Environmental Profile of Brazilian Green Coffee

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DOI: http://dx.doi.org/10.1065/lca2006.01.230

Abstract

Goal, Scope and Background. Brazil is the world’s biggest producer of coffee beans with approx. a 30% market share. Depending on climate conditions, approx. 30 million bags of coffee beans are exported annually from Brazil, while domestic consumption is around 10 million bags, which makes Brazil the world’s third largest coffee-consuming country. Therefore, the goal of this paper is to present the LCA of green coffee produced in Brazil for the reference crops 2001/02 and 2002/03 in order to generate detailed production inventory data as well as to identify the potential environmental impacts of its tillage in order to realize how to reduce those impacts and increase the environmental sustainability of this product. Only the inputs and outputs relative to the coffee tillage were considered. The production of fertilizers, correctives and pesticides were not included in the boundary, but only their amounts. The functional unit selected for this study was 1,000 kg of green coffee destined for exportation.

Methods. The LCI was performed according to the ISO 14040 standard series. All information considered in this study (use of water, fossil based energy, fertilizers and chemicals) were taken up in in-depth data collection and evaluation by questionnaires applied on a farm level and/or received by mail. Four Brazilian coffee producer regions were evaluated: Cerrado Mineiro, the Marília and Alta Mogiana regions in São Paulo State. These regions have the following geographic coordinates: 44 to 50° W longitude and 18 to 24° S latitude. The data refer to a production of 420,000 coffee bean bags and a productive area of approx. 14,300 ha. The varieties of coffee beans considered in this study were Mundo Novo, Catuaí (yellow and red), Icatu (yellow and red), Catucaí (yellow and red) and Obatã. Farm specific data along with agricultural production data have been combined to elaborate a coffee cultivation inventory, which will be applied in an emissions estimation.

Results and Conclusion. The production of 1,000 kg of green coffee in Brazil requires approx. 11,400 kg of water, 94 kg of diesel, 270 kg of fertilizers as NPK, 900 kg of total fertilizers, 620 kg of correctives, 10 kg of pesticides and 0.05 hectare of annual land use. Outputs related to these functional units are approx. 3,000 kg of waste water from coffee washing, 8,500 kg of waste water from the wet method and 730 kg of organic residue that is reincorporated to the tillage as fertilizer. The publication of an LCI of agricultural products is a fundamental step for understanding the potential environmental impacts of each tillage and then establishes the basis for product sustainability. In this way, this work is the first Brazilian initiative for applying LCA to coffee cultivation.

Introduction

The world coffee bean market is characterized by the presence of sixty coffee producing countries. Brazil and Colombia together command approximately half of the world market, while the remaining countries have small market shares. Brazil is the world’s biggest producer of coffee beans in terms of cultivated area and bag production with approx. a 30% market share. Depending on climate conditions, approx. 30 million bags of coffee beans are exported annually from Brazil, while domestic consumption is around 10 million bags, which makes Brazil the world’s third largest coffee-consuming country. Considering the year 2002 as a reference, the Brazilian coffee production (Coffea arabica) was 48,480,000 bags, representing 40.6% of the world’s exportation (Cecafé 2004).

Five states produce coffee in Brazil (Minas Gerais – 50.8%, Espírito Santo – 20.1%, São Paulo – 12.4%, Paraná and Bahia) with several differences in all the production aspects (Aguiar 2001, Igreja and Bliska 2002, Fazuoli et al. 1999, Kashima 1990, Verdade et al. 1974), being the main aspects described below:

1. Size of the coffee production areas. Ranging from a few (familiar properties) to a thousand hectares (company properties) giving diverse producer profiles;

2. Edafoclimatic differences among the cultivation regions. Cultivation areas are mainly located between 10–24° S latitude and 40–54° W longitude and show various climate types (semi-humid hot, semi-humid sub-hot, humid sub-hot, super-humid sub-hot, sub-dry and mesothermic);

Recommendation and Perspective. Different agricultural practices demonstrate different environmental profiles. The amount of agricultural pesticide is directly related to agricultural practices as tillage rotation, density of plants, etc. This study supplied important results for a better correlation of the agricultural practices and potential environmental impacts of coffee. Future updates of this study will show the evolution of the natural resource management such as land use, new agricultural practices, lower fertilizers and chemicals use.

Keywords: Agricultural products; Brazil; green coffee; life cycle inventory (LCI); sustainability
3. **Cultivated varieties.** The main varieties cultivated in the evaluated regions are Mundo Novo, Catuaí (yellow and red), Icatu (yellow and red), Catucá (yellow and red), Obatã, Acaiá and Tupi;

4. **Adopted spacer.** Ranging from traditional (4.0 x 2.5 m) and mechanical harvest (3.5 x 0.7 m) to more compact tillage (2.5 x 0.7 m);

5. **Coffee cultivation management.** Chemical use (type and quantity) and crop type (manual or mechanical);

6. **Local topography conditions.** Agricultural machinery and implement use, and adopted spacers;

7. **Coffee production and processing technology.** Producer revenue and techno-scientific information, besides socio-economical resources and development of the property.

Besides the above geographical factors influencing the coffee quality, the preparation process also directly affects the product quality. There are two coffee preparation methods: the dry method and wet method. Both methods have the following common stages: cleaning, separation, drying, storage, processing and classification (Fig. 1). Additionally, the wet method includes the separation of red coffee berries, pulp remotion, mucilage removal and product washing. In the dry method, the processing stages for preparing the yard coffees can be performed without the use of water. However, the use of water is essential in the wet method for obtaining the washed coffees or coffees without pulp (Alves 1999, Filho et al. 2002, Andrade et al. 1999, Nannetti 1999a–c, Thomaziello 2000a–b, Zambolin 2000).

Nowadays there is no environmental criteria established for ecolabel in Brazil, despite the efforts of conducting an LCA of leather in the southern region of Brazil at the beginning of 2000s in order to establish environmental criteria for the ecolabel of shoes. There is a tendency to consider the whole life cycle of the product for the establishment of the environmental criteria for the ecolabel (Canals et al. 2002). Thus, this study was the first LCA conducted for the establishment of an environmental profile of coffee cultivation in Brazil as a basic criteria for the sustainability of green coffee.

Food productivity has increased significantly due to new technologies, mechanization, chemical use and governmental policies. However, together with the positive effects on farming, some impacts like degradation of soil and water resources also occur. For instance, the excessive application of fertilizers (quantity and frequency) usually exceeds the soil ability to retain and transform the nutrients and make them available according to the crop needs. According to some studies, the saturation of the soil with nitrogen or phosphate has promoted losses of nitrates into groundwater and saturation of the soil with phosphate, that may also move into groundwater. Regarding pesticide use, these products on a farm level can cause the destruction of part of the soil flora and fauna, that in turn causes both physical and chemical deterioration (Cowell and Cliff 1997, Mattsson and Sonesson 2003, Zalidis et al. 2002). Then, a good control of the amount of inputs added to the tillage is very important from both an environmental aspect and from economic point of view.

According to Salomone (2003), the main categories of environmental impact verified in a life cycle assessment study applied to coffee production in the stage of coffee cultivation were eutrophication (320 g.eq PO4 3−/kg of packaged coffee) and terrestrial ecotoxicity (approx. 6 t/kg of packed coffee). In this study, the author included all life cycle stages from coffee cultivation through its distribution to consumers, consumption and disposal, aside from fertilizer and pesticide production data employing commercially available databases.

Nevertheless, there are also positive effects of agricultural activities in terms of biodiversity protection, carbon capture and oxygen generation. For instance, it was estimated that coffee plants capture approx. 35% as much of the carbon dioxide as the same area of woodlands (Pelupessy 2003).

### 1 Goal and Scope

The goal of this paper was to present the LCI of green coffee produced in Brazil for the reference crops 2001/02 and 2002/03 in order to obtain detailed production inventory data, as well as to quantify the potential environmental impacts of this tillage in order to realize how to reduce those impacts and increase the environmental sustainability of this product.

The scope of this work was to qualify and quantify the main environmental aspects of the green coffee production in Brazil in order to establish parameters for the sustainability and a future ecolabelling program for the Brazilian green coffee. Thus, the users of the information provided by this study are the coffee growers, the coffee growers’ association and the governmental agencies towards getting best practices going in accordance with the environmental sustainability of Brazilian coffee.

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![Flowchart of coffee processing](image-url)