IMPACT OF FACILITY MAINTENANCE SYSTEM ON PRODUCT PHYSICAL LOSSES IN A POULTRY FEED MILL UNIT

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RESUMO

O objetivo do estudo foi avaliar as perdas físicas de produtos, os custos e as contaminações causadas pelo sistema de manutenção dos equipamentos dos diferentes fases de produção de um fábrica de ração. O experimento foi conduzido em uma indústria de ração com capacidade de produção de 1000 ton.day^{-1}. Primeiramente, caracterizou-se o sistema de manutenção utilizados na indústria, em seguida quantificaram-se as perdas dos produtos nos setores externos e internos da unidade de produção. Dois métodos foram utilizados para a quantificação das perdas: por setor e por equipamento. Os produtos quantificados foram amostrados em diferentes pontos da área avaliada, para a contagem de colônias de fungos e salmonelas, número de insetos inteiros e fragmentados, ácaros. Os resultados mostraram um elevado número de manutenções não realizadas dentro do período programado, chegando a 70%. Além disso, o sistema de manutenção dos equipamentos utilizados na indústria, significativamente influenciou nas perdas físicas de produtos (120 Kg) e custos (US$ 38 por hora de trabalho). A análise microbiológica apresentou um alto índice de contaminação (7.4x10^{4} UFC.g^{-1}) nos produtos finais.

Palavras-chave: controle, indústria, qualidade

ABSTRACT

The aim of the study was to evaluate the quantitative, the costs and contaminations of the physical losses of products caused by maintenance system utilized on the equipments of the different stages of production of a feed mill. The

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experiment was conducted in a feed industry with capacity of production of 1,000 ton.day^{-1}. Firstly, a rising of the maintenance system used in the feed mill was done, after the products losses were quantified in the external and internal sectors of the milling steps. Two methods were utilized for losses quantification: per sector and per equipment of the feed industry. Samples of the products were collected in different points of area evaluated for counting of fungi and salmonellas colonies, whole and fragments insects and mites. The results showed a high number of maintenances not performed within the programmed period, arriving to 70%. In addition, the equipments maintenance system utilized in the feed milling, significantly influenced in the products losses, arriving to 120 Kg and costs of US$ 38 per hour worked. The microbiology analysis presented a high contamination index ($7.4x10^4$ CFU.g^{-1}) in the final products.

Keywords: control, industry, quality.

INTRODUÇÃO

Despite the significant quantities of grain produced in Brazil due to technology advances in the agricultural sector, improvements must be made in regards to quality and control. Product losses during harvest and post-harvest periods are observed year after year, however, real numbers for losses are not yet known and few suitable methods for control have been obtained. Some studies and estimates have been performed, but observed results still show significant variation estimating an index of 16% ± 4% for practically all crops (Jardine, 2002). Today, these indexes are outdated and must be revised. The Brazilian Post-Harvest Association admits a shortage of data in respect to this subject, indicating that the most sample recent work is the report produced by the Technical Commission for Reduction of Agricultural Losses, of the Brazilian Department of Agriculture, Storage and Agrarian Reform. Jardine (2002) affirmed that during storage, losses generally occur due to inadequate structures or storage networks, as well as poorly qualified workers which operate dryers, fumigation chambers, aerators and other equipment for reception, transportation and conservation of products in the storage units. In grain storage facilities and feed mills, losses are observed as product leaks from equipment (Fleura-Lessard, 2002). Product leaks are not tabulated in the majority of grain storage units since the products often collected and returned to the production process, running the risk of physical, chemical and biological contamination (Bennet & Klich, 2003; Krska et al., 2005; Schatzmayr et al., 2006) of the rest of the lot and compromising final product quality (Brera et al., 2004). The aim of the study was to evaluate the quantitative, the costs and contaminations of the product physical losses caused by maintenance system used on the equipments of the different stages of production of a feed mill.

MATERIAL E MÉTODO

This study was conducted in a commercial poultry feed mill unit located in the State of Minas Gerais, Brazil, with a production capacity of 1,000 tons of feed daily. The evaluation was realized with the collect of data referring to the maintenance system used in the feed mill. To maintenance standard was established by own factory to according with concepts described by Lamprechet (1995). All the mechanical components of the bucket elevator, auger and belt conveyer, silos, dryer, pre-cleaning, mixer, doser, pelleting, and grinder were evaluated. The maintenance system was analyzed considering the preventive maintenance performed during the programmed period, preventative maintenance not performed during the programmed period, anticipated preventative maintenance and maintenance not performed.

The following products were quantified: soybean meal, corn, visceral, bone, meat and feather meals, sorghum, integral soybeans, oils of viscera, feeds and other micro ingredients including: methionine, lysine, lime, salt, sodium bicarbonate, premixes and vitamins. All products encountered on the mill floor or in environments unsuitable for the product were considered as physical losses. These losses were quantified both inside (industrialization process) and outside (raw materials process) of feed mill (Table 1). The sampling points of products were selected before to start the study and they were used until the final experiment. Two different quantification methods were utilized: per sector of the milling and per equipment. In the quantification of product losses per sector was considered the type of product, the equipment operating time and the total area of sector. On the receiving and pre-cleaning sectors of corn were determined six points of sampling, however, on the drying of corn was selected four points and on the storage sector forty eight points. On the receiving sector of soybean meals were collected samples in three points, and on the storage sector seventeen points. The sectors of micro ingredients were collected samples in eighteen points.

Quantification of product losses per equipment was performed specifically for each type of product, capacity of transport of the equipments, operating time and total equipment area. On the equipments of receiving and storage of corn were collected samples in thirty four different points, on the receiving and storage soybean meal equipments were collected samples in ten points; however in the equipments of transport of feed were sampled eight points. The tarps measuring 1 m^2 were used to determine losses in each point. The total product weight represented product losses on the mill floor.

Table 1 - Schedules of sampling of the products in the feed mill

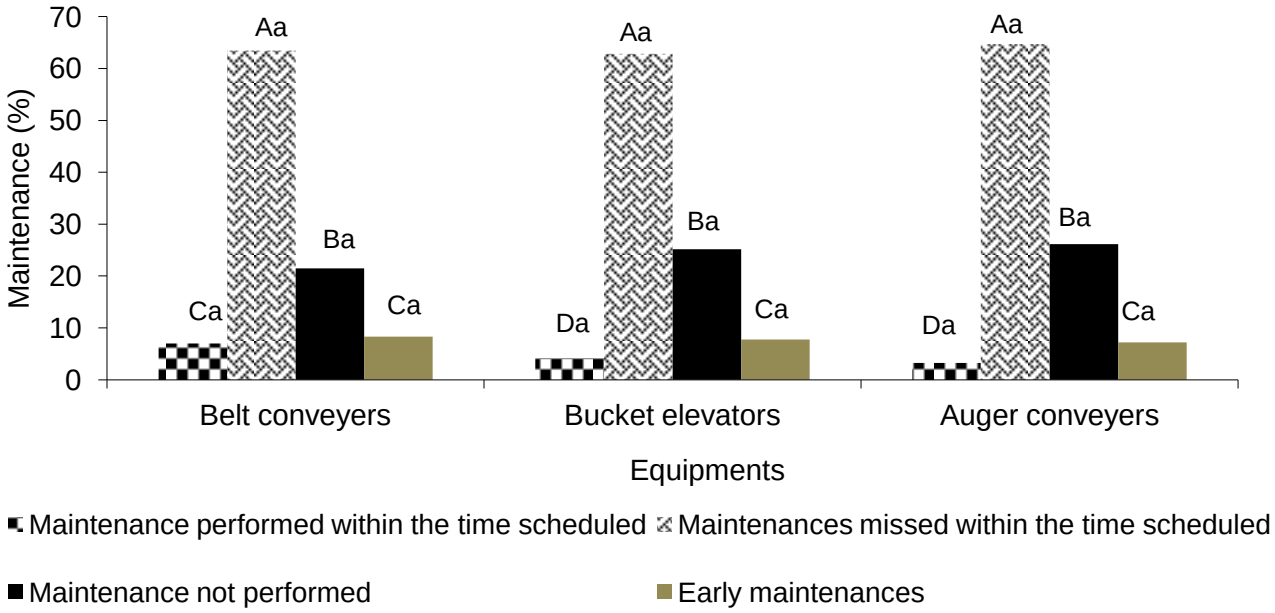
Months	Weeks	Dates	Times (h)
May	1	05/05	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		05/07	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		05/09	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	2	05/12	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		05/14	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		05/16	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	3	05/19	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		05/21	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		05/23	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	4	05/26	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		05/28	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		05/30	6:00 / 9:00 / 12:00 / 15:00 / 18:00
June	1	06/02	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		06/04	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		06/06	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	2	06/09	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		06/11	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		06/13	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	3	06/16	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		06/18	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		06/20	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	4	06/23	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		06/25	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		06/27	6:00 / 9:00 / 12:00 / 15:00 / 18:00
July	1	07/07	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		07/09	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		07/11	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	2	07/14	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		07/16	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		07/18	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	3	07/21	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		07/23	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		07/25	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	4	07/27	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		07/29	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		07/31	6:00 / 9:00 / 12:00 / 15:00 / 18:00
August	1	08/04	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		08/06	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		08/08	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	2	08/11	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		08/13	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		08/15	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	3	08/18	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		08/20	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		08/22	6:00 / 9:00 / 12:00 / 15:00 / 18:00
	4	08/25	7:00 / 10:00 / 13:00 / 16:00 / 19:00
		08/27	8:00 / 11:00 / 14:00 / 17:00 / 20:00
		08/29	6:00 / 9:00 / 12:00 / 15:00 / 18:00

The results were calculated for the total area, per sector and equipment, estimating the total amount of product losses. The process was repeated five times in the same day for different times of operation, different days and weeks during four months (Table 1). The data of products losses were analyzed in spreadsheets, showing quantitative and costs. Once week samples of the products losses for each sector of production and equipment was collected for determination of water content and analyzes of fungi and bacteria colonies, mites, insects whole and fragments.

The water content of the products (% w.b.) was determined using the indirect method, the meter of moisture Geole (G-800) after that equipment being calibrated with the official method from the oven, set at 103 ºC ± 2 ºC for 24 h (Brasil, 2009). The assessment of insects in the products was made by visual counting in 1 Kg of product sampled. The product sampled was poured into a table, with artificial lighting, and then pulled out with tweezers all the whole and fragments insects for counting. The samples for examination of mites were sieved through stainless steel mesh opening of 0.50 mm on a sheet of paper to separate the particles of dust mites. The mites were quantified under a stereomicroscope. All results were expressed in terms of 50 g of sample (Hughes, 1976). The analysis of toxigenic fungi was performed by Dhingra and Sinclair (1995). However, the counting of bacterial colonies was done to according method of the American Public Health Association-A.P.H.A. (Speck, 1984). The analyses were performed in triplicate and results were expressed as Colony Forming Unit per gram (CFU.g-1) of products. The maintenances systems and the levels of contamination in the steps of production were compared statically, using the Tukey test ($p>0.05$) and Sisvar 4.3® program.

RESULTADOS E DISCUSSÃO

The lack of production quality leads to premature failure of equipment, not as a matter of intrinsic quality of the equipment, but an incorrect operational action, which leads to immediate loss of production. Increasing the quality of maintenance should be considered with the increase of technical staff and also by establishing standard procedures for the carrying out, complying with all criteria and specific standards and regulations. Figure 1 characterizes the utilization and application of the maintenance system in the equipments of transport of a feed mill.



Averages values followed by the capital letter in the column compared between the maintenance type, and lower case letter in row compared between the equipments (p>0.05).

Figure 1. Evaluation of maintenance (%) on equipments of the feed mill.

Losses of products per equipment of the feed mill were evaluated in the Table 2. The index of corn losses in the bucket elevators arrived 60%. The losses of soybean meal in belt conveyers represented approximately 80% of the total. In the feed production the losses of products were highest in the bucket elevators at 72.39% (Table 3). The function of the carriers to interconnect structures and machinery is moving the mass of products in directions vertical, horizontal and inclined. To perform those functions is essential to carry out carefully planned and executed maintenance, minimizing the chance of breakage of equipment, reducing lost time on interruptions and loss of products.

Table 2 - Losses of corn grains in the transport equipments of receiving and torage

Equipments	Area (m^2)	Losses + SD ($Kg.m^{-2}$)	Total losses + SD (Kg)	Total (%)	Costs[1] + SD ($US\$.h^{-1}$)
Bucket elevator 1	7.5	0.176 ± 0.010	1.322 ± 0.075	5.60	0.271 ± 0.015
Bucket elevator 2	7.5	0.183 ± 0.008	1.373 ± 0.060	5.82	0.281 ± 0.012
Bucket elevator 3	7.5	0.192 ± 0.011	1.442 ± 0.083	6.11	0.296 ± 0.017
Bucket elevator 4	7.5	0.161 ± 0.012	1.204 ± 0.090	5.10	0.247 ± 0.018
Bucket elevator 6	7.5	0.195 ± 0.009	1.461 ± 0.068	6.19	0.299 ± 0.014
Bucket elevator 7	7.5	0.171 ± 0.010	1.283 ± 0.075	5.43	0.263 ± 0.015
Bucket elevator 8	7.5	0.301 ± 0.020	2.256 ± 0.150	9.55	0.462 ± 0.031
Bucket elevator 9	7.5	0.184 ± 0.013	1.380 ± 0.098	5.84	0.283 ± 0.020
Bucket elevator 10	7.5	0.141 ± 0.014	1.058 ± 0.105	4.48	0.217 ± 0.022
Bucket elevator 11	7.5	0.175 ± 0.016	1.316 ± 0.120	5.57	0.269 ± 0.025
Belt conveyer 1	8.0	0.032 ± 0.008	0.256 ± 0.064	1.08	0.052 ± 0.013
Belt conveyer 2	35.0	0.013 ± 0.002	0.445 ± 0.070	1.88	0.091 ± 0.014
Belt conveyer 3	35.0	0.041 ± 0.009	1.422 ± 0.315	6.11	0.292 ± 0.064
Belt conveyer 4	8.0	0.028 ± 0.006	0.224 ± 0.048	0.95	0.046 ± 0.009
Belt conveyer 5	35.0	0.015 ± 0.004	0.523 ± 0.140	2.22	0.107 ± 0.029
Belt conveyer 6	35.0	0.014 ± 0.003	0.484 ± 0.105	2.05	0.099 ± 0.022
Belt conveyer 7	15.0	0.031 ± 0.010	0.466 ± 0.150	1.97	0.095 ± 0.031
Belt conveyer 8	22.0	0.019 ± 0.007	0.414 ± 0.154	1.75	0.084 ± 0.031
Belt conveyer 9	17.0	0.037 ± 0.005	0.628 ± 0.085	2.66	0.129 ± 0.017
Belt conveyer 10	24.0	0.027 ± 0.007	0.638 ± 0.168	2.70	0.131 ± 0.034
Belt conveyer 11	22.0	0.022 ± 0.005	0.493 ± 0.110	2.09	0.101 ± 0.023
Belt conveyer 12	22.0	0.031 ± 0.006	0.678 ± 0.132	2.87	0.139 ± 0.027
Belt conveyer 13	9.0	0.017 ± 0.005	0.156 ± 0.045	0.66	0.032 ± 0.009
Belt conveyer 14	9.0	0.016 ± 0.003	0.143 ± 0.027	0.61	0.348 ± 0.005
Belt conveyer 15	9.0	0.016 ± 0.004	0.141 ± 0.036	0.60	0.029 ± 0.007
Belt conveyer 16	9.0	0.021 ± 0.004	0.187 ± 0.036	0.79	0.038 ± 0.007
Auger conveyer 1	22.0	0.036 ± 0.008	0.787 ± 0.176	3.33	0.161 ± 0.036
Auger conveyer 2	22.0	0.031 ± 0.007	0.691 ± 0.154	2.93	0.141 ± 0.032
Auger conveyer 3	9.0	0.014 ± 0.003	0.126 ± 0.027	0.53	0.026 ± 0.005
Auger conveyer 4	9.0	0.017 ± 0.004	0.156 ± 0.036	0.66	0.032 ± 0.007
Auger conveyer 5	9.0	0.017 ± 0.005	0.152 ± 0.045	0.64	0.031 ± 0.009
Auger conveyer 6	9.0	0.017 ± 0.006	0.154 ± 0.054	0.65	0.032 ± 0.011
Auger conveyer 7	7.5	0.020 ± 0.007	0.152 ± 0.053	0.64	0.031 ± 0.011
Total			23.610 ± 0.671	100	5.155 ± 0.642

[1]Average price per kilogram of corn (240 samples) (BM&F, 2008), US$ 0.205. Evaluation realized for 1 hour the equipments running (flow 60 $ton.h^{-1}$ of products). SD (Standard Deviation).

For this, bucket elevators should be inspected for stains of heat due to friction between the belt mugs or plates coated with, observe noises of friction between the cups and the structure of the carrier or screws. Preventive maintenance is important to check the belt is properly stretched and mugs lined up to replace the damaged mugs, repair damage at the seams and straps shirts, tighten loose screws, lubricate bearings and gear units as specified by the manufacturer or replace damaged bearings with life useful exhausted and verify the correct operation of the safety devices. In maintenance of belts conveyor to reduce the losses of products in the transport is recommended to check the status of

the belt for damage cutting, observe the alignment, check the condition of bearings and bushings, to replacement of damaged rollers and adjust the belt tension.

Table 3 - Losses of soybean meal in the transport equipments of receiving and storage of the feed mill

Equipments	Area (m²)	Losses + SD (Kg.m^{-2})	Total losses + SD (Kg)	Total (%)	Costs[1] + SD (US$.h^{-1})
Bucket elevator 1	7.5	0.082 ± 0.020	0.618 ± 0.150	6.18	0.222 ± 0.054
Belt conveyer 1	16.5	0.071 ± 0.016	1.176 ± 0.264	11.76	0.423 ± 0.095
Belt conveyer 2	17.5	0.076 ± 0.021	1.337 ± 0.368	13.37	0.481 ± 0.132
Belt conveyer 3	21.0	0.075 ± 0.024	1.578 ± 0.504	15.78	0.568 ± 0.181
Belt conveyer 4	12.5	0.081 ± 0.014	1.017 ± 0.175	10.08	0.366 ± 0.063
Belt conveyer 5	14.4	0.072 ± 0.023	1.033 ± 0.331	10.33	0.372 ± 0.119
Belt conveyer 6	13.0	0.084 ± 0.012	1.092 ± 0.156	10.92	0.393 ± 0.056
Belt conveyer 7	7.8	0.080 ± 0.021	0.625 ± 0.164	6.25	0.225 ± 0.059
Auger conveyer 1	10.0	0.071 ± 0.018	0.714 ± 0.180	7.14	0.257 ± 0.065
Auger conveyer 2	10.0	0.081 ± 0.017	0.809 ± 0.170	8.09	0.291 ± 0.061
Total			10.000 ± 2.462	100	3.124 ± 0.885

[1]Average price per kilogram of soybean meal (240 samples) (BM&F, 2008), US$ 0.360. Evaluation realized for 1 hour the equipments running (flow 60 ton.h-1 of products). SD (Standard Deviation).

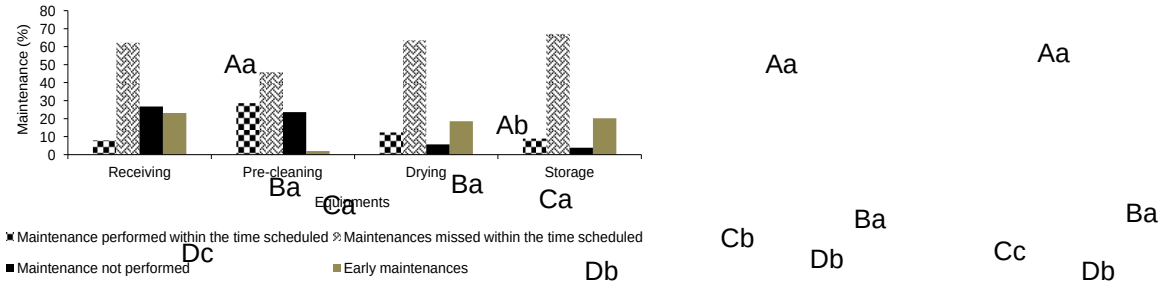
In the case of screw conveyors (Table 4) must be noted the condition of bearings, alignment, and the state of the helical trough. In the current carriers should be analyzed in maintaining the status of bearings, alignment of the current state of the blades and sealing of the chute.

Table 4 - Losses of products in the transport equipments of feed production of the feed mill

Equipments	Area (m²)	Losses + SD (Kg.m^{-2})	Total losses + SD (Kg)	Total (%)	Costs + SD (US$.h^{-1})
[1]Bucket elevator 1	6.25	0.797 ± 0.145	4.984 ± 0.906	28.94	1.535 ± 0.279
[2]Bucket elevator 2	6.25	0.231 ± 0.087	1.446 ± 0.544	8.40	0.505 ± 0.199
[1]Bucket elevator 3	6.25	0.528 ± 0.104	3.299 ± 0.650	19.15	1.012 ± 0.199
[1]Bucket elevator 4	6.25	0.438 ± 0.101	2.739 ± 0.631	15.90	0.841 ± 0.194
[1]Auger conveyer 1	3.00	0.178 ± 0.047	0.535 ± 0.141	3.11	0.164 ± 0.043
[3]Auger conveyer 2	3.00	0.374 ± 0.087	1.121 ± 0.261	7.02	0.317 ± 0.074
[3]Auger conveyer 3	3.00	0.231 ± 0.076	0.694 ± 0.228	4.03	0.196 ± 0.064
[4]Auger conveyer 4	3.00	0.205 ± 0.064	0.616 ± 0.192	3.58	0.174 ± 0.054
[1]Auger conveyer 5	3.00	0.154 ± 0.042	0.461 ± 0.126	2.68	0.142 ± 0.039
[5]Auger conveyer 6	6.00	0.110 ± 0.036	0.660 ± 0.216	3.83	0.203 ± 0.066
[5]Auger conveyer 7	3.00	0.116 ± 0.040	0.347 ± 0.120	2.01	0.106 ± 0.037
[5]Auger conveyer 8	3.00	0.107 ± 0.033	0.322 ± 0.099	1.87	0.099 ± 0.030
Total			17.222 ± 4.114	100	5.294 ± 1.278

Average price per kilogram (BM&F, 2008): [1]for all the products (US$ 0.307), [2]vegetal meals (US$ 0.349), [3]corn (US$ 0.283), [4]animal meals (US$ 0.283), [5]feed (US$ 0.307). Evaluation realized for 1 hour the equipments running (flow 60 ton.h^{-1} of products). SD (Standard Deviation). (240 samples).

Figure 2 represent the results of the maintenance system applied in the external sectors of the feed industry.



Averages values followed by the capital letter in the column compared between the maintenance type, and lower case letter in row compared between the equipments (p>0.05).

Figure 2. Maintenance (%) in the external sectors of the feed mill.

Table 5 and 6 are the results of the losses and total costs of corn and soybean meal determined by the external sector of the feed mill. In the corn grains, 82% of loss occurring in the receiving area

Table 5 - Losses of corn in the external sectors of the feed mill

Sectors	Area (m^2)	Losses + SD ($Kg.m^{-2}$)	Total losses + SD (Kg)	Total (%)	Costs[1] + SD ($US\$.h^{-1}$)
Receiving	1071	0.652 ± 0.128	36.899 ± 7.584	82.32	7.564 ± 1.554
Pre-cleaning	36	0.015 ± 0.024	0.554 ± 0.864	1.24	0.113 ± 0.177
Drying	34	0.018 ± 0.003	0.598 ± 0.102	1.33	0.122 ± 0.021
Storage	1058	0.006 ± 0.002	6.771 ± 2.116	15.11	1.388 ± 0.434
Total			44.822 ± 10.666	100	9.065 ± 2.186

[1]Average price per kilogram of corn (240 samples) (BM&F, 2008), US$ 0.205. Evaluation realized for 1 hour the sector working (flow 60 $ton.h^{-1}$ of products). SD (Standard Deviation). (240 samples).

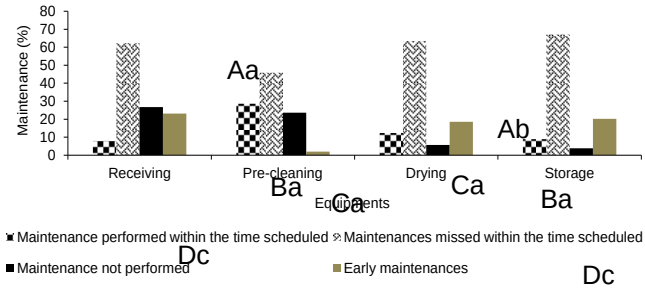
According to Figure 3, among 40% to 70% of maintenance of machinery from every sector of manufacturing of food are not held on scheduled time, between 3% and 25% of maintenance is not performed, while less than 30% are held on time. Approximately 20% of the maintenance of the machineries is anticipated. However, the storage silos of soybean meal were presented greatest losses, comprising 78%. The importance of a well maintained installation, with few interruptions, ends up promote a competitive advantage over its competitors (Coradi et al., 2009).

Table 6 - Losses of soybean meal in the external sectors of the feed mill

Sectors	Area (m^2)	Losses ($Kg.m^{-2}$)	Total losses + SD (Kg)	Total (%)	Costs[1] + SD ($US\$.h^{-1}$)
Receiving	171	0.036 ± 0.005	3.652 ± 0.531	21.88	1.315 ± 0.191
Storage	695	0.036 ± 0.005	12.916 ± 1.790	78.11	4.649 ± 0.644
Total			16.535 ± 2.321	100	5.964 ± 0.835

[1]Average price per kilogram (BM&F, 2008), US$ 0.360. Evaluation realized for 1 hour the sector working (flow 60 $ton.h^{-1}$ of products). SD (Standard Deviation). (240 samples).

To reduce the losses of products in the pre-cleaning machines must be adjusted for speed and incline vibrating sieves, bearings with life exhausted must be replaced, air leaks should be repaired and screens appropriate according to the type product should be used. The storage silos, dryers and receiving system of material should be cleaned constantly, avoiding generation of toxic gases, pests and rodents. Equipments and accessories of machines to be follow to eliminate any obstruction to the flow of products. In the Figure 3 was analyzed the internal sectors of the industry.



Averages values followed by the capital letter in the column compared between the maintenance type, and lower case letter in row compared between the equipments (p>0.05).

Figure 3 - Maintenance (%) in the internal sectors of the feed mill.

For all the internal sectors of the feed mill were observed high index of maintenance not performed in the scheduled time (68% to dosing sector) (Table 7).

Table 7 - Losses of products in the internal sectors of the feed mill

Sectors	Area (m²)	Losses + SD (Kg.m^{-2})	Total losses + SD (Kg)	Total (%)	Costs + SD (US$.h^{-1})
[6]Weighing	32.50	0.026 ± 0.009	0.837 ± 0.293	10.45	0.096 ± 0.034
[7]Weighing	10.20	0.016 ± 0.004	0.161 ± 0.041	2,01	0.300 ± 0.076
[8]Weighing	20.30	0.010 ± 0.002	0.194 ± 0.041	2.42	6.786 ± 1.434
[2]Receiving	9.40	0.080 ± 0.018	0.752 ± 0.169	9.40	0.262 ± 0.058
[9]Dosing	8.35	0.013 ± 0.003	0.109 ± 0.025	1.36	0.013 ± 0.002
[4]Dosing	8.35	0.066 ± 0.022	0.549 ± 0.184	6.85	0.155 ± 0.052
[4]Dosing	8.35	0.038 ± 0.010	0.314 ± 0.084	3.92	0.088 ± 0.024
[4]Dosing	8.35	0.060 ± 0.025	0.498 ± 0.219	6.22	0.141 ± 0.062
[2]Dosing	8.35	0.148 ± 0.050	1.240 ± 0.428	15.48	0.432 ± 0.149
[3]Dosing	8.35	0.106 ± 0.034	0.888 ± 0.284	11.08	0.251 ± 0.080
[2]Dosing	8.35	0.017 ± 0.005	0.146 ± 0.042	1.82	0.051 ± 0.015
[4]Dosing	8.35	0.021 ± 0.007	0.176 ± 0.058	2.19	0.050 ± 0.016
[1]Adition	3.60	0.064 ± 0.022	0.230 ± 0.079	2.87	0.071 ± 0.024
[1]Mixing	2.50	0.078 ± 0.020	0.195 ± 0.050	2.43	0.060 ± 0.015
[1]Grinding	3.40	0.076 ± 0.023	0.259 ± 0.078	3.23	0.080 ± 0.024
[1]Grinding	9.70	0.036 ± 0.013	0.352 ± 0.126	4.39	0.108 ± 0.039
[5]Pelletition	15.40	0.032 ± 0.008	0.493 ± 0.123	6.15	0.151 ± 0.038
[5]Expedition	10.24	0.010 ± 0.003	0.106 ± 0.031	1.32	0.032 ± 0.009
[5]Expedition	10.24	0.012 ± 0.004	0.123 ± 0.041	1.53	0.036 ± 0.012
[5]Expedition	10.24	0.013 ± 0.002	0.134 ± 0.020	1.67	0.038 ± 0.005
[5]Expedition	10.24	0.012 ± 0.005	0.120 ± 0.051	1.49	0.040 ± 0.017
[5]Expedition	10.24	0.013 ± 0.004	0.135 ± 0.041	1.69	0.042 ± 0.013
Total			8.009 ± 2.508	100	9.283 ± 2.198

Average price per kilogram (BM&F, 2008): [1]for all the products (US$ 0.307), [2]vegetal meals (US$ 0.349), [3]corn (US$ 0.283), [4]animal meals (US$ 0.283), [5]feed (US$ 0.307), [6]Microingredients (US$ 0.115), [7]Lysine (US$ 1.867), [8]Premixes (US$ 34.984), [9]Oils (US$ 0.116). Evaluation realized for 1 hour the sector working (flow 60 ton.h^{-1} of products). SD (Standard Deviation). (240 samples).

The maintenance not performed was not higher than 30% of the total, while the advance did not surpass 10%. All maintenance performed on the scheduled time was among 10% and 35%. Significant products losses were observed in the dosing (Table 7). However, the highest cost of the premixes was determinant to represent the highest cost with the losses in the process. Given that production costs are increasingly high and profit margins are relatively low, it is important to avoid any loss in production systems and rational, even though they are almost insignificant as the amount of production in a factory. These costs, when analyzed at the end of one month or one year's production will be relevant and certainly will take the industry to rethink its policy of quality management on a better program of equipment maintenance by providing stops at the scheduled time by investing in training and hiring of qualified personnel. These factors will cost to feed plant an initial price, but easy to change the gain in production, quality and profits over time. Although the maintenance costs of machinery and equipment industries are high, when encountered with total losses of products (Table 8) observed that there are advantages in adopting measures to control and monitor of the failures of repairable products.

Table 8 - Total losses of products in the feed mill

Evaluation	Products	Total losses + SD (Kg)	Total losses (%)	Total costs + SD (US$.h^{-1})
Equipments	Corn grains	23.610 ± 0.671	19.64	5.155 ± 0.642
Equipments	Soybean meals	10.000 ± 2.462	8.32	3.124 ± 0.885
Equipments	Feed production	17.222 ± 4.114	14.33	5.294 ± 1.278
Sectors	Corn grains	44.822 ± 10.666	37.30	9.065 ± 2.186
Sectors	Soybean meals	16.535 ± 2.321	13.76	5.964 ± 0.835
Sectors	Feed production	8.009 ± 2.508	6.66	9.283 ± 2.198
Total		120.198 ± 22.742	100	37.885 ± 8.024

The physical loss of product at the mill maintenance system caused by inadequate equipment and machinery become even more relevant when observing the damage caused by poorly managed when production unit, reducing the quality of other lots, and the mixture contamination. The high water contents reported in Table 9 justify the presence of microbiological contamination in the samples (Coradi et al., 2011). Among the types of contamination found in samples of products are high levels of fungi, mites, insects and *Salmonella* sp. (Table 9).

Table 9 - Microbiological contamination in the losses products

Products	Water content (%w.b.)	Insects (n^0.)	Mites (n^0.)	Fungi (CFU.g^{-1})	*Salmonella* sp. (CFU.g^{-1})
Corn grains	17.7 b	16 a	15 a	6.8x10^4 a	1.2x10^2 b
Vegetal meals	18.5 a	12 b	12 b	7.4x10^4 a	4.3x10^2 b
Flours animals	17.4 b	7 c	8 d	5.3x10^3 b	5.7x10^3 a
Microingredients	16.2 c	6 c	6 d	4.6x10^2 c	3.9x10^2 b
Feeds	16.8 c	8 c	10 c	4.8x10^4 a	3.6x10^2 b

Averages values followed by the lower letter in the column compared between the steps of production (p>0.05).

The contamination can decrease dry matter digestibility, amino acid, and vitamin and fat contents in feed. Consequences in the microbiological development, the production of mycotoxins and bacteria Salmonella species are among the main problems for the animals.

CONCLUSÕES

The maintenance system of the feed industry had direct influence on the losses of product (120.198 Kg.h^{-1}) increasing the production cost to US$ 37.885 per hour worked. All the production system was compromised by contamination microbiological when the products losses were mixed in the lots of production

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