
Principles for the use of biomass in a circular economy

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To respect planetary boundaries and achieve the Sustainable Development Goals, better management of natural resources is needed. Our global agricultural system, and the livestock system, in particular, has a large impact on the environment and high resource use. As the demand for biomass increases, not only for food but also for feed, fuel and fibre, increasing competition for biomass, land and other natural resources occur. All these uses are inextricably linked, therefore we are in need of a sustainability framework that encompasses all these uses. Concepts such as the circular economy and circular agriculture have been proposed in research, policy and business circles to address resource use issues, particularly in relation to directing biomass to its highest value use. Many circularity frameworks and concepts exist to direct biomass towards its highest value, however, these concepts exist outside scientific literature with limited critical appraisal and are spread across different disciplines with little cross-fertilisation. Furthermore, these concepts have not been fully translated to the entire agricultural system which connects multiple uses of biomass beyond food such as feed, bioenergy, biomaterials, chemicals and pharmaceuticals. This study addresses this gap by bringing together insights from research in the circular economy, bio-economy and circular agriculture. In this opinion paper, we present a set of principles for the use of biomass in a circular economy, identifying barriers and opportunities for more circular use of biomass. We conclude that principles that take a holistic view of biomass' multiple uses are needed given the increased competition for resources. We place special emphasis on the role of energy in a circular economy, arguing that given limits set by thermodynamics, full recycling may be impossible. We furthermore emphasise that ecosystem services and biodiversity should be protected since social systems will likely not be able to achieve circularity by technological means alone. The principles will, however, have implications for economic growth.