Extended abtract

EXTENDED ABSTRACT

Title: Circular economy, indicators and strategies. An applicaction of the plastic materials in the agrifood sector
(Economía circular, indicadores y estrategia. Una aplicación de los materiales plásticos en el sector agroalimentario)

Authors and e-mail of all: Ana Palanca Roig
anapalank@gmail.com

Department: Economía y C. Sociales E.T.S. de Ingeniería Agronómica y del Medio Natural

University: Universitat Politècnica de València-UPV

Subject area: *Economía del conocimiento, creatividad y geografía de la innovación*

Abstract:

Despite the linear economy, a **circular economy (CE)** emphasizes key aspects for the environment such as recycling, pollution reduction, paying special attention to the “downstream” production and consumption processes. In this way, the CE seeks a balance between environmental economic development and resource protection.
Most of the literature shares the concept of CE as a closed cyclic system. In this sense, CE is an approach that aims to achieve greater productivity of resources in order to reduce waste and avoid pollution.

This communication aims to analyze the indicators (such as socio-economic, innovation, environmental, etc.), normally used in the framework of the CE. The quantification of the indicators being relevant in order to analyze the level of progress of an organization in the CE and support decision-making. There is currently no package of universally accepted indicators and subsequent monitoring is not homogeneous.
Specifically, the case of plastic materials in the agri-food sector will be analyzed, highlighting innovative solutions for the reduction of waste in the sector and the efficient use of resources. It should be noted that the agri-food sector is a key piece of economic development at the regional level.

CE Framework

Focusing on the framework of the CE, **the term Circular Economy (CE)** has been related with a broad range of meanings by different authors, but they share the concept of cyclical closed-loop system (Murray et al. 2017). In the following text, it is highlighted the different concepts and definitions related to the CE as a framework for the CE indicators.
Linguistically, the term circular economy (Murray et al. 2017) is an antonym of a linear economy. A linear economy is defined as converting natural resources into waste, via production, leading to the deterioration of the environment.

A significant difference between the circular economy and the linear economy is that sustainable development, when applied through the linear model of production, may emphasize waste reduction, recycling and reduction of pollution, focusing mainly on the downstream processes of production and consumption. (Sauvé et al, 2016)
CE it is defined (Zhou 2006) as 'economic activities according to the ecological and economic regulations, aiming at a social and material symbiosis of materials, energy and information between enterprises and industries.
In the CE, new concepts of economy, value, production, and consumption, sustainable development of the economy, environment and society are developed.
It is highlighted (Hu et al. 2011) that the focus of the Circular Economy is on resource productivity and eco-efficiency improvement, and it is adopted the 4R approach: reduce, reuse, recycle, and recover.
In a circular economy, the consumption of raw virgin resources is reduced to optimize the use of by-products, wastes or recycling of discarded products as the primary source of resource materials and to reduce pollution generated at each step (Pinjing et al., 2013).
(Korhonen, et al.; 2018) have analized the definition of CE provided on recent publications such as (Hobson, 2016)
The CE has been defined as an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models. (Singh et al, 2016) CE is an economic strategy that suggests innovative ways to transform the current predominantly linear system of consumption into a circular one, while achieving economic sustainability with much needed material savings. A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. (Haupt et al., 2017)
(Wu et al., 2014) CE aims to achieve optimum production by minimizing natural resource utilization and pollution emission simultaneously, and minimum wastage by reusing the wastes from production and minimum pollution by recycling and restoring the technically useless wastes.
(Blomsma et al, 2017) CE is a general term covering all activities that reduce, reuse, and recycle materials in production, distribution, and consumption processes.

CE indicators and strategies

In addition, it is considered the definition of an indicator provided by the OECD (2014) where an indicator is defined as "a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor".
Given the number and diversity of sustainability indicators that have been developed (Saidani et al 2018), there are different classifications described in the literature: e.g. Krajnc and Glavic (2003) who classified 89 indicators according to environmental, economic and social areas; (Saisani et al) grouped into 5 relevant categories to clarify their usage and facilitate their application in companies: (i) environmental impact and chemical release; (ii) pollution 350 from emissions and wastes; (iii) end of life management and chemicals usage related indicators; (iv) raw materials and facility management related indicators; and (v) energy and water management.

It is described that although CE indicators are in expansion and they are becoming increasingly discussed through the academic literature, there is still a lack of in-depth investigation on their completeness, classification, possible complementary and applicability from an industrial or political perspective. They described a research methodology to identify, analyse and characterize the CE indicators. (Saidani et al, 2018)

Moreover, the literature review (Merli et al, 2018) shows that the development of a specific indicators' set for CE is still at an early stage, especially for the micro level of analysis (Elia et al., 2016). The development of indicators will also contribute to a deeper understanding of CE and to evaluating the related concepts that are emerging in a more mature pase.

There are a number of factors that serve as barriers (Geng et al, 2012) for the implementation of the EC indicators such as 1) the inexistence of detailed description or standardized process on data collection, calculation and submission, 2) the voluntary implementation of the EC indicators, 3) there are no specific goals and values that may be used as benchmarks.

Regarding the weight given to each indicator, several methodologies are proposed: average weighting (Li and Zhang, 2005), analytic hierarchy process- identify the bottlenecks in the development of CE (Chen, 2006; Qian et al., 2008 and the grey correlation degree method- control for a balanced development (Zhang 2005).

Both Chinese and European CE policies identify the need for indicator systems to monitor progress (McDowall et al, 2017). Moreover, it is highlighted that the indicators should not be seen solely through a CE lens, given that they are also associated with policy initiatives.

(Saidani et al, 2018) proposed the following categories for the CE indicators: 1) levels (micro, meso, macro), 2) Loops (maintain, reuse/reman, recycle), 3) Performance (intrinsic, impacts), 4) Perspective (actual, potential), 5) Usages (e.g. improvement, benchmarking, communication), 6) Transversatility (generic, sector-specific), 7) Dimension (single, multiple), 8) Units (quantitative, qualitative), 9) Format (e.g. web-based tool, Excel, formulas), 10)Sources (academics, companies, agencies). They tested some case studies, specially we focus on the plastic waste treatment (Huysman et al. 2017) to quantify the CE performance of different plastic waste treatment options, considering the environmental benefits.

The EEA (European Environment Agency) (2016) suggested the measure and reporting of the degree of circularity achievements should be specified throughout the life cycle of products or systems, that is to say on the following stages: design (e.g. easy of disassembly), production (evolution of the overall (primary, secondary) use of materials), consumption (lifespan, use intensity), end-of861 life (volume of landfill evolution).In addition, a CE monitoring framework should be flexible to maintain the indicators effectiveness throughout the evolution of the transition. Any indicator set such as in the fields of sustainability and circularity, should be adaptive enough to reflect the varying and time-evolving stakeholders' needs (Lützkendorf, 2017).

(Saidani et al, 2018) characterized and classified 55 sets of CE indicators, bringing some clarity on their purposes and therefore support their appropriate use and dissemination, notably thanks to a user-friendly selection tool associated to the database of these CE indicators. It is highlighted that, further emphasis is needed to expand and open up the discussion on three key perspective: (i) the advanced robustness of – existing and future – CE-indicators; (ii) their enhanced adoption by industrialists to conduct CE strategies; and (iii) their contribution to catalyze the transition towards a more CE.

The European Commission (EC, 2009) has used the following criteria to select CE indicators related to resource efficiency: policy relevance; coverage of all relevant categories and resources; coherence and completeness; transparency of trade-offs and negative side effects such as burden shifting; applicability to different levels of economic activities.

Due to the dynamism of CE, the CE indicators are needed to track the progress and provide direction and criteria about where to go next (Saidani et al, 2018). In addition, making CE indicators more transparent and and thus enlightening decision-making (Thomas, 2013), will make them certainly more applicable.

Generally speaking, the implementation of CE strategies requires new organizational and business models, enhanced technologies augmented know-how and shared knowledge as well as a redefinition of industrial process and product innovations (EEA, 2016). And all these changes have to be economically, socially and environmentally sustainable to guarantee a successful implementation of the CE – effective and efficient – in the long run (Saidani et al, 2018).

(Banaitė, 2016) Analyzed the EC indicators in the context of sustainable development and found that at micro level, indicators are tailored to individual firms or an industry's characteristics and not focuses on both circular economy and sustainable development principles and components. In addition, there are no social indicator's in reviewed CE evaluation systems at the meso level. Also, it should be paid more attention to economic indicators, because all indicators mostly focus on resource reduction and recycling. At the macro level, the indicator systems are generally based on 3R principles and just some integrate all sustainable development components.

(Parmenter, 2015) key performance indicators (KPI) are widely used and acknowledged in industrial practices. However, developing appropriate circularity indicators appears to be relevant in the context of circular economy transition.

The EASAC found out that many available indicators may be appropriate for monitoring progress towards a circular economy. These indicators were grouped into sustainable development, environment, material flow analysis, societal behaviour, organizational behaviour and economic performance. However, product circularity performance was not directly considered in these indicators.

(Ghisellini et al. 2016) confirmed that current indicators are barely focused on the circularity at the scale of individual products

(Franklin-Johnson et al, 2016) Existing indicators and assessments have not the capacity to capture the entire circular economy performance of products. They provided a novel indicator for environmental evaluation performance linked to circular economy, on the basis of which circular economy central point is value creation through materials retention in a loop of high added value. The longevity indicator called "Resource Duration" measures material retention based on the amount of time a resource is kept in use, regarding three following aspects: initial lifetime; durability earned through reuse or refurbishing; durability gained thanks to recycling. This non-monetary indicator is only focused on environmental efficiency of resources and could therefore be used as a local or complementary indicator, rather than a global one which could embrace the whole circular economy paradigm.

The Ellen MacArthur Foundation decided to launch the "Circularity Indicators Project" in May 2015. According to the Ellen MacArthur Foundation, the benefits of proper circularity indicators could be significant: from decision-making tool for industrial practitioners, to internal reporting, through rating or evaluation of companies

The Material Circularity Indicator (MCI) is describes by the Ellen MacArthur Foundation as a tool for European companies to assess their products and business models performance in a context of circular economy. This indicator is particularly intended for use in product design but could also be used in internal reporting or for procurement and investment decisions

The Circular Economy Toolkit (CET) is an assessment tool to identify potential improvement of products' circularity (Evans et al, 2017). This tool is also freely accessible online

The Circular Economy Indicator Prototype (CEIP), (Griffiths et al, 2016), aims at evaluating product performance in the context of circular economy. The CEIP uses a points-based questionnaire. Fifteen weighted questions are divided into 5 lifecycle stages, namely: design or redesign; manufacturing; commercialisation; usage; and end-of-life. Once the questionnaire is completed, one gets an overall score of the product circularity performance plus a spider diagram showing circularity performance across different parts of the lifecycle.

(Saidani et al, 2017) Analysed the MCI, CET and CEIP tools and indicators and concluded with the recommendation that the design and construction of an advanced framework to measure product circularity should considerer mainly five cornerstones, namely: (i) systemic by design; (ii) integrated and operational; (iii) adaptive and flexible; (iv) intuitive user interface; (v) connection with sustainable development pillars. Although they provide a first and a rapid overview of products' circularity, current tools neither consider the whole complexity of the circular economy paradigm

Considering the large number of natural resources with different characteristics, it is extremely complex to develop indicators that properly reflect resource use and its impacts on environment, economy and security (Behrens et al., 2015). Indicators must be simple and intuitive to further facilitate the measuring of progress towards agreed targets and to simplify the communication to the public. It is vital that the indicators are robust and that they link simultaneously to all relevant issues of the stakeholders at a specific place and point in time being calculated using similar methodologies and harmonised statistics.

The economic value is an indicator that is extensively used in decision making. (Di Maio et al, 2017). A key advantage of using economic value is that while mass represents only quantity, economic value embodies both quantity and quality. In addition, the value-based resource efficiency (VRE) indicator is as simple as the mass-based resource efficiency indicators but better aligned with social, environmental and economic policies. Moreover, the VRE indicator measure resource efficiency and circularity and it is more aligned with the market value of resources

CE indicators are commonly grouped into micro-level (organizations, products, consumers), meso-level (symbiosis association, (eco)- industrial parks), and macro-level (city, province, region, or country) (Geng et al., 2012; Saidani et al., 2017;).

(Geng et al, 2009) Analyzed the regional CE initiatives that have been successful to date in Dalian (China), including those focusing on conserving energy and water resources and others focusing on reduced industrial emissions They measured and compared the following indicators: energy consumption per GDP; energy and water consumption per industrial value added; waste discharges; waste treatment; and indicators linked to waste reclamation (e.g., the rate of treated wastewater recycling and rate of industrial solid waste reclamation). The case of Dalian showed that there is a need to further promote CE strategies and each city should develop its own CE action plans by considering local realities.

(Bocken et al, 2016) Developed a simple circular economy strategy framework was developed to provide a conceptual overview of the possible design and business model strategies for a circular economy.
-Circular product design strategies: slowing-designing long-life products and for product-life extension; closing-design for a technological cycle, biological cycle and dis- and reassembly.
-Circular business model strategies: slowing-access and performance model, extending product vale, classic long life and encourage sufficiency; closing-extending resource value and industrial symbiosis.

To monitor plastic waste treatment management, suitable indicators are needed. (Huysman et al, 2017) developed an indicator to quantify the circular economy performance of different plastic waste treatment options where the quality of the recycled material is used as starting point. The indicator is defined as the ratio of the actual obtained environmental benefit (i.e. of the currently applied waste treatment option) over the ideal environmental benefit according to quality, the latter being the benefit of the waste treatment option to which the stream should be directed according to its composition/quality with a minimal required effort, assuming closed-loop recycling is better and incineration is less preferable. This indicator and its results can be useful for policies aiming toward a circular economy. The plastic waste could be assigned to the most suitable waste treatment option according to quality, in order to obtain a higher environmental benefit in terms of resource consumption.

Applicaction of the plastic materials in the agrifood sector

The European agri-food system, in particular, is based on a large number of small-scale family-based producers, retailers, and food service outlets operating alongside large-scale globalised companies (http://www.fao.org/3/a-i5857e.pdf)

The reviewed literature (Borrello et al, 2016) supports the idea that the implementation of a circular economy in the agri-food sector would reduce environmental and economic costs due to food waste disposal. Moreover, the principles of circular economy in the agri-food sector include sustainable systems of production and consumption that considers societal challenges. These societal challenges refer to climate change, raw materials scarcity and environmental pollution among others (McCormick et al, 2013)

In addition, seven categories were identified in the framework of CE in the agri-food sector (Borrello et al, 2016): regulatory limitations; reverse cycle logistics management; geographic dispersion of enterprises; system boundaries and leakages of matter; acceptance among consumers; technology development and diffusion; uncertainty of investments and incentives.

The agri-food products require packaging with barrier to oxygen and water vapor, in order to limit their oxidation and water activity and thus provide a long shelf-life, maintain their quality and avoid bacteria growth (Manzini et al, 2013)

Currently there are different types of environmentally friendly packaging solutions (e.g. biodegradable packaging), active packaging (e.g. modified atmosphere packaging –

MAP) and functional packaging (e.g. packaging used for cooking in the microwave ready-to-cook products) (Mahalik and Nambiar, 2010).

Most polymers used as packaging materials are petrol-based and thus do not follow the principle of sustainability. Therefore, biopolymers are a very attractive substitution for petrol-based packaging materials. Today bio-polymers are only used in a few applications. Especially disposable tableware and waste bags are made from these materials. Although being bio-based, they are usually not compostable and sometimes not even recyclable.

One of the key challenge for future research in agri-food supply chain is the measurement of correlations between logistics operations and decisions (e.g. shipment typologies, transportation modes, packaging solutions, environmental and climatic conditions), multi stress monitoring and evaluation, quality and safety effects of food products at the point of consumption. There are evident lacks about the contemporary influence of the environmental factors. (Manzini et al, 2013)

EU has promoted and financed new circular businesses (COM(2014) 398 final]) however, the lack of regulation still limits potential operational tools of circularity. Supply chains are still locked in traditional linear management systems. More specifically, waste collection areas should be easily reachable from consumers and waste storage areas should be designed in order to quicken collection and transportation.

Furthermore, the uncertain investment environment inhibits firms in the agri-food supply chain from investing in new technologies and in new business models. Hence, the distribution of companies operating in new sustainable circular businesses is still scarce (Borrello et al, 2016)

References

Mahalik, N. P., & Nambiar, A. N. (2010). Trends in food packaging and manufacturing systems and technology. Trends in food science & technology, 21(3), 117-128.

Bureau, J. C., Disdier, A. C., Emlinger, C., Fouré, J., Felbermayr, G., Fontagné, L., & Jean, S. (2014). Risks and opportunities for the EU agri-food sector in a possible EU-US trade agreement (Doctoral dissertation, European Parliament's Committee on Agriculture and Rural Development).

EEA, 2016. Circular economy in Europe - Developing the knowledge base (No. 2). European Environmental Agency.

Ellen MacArthur Foundation, 2015a. Circularity indicators - An approach to measuring circularity (Methodology).

Blomsma, F., & Brennan, G. (2017). The emergence of circular economy: A new framing around prolonging resource productivity. Journal of Industrial Ecology, 21(3), 603-614.

Manzini, R., & Accorsi, R. (2013). The new conceptual framework for food supply chain assessment. Journal of food engineering, 115(2), 251-263.

Ellen MacArthur Foundation. The New Plastics Economy: Catalysing action, 2017

Aguilar A, Magnien E, Thomas D. Thirty years of European biotechnology programmes: from biomolecular engineering to the bioeconomy. New Biotechnol. 2013; 30:410-425.

de Besi M, and McCormick K. (2015). Towards a bioeconomy in Europe: National, Regional and Industrial Strategies. Sustainability7, 10461-10478.

Borrello, M., Lombardi, A., Pascucci, S., & Cembalo, L. (2016). The seven challenges for transitioning into a bio-based circular economy in the agri-food sector. *Recent patents on food, nutrition & agriculture*, *8*(1), 39-47.

EU - European Union: European commission, communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions, towards a circular economy: A zero waste program for Europe, 2 July 2014, COM(2014) 398 final

Geng, Y., Fu, J., Sarkis, J., & Xue, B. (2012). Towards a national circular economy indicator system in China: an evaluation and critical analysis. *Journal of cleaner production*, *23*(1), 216-224.

Geng, Y., Sarkis, J., Ulgiati, S., & Zhang, P. (2013). Measuring China's circular economy. *Science*, *339*(6127), 1526-1527.

Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the circular economy in China: moving from rhetoric to implementation. *Journal of cleaner production*, *42*, 215-227.

McDowall, W., Geng, Y., Huang, B., Barteková, E., Bleischwitz, R., Türkeli, S., ... & Doménech, T. (2017). Circular economy policies in China and Europe. *Journal of Industrial Ecology*, *21*(3), 651-661.

Franklin-Johnson, E., Figge, F., & Canning, L. (2016). Resource duration as a managerial indicator for Circular Economy performance. *Journal of Cleaner Production*, *133*, 589-598.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner production*, *114*, 11-32.

Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., & Kendall, A. (2018). A taxonomy of circular economy indicators. *Journal of cleaner production*.

Elia, V., Gnoni, M. G., & Tornese, F. (2017). Measuring circular economy strategies through index methods: A critical analysis. *Journal of Cleaner Production*, *142*, 2741-2751.

Haupt, M., Vadenbo, C., & Hellweg, S. (2017). Do we have the right performance indicators for the circular economy?: insight into the Swiss waste management system. *Journal of Industrial Ecology*, *21*(3), 615-627.

Di Maio, F., & Rem, P. C. (2015). A robust indicator for promoting circular economy through recycling. *Journal of Environmental Protection*, *6*(10), 1095-1104.

Huysman, S., De Schaepmeester, J., Ragaert, K., Dewulf, J., & De Meester, S. (2017). Performance indicators for a circular economy: A case study on post-industrial plastic waste. *Resources, Conservation and Recycling*, *120*, 46-54.

Blomsma, F., & Brennan, G. (2017). The emergence of circular economy: A new framing around prolonging resource productivity. *Journal of Industrial Ecology*, *21*(3), 603-614.

Merli, R., Preziosi, M., & Acampora, A. (2018). How do scholars approach the circular economy? A systematic literature review. *Journal of Cleaner Production*, *178*, 703-722.

Banaitė, D. (2016). Towards circular economy: analysis of indicators in the context of sustainable development. *Social Transformation in Contemporary Society*, *4*(9), 142-150.

Saidani, M., Yannou, B., Leroy, Y., & Cluzel, F. (2017). How to assess product performance in the circular economy? Proposed requirements for the design of a circularity measurement framework. *Recycling*, *2*(1), 6.

Parmenter, D. (2015). *Key performance indicators: developing, implementing, and using winning KPIs*. John Wiley & Sons.

Ellen MacArthur Foundation (EMF). Circularity Indicators—An Approach to Measure Circularity. Methodology & Project Overview; Ellen MacArthur Foundation (EMF): Cowes, UK, 2015.

Evans, J.; Bocken, N. The Circular Economy Toolkit. Available online: http://circulareconomytoolkit.org/ (accessed on 1 February 2017)

Griffiths, P.; Cayzer, S. Design of indicators for measuring product performance in the circular economy. In 3rd International Conference on Sustainable Design and Manufacturing, SDM 2016; Springer Science and Business Media Deutschland GmbH: Berlin, Germany, 2016; pp. 307–321.

Di Maio, F., Rem, P. C., Baldé, K., & Polder, M. (2017). Measuring resource efficiency and circular economy: A market value approach. *Resources, Conservation and Recycling*, *122*, 163-171.

Behrens, A., Taranic, I., Rizos, V., 2015. Resource Efficiency Indicators for Policy-Making. CEPS Working Document, ISBN 978-94-6138-483-6

Geng, Y., Zhu, Q., Doberstein, B., & Fujita, T. (2009). Implementing China's circular economy concept at the regional level: A review of progress in Dalian, China. *Waste Management*, *29*(2), 996-1002.

Bocken, N. M., De Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308-320.

Murray, A., Skene, K., & Haynes, K. (2017). The circular economy: An interdisciplinary exploration of the concept and application in a global context. *Journal of Business Ethics*,*140*(3), 369-380.

Wei, S., Zhou, Q., & Koval, P. V. (2006). Flowering stage characteristics of cadmium hyperaccumulator Solanum nigrum L. and their significance to phytoremediation. Science of the Total Environment, 369(1-3), 441-446.

Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. Environmental Development, 17, 48-56.

Hu, J., Xiao, Z., Zhou, R., Deng, W., Wang, M., & Ma, S. (2011). Ecological utilization of leather tannery waste with circular economy model. Journal of Cleaner Production, 19(2-3), 221-228.

Pinjing, H., Fan, L., Hua, Z., & Liming, S. (2013). Reference to the circular economy as a guiding principle. *Waste as a Resource*, *37*, 144.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner production*, *114*, 11-32.

Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the circular economy in China: moving from rhetoric to implementation. *Journal of Cleaner Production*,*42*, 215-227.

Geng, Y., Zhu, Q., Doberstein, B., & Fujita, T. (2009). Implementing China's circular economy concept at the regional level: A review of progress in Dalian, China. *Waste Management*, *29*(2), 996-1002.

Ellen MacArthur Foundation (2012), 'Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition', www.thecirculareconomy.org.

http://www.fao.org/3/a-i5857e.pdf

Franklin-Johnson, E., Figge, F., & Canning, L. (2016). Resource duration as a managerial indicator for Circular Economy performance. Journal of Cleaner Production, 133, 589-598.

Lützkendorf, T., & Balouktsi, M. (2017). Assessing a sustainable urban development: Typology of indicators and sources of information. Procedia Environmental Sciences, 38, 546-553.

Singh, J., & Ordoñez, I. (2016). Resource recovery from post-consumer waste: important lessons for the upcoming circular economy. Journal of Cleaner Production, 134, 342-353.

Keywords: *circular economy, agrifood sector, indicators, plastic*

JEL codes: Agricultural and Natural Resource Economics • Environmental and Ecological Economics; Economic development, Innovation, Technological Change, and Growth