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# Indicators for Circular Economy in the Agri-food Sector

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Agriculture and the food sector plays a crucial role in the preservation and sustainable use of natural resources. Moreover, it has an enormous potential to mitigate climate change if compared to other economic sectors. The development of agriculture activity has brought about relevant negative environmental impacts: overexploitation of natural resources, soil and water pollution, changes in land use, biodiversity loss and CO<sub>2</sub> emissions, among others. Future perspectives point out that these consequences will be strengthened. On the one side, agriculture production should be increased to meet the food needs of a growing world population. On the other side, changes in food demand drive changes in

agricultural production. These trends will exert further pressure on natural resources and their intensification level. In this sense, more external inputs will be applied (nutrients, agrochemicals, energy, etc.) and more polluting outputs will be produced (sub-products, organic and inorganic wastes, nitrates, etc.). The food sector is inherently linked to agriculture and offers manifold opportunities to improve its circularity by reusing resources, valorising by-products, cascading use of biomass, reducing food loss and food waste. By-products and wastes from the food industry are often used in agriculture e.g. as feedstuffs or fertilisers.

Accordingly, alternative production and consumption models relying on circular economy principles are required to face these challenges and revert the trends. A circular economy (CE) can be considered “*an economic system that replaces the ‘end-of-life’ concept with reducing, reusing, recycling and recovering materials in production and consumption processes...[]...with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity.*” (Kirchherr et al. 2017). Therefore, a key principle of the CE is the optimization of resource yields by keeping materials in use for the longest possible in technical and biological cycles. Nevertheless, this should be accompanied with the regeneration of natural systems (by controlling finite stocks and balancing renewable resource flows), and the design out of waste and pollution (by rethinking and redesigning processes) to ensure the deployment of a sustainable circular economy. The integration of these circular economy principles through technological and non-technological innovations in agricultural production, food production and consumption systems can contribute to increase resource efficiency and reduce environmental footprint substantially, at the time that the system becomes more cost-effective and socially responsible.

There are some different types of agriculture systems (intensive/extensive) and contexts (urban/rural) where CE indicators have to be defined and used to quantify the circularity of the systems. Reliable indicators to measure and document progress in the achievement of CE principles are still lacking, particularly in the agri-food sector (Kristensen and Mosgaard, 2020). Circularity assessment of such indicators is an essential requirement for the achievement of concrete actions and for the achievement of measurable results in the transition to a CE in agricultural and food systems. Agrarian companies and food producers commitments toward the circular economy might remain aspirational and unspecific in the absence of specific indicators. Contrarily, the development of these measurement tools can help producers and consumers to differentiate the genuinely circular agricultural and food products from the rest. In addition to circularity indicators, other sustainability indicators are needed to assess positive or negative impacts of circular economy approaches in the United Nations Sustainable Development Goals (SDGs), particularly in a sector like agri-food, crucial to achieving many of those goals (e.g. zero hunger and clean water and sanitation).

The conceptual grounds of CE have been developed mainly in the manufacturing sector. Further developments are needed to apply these concepts to agriculture. The recent

developments at EU level, i.e. incorporating CE within the Green Deal, have made the CE part of a more integrative space, dealing also with resources use and protecting and restoring biodiversity. For the understanding, measurement and monitoring of CE, a major challenge will be the establishment of a consensuated and holistic indicator-based monitoring system (Kalmykova et al, 2018). These indicators must cope with a coordinated alignment of the production sectors with the envisaged developments promoted by the SDGs in order to assess the agricultural sector in a holistic way, preventing unexpected spill-over effects (Moraga et al, 2019). In addition, these indicators should be able to assess different scales in order to capture CE's regional and global impacts. Thus far, a series of indicator sets, footprints and dashboards have been proposed, but have not yet achieved consensus for their application, so this is still subject for international debate (Paulik, 2018).

This special issue intends to contribute to this field of research, by collecting high-quality manuscripts dealing with exploration and implementation of indicators to measure the progress level in the achievement of CE in the agri-food sector. Original research articles and review papers from all disciplines are invited to address the following topics:

- New socio-economic indicators at different levels to measure the circularity in the agri-food sector
- New indicator-based monitoring systems in the agri-food sector
- Analysis of the synergies and trade-offs between agri-food circular economy strategies and the Sustainable Development Goals
- Novel metrics to evaluate the potential of circular economy strategies to regenerate agricultural land
- Novel metrics quantifying the resource and sustainability savings of cascading practices in the agri-food sector
- Metrics demonstrating how circular economy principles and strategies could manifest in food production and consumption systems
- Quantitative and qualitative comparisons of new circular economy strategies with current linear practices in the agri-food sector
- Monitoring systems for assessing agroecosystems and agro-food chains
- Sustainability indicators derived from the SDGs for the assessment of bioeconomy systems
- New evidence gathered from case studies or success practices that show the positive and negative impacts of circular economy strategies with broad implications in the agri-food sector

## **Important Dates**

- Full paper submission deadline: October 31, 2020
- Final decision notification: May 31, 2021
- Publication: As soon as accepted

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