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Converting Waste into Value Through Circular Economy

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The food production chain generates substantial volumes of biowaste, which poses significant environmental challenges (Van Raamsdonk, et al., 2023). Applying circular economy principles offers an opportunity to valorize these organic waste streams and transforming them into valuable resources. The Moerman ladder emphasizes a hierarchical approach to organic waste management prioritizing food use for human consumption over feed, bio-based materials, energy recovery, and composting, where waste prevention is not feasible (Waarts, 2011).

Residual organics generated during the pre-consumption phase, such as agricultural byproducts, offer a clean, uncontaminated resource well-suited for valorization (unlike household waste, which often remains mixed or contaminated even when separately collected). Valorizing these industrial waste streams offer multi-dimensional benefits contributing to creating:

- *Social Value* by upgrading agricultural residues into food products, addressing nutritional deficiencies and food security challenges;
- Economic Value by transforming residual biomass into high-value consumer goods, such as bio-based products, supplements, or cosmetics, generating new revenue streams; and
- *Environmental Value* by utilizing organic residues for purposes like soil enrichment, fostering biodiversity and reducing reliance on synthetic fertilizers.

In this paper we illustrate the valorization of wine residues, a sector of significant importance, with research showing that approximately 75% of global grape production is allocated to winemaking (Zhu et al., 2015). A key by-product of this process is grape pomace, which accounts for 20-30% of the total grape weight processed during production (Dwyer et al., 2014). It consists of leftover skins, seeds, and stalks (Beres et al., 2017). Wineries can serve as an example of a circular economy model by composting residues to establish a closed-loop system. While this approach requires minimal effort, it also generates limited value, positioning it low on the Moerman hierarchy of waste valorization. On the other hand, wine residues offer opportunities to deliver value across all domains (see examples provided by (Beres et al., 2017), including producing edible oils from grape seeds to address nutritional needs (high on social & economic value), developing vitamin E supplements, cosmetics, and other high-value products (economic value), and reducing waste and improving soil health through composting (environmental value).

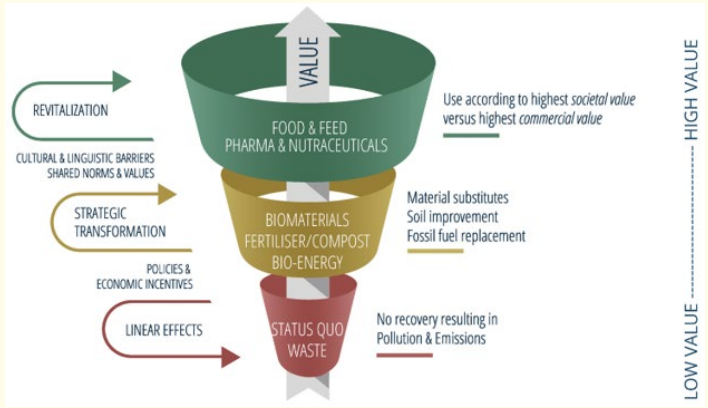

Figure 1: Circularity4All Hierarchy for Bio-based Materials. Graphic credit: Cynthia Reynolds, Circular Economy Coalition, 2024.

Findings from surveys and workshops conducted by the University of Maribor and Circular Economy Coalition utilizing the Circularity4All Hierarchy (Circular Economy Coalition, 2024, Figure 1) suggest that the private sector in principle maintains interest in creating social as well as economic value due to the potential for higher returns. In practice, however, this approach is less frequently adopted within industries, as developing products with higher economic value typically requires significant effort, new investments, and potential partnerships, unless the enterprise can achieve it independently (e.g., producing edible grapeseed oil or basic cosmetics directly at the winery). Yet, the by-products often need to be redirected to other enterprises, potentially even in different sectors, facilitating what is known as industrial symbiosis. Although still rarely practiced on a large scale, this area holds significant potential for innovation. Once upscaled, it could drive job creation, enhance local resilience, stimulate the development of new markets, open diverse revenue streams, and strengthen economic stability.

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