brazil

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Abstract

The main goal of this article is to present the System for Grain Storage in Brazil (SIARMA), which aims to identify grain storage prices (soy and corn) in Brazil for the main producer regions. Also, it is presented the developed tool, integrating an information system of secondary statistics (statics of storage capability, grain production, exportation seasoning, marketing prices and road freight prices) in a way it can quantify logistics strategies to maximize the revenue of the Brazilian producer and evaluate benefits that could come out from the use of storage. It is presented a case for the main producer state of soy and corn in Brazil, Mato Grosso. Such tool has presented successful results to instigate discussions about economic benefits of storage and support the decision-making both in public as well as in private sectors. Also, are presented data source of grain storage in the country. Siarma's next steps involve the incorporation of other agricultural products, identifying annual storage levels, among other factors.

Keywords: Grain; Brazil; Storage; Stock; SIARMA; SIFRECA

Background

Context of the storage situation in Brazil

The storage in the country has the function of keeping the products in order to meet needs in different places and periods with the due quality. In the case of the agriculture, this characteristic of maintaining the grains offer throughout the off-season is extremely important. On the other hand, the storage can also be used as a commercial strategy to obtain higher revenues in the product sales with opportunity in periods of lower logistics costs and/or higher marketing prices. The Brazilian grain storage capacity accounts for something around 131 million tons (Brazilian Institute of Geography and Statistics - IBGE, 2016a), while the grain (soybean and maize) production in the country is about 182 million tons (IBGE, 2016b), implying a storage deficit of about 28%. Still in this line, it is estimated that only 17% of that capacity is associated with on-farm storage structures (IBGE, 2016b). Such configuration, added to Brazil's continental dimensions and its big production records (especially when considering the external markets), implies some logistic bottlenecks such as long lines at land and port terminals; accumulation of grains ("Open sky") outside the storage units, which has accounted for big amounts of post-harvest losses; high logistic costs (related to an environment with lack of infrastructure and storage capacity) to supply a very concentrated demand in some periods of the year.

Figure 1 shows a relationship between the evolution of grain production (soybean and corn), total and relative[1] storage capacity in Brazil. It is interesting to note that storage capacity has accompanied the production of grain, but in a non-proportional way - agricultural production has increased more than the growth of storage.

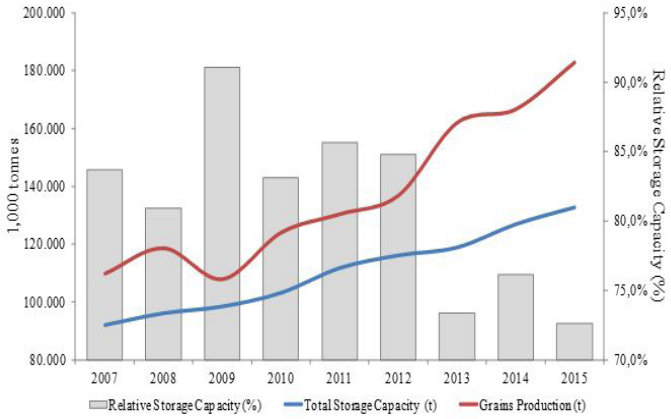

Figure 1: Evolution of storage capacity (total and relative) and grains production in Brazil. Source: developed from IBGE (2015a) [1] and IBGE (2015b) [2].

For reference purpose, the logistic cost of soy from the main Brazilian state producer, Mato Grosso, revolves around 30% of the product market price, going to Santos Port [3]. Specifically, for corn, depending on the transportation corridor, it can reach very significant and close levels to the marketing price.

About the Information System for Grain Storage in Brazil (SIARMA)

The Information System for Grain Storage in Brazil (SIARMA) aims to identify the prices of grain storage service in the main producing regions of the country, more specifically: to perform research on key storage features, especially on agricultural products (soybean and corn). SIARMA is linked to the University of Sao Paulo (USP), College of Agriculture "Luiz de Queiroz" (ESALQ), specifically at Group of Research and Extension in Agroindustrial Logistics (ESALQ-LOG).

The data gathering occurs annually and the report is available in free format at ESALQ-LOG Group website. The contributors of the research also receive an electronic report via email. The report presents the following information: storage price, composition storage price, static storage capacity and relative storage capacity.

A logistic strategy simulator was also created to reduce the information asymmetry in the Brazilian agriculture, integrating the SIARMA with the Information System for Freight Value (SIFRECA), which provides information on freight prices used in many transportation corridors of agriculture products in Brazil. This tool aims to support deciding whether to use or not to use the storage for the product marketing, given the commercial conditions (price of grain) and logistic conditions (transportation and storage costs). Besides, such tools evaluate if the use of storage in the specified conditions brings economic benefits for the analyzed period.

Methodology used

The methodology used on SIARMA to create a store price index involves the following steps:

a. Definition of the interviewed: In this step, the goal is to identify the sample that will be interviewed, in order to meet the main soy and corn producer's region in the country. This selection involves, specifically the main states that produces soy and corn in the country. Then we select the cities with the highest production levels and storage static capacity for each meso-region of the defined states. The last one involves a selection of warehouses group (service providers) to be interviewed based on the available warehouses registration bank of National Supply Company - CONAB (2015) [4] - the selection on this registration bank occurs randomly in each selected city.

b. Interviews with the selected warehouses. In this step, a group of researchers from ESALQ-LOG made interviews by telephone. The research is done annually and involves around 100 interviewed agents. The objective of the interview is to collect the following information:

- Storage price.
- Storage capacity.
- Receiving and shipping flows.
- Stored grains.
- Current investments.

c. Processing of the collected information. In this step, it is made a statistical analysis of the information, especially regarding storage price. In this case it is defined a confidence interval for the data of each producer state, involving the average more/less one standard deviation - values in this interval go into the analysis, the ones out of this gap are excluded.

d. Indicators' generation: Storage Rate and Storage Price:

Storage Rate consists of three types of rates:

- Fixed Rate: it refers to the charge related to the use of warehouse, regardless of the storage period. It includes the reception operations, pre-cleaning, drying (it was adopted the standard of 17% of moisture), purge and shipping operations.
- Variable Rate: it refers to the rate of the storage operation for a period of 30 days, after the grace period negotiated.
- Technical Loss: it refers to the contractual tolerance related to the physical losses during storage service, in %.
- Storage Price refers to the price of storage service, charged for a specific period in the contract. It is calculated according to the previously reported rates, and it can be calculated by the equation (1):

$$PARM_{in} = TF_i + \frac{(n - c_i)}{30} TV_i + qt_i pc_i \quad (1)$$

for $n < c$, $TV_i = 0 TV_i = 0$

Where:

$PARM_{i,n}$ is the storage price for the region *i* for *n* days stored (US$/t).

TF_i is the fixed rate used at warehouse in the region *i* regardless on the storage period (US$/t).

TV_i is the variable rate related to the operation of storage in region *i*. usually, this rate is negotiated for thirty-day contracts. In this case, it was decided to standardize the rate based on the number of days stored.

n is the number of days the grain get stored.

c is the number of days of the grace period.

qt_i is the technical loss (%).

pc_i is the price of grain (US$/t).

Specifically for the development of the logistic strategy simulator, it was structured the following set of information:

- Freight price indicators: originating from linear regressions of the freight price according to the distance for each month and region analyzed in Brazil, using information available at SIFRECA (2015) [5].
- Capacity of grain storage levels for the meso-region interested producer: Statistic originated from CONAB (2015) [6].
- Price storage indicators according to the numbers of days stored: SIARMA (2015) [7].
- Price marketing indicators according to time: Center for Advanced Studies on Applied Economics - CEPEA (2015) [8].
- Exportation statistics by port according to time: Secretariat of Foreign Trade, part of Ministry of Development, Industry and Foreign Trade - MDIC/SECEX (2015) [9].

The simulator involves comparing and commercializing the analyzed grain in the month of its production, or storing it for a posteriori marketing, taking into consideration the marketing prices, transportation and storage prices in force at the time. This way it is possible to: (i) evaluate if the storage in fact brings economic benefits and (ii) indicate the optimum situation to maximize the product net revenue, defined by the equation (2).

$$ENR_{hp} = MP_p - TP_p - SC_{hp} \quad (2)$$

Where:

ENR_{hp} is the expected net revenue from the sale in the period *p* of the product harvested in the period *h* (US$/t).

MP_p is the market price in the period *p* (US$/t).

TP_p is the transportation cost in the period *p* including flows from farm to warehouse and from this to the port (US$/t).

SC_{hp} is the cost of storage from the harvesting period *h* up to the marketing period *p* (US$/t).

The economic benefit of grain storage in Brazil is reached when the expected net revenue obtained in the situation where the grain harvested in the period *h* and marketed in the period *p* is higher than the expected net revenue in the commercialization of the grain in the harvest period *h* (without storage), as specified by equation (3).

Condition for the economic benefit of storage:

$$ENR_{hp} \geq ENR_h \quad (3)$$

Where:

ENR_h is the expected net revenue from the sale of the product harvested in the period *h* (without storage) (US$/t).

The SIARMA report is available in “PDF” and the logistic strategy simulator in electronic worksheet.

Obtained Results

The first set of results generated by SIARMA is the coefficient indicator of the storage rate for storage price calculation, using the equation (1). The Tables 1 and 2 shows the indicators of average parameters for storage fee for soybean and corn in selected producer states in Brazil, respectively.

Average Parameters	Unit	Example of Evaluated States (*i*)		
		Goiás	Mato Grosso	Mato Grosso do Sul
Grace period (c)	Days	29	41	20
Variable Rate (TV)	US$/t	1.48	1.23	1.47
Fixed Rate (TF)	US$/t	6.85	7.26	6.88
Technical Losses (qt)[1]	%	0.30	0.30	0.30
Price of the grain (pc)[2]	US$/t	351.49		
Technical Losses in U$$/t (qt x pc)	US$/t	1.05	1.05	1.05
Amounts related to the standard moisture of 17% [1]Technical Losses (qt): represent the amount of losses tolerated by contract in the storage operations (% of the amount stored). [2] Soybean price: April/2015 (CEPEA, 2015) [8]. Source: SIARMA (2015) [7].				

Table 1: Indicators of average parameters for storage fee - soybean.

Average Parameters	Unit	Example of Evaluated States (i)		
		Goiás	Mato Grosso	Mato Grosso do Sul
Grace period (c)	Days	28	40	15
Variable Rate (TV)	US$/t	1.84	1.25	1.02
Fixed Rate (TF)	US$/t	6.44	7.82	7.03
Technical Losses (qt)[1]	%	0.30	0.30	0.30
Price of the grain (pc)[2]	US$/t	145.77		
Technical Losses in U$$/t (qt x pc)	US$/t	0.44	0.44	0.44
Amounts related to the standard moisture of 17% [1]Technical Losses (qt): represent the amount of losses tolerated by contract in the storage operations (% of the amount stored). [2]Soybean price: April/2015 (CEPEA, 2015) [8]. Source: SIARMA (2015) [7].				

Table 2: Indicators of average parameters for storage fee - corn.

It is interesting to note a high correlation between the level of grain production in the producing regions and the storage capacity in Brazil, as shown in Figure 2.

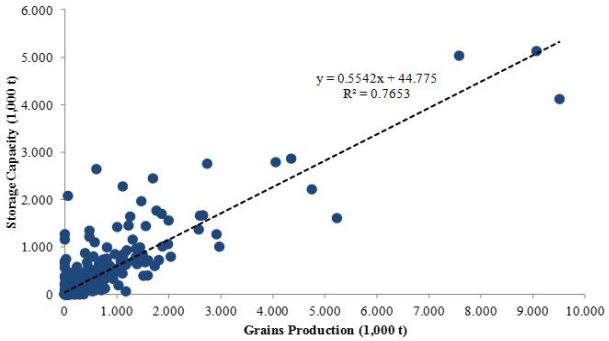

Figure 2: Correlation between storage capacity and grain production by meso-region level. Source: developed from IBGE (2015a) [1] and IBGE (2015b) [2].

Regarding the logistic strategic simulator, the results occur according to the definition of the parameters to be evaluated, involving: (i) production region; (ii) transportation corridors (port), (iii) harvest; (iv) marketing period; and, (v) distance between farm and warehouse.

The examples of the generated results were programmed for the following specifications:

- Product: Soybean
- Origin: Meso-region of Sorriso (Mato Grosso).
- Transportation Corridor: Santos Port (SP).
- Harvest: March/2015.
- Marketing Period: June/2015.
- Road distance from the farm to the warehouse: 50 kilometers.

Figure 3 shows the storage price indicators as a function of storage period (US$/t and US$/t.day) as an example there is the state of Mato Grosso for soybean. In this situation, for each day stored, the storage price for the producer is enhanced in approximately US$ 0.04 per ton.

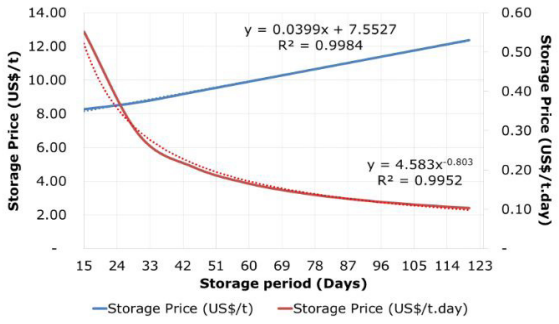

Figure 3: Storage Price as a function of storage period (US$/t and US$/t.day) for soybean - Mato Grosso state. Source: SIARMA (2015) [7].

The strategy selected for the soybean harvest in March and the commercialization in June, incurs in expected net revenue of US$ 231.11 per ton (equivalent to 69.33% of the gross revenue, which means, from the marketing price), taking into account soy marketing price and transportation price in June, besides the storage costs between March and June. Figure 4 presents the impact of logistic costs on soybean farmers' revenue for the defined strategy.

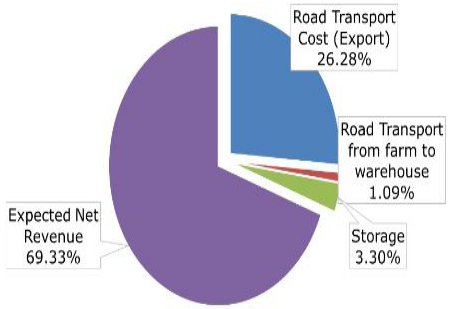

Figure 4: Impacts of logistic costs on soybean farmers' revenue for the selected strategy (simulation) - Mato Grosso state. Source: SIARMA (2015) [7].

Figure 5 presents the storage viability analysis for the selected strategy, involving the optimization of the expected net revenue of the soybean farmer. In this context, in case the producer had commercialized the soy on the same month of the harvest (March) his expected net revenue would be around US$ 253.62 per ton (opportunity cost). With the use of storage and marketing in subsequent months, the expected net revenue is lower than the opportunity cost. For the selected marketing strategy in June, the producer stopped making US$ 19.21 per ton, which means, the storage formation did not bring any economic benefit.

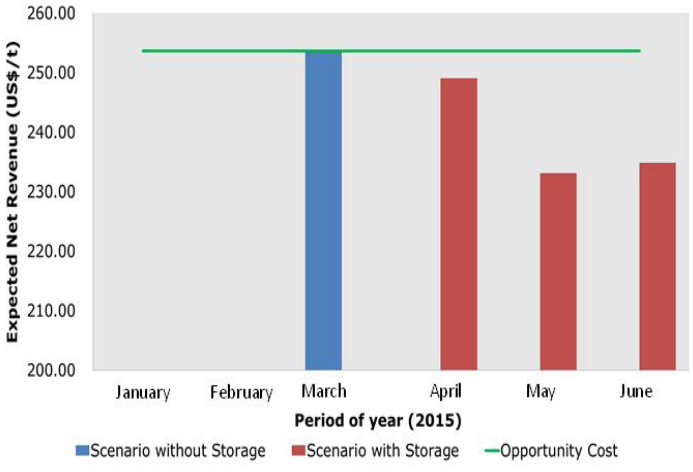

Figure 5: Storage viability analysis: optimization of the expected net revenue of the soybean farmer. Example for Mato Grosso state. Source: SIARMA (2015) [7].

Conclusion

SIARMA seeks to identify storage service prices of soy and corn in the main regions of Brazil, and has performed successful results. Besides from being an important system in the contribution of the reduction of asymmetric information in the market, and in helping the decision-making at the strategic, tactical and operational levels for both the private and public sectors, based on the integrated analysis tool of the commercialization and logistic market (SIARMA and SIFRECA integration). As well as secondary statistics for valuation and stock management, specially related to the quantity of the benefits (or not) on the formation of soy and corn stocks - given the highly competitive structure of the agricultural and logistic commodities market. In Brazil, there are official providers of grain stocks. The first is a National Company of Food Supply, so-called CONAB.

CONAB releases information of public and private stocks. In the case of private, they are included coffee and rice. The public stocks involve various products such as soybean, corn, wheat, among others. The types of information provided are volume, spatial distribution and segment of storage in state level. The method consists of a questionnaire applied by post or email to register agents at the public information system of CONAB. The frequency is annual.

The second provider is ABIOVE - Brazilian Association of Vegetable Oil Industries, specific for soy complex. ABIOVE [10] releases information of soybean, soymeal and soy oil private stocks for a national level. ABIOVE performs a survey about the soybean volume used by companies with activities in the soybean industry. The information is published monthly.

Success Achievement and Issues for Further Research

SIARMA's next steps involve: (i) Expansion of the survey of storage prices for other agricultural products in the country; (ii) Identification of the turns number of the warehouses, evaluated to estimate the level of annual inventory formed in different producing regions; (iii) Collection of inventory information at the level of railway, waterway and port terminals; (iv) Cost structure for implementation of the various types of warehouses in the country; and (v) Structuring mathematical models to identify and recommend the optimal location of new warehouse facilities in the country.

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