Recycling of coffee by-products by composting regarding climate relevant emissions and products

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Introductive summary:

Throughout the world, the agriculture, sanitation and waste management sectors are mainly carried out in isolation, resulting in permanent nutrient drainage and large amounts of greenhouse gas (GHG) emissions due to inadequate or excessive use of fertilizers (San Martin Ruiz, et al. 2018). The purpose of this first part of study is to develop an innovative experimental methodology for the sustainable recycling and improved treatment of coffee by-products to produce organic compost, which can be used in agricultural crops including coffee plantations. The methodology will be implemented in a Mill in Costa Rica, due to the current waste management problems and the potential it possesses to reduce GHG emissions during its production cycle.

One of the main objectives is to explore the use of coffee by-products and other organic materials as an economical, health-safe fertilizer and soil amendment. In this way, it could satisfy various needs of the producers associated within the Mill, also providing an added value to the coffee waste, attributing greater competitiveness to the use of low emission waste products, and in parallel, counteracting the emissions produced when the parameters during the decomposition process are not optimally considered. To achieve the solution of the coffee by-products management, experiments will be conducted to explore and optimize thermophilic processes of coffee by-products and other organic waste materials, with the aim of creating a nutrient-rich fertilizer as a soil amendment as a first place.

A previous study was done together with NAMA Coffee Project in order to estimate the emissions during the actual composting processes giving results of 60 times higher than emission rates at garden waste or bio-waste composting plants referenced in literature (San Martin Ruiz, et al. 2018). Under these conditions, a new technique of composting was implemented in order to evaluate an improvement in composting techniques, accelerating the process and at the same time, obtaining low methane emissions. By having this approach, the recycling of coffee by-products could lead to a reduction of GHG emissions from several sources. A reduction CH_4 emission is expected through the process of coffee by-products by using them as a nutrient-rich material and good quality product, instead of pouring them into the soil and in open field depositions as nowadays. The use of organic compost as fertilizer can become a sustainable practice for the coffee sector which can lead a reduction in the use of mineral and nitrogen fertilizers, therefore, a reduction of the GHG emissions in the country.

Approach:

The coffee by-products (Figure 1) are divided into beans, silver skin, parchment or husk, mucilage, pulp and skin (Braham and Bressani 1979). The silver skin remains on the seed through the processing and leave the bean as a husk after the roasting process. The husk is removed during the milling process from the bean during wet processes and is mainly made of lignocellulose (Rathinavelu and Graziosi 2005). The pulp is rich in pectins and sugars where this come off after the wet process and together with the skin is intact at the beginning of a natural dry process. Currently in each harvest season, the Mill produces approximately 30.000 tons of coffee by-products and 200.000 Fanegas per year (1 Fanega= 235 kg of coffee fruit (Infoagro 2019)).

The current composting treatment at the Mill is made forming windrows of coffee pulp and skin with a small percentage of coffee husks (below 5%) which are composted within 8 weeks. For the mechanical turning of the compost, a Backhus turner is daily used. After those 8 weeks, from 5000 coffee producers, a third, collect the treated coffee by-products and spread them on the coffee fields. When this material loses volume, in order to optimize the space, the windrows are stacked again.

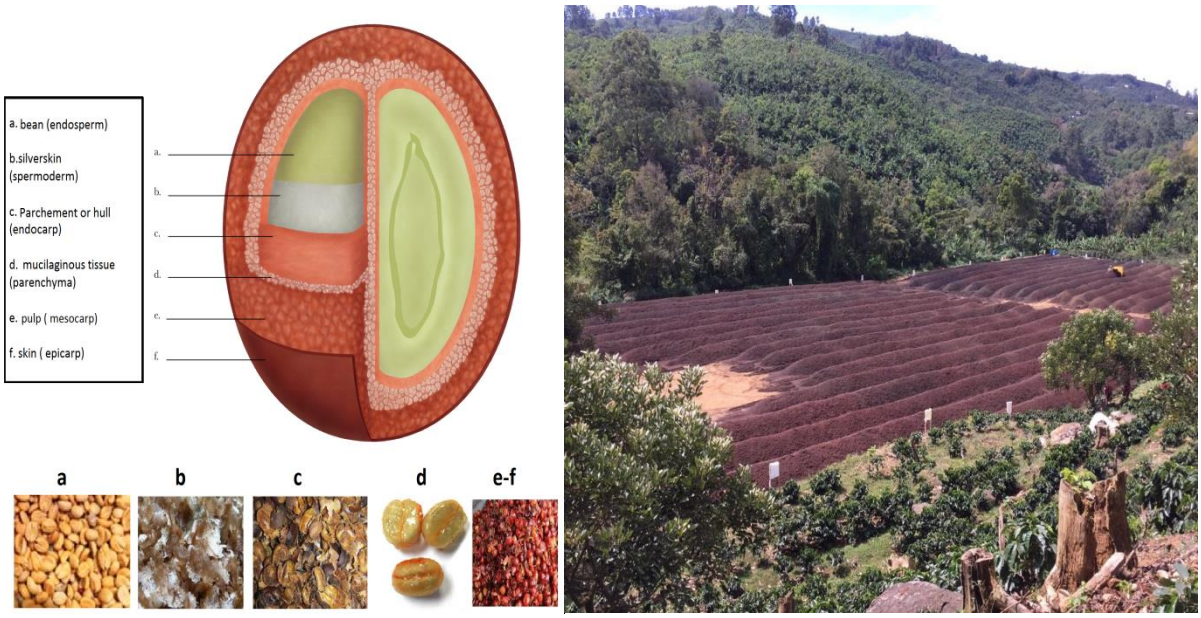

Figure 1: Coffee Cherry in longitudinal Cross-Section and Cutout (Infobit. 2019) and windrows at the mill

During the first experimental phase of this project, the characterization of coffee pulp and husk were carried out performing a chemical analysis in order to obtain the properties and features of the coffee by products as a first instance. Thereafter, 4 different composting processes were developed and carried out in Germany to test different mixtures of materials and how their profiles during the entire composting process are, having each treatment a different or additional component and quantities.

Subsequently, 3 different experiments with coffee by-products and green waste were performed in rotary drums (tumblers) for a period of 5 weeks and one experiment in a composting plant facility. During the composting processes, the most important parameters to be considered such as temperature, pH, humidity, organic content and methane emissions were controlled (VDI 2006). The methane emissions were carried out using a sampling bag made from Nalophan which is the standard in odor monitoring on an average of duration of 5-30 min. The gases were extracted for the analysis using Fourier-Transform Infrared Spectroscopy (FTIR).

Nevertheless, 7 different mixtures were made during the composting process at the Mill in Costa Rica during the harvest 2018-2019 in order to control some of the composting parameters on site and their reactions using coffee-byproducts as a primary material. The composting processes were carried out forming triangular windrows during 10 weeks with a weekly turning. Preliminary results during this first phase of the project follow the appropriate composting profile, as well as the reduction of methane emissions in comparison with the current treatment in Costa Rica. The implementation of the technique at the Mill to measure the new methane emissions and to obtain new emissions factors within this process will be carried out during the second part of the research including the new techniques proposed.

References:

Braham, J.E, and R. Bressani. "Coffee Pulp: Compostion, technology and utilisation. Panama: Insitution of Nutrition of Central America and Panama, 1979." *Insitution of Nutrition of Central America and Panama*, 1979.

Infoagro. *Information system for the Costa Rican agricultural sector (Sistema de informacion del sector agropecuario),*. 2019. http://www.infoagro.go.cr/B (accessed 01 04, 2019).

Infobit. *infobit.* 2019. http://www.infobit.co/coffee-cherry-drawing.html. (accessed 01 04, 2019).

Rathinavelu , Rajkumar, and Giorgio Graziosi . "Potential alternative use of coffee wastes and by-products." *International Coffee Organization*, August 17, 2005: ED 1967/05.

San Martin Ruiz, Macarena, Martin Reiser, Gerold Hafner, und Martin Kranert. "A Study about Methane Emissions from Different Composting Systems for Coffee By-products on Costa Rica." *HRPUB*, 2018.

VDI. „VDI 3475: Emission control Mechnical-biological treatment facilities for municipal solid waste.“ *Verein Deutscher Ingenieure*, 2006.