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# Post-Harvest Soybean Loss During Truck Transport: a Case Study of Piauí State, Brazil

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**Abstract.** Reducing post-harvest losses in the grain production system are of great interest to Brazilian agricultural production. Truck transport is commonly used world wide for the distribution of goods for trade. In Brazil, truck transportation is usually the most economical way to distribute goods in places where inexpensive or natural means of transport alternatives are not available. Truck transport plays a significant role in moving raw materials and processed products from the agricultural production. This study aimed to evaluate the post-harvest loss in transportation in soybean in the state of Piauí. The route of trucks loaded with soybean was analyzed from two regions. The trucks were weighted when leaving the farm and again weighted when arriving at the processing plant. Results indicate that there was a difference in weight between the farm and final destination indicating possible losses during the road transport.

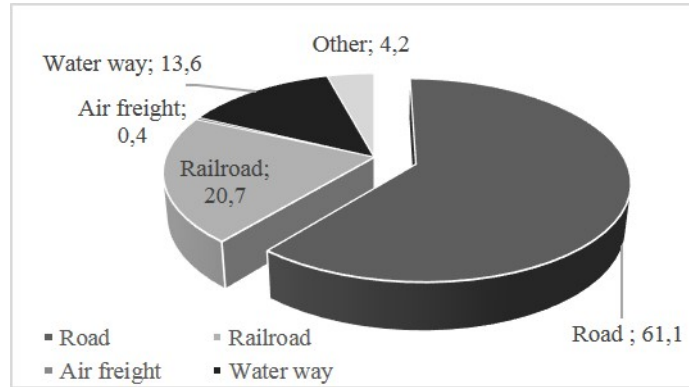
**Keywords:** Distribution networks · Logistics · Transportation plan.

## 1 Introduction

Post-harvest losses in food grains at different stages of their handling would help assess the extent and magnitude of losses and propose mitigation actions to reduce the losses. Amongst the cereals post-harvest losses the truck transportation represents nearly 1% of losses [1] [2].

Truck transport is commonly used worldwide for the distribution of goods for trade. In Brazil, truck transport is usually the most economical way to provide an allocation of goods in places where inexpensive (railways) or natural (rivers) transport alternatives are not available. Truck transport plays a significant role in moving raw materials and processed products from the agricultural rich North and Midwestern region of Brazil to the port cities of the South. Current estimates of grain loss during truck transport are reported to be between 1-5% of a typical load of cereals (27,000 kg), and losses stem from inadequately drying the grain before transport and the use of non-grain trucks to haul grain for distances upwards of 2,500 to 3,000 km. For soybeans, these long hauls may take up to 2-3 days during the rainy season and the grain loses quality when it reaches the port [3]. Brazil has large proportions and distances and the costs for transport of

materials and products over long geographical distances are high. These increases cost and consequently the price of the final product. This scenario continues to bring investment losses, and the decline in the quality of the Brazilian modal transport infrastructure increases the loss of international competitiveness [4]. Worldwide, Brazil stands in the 48th position Global Competitiveness Index, and in the 107th place in infrastructure [5]. The adoption of freight transportation adopted in Brazil is shown in Fig. 1



**Fig. 1.** Freight transportation forms in Brazil. Adapted from [6]

Brazilian soybean production is distributed in 25 million hectares with a harvest of 73.3 million metric tons during the 2011/2012 harvest. Peak production occurred in the Midwest and South regions (states of Mato Grosso, Parana, and the Rio Grande do Sul with yields of 20.83, 14.37, and 10.05 million metric tons respectively. Current production costs for soybeans in the central regions of Brazil are estimated at \$1,156 U.S. per hectare [7]. The occupation of Piauí savanna began between the 1970s and 1980s with live-stock projects and cashew cultivation incentivized by the government credit lines, which encouraged people from other states to migrate to Piauí. From 1990, it intensified the implementation of large scale soybean production in the state, which currently represents 24% of the area planted in the Northeast and 2% of Brazil's area. According to [8] in the last soybean harvests the state of Piauí had an increase of 76% of the planted area. This value was higher than the whole Northeastern region development (46%), and the Brazilian increase in soybean production (32%) in the same period. This scenario characterizes the state as a new agriculture frontier mainly the Mapiatoba compound, which represents 18% of the state planted area. Soybean production is located in high and flat agricultural lands with appropriate rain index; however, the newly developed areas lack in logistic infrastructure. According to [9] 65% of the soybean produced in Brazil is transported by roads to processing plants and ports. The bad conditions of the roads increase the operational costs by 30%. In the Piauí state, 100% of

produced and harvested soybean is transported by two ways routes, and some of them are dusty roads. The truck is not appropriate as well implicating in the additional cost of freight [10]. The cargo composition refers to the distance of transport, season, and the product [11]. The proper transportation of grains is an important issue in reducing the losses [12]. Perishable materials such as cereals require specific environmental conditions (such as air temperature and relative humidity) to maintain quality. The excess of moisture in the truck loads might induce the product fermentation reducing final quality [13]. Although worldwide the grain loss limit in transportation is around 1% [1], in Brazil it is acceptable values near 3% of bulk grain transportation [10]. This study aimed to analyze the soybean post-harvest loss by loads transported in trucks from two different regions to the processing plant.

## 2 Methodology

The case-study designed to verifying the amount of soybean loss that occurred during truck transportation from the producing area to the central point from where the grain is directed to the industrial processing plant in the county of Uruçuí Table 1. Data were recorded from March to May 2014 from four farms located in two different regions

**Table 1.** The data are recorded and the dataset organization.

Region	Farm	Data recorded	Truckloads (n)
1 (Nova Santa Rosa)	a	Distance from the farm to	222
	b	destination; truck load weight	
2 (Baixa Grande do Ribeiro)	c	(t) at farm and destination;	273
	d	type of road	

Information was recorded from 495 truckloads of soybean from the farm to the processing plant (crushing operation) located in Uruçuí in the interior of Piauí State, Northeastern of Brazil. From the total of loads 222 where originated from two farms in region 1 (Nova Santa Rosa), and 273 from two farms in region 2 (Baixa Grande do Ribeiro). For each load, the weight in the farm and the weight at the final destination was compared and the eventual loss calculated. Several trucks were used in the soybean transportation; therefore, the specificity of the vehicle was not considered in this study. The distance from the farms in region 1 (a, b) to the final destination was 166 km. In this scenario, 60% (110 km) of the distance the road was covered with asphalt and 34% (56 km) was a dusty road. The distance from the farms in region 2 (c, d) to the processing plant was 296 km with approximately 85% (246 km) of asphalt road and 15% (50 km) of the dusty road. Descriptive analysis was applied to data using the calculations of the mean trend such as the median, dispersion, and the standard deviation for each distance and weight.

### 3 Results and Discussion

Truckloads (222 from farms a and b) from region 1 (Nova Santa Rosa) presented an absolute difference in weight of 25.56 t (0.28%), as shown in Table 2. The 273 loads from region 2 (Baixa Grande do Ribeiro) traveled 346 km to reach the processing plant. The total volume transported was 10,968t, from that 10,952 t reached the final destination. The amount of bulk load of 15.59 t (0.14%) was lost along the way Table 3.

**Table 2.** Data on the truckloads of soybean transported from the farms in region 1 (Nova Santa Rosa)

	Load (n)	Weight at farm (t)	Weight at destination (t)	Loss (t)	Average	Median	SD
Farm 1	106	4344	4336	8.52	0.08	0.06	0.15
Farm2	116	4562	4545	17.04	0.15	0.09	0.13
Total	222	8906	8880	25.56	0.12	0.07	0.14

n=number of loads; SD=standard deviation

**Table 3.** Data on the truckloads of soybean transported from the farms in region 2 (Baixa Grande do Ribeiro)

	Load	Weight at farm (t)	Weight at destination (t)	Loss (t)	Average	Median	SD
Farm 1	230	9210	9197	13.50	0.06	0.05	0.03
Farm2	43	1758	1756	2.10	0.05	0.05	0.01
Total	273	10968	10952	15.59	0.06	0.05	0.03

n=number of loads; SD=standard deviation

According to [2], in a study of two communities in Bangladesh, it was found that the losses in the transport of rice and wheat, amounted respectively to 13.90% and 5.53% of total losses in post-harvest. The authors [14] described a case study in India found transport losses for rice and 9.63% to 11.81% wheat, reaffirming that the losses transportation are also present in other grain crops. The route from region 1 to the processing plant (Nova Santa Rosa - Uruçuí) was done using the road PI 391 and BR 324, totaling 166 km, of which 56 km (34%) consists of the unpaved (dusty) road. However, the route from region 2 to the processing plant (Baixa Grande do Ribeiro – Uruçuí) was held using the road BR 342 / IP 392, that has 15% (50 km) of its entire route of the unpaved (dusty) road. Relating the amount of losses in the total volume transported the

loads Nova Santa Rosa were moved longer distances on the unpaved road and had more volume of lost grain. Therefore, in this case, it can be inferred that the larger the unpaved road route, the higher the volume loss, possibly due to greater load trepidation on this kind of road. According to [15] in developing countries, the transport losses occur due to accidents, poorly maintained roads, lack of infrastructure and vehicles. This fact is confirmed by the value of the average losses found in charges in the region 1 showed higher average, almost double compared to loads of region 2. About the median, the discrepancy is smaller because a region has median loss of 0.07 t and another a loss of 0.05t. In a report of the World Bank [16], in the Logistic Performance Index (LPI) that evaluates the quality of domestic trade and transport infrastructure, Brazil is ranked in 55th place, with a long wait in ports for international trade. Therefore, investment in improving transportation of cereals of crucial for the country, especially that the economy is highly based on the grain/commodity trade.

#### 4 Conclusions and Outlook

In both areas studied and considering all considered loads, there was a difference in weight between the source and destination indicating possible losses during the road transport. The international standards find 0.25 of losses acceptable within the players along the supply chains. As the losses in this study are 0.14%, there should not be a problem when considering of supply chains point of view. However, when the scale of business in applied the total loss was nearly 25 tons, and this amount is certainly not a slight loss. Regarding the type of road, the path that has the longest section without pavement showed a higher degree of grain loss.

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