

Material Flow Analysis for Agro-Industrial By-Product and Waste Valorization in Advancing Circular Economy Transition

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Abstract

The Circular Economy (CE) is built on the principle of closing resource loops and keeping products and materials in use for as long as possible, in contrast to the Linear Economy, which relies on extracting resources from the environment and their subsequent disposal. This shift is vital for sustainable development and achieving climate neutrality by 2050. The agro-industrial sector significantly impacts both the economy and environment, requiring effective strategies for waste and by-product valorization. Material Flow Analysis (MFA) provides a structured methodology to assess the flows and stocks of materials within a system over a defined period and a specific spatial boundary. By mapping the movement of materials across the supply chain's links, MFA enables the identification of inefficiencies, waste generation points, and potential areas for circular resource use. As such, it serves as a key analytical tool for evaluating resource efficiency and supporting the transition to a CE. This study applies MFA to the oliviculture and poultry sectors in the Centro Region of Portugal, to quantify material flows, identify hotspots of waste and by-product generation, explore valorization opportunities, and offer practical recommendations to facilitate CE transition. Data collection will involve semi-structured interviews with key stakeholders and surveys distributed to relevant regional companies, with additional data from national and international databases. Findings will offer insights applicable to other agro-industrial sectors and regions, reinforcing the value of MFA as a key decision-making tool for identifying critical waste generation points, exploring by-product and waste valorization opportunities and enhancing resources circularity.

Keywords

Circular Economy, Material Flow Analysis, Agro-industry, By-Product, Waste, Valorization.

Biographies

Tomás Justino is currently pursuing his MSc in Industrial Engineering and Management at the University of Coimbra, where he previously completed his BSc degree in the same field. His research is focused on mapping the flows of materials in the Centro Region of Portugal.

Vanessa Magalhães has a BSc and a MSc in Industrial and Management Engineering and a PhD in Mechanical Engineering from University of Coimbra, where she is an Assistant Professor of Logistics, Production and Operations

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Susana Garrido holds a PhD and Habilitation in Management and is currently an Associate Professor at the University of Coimbra. Her research interests are focused in the circular economy, sustainability, supply chain, lean, green, and logistics management. She has published more than 300 scientific works in books, chapters, articles, and conference proceedings. She is a reviewer for many journals and international conferences, editor-in-chief, associate editor, and editorial board member of several top international journals. She is part of the Scientific Evaluation Board of ERA-MIN European Funding Program on “Raw Materials for Sustainable Development and the Circular Economy”.