Original Research Article

Quantification of corn grains losses in road transport

ABSTRACT

The present work had the objective of quantifying corn grain losses in road transportation along a section of highway BR 163 in the state of Mato Grosso. The survey was done in July and August of 2016 in the section between the Imigrantes Highway, within the city of Cuiabá - MT, and the municipality of Nova Mutum – MT. This stretch is considered to be the one with the highest flow of grain loads in the state of Mato Grosso. Twenty one collect points were established along the stretch, with a distance of 10 km from one point to the other, at each collect point 3 areas of 1m² were delimited with the aid of a fixed frame of wood with the same area, in a distance of 1.3 m from the highway margin, in the north-south direction, which is the direction of the grain flow. The samples were placed in identified plastic bags and taken to the laboratory for separation and weighing. The points of the biggest grain losses were points 06 and 12 of the section, where it was verified pavement in poor quality with much road surfacing, and the points of lower losses were collected in the top quality asphalt range.

Keywords: grain flow; logistics, production

1. INTRODUCTION

The expansion of agricultural areas accompanied by new technologies and forms of planting make Brazil stand out in the cultivation of grains and occupy an important place in the production and supply world, projecting it in an optimistic scenario of productivity (United Nations Organization for Food and Agriculture (FAO) and United States Department of Agriculture [1].

According to the author cited in the reference [2], the national production of corn grains in the 2017/18 harvest was 80.70 million tons. In Mato Grosso the production was of 26.40 million tons. For the 2018/19 crop, the national production estimate is 91.65 million tons. In Mato Grosso the estimate is 28.38 million tons. The growth should be 13.6% for domestic production and 7.5% for Mato Grosso's production.

Despite the climatic and technological advantages presented in Brazil in the areas of grain production, much of this is mitigated when related to this context grain losses occurring in the transport logistics by the main existing means that are the highways, railroads, waterways and ports [3], highlighting the Brazilian highways that did not follow the agricultural expansion. According to the author cited in the reference [4], the Brazilian transport matrix is unbalanced, with 64% of all cargo transported in the country through highways, only 22% for the railroad modal, and 14% for the modal waterway, a very different reality (32%, 43%, 25%) and Russia (8%, 81%, 11%). The ideal distribution in grain transport, such as maize, would be by railroads and waterways, with the use of the modal route directed to the supply of intermodal terminals near the producing centers [5]. According to the authors cited in the reference [6] corroborate with this information, where it states that national grain production could be greater were it not for the problems faced with the outflow logistics where billions are lost due to the limited investment in infrastructure, with projects aimed at only capping the existing holes, without enlarging and giving better quality to the existing mesh, and still without proposals that aim to reduce the displacement that is still in long distances.

The flow of the agricultural harvest in Brazil is a visible bottleneck when it comes to grain logistics, the country begins to lose competitiveness from the movement of the harvest in the farm to the shipment in ports, raising the cost of products with logistics in transportation [7]. According to the author cited in the reference [5], the transport of volumes over long distances, provide a low value added to the product, thus reducing its competitiveness in the market, the same author cites that the paving of BR 163 to the port of Santarém in Pará, would already bring a reduction of $ 30 per tonne in freight, thus adding value to the grain transported. Thus, all efforts generated in recent years to raise agricultural products to the level they are in are dissolving due to quality problems in the road transportation system and by more efficient means such as waterways and railroads, are not very representative in the outflow [8].

According to the author cited in the reference [9], about 0.25% of the grains that are carried along the route. Just make an analogy at harvest time. By contract, such loss, when greater than 0.2%, is banked by the carrier himself. But the economic impact is felt throughout the production chain until the final consumer, who ends up paying more expensive for the product. During the transport of the field to the ports of Santos (SP) and Paranaguá (PR), of the 18.78 million tons of soybean that Mato Grosso produced in the 2011 harvest, for example, it is estimated that 47.5 thousand tons of on the roads. According to calculations by the Center for Grain Marketing (Grain Center), of the Federation of Agriculture and Livestock of Mato Grosso (FAMATO), waste means a loss of R $ 21 million each year for the sector.

In the movement of the farm to the warehouses, the grain losses are scattered along the highways, coming from the modal choice for the freight price; the lack of conservation of highways; the lack of connection between road, rail and waterways; the low supply of another type of modal for the transportation of cargo; the lack of investment in cereal car bodies; losses during storage; long distances to storage sites; lack of maintenance in warehouses and the lack and inadequate use of cargo protection tarpaulins [10,11].

Historically, there have been few studies that focused on assessing the efficiency of short-haul grain transport or on measuring losses that occur during this stage of the supply chain. Poor road conditions, improper truck maintenance, overloading, and ineficiente transfer of grain are major causes of transportation losses of grain [12].

In view of this scenario, where the state of Mato Grosso is located, being the largest maize producer in the country, and facing serious problems in order to transfer this grain to its final destination, the objective of this work is to quantify the loss of corn grains in the margins of the BR 163 highway in the state of Mato Grosso.

2. MATERIAL AND METHODS

The evaluation work was carried out at the Nucleus of Storage Technology (NTA) of the Faculty of Agronomy and Animal Science (FAAZ), at the Federal University of Mato Grosso, Cuiabá - MT campus.

The survey was carried out in July and August of 2016 in the stretch between km 499 of BR070, which is an overlapping point between BR070 and BR163, on the Imigrantes highway, within the city of Cuiabá - MT, and km 536 of BR163, in the municipality of Nova Mutum - MT. The section where it comprised the evaluation points had approximately 210 km, being considered the section of greater flow of loads of grains of the state of Mato Grosso.

A total of 21 collection points were established along the stretch, with a distance of 10 km from one point to the other, in order to randomize collection points. For the distance between the points a margin of difference of 500 meters was accepted for more or less, in order to avoid points of collection in very dangerous places, lack of parking space or that in any way put safety at risk of collections.

At each collection point an area of 1 m^2 was fixed with the aid of a fixed frame of wood with the same area, at a distance of 1.3 m from the highway margin, in the north-south direction of the highway, which is the direction of the grain flow in BR 163 in the section considered, as exemplified in Figure 1; from this first collection area, two more areas to be collected were selected, one 30 m before and the other 30 m after the first area fixed at the point. In the areas were collected all residues of grains present and demarcated with white spray paint, in addition each collection point was georeferenced with a GPS Garmin model Etrex legend. The markings of the points and areas were carried out on 07/19/2016 and the collections were held weekly on 07/25/2016, 08/01/2016 and 08/08/2016.

Figure 1. Area of corn grain collection on the shoulder of BR163 highway.

The grains were collected on the side of the road, along the gutters and near the lawn, with a broom, brush and dustpan. The collected material was placed in plastic bags properly identified and taken to the laboratory for separation and weighing.

The experiment was carried out in subdivided plots, 21 plots (collection points), 3 subplots (collection times) and 3 replicates (collection areas at points). Statistical analyzes were performed using software Assistat (2016), version 7.7 pt. To verify the differences between the treatments, the analysis of variance (ANOVA) was used by means of the F test. When significant to the comparison of means for the treatments was performed by the Scott-Knott test.

3. RESULTS AND DISCUSSION

The data were first submitted to analysis of variance of the data, as can be verified in Table 1, which shows significance at 0,05 only for the 21 collection points, with no significance for either the evaluation times or the interaction.

Table 1. Analysis of Variance for Volume of losses as a function of the points along the course in BR 163 – MT, Brazil

FV	GL	SQ	QM	F
Treat. A	20	203.310,607	10.165,535	20,337 **
Res. A	42	20.993,224	499,838	-
Parcel	62	224.303,831	-	-
Treat. B	2	504,425	252,212	2,019ns
Inter. TA x TB	40	5.008,261	125,206	1,002 ns
Res. B	84	10.488,668	124,865	-
Total	188	240.305,187	-	-

The coefficient of variation presented high values, this is explained by the fact that, however great the control performed in the choice of points, the factors that directly influence the loss of grains are not controllable, such as the different conditions of road quality along the evaluated route and the grain haul trucks.

After the analyzes, we can observe the averages of all the collection points in BR 163 in Table 2, where we found a greater grain loss in points 6 and 12 of the highway. In these points of the highway, a high number of punctual tailings of holes were verified, as verified in Figure 3, the process of covering holes generates a condition of instability for the truck. According to the authors cited in the reference [13]. Which explains that this generated trepidation causes the grains to seek accommodation points in the body, and in cases where the body has some kind of gap or opening these grains tend to move to these points and get lost.

According to the authors cited in the reference [14], grain losses is also caused by the lack of uniformity and sealing provided by manual winding, method widely used to cover the upper body. A secondary, but not least, problem is the high time for handwinding. The same author proposes an automated wrapping system for bulk carriers aiming at reducing losses, which can be considered a phytosanitary issue, since one of the main sources of dissemination of the main diseases of corn and soybeans are the grains that fall on the roadsides.

According to authors cited in the reference [15] with only 20% of road pavements and 1.7 million km of road surface, poor rural road conditions in Brazil create substantial bottlenecks due to intensive use during the soybean and corn harvest. According to [16] the Brazilian law dictates that trailers can have a maximum weight of either 45 or 57 tonne (based on the total length of the trailer, Resolution N 210, 2006) [17] however overloading during transport of grain from farm, to storage is common. The combined effects of poor road conditions and road maintenance, truck vibrations and overloading, and poor maintenance of trailers on grains lost during transport have been studied by [18 and 19].

Of the six points that stood out with the lowest losses (P18, P17, P15, P16, P19 and P21), four are located in the Serra da Caixa Furada, in the stretch that includes the exit of the city of Rosário Oeste - MT and Posto Gil , this stretch being duplicated with good quality asphalt. In Brazil, road transportation is the main means used for transportation, and its roads are expected to be in a good condition to generate more competitiveness in the flow of its products. The country has 1,720,607 km of roads, being only 213,229 km of paved roads, about 12.4%, according to a CNT survey that surveys the conditions of Brazilian roads since 1995 [4].

Table 2. Average grain losses of corn in grams of the points collected in BR 163 – MT, Brazil

Points	Averages
P6	122,018 a
P12	114,092 a
P7	52,426 b
P9	50,848 b
P2	49,923 b
P5	40,914 c
P8	39,148 c
P14	36,541 c
P13	32,495 c
P10	22,197 d
P4	20,160 d
P11	19,507 d
P1	19,301 d
P20	15,251 d
P3	13,976 d
P21	9,287 e
P19	4,498 e
P16	0,148 e
P15	0,142 e
P17	0,034 e
P18	0,000 e

Means followed by the same letter do not differ statistically from each other at the 5% level of significance by the scott-knott test

Figure 2. Corn kernels fallen on the highway in the section of point 6 of collection.

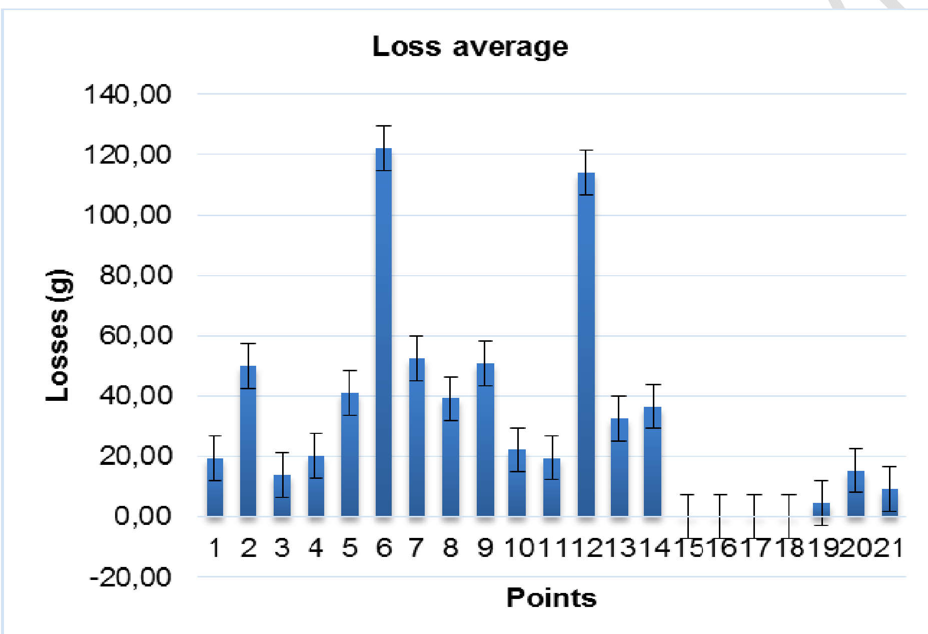

Figure 3. Representation of the means of the points of the course with their respective standard errors.

Grain haulers are not designed to run on asphalt of poor quality, as is verified in most of the section evaluated, the tires, wheels, springs and the bodywork do not support the undulations of the roads, thus causing damages to the Carriers, truck drivers and the owners of the grain transported. The average age of these trucks is 9.7 years of age, according to [21]. The older fleet is used by the self-employed, whose average age is 12.7 years, followed by cooperatives with 8.7 years. The business fleet is 7.9 years old. Thus, the need for renewal of the existing fleet is added to the expansion of Brazilian agribusiness as a determining factor for the development of the grain transport market [14]. In their work, [20], evaluated the operational cost of freight trucks that travel on highways with different paving qualities. Considering that the road in great condition of conservation is the base of the calculation, therefore, there is no increase; however, if it is in good condition, the increase is

19.4%, if regular, 41%, bad, 66% and 91.6% if it is in poor condition. A very important factor responsible for much of the loss is the government's unwillingness to invest in road infrastructure, since trucks suitable for this activity have a higher cost.

According to the authors cited in the reference [22], poorly maintained roads and old trucks are the main factors of losses. They are considered as the main causes for the waste of the production during the transport: the age advanced of the fleet, the poor conservation of the trucks and the bad conditions of good part of the Brazilian highways. Studies indicate that 1% of load above the limit in an isolated axis increases in 4.32% the pavement wear. That is, if the overhead is 5% in the truck, a highway designed to last 10 years has its useful life reduced to 8.1 years. If the weight exceeds 20%, the durability of the floor will fall to only 4.5 years [23].

According to the [4] the decrease in the number of truck licenses in recent years has affected the magnitude and average age of the national fleet. The number of trucks in circulation in Brazil grew 14.2% between 2012 and 2016, while the number of trucks in the same period increased 13.2% and 7.8%, respectively. The current fleet of trucks in 2017 was 1.9 million units. The average age of the trucks went from 10 years and 3 months in 2016 to 10 years and 8 months in 2017. In the midst of so many obvious problems, finding a solution that sidesteps these obstacles, and still makes us more competitive in the marketplace, is a logistical challenge.

4. CONCLUSION

The present work was able to verify the main potential factors for losses. The contribution of this study is evident, being clear its representativeness for the food sector, since the need of information for the farmer is primordial to the cultivation of excellence. It was verified that the quality of the roads and trucks, with a quality seal for the body, are preponderant factors for the mitigation of losses of corn grains. It is advised to adhere to the use of properly insulated truck or bucket trucks. Perform periodic bodywork reviews. Depending on the condition of the road, stipulate maximum speed for grain conveyors. The solution for the reduction of grain losses in the flow of the crop goes through investments in improvement of the road network and of the trucks.

COMPETING INTERESTS

We declare that no competing interests exist.

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