Practices of Sustainability in Supply Chains: Experiences in South America

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Abstract
This paper deals with practices and evidences of sustainability in supply chains. Research conducted by Thun and Müller (2010) in the German automotive industry, shows that the concept of sustainable management of the supply chain is still incipient, being still under development. We adopt a qualitative approach over two case studies carried out in South America. Information in this paper was gathered by literature review, interviews with experts in Brazil and also from works being conducted in Brazilian universities and research institutes. Within this context, the research presented includes case studies carried out in South America, specifically in Brazil: Supply chain of empty packings of pesticides and; Biofuels Supply chains. Besides contributing for the preservation of the atmosphere for future generations, the management of the supply chain for packings of pesticide develops an important socio-economic function in Brazil. It generates more than 2,500 direct jobs along the whole chain (associations of distributors, cooperatives, collection points, carriers, recycling companies and services providers). Finally, it is clear that the competitiveness and sustainability of the supply chain of biofuels depend on the adoption of integrated logistics practices, without which the current failures prevents the consolidation of governmental defined goals.

Keywords: sustainable supply chains, biofuels, pesticides packings
Introduction
Increasingly the final consumer cares about the environment and the companies charge an ecologically correct posture. In a survey conducted from 1,200 scholarly articles, book chapters, publications and newspaper articles, the term “sustainable supply chain”, appears as a specific content concept in 227 (Srivastava, 2007). The research conducted by Srivastava (2007) concludes that increasing assigned importance is due to growing environmental degradation, reduced availability of natural resources, overloading of spaces used for discharge of effluents and the increasing levels of pollution.

This new behavior, coupled with the social concern, makes the adoption of an environmental policy in companies a growing need. Government regulations and demands of society on environmental accounting operations of companies have brought this issue to the agenda of executives and concerns in the strategic planning of businesses. At the same time companies are integrating their operations in the supply chains to reduce costs and improve customer service. They now also seek these environmental demands of society. The management of the operation processes of the supply chain for improvement of their performance and environmental concerns are not necessarily conflicting and usually can be conducted together. The company may involve suppliers and customers to meet or even exceed the expectations of environmental commitment to their end consumers and government.

Research conducted by Thun and Müller (2010) in the German automotive industry, shows that the concept of "green" management of the supply chain is still incipient, being still under development. While the application of management practices in the supply chain back to the early 80s, the "green" practices are more recent, having most businesses started its implementation in less than 5 years (2004 when we relate to the year publication of the study). This conclusion is also observed in academia as proof a study by Carter and Easton (2011) analyzed

80 articles obtained from a selection of 132 identified, published in relevant journals in the area between the years 1991 and 2010. They found that approximately and 55% of the articles analyzed did not apply any theoretical knowledge in conducting the analysis and proposed management of the supply chain under the aspect of sustainability. To dismember the periods in two blocks (1991-2000 and 2001-2010) the percentages indicate another feature: while in the first period the percentage of articles without a theoretical basis was 87.5 % in the subsequent period this percentage decreased to 33.3 %, indicating an evolution in the treatment of the subject by the academy as well as in business.

As stated by Srivastava (2007), the vision of social responsibility centered design of products, processes, marketing, operations and effluent management of a company , or a single link of the generally extensive supply chain , has changed : from 1990, concern is increasingly widespread, considering the total integration of the final links and impacts on the environment.

According Hervani and Helms (2005), in his work on Green Supply Chain Management, improvements in the sustainability of a supply chain run of understanding of their current terms of sustainability , followed by the analysis, measurement of environmental impact indicators for continuous improvement and guided by the standards of ISO - 14000 , constituting the steps "planning, implementation, verification and performance". The sustainable supply chain management based on the conventional structure of the processes of supply chain management (Thun and Müller, 2009), cannot separate the two terms. In fact, analyzing the structure analysis SCOR 10.0 proposed by the Supply Chain Council (SCC, 2010), it is observed that the difference between them is only the introduction of some processes (notably the capture and
disposal of effluents), the additional metrics adopted (basically related to greenhouse gas emissions and ecological footprint) and best practices (collaboration throughout the chain, minimizing the consumption and costs of energy and fuel recycling and minimizing the use of packaging).

We, thus, conclude that the practices of sustainable supply chain management (Green Supply Chain Management) are recent, having received more attention from the business and academic world of the last 5-10 years, the attitude of managers still focuses more in a link (your company) than the length of the string ("cradle to grave"), after more simplistic approach and just anchored in the concepts and theories of management, in which sustainability was confused with preservation of the environment, observed trend of greater depth and breadth in the research and treatment of problems and practices of sustainable management of the supply chain (Carter and Easton, 2011).

Methodology and case studies
In contrast to quantitative research, which takes a phenomenon to analyze its components, giving rise to the variables of the study, qualitative research seeks to clarify how all the parts operate to form a whole. In this research paper is adopted a qualitative approach, where the researcher is the main tool for collecting and analyzing data. Overall a qualitative study is very descriptive, being developed by the reason that the existing theories are not sufficient to adequately explain the phenomenon in question. The purpose of a qualitative study is not to test theories. So there are no research hypotheses to be deduced from the theory (Merriam, 1998).

Within this context, the research presented includes case studies carried out in South America, specifically in Brazil. While dealing with one aspect, sustainable supply, the cases address different realities and were also made at different times. Both cases follow the same logic of data collection. Observations were made both structured and unstructured, as well as interviews with those involved in the system to obtain answers to research questions. Besides the interviews, photos and notes of observations were also used as primary data. The secondary data used were mainly printed information and internal documents of the companies for other purposes (processed volumes, transported volumes). Hereafter are presented the case studies and their respective supply chains.

Supply chain of empty packings of pesticides in Brazil
Before the legislation previously mentioned, every sold product arrived to the farmer's hands with a simple guide that mentioned ways of conditioning the packings in rural areas. The most common “treatment” was to bury (following a series of technical procedures applied by the farmers) and incineration. At the present time, the logistics process of destination and treatment of empty packings of pesticides follows the flow presented in the figure 1.

![Figure 1: Reverse Logistics for empty packings of pesticides.](image-url)
The process of reverse logistics of empty packing begins with the farmer, who has the legal obligation of, packing, or three times pressure wash and returns them within one year of purchase or six months after the due date of the validity of the product. Washing under pressure is used only in the case of rigid packaging, such as high density polyethylene and metal, which represent 85% of the material on the market. The advantage of the washing process is to make the packaging into common due to the reduction or elimination of contamination, ensuring that the farmer also earn that respect, since it can take about 3% more product, which previously had as waste packaging. The washed packages must be delivered to a reception given by the dealer on the invoice. The lids of the containers must be with holes. The packaging should never be carried along with people, animals, food, medicine or inside closed vehicles, when it is not washable. As for flexible, like paper bags, and aluminized low density polyethylene, which represent about 15% of total packaging circulating in the market because they are difficult to wash, are destined for incineration (INPEV, 2012).

The construction of the collection center is the responsibility of dealers of pesticides. Moreover, it is up to them to indicate on the invoice, the address of the nearest receiving property of the farmer, guided the choice of form and time for delivery. Packages returned by farmers are inspected one by one, by trained staff at the reception, to establish the conditions for return, washed and unwashed, sending, after verification, proof of delivery for inspection purposes. Some of these units have received larger areas and can perform an operation to reduce the volume, facilitating transport to the final destination. They are called central receiving stations or units that receive and sort the packages to be delivered in bulk units within their catchment area.

At the other end of the process of reverse logistics are the manufacturers of pesticides. As of central receiving, it is the industry the legal responsibility for coordination of transport, by incineration, the recycling facility for the manufacture of goods that use as raw material, packaging material from washed and returned, although it is up to their social responsibility to educate retailers and farmers, both on the use of the product and on the importance of reverse logistics process (Sato, Carboni, Moori, 2006).

The measure aims to prevent chemical residues return to nature and the inadequate reuse of the material. Without proper collection, packing are dangerous sources of environmental pollution can contaminate soil, groundwater and still reach directly to human health (INPEV, 2012).

The supply chain introduced in the previous figure can be broken down into various actors and their relationships, leading to a chain. In this study, the connections or relationships with a focus on recycled or recovered the first order, breaking the supply chain into two subsystems or stages: data collection and system of post-collection (Figure 2).
Figure 2: The investigated supply chain and its subsystems: collection and post-collection.

Mandatory since June 2002, returning empty containers of pesticides has increased in the country. With this, Brazil is already the country that collects pesticide containers in the world. The mesh of receiving empty now has 350 units managed by 185 associations, cooperatives and 40 dealers representing more than 2,200 distributors in 23 federal states, elevating Brazil to the world leader in collection and disposal of empty containers of pesticides, surpassing the 30 largest countries with similar systems for the collection together, including: Germany, Australia, USA, Canada and France (INPEV, 2012).

The reverse logistics using the same truck that carries the full pesticide containers for distributors and cooperatives to bring empty containers (bulk or packaged), for storing it in the collection centers is more efficient in terms of costs. Before this process, the truck used to return empty. This process has advantages such as safety for the environment and health, as it uses a carrier capable of performing this type of transport and economy, since the truck has some of the costs paid when he took full containers. In four years of operation of the disposal, have been handled 15,981 trucks (equivalent to the truck), without any accident. Starting from a generic model of circular flow of materials (Figure 2), the system studied is positioned between the end consumer and supply chain, traditional or direct.

The system of post-collection can end with a producer of raw material, a manufacturer of final product (if parts are reused), an exploiter of energy (using fractions of a product as fuel) or other recyclers. The system of post-collection starts after the selection and removal of products to be recycled. After these processes, the system of post-collection is to be treated as a regular supply chain.

The adoption of a procedure for dealing with the disposal of empty pesticide is complex and requires the effective participation of all those involved in manufacturing: marketing, use, licensing, inspection and monitoring activities related to handling, transport, storage and processing of these packages.

In the 90’s the Brazilian industry began to seek a solution for the problem of empty packings of pesticides. By that time a partnership among ANDEF (the General office of Agriculture of the state of Sao Paulo), AEASP (the Association of the Agricultural Engineers of the State of Sao Paulo) and COPLANA (the Association of Sugar Cane Producers of Guariba District) was created in order to study the flow of empty packings of pesticides. Through this
initiative it was implemented the first unit of reception and primary treatment of packings of pesticide. Recycling alternatives were created through an agreement with a small company of the pesticide industry.

An important and critical step for conducting this project was the contribution of the Brazilian Association of Technical Standards (ABNT) for the development of standards and procedures for the treatment and washing process of empty packings of pesticides. The establishment of these procedures has permitted that the packings of pesticide could pass to a dangerous residue to be considered common dejections, which made possible its recycling.

On December of 2001 the National Institute of Processing of Empty Packings was founded (INPEV). In March of 2002 the INPEV started to operate with the support of 22 pioneering companies. By the end of 2007 INPEV has collected 3.700 tons of empty packings of pesticides. After 4 years of operation, INPEV already processed a total of 56.000 tons of empty packings of pesticides. Now the Brazilian system of final destination of empty packings of pesticides is world reference in the subject when destining more packings than the sum of 30 countries that possess similar programs. Nowadays, the institute operates with 66 companies and 7 associated entities. The structure of the supply chain operated by INPEV is formed by 365 processing units (collection points, central warehouses and recycling plants), which meant 19.634 tons of packings by the end of 2011.

Biofuels Supply chains in Brazil

The actual biofuels supply chains are probably best described in the guidelines for Agro-energy policy 2006-2011 (MAPA, 2005) that was started in 2005 by the Ministries of Development, Industry and Foreign Trade (MDIC), Agriculture (MAPA), Science and Technology (MCT), Mining and Energy (MME). The aim of this policy is to offer guidelines to public policies and actions towards the development of renewable energy supply chains and expansion of their share in the Brazilian energy matrix. The following goals for bionenergy can be extracted from the document:

- Development of Agro-Energy through expansion of the ethanol sector;
- Implementation of the biofuels production supply chain;
- Expansion of forests grown for energy production and use of agro-forestry waste;
- Expansion of crops that does not affect the production of food for domestic consumption;
- Technological development that promotes competition, reduces environmental impacts and contributes to economic and social inclusion, including the use of energy biomass in small scale; community-wide energy autonomy, specifically in remote areas;
- Generation of jobs an income (development towards the interior of Brazil, social inclusion and reduction of regional disparities, etc);
- Brazilian leadership in the international trade of agrofuels and adherence to the national environmental policy and integration in the clean development mechanism of Kyoto Protocol.

In 2004 Brazil has started a program to develop biodiesel that is still immature compared to the ethanol program that started in 1975, so, it can be said that Ethanol is a product, biodiesel is a project. The possibility of using vegetable oils as fuel has been recognized since the beginning of diesel engines. In 1911, Rudolph Diesel presented an engine based on compression-ignition: the diesel engine. At that time there was no specific fuel to feed this engine. Rudolph Diesel used
groundnut oil. The predicted shortage of fossil fuel encouraged the search for substitutes for petroleum derivatives. This search resulted in an alternative fuel called “biodiesel”.

The concept of biodiesel is still under discussion. Some definitions consider biodiesel as any mixture of vegetable oil and fossil diesel, while others take into account only mixtures of alkyl esters of vegetable oils or animal fats and diesel. The definition adopted by the Brazilian Biodiesel Programme is: “a fuel obtained from mixtures, in different proportions, of fossil diesel and alkyl esters of vegetable oils or animal fats”. Technically speaking, biodiesel is the alkyl ester of fatty acids, made by the transesterification of oils or fats, from plants or animals, with short chain alcohols such as methanol and ethanol. Glycerine is, consequently, a by-product from biodiesel production.

A suitable source to produce biodiesel should not compete with others applications that reach higher prices, for example pharmaceutical raw material. But the demand for pharmaceutical raw material is lower than for fuel sources. Palm oil (*Elaeis guineensis*) is an important alternative for the sustainable development of some regions of Brazil, including Amazonia. Elbersen (2008) reviewed palm oil production for biodiesel in Brazil. In short, African Palm Oil is the most productive oil crop available in Brazil with 4000 to 6000 liter per ha per year. Brazil produces only 0.5% of palm oil in the world, mainly in a few areas in the state of Pará (Amazonia) and near the Northeast Coast and actually is a net importer of palm oil. Still, it has the largest land area potentially available for palm oil production. Estimates vary widely from 70 million ha (Rodrigues and Macedo Beltrão, 2006); 20 million ha as mentioned by Kaltner et al. (2005) to 7 million ha by Gazzoni (2007). Much of the suitable land is covered by rainforest and should not be a sustainable or Greenhouse Gas positive option. Still, for degraded areas is seen as very promising.

Another source oil/fat for biodiesel production is tallow. Tallow is a by-product of meat processing. Brazil is the world’s largest beef producer with more than 200 million heads, producing around 1 million tons of beef per year. Alternative uses include soap production. It has been reported that due to increased soy oil prices in recent years, some biodiesel plants are producing biodiesel from tallow as a feedstock. As a result, tallow price has increased (Almeida et al., 2008). With conventional biodiesel production technology tallow can only be mixed to a small degree into biodiesel if current EU biodiesel regulations are to be observed.

**Sustainable biofuels policies in Brazil**

In December 2004 a new National Program for Production and Use of Biodiesel (PNPB) was launched that is the basis of current development in Brazil. The program has two main goals: Fuel supply diversification and social inclusion and regional development. Secondary drivers for the biodiesel program which can be found in documents include adding value to the soy production chain; soy oil is a by-product of protein production leading to an oil surplus that explains its low price in Brazil. For isolated areas that use diesel for electricity production, local biodiesel production provides an alternative of source because of high costs (mainly logistics) of fossil diesel in these areas. Another secondary driver is the opportunity biodiesel provides in reducing air pollution in urban areas due to the reduction of emissions when biodiesel is blended with fossil diesel.

As part of the PNPB law nº 11.097 (January 13th, 2005) was adopted mandating a blend of 2% of biodiesel (B2) in the fossil diesel in 2006, 3% (B3) in 2010 increasing to 5% (B5) in 2013. The target of a blend of 5% was achieved in 2010 (Figure 3). This represents the increasing of the whole chain of biodiesel in Brazil and consolidation of BNPB.
Biodiesel was expected to create 250,000 new jobs mainly for small farms until 2011. Another law was approved in 2005 (nº 11.116/2005) that regulates federal tax exemptions for fuel producers which source certain types of crops from small farmers in certain regions and gives access to credit lines (Almeida et al., 2008), the “Social Fuel Seal”.

The Social Fuel Seal component is an ID issued by the Ministry of Agrarian Development to biodiesel producers that promote social inclusion and regional development by generating employment and income for family farmers (Campos and Carmelio, 2006). Through the social fuel seal the biodiesel producer will have access to financial options with different coefficients of reduction, access to better financing terms with financial institutions that have special financing for projects with social fuel seal:

- 31% tax exemption is given to biodiesel from produced from castor and palm oil in North and Northeast regions of Brazil (The least developed ones).
- 68% tax exemptions is given to biodiesel produced in small family based agriculture.
- 100% tax exemption is given to a combination of the two above.

The biodiesel producer may also use the seal for commercial sale of its production. These must meet the following requirements:

- Acquire minimum percentage of raw materials from family farmers, where it was established as 10% in the North and Midwest, 30% in the South and Southeast regions and 50% in the Northeast and semi-arid, and;
- enter into contracts with family farmers establishing deadlines and delivery of raw materials and prices,

Some measures should be taken to mitigate the limitations of the introduction of this renewable fuel in the energy mix of the country. The implementation of this process should be carried out gradually, so as to ensure the sustainability of production and biodiesel market in the country.

Conclusions

Besides contributing for the preservation of the atmosphere for future generations, the management of the supply chain for packings of pesticide develops an important socio-economic function in Brazil. It generates more than 2,500 direct jobs along the whole chain (associations of distributors, cooperatives, collection points, carriers, recycling companies and services providers).

One of the main goals of the legislation is to direct the material flows in packings of pesticide chains in an economical way towards environmentally friendly disposal options. Therefore, it is necessary for legislators to understand the structure of the supply chains for
packing sod pesticide, technologies and markets. The primary goal of a legislator is to develop competitive markets by turning the negative value of packings of pesticide into a positive one. This can be done by encouraging research and development for new products derived from packings of pesticide and for better methods to process those packings.

In line with this discussion, this paper has identified two research topics that are of importance for scrap tire supply chain management:

- How to set the budget for empty packings management programs and how to allocate it to different markets?
- How to organize the collection of empty packings?

These issues can also be applied to other industries for which landfilling pose a heavy environmental burden. For example, the End of Life Vehicle Directive of the EU stipulates that starting from January 2007 drivers will able to leave ELVs at an authorized treatment facility without incurring a charge.

Regarding biofuels supply chains, Brazil is already an important supplier of biodiesel (or feedstock) and bioethanol through re-export of soy biodiesel from the US to EU. Still this does not seem to be the way of the future. Direct Brazil/EU trade of biofuels must be the goal for the near future.

Holding the 6th biggest GDP of the world, for the coming years Brazil will be developing its own biodiesel infrastructure and market that will demand much of the resources. Apart from soy most of the biodiesel production options require some time to be developed even if, as with Jatropha and Castor, progress is made fast.

Despite the potential in Brazil for oleaginous cultivation, and consequently for biodiesel production, there are challenges for setting up and consolidating a wide program of biodiesel use as fuel. The principal challenges and considerations focused agronomic; infrastructure areas and environmental perspectives as follow:

**Agro-economic perspectives**

- Plan and execute an ecologically sustainable agricultural zoning of oleaginous cultivation;
- assure supply of raw material with minimal costs to the producer;
- establish financial support to amplify the cultivation of oil plants;
- develop research to select new varieties and systems of tilling with low environmental impact;
- intensify search for genetic improvement of oil plants, with the purpose of increased productivity and yield of oil for biodiesel;

**Infrastructure perspectives**

- Improve the infrastructure of transport and distribution;
- improve the connections of the productive chain.

**Environmental perspectives**

- Reduce the emissions of harmful species (e.g. CO, particulate matter, sulphur compounds);
- get a clear diagnosis on the environmental impacts of biofuel uses, along with its advantages and benefits.

Although it is clear that public pressure is already relevant for biodiesel distributors, at this moment there are no specific demands on the sustainability of biodiesel in Brazil. It can be argued that the official sustainability demands will focus heavily on GHG performance of biofuels as this is a primary driver for the existence of biofuels in the EU. Finally, it is clear that
the competitiveness and sustainability of the supply chain of biofuels depend on the adoption of integrated logistics practices, without which the current failures prevents the consolidation of governmental defined goals. Through the planning and implementation of an effective management structure of the supply chain, aggregating skills and considers the specificities of Brazil, it will be possible-effect chain of biodiesel as an instrument of regional sustainable development.

References


