Food supply chain losses and waste: what are the challenges for the Brazilian soybean industry?

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Problem Statement

A more efficient use of the food production chain and a decrease in the amount of food losses can dramatically help the maintenance of natural resources and food security. It is estimated that an additional one billion people may be fed if food losses could be reduced by half.

In Brazil, one of the major soybean producers of the world, the central idea is to see its soybean supply chain losses and waste. The total world production is estimated close to 311200.0 1000 metric tons. In 2014, for the United States, the estimated production is 110000.0 1000 metric tons; for Brazil, 94000.0 1000 metric tons. Another major producer is Argentina, with 55000.0 1000 metric tons of soybean in grain. The Brazilian industry turns about 30700.0 1000 metric tons of soybean as an average per year, producing 5800.0 1000 metric tons of edible oil and 23500.0 1000 metric tons of protein meal, contributing to national competitiveness in production of meat, eggs and milk (MAPA, 2014).

Although the production is abundant, the counterpoint of losses and waste in the soybean global supply chain call attention to the volume of food and resources being lost. According to the National Food Supply Company (CONAB, 2014), these losses, especially related to adverse weather conditions during harvest, storage and transportation, reach between 5.0-10.0% of total production in Brazil. Therefore, this work will enable a more accurate diagnostic of the waste in the Brazilian soybean industry.

Objectives

The aim of this paper is to quantify and identify the sources of the food losses and waste of the Brazilian soybean industry, headed for human food, considering the stages of food supply chain, in the period 2002-2011.

Procedures/methodologies/approaches

The theoretical background considered studies, such as, Parfitt, Barthel and Macnaughton (2010), Godfray et al. (2010a; 2010b), Gustavsson et al. (2011), Kummu et al. (2012), Junguo et al. (2013), Lebersorger and Schneider (2014).

Data were collected by the Food and Agriculture Organization of the United Nations - Statistics Division (FAOSTAT) and systemized using the methodology of Gustavsson et al. (2011). These data include information on the domestic supply (i.e. production) and domestic utilization (i.e. food - direct to human consumption - and processing) of oilseeds and pulses group, specifically for the Brazilian soybean grain in a period of ten years, from 2002 to 2011 (latest year available in the database).

"Per definition, food losses [production, postharvest and processing stages in the FSC] or waste [retailers' and consumers' behavior] are the masses of food lost or wasted in the part of food chains leading to 'edible products going to human consumption'" (Gustavsson et al, 2011, pp. 02). To calculate the quantities of losses (stages: agricultural production, postharvest handling

and storage, processing and packaging) and waste (stages: distribution, consumption) of soybean in the five stages of the Food Supply Chain (FSC), the losses rates used by Gustavsson et al. (2011) were adopted, which are arranged in Table 1. It should be noted that it is the official and available data for the Brazilian reality, although these rates are an average for Latin America (which were adopted in this paper).

Table 1. Losses and waste percentage from oilseeds and pulses in each stage of the FSC, in Latin America

Losses and waste percentage in each step of the FSC	Value
Agricultural production = 6%	0.06
Postharvest handling and storage = 3%	0.03
Processing and packaging = 8%	0.08
Distribution = 2%	0.02
Consumption = 2%	0.02

Source: Elaborated by authors based on Gustavsson et al. (2011).

Results

According to Table 1, Table 2 shows the amount (estimated net values) of food losses and waste in all stages of the production chain of Brazilian soybean industry, from 2002 to 2011. The first three stages of the FSC had the highest absolute values of losses, i.e. agricultural production, postharvest handling and storage, and processing and packaging.

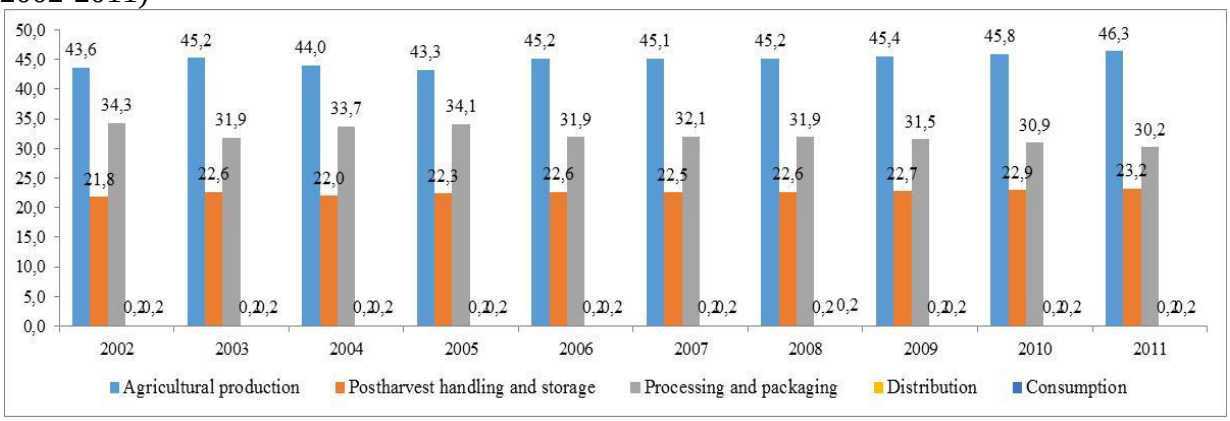
Table 2. Losses and waste calculations on primary equivalent from Brazilian soybean industry in each stage of the FSC (2002-2011)

Stage	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	%
Agric. product.	2566.1	3115.1	2973.0	2973.0	3147.9	3471.4	3590.0	3440.7	4125.4	4488.9	74.9
Postharvest	1283.1	1557.6	1486.5	1535.5	1574.0	1735.7	1795.0	1720.4	2062.7	2244.5	74.9
Processing	2019.6	2195.0	2275.9	2341.5	2221.2	2468.3	2534.3	2385.4	2783.6	2922.0	44.7
Distribution	10.3	11.2	11.6	11.9	11.3	12.5	12.9	12.2	14.2	14.9	44.7
Consumption	10.3	11.2	11.6	11.9	11.3	12.5	12.9	12.2	14.2	14.9	44.7
Total	5889.4	6890.1	6758.6	6873.8	6965.6	7700.4	7945.1	7570.7	9000.0	9685.2	64.5

Source: Calculated by authors. Note: values in 1000 metric tons.

The values of the five stages of FSC (Table 2) in Brazilian soybean (grain) led to Figure 1, which plots the evolution of food losses and waste. Regarding to this product, it appears that the food losses in the agricultural production was 46.3% in 2011 (that is, 4488.9 100 metric tons). Processing and packaging (30.2% in 2011) and postharvest handling and storage (23.2% in 2011) were in second and third positions, respectively. The distribution and consumption have not shown significant percentage of waste due to the fact that soybean is little consumed human food, as it is the raw material for the processing of many food products.

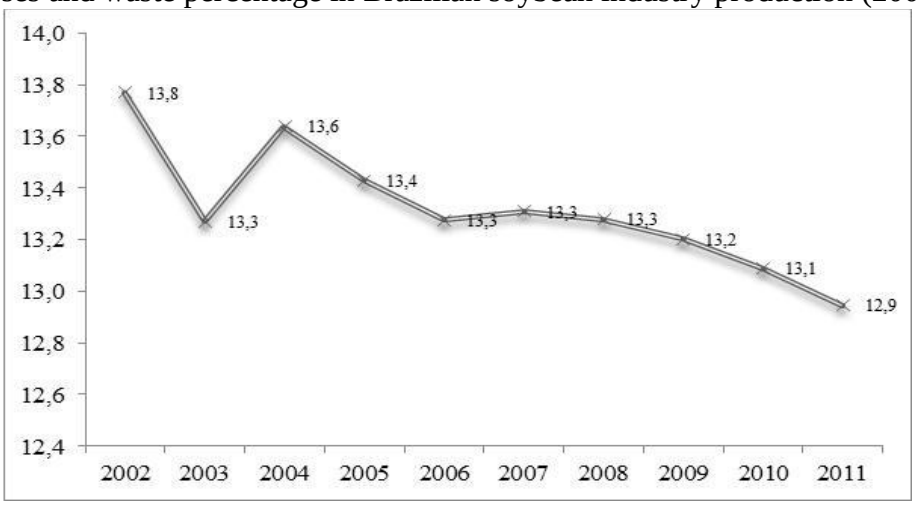
Figure 1. Losses and waste percentage from Brazilian soybean industry in each stage of the FSC (2002-2011)



Source: Elaborated by authors.

In the period of 2002-2011, soybean production grew 74.9%, from 42769.0 to 74815.0 1000 metric tons; while the food losses increased 64.5%, from 5889.4 to 9685.2 1000 metric tons. The losses percentage in relation to Brazilian soybean industry production can be observed in Figure 2, which is 13.8% in 2002 and 12.9% in 2011.

Figure 2. Losses and waste percentage in Brazilian soybean industry production (2002-2011)



Source: Elaborated by authors.

Figure 3 presents the three main stages in terms of volume of soybean losses in the supply chain, the causes of them and the possible solutions to reduce these losses (Gustavsson et al., 2011; Bond et al. 2013; Verghese et al. 2013; Irfanoglu et al. 2014).

It can be observed that in the three stages of the supply chain, the needed actions to reduce losses require relatively large investments, because they involve breeding programs of soybean varieties, more modern and efficient agricultural and industrial equipment. Thus, developing countries have fewer resources to obtain these kind of equipment, then they suffer the consequences and this fact contributes to greater agricultural losses.

Figure 3. Losses factors and alternatives for their reduction in each stage of the soybean supply chain

Stages	Factors causing losses	Possible alternatives to reduce losses
Agricultural losses	Diseases and pests on crops; unfavorable climatic conditions for cultivation; mechanical damage to the crop.	Greater investment in breeding programs to obtain varieties adapted to drought and diseases and more resistant to mechanical damage. Proper management of mechanical harvesting.
Postharvest losses	Inadequate preparation of soybean in trucks carrying the load, causing spillage along the way of making up storage; poor storage conditions; improper handling.	Using appropriate trucks and in good conditions to transport soybean; major investments to improve roads, so there is less load vibrations and, therefore, less spills in transport; appropriate storage conditions; proper handling of soybean in the loading stages in trucks and storage bin.
Processing losses	Industrial processing of soybean in conditions outside the international standards.	Adequacy of soybean manufacturing processes as raw material; greater investments in machinery; more modern and efficient equipment to reduce losses in processing.

Source: Elaborated by authors.

Conclusions

In the case of soybean cultivated in Brazil, we can conclude that the main stages of the food supply chain in which there are losses are: agricultural production; processing and packaging; postharvest handling and storage. It was found that the following stages - distribution and consumption - show lower losses due to the fact that soybean usage is mostly industrialized, as a raw material to other market products.

From these findings, it was possible to apply and view alternatives which result in the losses reduction in each of the stages in the food supply chain. The data collection happens directly in Brazilian statistical institutions in order to get more current data than the ones provided by FAOSTAT, ranging up to 2011.

The identified causes and the possible solutions to reduce losses are useful to act directly on the stages with the worse scenario. This also allows the selection of priorities by public agencies and private groups to drive their investments in accordance with the limits of performance, being useful for increasing the efficiency of Brazilian soybean industry and, therefore, reducing food losses.

References

Bond, M. et al. 2013. *Food waste within global food systems*. A Global Food Security report.

National Food Supply Company (CONAB). 2014. (Accesed 20/11/2014). *Acompanhamento da safra brasileira de grãos*. Available at: http://www.conab.gov.br/OlalaCMS/uploads/arquivos/14_09_10_14_35_09_boletim_graos_setembro_2014.pdf

Food and Agriculture Ornanization of the United Nations / Statistics Divison (FAOSTAT). 2014. (Accessed 10/08/14). *Food balance sheets*: Brazil, soyabeans, 2002-2011. Available at: http://faostat3.fao.org/download/FB/FBS/E.

Gustavsson, J. et al. 2011. *Global food losses and waste*: extent, causes and prevention. Rome: Food and Agriculture Organization of the United Nations, Swedish Institute for Food and Biotechnology.

Godfray, H. C. J. et al. (2010a). Food security: the challenge of feeding 9 billion people. *Science*, 327(5967), 812:818.

Godfray, H. C. J. et al. (2010b). The future of the global food system. *Philosophical Transactions of the Royal Society B-Biological Sciences*, 365(1554), 2769:2777.

Irfanoglu, Z. B. et al. 2014. Impacts of reducing global food loss and waste on food security, trade, GHG emissions and land use. In: 17th Annual Conference on Global Economic Analysis. Dakar.

Junguo, L. et al. 2013. Food losses and waste in China and their implication for water and land. *Environmental Science & Technology*, 47(18), 10137:10144.

Kummu, M. et al. 2012. Lost food, wasted resources: global food supply chain losses and their impacts on fresh water, cropland, and fertiliser use. *Science of the Total Environment*, 438, 477:489.

Lebersorger, S.; Schneider, F. 2014. Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures. *Waste Management*, 34 (11), 1911:1919.

Ministry of Agriculture - Brazil (MAPA). 2014. (Accessed 20/11/14). *Culturas - soja*: Brazil. Brasília. Available at: http://www.agricultura.gov.br/culturas/soja.

Parfitt, J.; Barthel, M.; Macnaughton, S. 2010. Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B-Biological Sciences*, 365(1554), 3065:3081.

Verghese, K. et al. 2013. *Final report*: the role of packaging in minimising food waste in the supply chain of the future. RMIT University, Australia.