Acorbat Revista de Tecnología y Ciencia

Good practices and use of fertilizers to reduce the carbon footprint in the banana industry

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Contribución:
Tecnológica

Sección:
Cambio Climático y Agrometeorología

Recibido:
15 Diciembre, 2023
Aceptado:
15 Enero, 2024
Publicado:
16 Abril, 2024

Cita:
Lebender U and Brentrup F. 2024. Good practices and use of fertilizers to reduce the carbon footprint in the banana industry. *Acorbat Revista de Tecnología y Ciencia* 1(1): 80
https://doi.org/10.62498/ARTC.2480

Agriculture is responsible for 10% to 12% of the total global greenhouse gas (GHG) emissions (Smith et al., 2007). The overall levels of GHG emissions from agriculture is expected to increase further due to the need to expand agricultural production to meet the growing demand for food, feed, fibre, and bioenergy.

The awareness of the impact of climate change and the growing demand from consumers for more sustainable products has led companies to include sustainability as an important criterion for evaluation of their clients and investors.

The need to mitigate climate change has led many food companies (FC) to publish emission reduction targets towards climate neutrality e.g. within the Science-Based Target initiative (SBTi framework). They are investing heavily in initiatives to bring them closer achieving these goals. Such goals can be consulted in the company's sustainability reports. To monitor the achievements of such goals life cycle analysis (LCA) and carbon footprinting is used to guide challenging decisions and select between technology paths (McManus and Taylor, 2015).

The concept of carbon footprinting follows the life cycle assessment methodology, i.e., it accounts for all GHG emissions that are related to a product over its life cycle. The general boundaries of the life cycle of a product are from "cradle-to-grave," which means from the extraction and supply of raw materials needed for the product under investigation up to the final disposal of the product after it has completed its life cycle as waste. However, in practice the boundaries of a product carbon footprint (PCF) analysis are often set narrower, for instance from "cradle-to-factory-gate" or from "cradle-to-farm-gate."

For PCF analysis of agricultural products, the boundary of "cradle-to-farm-gate" is often applied. This provides valuable information about the climate impact of agricultural products and allows farmers to optimize agricultural practices in order to provide low-carbon agricultural products to their customers.

Banana is one of the most exported fruits being Latin America and the Caribbean (LAC) the world's leading exporting region (FAO, 2023), a staple starch crop for millions, and an important source of income for producers across the tropics and subtropics. The carbon footprint of the banana industry is spread across the entire value chain, which can be divided into several steps (Figure 1). Carbon footprint boundary settings can be defined for instance up to the farm gate ("cradle-to-gate") or up to the final consumer ("cradle-to-grave"), depending on the scope of interest. Therefore, it is important that these boundaries are clearly defined, include all emissions relating to the activity and the boundaries established and ensure transparent communication of appropriate information to the interested parties (GHG Protocol). Carbon footprint calculations will also allow banana stakeholders to evaluate their environmental performance under varying conditions and to identify scope for mitigating greenhouse gas emissions.

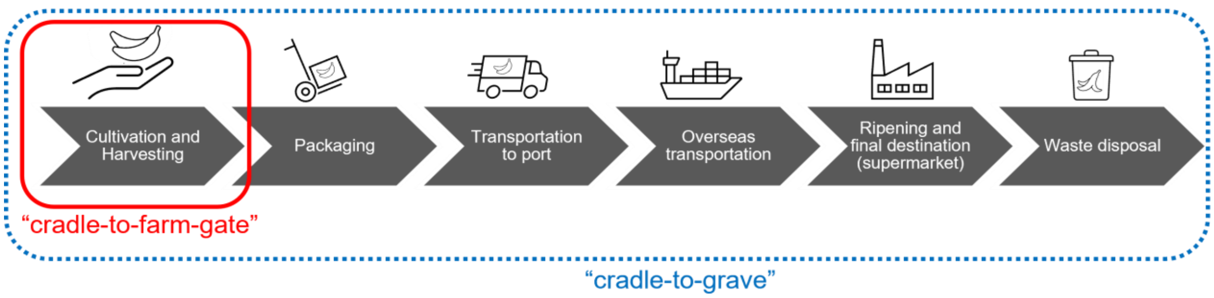

Figure 1. Stages in the banana value chain with the focus of primary production ("Cultivation and Harvesting") – "cradle-to-farm-gate".

Despite bananas being an important product, only few carbon footprint analyses have been published and the results vary depending on the methodology (e.g. boundary setting), and data used. Although different boundaries have been defined, most banana carbon footprint studies have identified maritime transport (including refrigerants) as the main contributor to GHG emissions in the banana supply chain (FAO, 2017). The magnitude of the transport emissions depends on the distance travelled by ship and by truck, how well logistics are optimized and what kind of refrigerants are used. Fertilizer production and the use of fertilizers was identified as the second main GHG contributor to the banana supply chain.

As previously mentioned only few carbon footprint analyses have been published for the banana supply chain, even less of them reported the GHG emissions from fertilizer production and application separately.

The comparison of carbon footprints from five different studies ("cradle to farm-gate") shown in Figure 2 illustrates the reported contributions of fertilizer production and fertilizer application (soil emission) to total farm gate emissions.

The studies analyze the cultivation and harvesting of banana in Costa Rica (Svanes & Aronsson (2013), Soil & More (2010)) and Ecuador (Veliz et al. (2022), Roibas et al. (2015), Iriarte et al. (2014)). Across these studies, the farm-gate carbon footprints range from 0.14-0.3 kg CO_2e kg^{-1} banana with a contribution of the fertilizer production accounting for 15%-36% of emissions from cultivation (average: 23%). The energy use accounts for an average of 15% of all on-farm emissions.

The main hotspot identified within the boundary setting "cradle-to-farm-gate" are the soil emissions with an average of 43% of all on-farm emissions. Fertilizers are used in banana plantation to provide its essential nutrients, aiding in its growth and productivity. However, fertilizers, mainly nitrogen (N) fertilizers, can contribute to greenhouse gas emissions during their production, transportation to the application sites and due to the release of nitrous oxide (N_2O) emissions from soils after application (Brentrup et al., 2018).

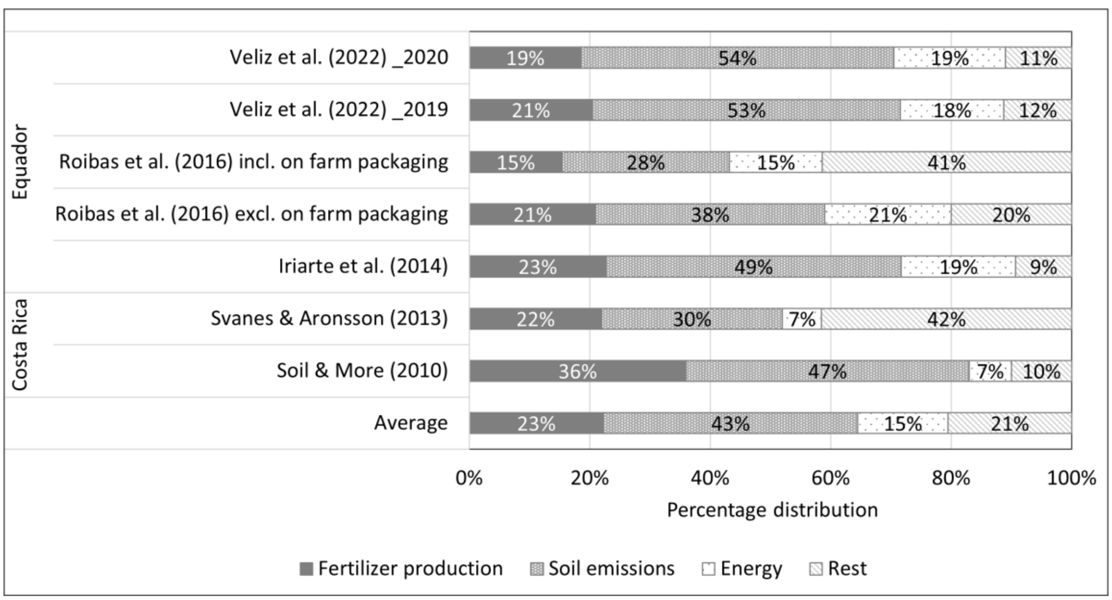

Figure 2. Comparison of carbon footprints from different studies ("cradle to farmgate") and their contribution to the carbon footprint of banana cultivation.

To meet the expected surge in food demand due to the anticipated growth of the global population agricultural production needs to increase on existing land by increasing the yield per unit of area. However, current agriculture needs to go hand in hand with sustainable agriculture, with the aim of reducing the possible side effects that the use of agricultural inputs can cause to our planet due to production of greenhouse gases.

The use of the 4R's framework for fertilizer use (right rate, right place, right source, and right time (https://nutrientstewardship.org/4rs/benefits-using-4rs/) and nutrient optimization are important because they increase nutrient use efficiency and affect the crop performance as farmers must follow recommendations according to crop, environmental conditions, and product availability. But quite often, food producers define good practices based solely on their on-farm activities. As agriculture relies also on input supply, improvements in the industrial processes for input production, such as fertilizers are also important in helping farmers to reduce their carbon footprint by decarbonising their input supply.

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