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EMBRACING THE CIRCULAR ECONOMY: A PARADIGM SHIFT FOR SUSTAINABLE PROSPERITY

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Abstract

The study aimed to set up a review of the scientific literature concerning the circular economy, called to become a viable alternative to the linear "take-make-dispose" approach and assure sustainability. It synthesizes, in a logical order, the main aspects regarding the circular economy versus linear economy and has a critical approach comparatively pointing out the benefits and restrains. The two economic models are illustrated in schemas in such a way to clearly distinguish the difference in their objectives, principles and benefits. Also, the study presents the key policies and initiatives of the circular economy, highlighting the EU's commitment and the metrics for measuring the circularity. Regarding the circular agriculture, it is emphasized the efficiency in resource use, recycling, and waste reduction, closed nutrient loops, biodiversity conservation, climate change mitigation, food production and consumption, and the creation of economic value. Circular agriculture practices such as agroforestry, crop rotation, composting organic farming, and regenerative agriculture are also presented. Circularity in agriculture should cease to be seen merely as a concept, it should be considered a necessity for building a sustainable and resilient economy of the future.

Key words**:** *circular economy versus linear model, objectives, good practices in circular agriculture*

INTRODUCTION

The circular economy has been issued as a new economic model adapted to the present reality and has the goal to become an alternative to the traditional linear model of development, nicknamed "take-make-dispose" approach.
The circular economy highlights the importance of the efficiency in using the resources, the need to diminish wastes and to assure the sustainability.
The circular economy means that the use of raw materials, products and resources to be on a long-term and, at the same time, to find solutions to reduce wastes and maximize value. This feature is completely different from the linear economic model which is based on the extracted raw materials, manufactured commodities and waste disposal [45].
The circular economy incorporates new orientations and solutions of development, involving both theoretical economical and environment principles, rethinking the model design, and promoting new good practices with the purpose to develop production and consumption systems which are more sustainable and resilient [46].
Starting from its roots traced back to various historical and contemporary influences, the concept of the circular economy has evolved over time [24] as mentioned below:
Economic Theory*:* The idea of maximizing resource efficiency and minimizing waste has been present in economic thought for

centuries. Concepts such as "waste equals food" and "cradle-to-cradle" thinking, which emphasize the cyclical nature of resources, have been discussed by economists like Kenneth Boulding and Nicholas Georgescu-Roegen [23].

Industrial Ecology: In the 1970s, industrial ecologists began exploring the parallels between industrial systems and natural ecosystems. They emphasized the importance of closed-loop systems, where waste from one process becomes a resource for another, mirroring the nutrient cycling found in ecosystems.

Cradle-to-Cradle Design: In the early 2000s, the architect William McDonough and the chemist Michael Braungart popularized the concept of cradle-to-cradle design [42], which sustains those products to be designed in such a way based on raw materials so that later to be continually recycled or biodegraded, without losing quality or value.

***Performance Economy*:** In 2006, Walter R. Stahel, often named as the "father of the circular economy," published the book "The Performance Economy," where it is discussed the need to pass from the linear "take-make-dispose" model to a circular economy model, which has to assure the performance in business and the efficient use of resources.

Ellen MacArthur Foundation: The Ellen MacArthur Foundation, established in 2010, has significantly promoted the circular economy concept [14, 15].

The combination between research and education, and also the collaboration between businesses and policy, could emphasize the role of circular economy as a solution to global sustainability challenges.

In this context the purpose of the paper is to synthetize the basic ideas spread by the scientific literature in connection to the circular economy emphasizing the sustainability problem strengthen by the innovative perspective considered a viable alternative to the linear "take-make-dispose" approach.

Objectives and good practices in agriculture and also highlighted.

MATERIALS AND METHODS

In order to characterize the circularity of the economy, the paper starts from the Circularity Gap Report set up The Circular Economy Foundation (CEF), a non-profit organization in Brussels. Their approach in assessing the circularity of the economy is a data-driven approach and produces both metrics for circularity and proposes practical solutions.

The period analysed in this study spans from 2018 up to 2023.

The 2018 report established that the world economy was only 9.1% circular, but in 2023 the global circularity fell to 7.2%.

Based on the data provided, the present paper reviewed a number of 30 scientific publications on the topic of circularity in economics and synthetizes the main problems and principles of the transition to circularity in economics [8, 12].

RESULTS AND DISCUSSIONS

1. The take-make-dispose Approach

The take-make-dispose approach, also known as the linear economy, is characterized by a linear flow of materials and resources through the economy, with little emphasis on resource conservation, waste reduction, or sustainability.

This linear model is increasingly recognized as unsustainable in the face of growing environmental challenges and resource constraints, leading to calls for a transition towards more circular and regenerative economic models.

This traditional economic model is characterized by several key features, such as:

Resource Extraction

In the take-make-dispose approach, natural resources are extracted from the environment to meet production needs.

This often involves the depletion of finite resources, such as fossil fuels, minerals, and timber, without considering the long-term implications for resource availability and ecosystem health.

Production

Once resources are extracted, they are used to manufacture products through various

production processes. These products may range from consumer goods to industrial equipment and infrastructure. The emphasis is typically on maximizing production efficiency and output to meet consumer demand.

Consumption

In the consumption phase, products are distributed to consumers through retail channels and consumed for their intended purposes.

Consumers purchase goods based on their needs, preferences, and purchasing power, often leading to the accumulation of goods and materials that may ultimately be discarded.

Waste Generation

At the end of their life cycle, products in the linear economy are typically disposed of as waste.

This results in significant waste generation, including both solid waste and pollutants, which can have adverse environmental and health impacts.

Waste management strategies often focus on disposal methods such as landfilling or incineration, rather than prioritizing resource recovery or recycling.

Limited Value Retention

One of the defining characteristics of the take-make-dispose approach is the limited retention of value throughout the product life cycle.

Once products reach the end of their useful life, they lose their economic value and are treated as waste, leading to the inefficient use of resources and economic inefficiencies.

Environmental Degradation

The linear economy is associated with significant environmental degradation, including habitat destruction, pollution, and greenhouse gas emissions.

The extraction of natural resources, energy-intensive production processes, and waste disposal contribute to environmental pressures and negative ecological outcomes.

The linear economy model is schematically illustrated in Fig. 1.

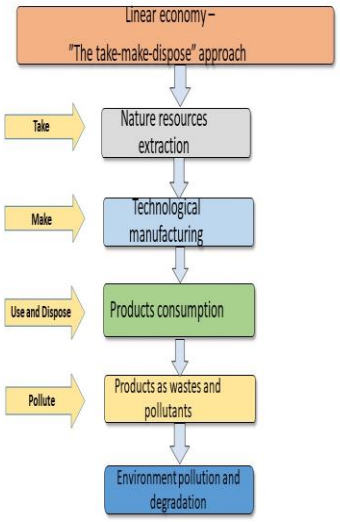

Fig. 1. The linear economy model
Source: Own design.

2.The Circular Economy Model as an Alternative

The circular economy is based on the following main principles as mentioned by [33]:

Products have to be designed eliminating Waste and Pollution: Products should be carefully designed for allowing them to have a long life cycle, also the chance to be recycled and repaired, under the conditions that wastes and pollution to be eliminated. In this way, the circular economy aims tries to minimize the negative impact on the environment along the product life.

Keeping Products and Materials in Use: Instead of discarding products at the end of their life cycle, the circular economy emphasizes reuse, refurbishment, and recycling. This prolongs the lifespan of products and reduces the need for new raw materials.

Key principles and strategies of the circular economy include:

Product Life Extension: Extending the lifespan of products through repair, refurbishment, and remanufacturing.

Resource Recovery and Recycling: Recovering and recycling materials from products at the end of their life cycle to create

new products or inputs for manufacturing [36].

Sharing Platforms and Collaborative Consumption: Encouraging shared use of products and resources through platforms such as car-sharing, co-working spaces, and tool libraries.

Product-as-a-Service Models: Shifting from ownership to service-based models where consumers pay for the use of products rather than owning them outright, incentivizing product longevity and resource efficiency.

Industrial Symbiosis: Fostering collaboration among industries to exchange materials, energy, and by-products to reduce waste and maximize resource efficiency [36].

Beneficial impact on Regenerating Natural Systems: According to the principle of the circular economy, natural systems will be regenerated using good practices destined to recover ecosystems, preserve biodiversity, and diminish the negative effects of climate change. This means that land to be used in a sustainable manner so that ecosystems to be restored and energy sources to be renewable.

Therefore, the circular economy represents "a paradigm shift in how we produce, consume, and dispose of goods and resources" as mentioned by [22].

By transitioning to a circular economic model, societies can achieve environmental sustainability, economic resilience, and social well-being while minimizing the negative impacts of resource depletion and waste generation.

The circular economy model is displayed in Fig. 2.

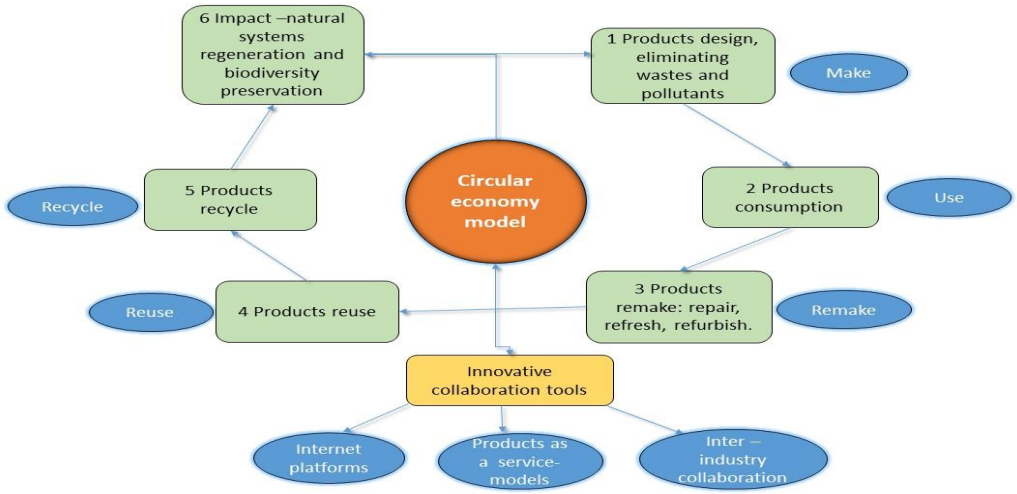

Fig. 2. The circular economy model
Source: Own design.

3. The Circularity Gap Assessment

The Circularity Gap Report is an annual publication that assesses the global progress towards circularity.

It provides insights into the current state of the global economy's circularity, highlighting the gap between the current level of circularity and the level required to achieve sustainability goals.

It draws on data and analysis from various sources to evaluate key indicators of circularity, including material use, waste generation, and resource efficiency [8, 41]. The Circularity Gap Report serves as a valuable tool for policymakers, businesses, researchers, and civil society organizations to understand the current status of circularity globally and identify opportunities for improvement. It contributes to ongoing efforts to promote sustainable consumption and production patterns and address pressing environmental challenges [12].

Key components of the Circularity Gap Report typically include:

Circularity Indicators: The report assesses various indicators of circularity, such as material circularity, waste generation rates, and resource productivity. These indicators

help to quantify the extent to which resources are being used efficiently and kept in the economy.

Circularity Gap Analysis: The report identifies the gap between the current level of circularity and the level required to achieve global sustainability goals, such as reducing greenhouse gas emissions, mitigating resource depletion, and minimizing waste generation.

Regional and Sectoral Analysis: The Circularity Gap Report often provides insights into regional and sectoral variations in circularity. It assesses the progress made by different countries, regions, and industries towards adopting circular economy practices.

Policy Recommendations: Based on its analysis, the report offers recommendations for policymakers, businesses, and other stakeholders to accelerate the transition to a circular economy. These recommendations may include policy interventions, business strategies, and investment priorities [47].

4. Metrics development

These metrics provide a comprehensive framework for evaluating progress towards a circular economy, helping businesses, governments, and stakeholders to identify opportunities for improvement and track performance over time [25]. Metrics used to measure circular economy typically focus on several key aspects [41]:

Resource Efficiency: This metric assesses the amount of resources used in production processes compared to the output generated. It includes indicators such as material productivity, energy efficiency, and water usage.

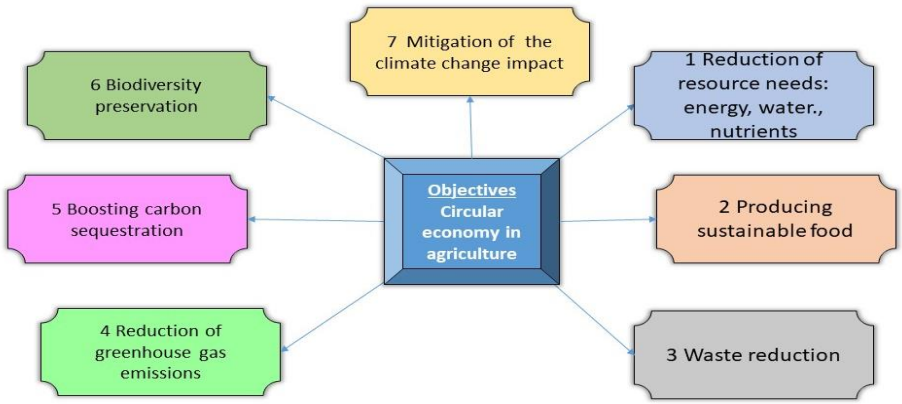

Fig. 3. The objectives of the circular economy
Source: Own design.

Waste Reduction: Measures the amount of waste generated throughout the product lifecycle, including production, consumption, and disposal. This can include metrics like waste diversion rates, recycling rates, and the percentage of materials reused or repurposed.

Product Longevity and Durability: Evaluates the lifespan of products and materials, aiming to prolong their use and reduce the frequency of replacement. Metrics may include product lifespan, repairability, and the percentage of products designed for reuse or refurbishment.

Circular Input-Output Flows: Tracks the circulation of materials, components, and products within the economy, aiming to minimize the extraction of new resources and maximize the utilization of existing ones. Metrics can include the percentage of recycled content in products, remanufacturing rates, and the proportion of materials recovered for reuse.

Value Retention: Measures the ability of products and materials to retain their value over time through reuse, remanufacturing, and recycling processes. This metric can include indicators such as the economic value generated from secondary materials and the percentage of products and materials retained within the economy.

Ecosystem Health: Considers the broader environmental impacts of economic activities, including biodiversity conservation,

ecosystem restoration, and carbon emissions reduction. Metrics may include the ecological footprint of production processes, the restoration of natural habitats, and the preservation of biodiversity.

Social and Economic Benefits: The circular economy is destined to strengthen social and economic effects such as: the appearance of new jobs in the labour market, creating and strengthening new initiatives, in the field of innovation and community resilience. the effects will be quantified in terms of: employment in the sector where circular economy is implemented, high investments in research and development, and the benefits repartition in an equitable manner across society [20].

5. EU Policies

The EU makes many actions destined to promote the circular economy, by developing new strategies for implementing modern and effective technologies and circular economy for a sustainable growth as shown the EU's Circular Economy Action Plan [16], the European Green Deal [17], the Shaping Europe's Digital Future [19], the European Digital Strategy [19], and the European Skills Agenda 18, 10].

In general, foundations and organizations dedicated to the circular economy typically work towards advancing the principles of resource efficiency, waste reduction, and sustainability within various sectors of society, including business, government, academia, and civil society. They may engage in activities such as research, advocacy, policy development, education, and collaboration to foster the transition to a circular economy.

Romania has access to EU funding programs that support circular economy projects [6, 44]. These funds can be utilized to implement initiatives aimed at improving resource efficiency, reducing waste, and promoting circular economy which and can contribute to restoring biodiversity naturally in Europe [9, 11].

Biological resources are an essential contribution to the Romania's economy and will play an even more important role in the future. Through actions taken as a result of the strategy and of the action plan in the field of bio economy, policy makers aim to ensure sustainability and renewable biomaterials.

6. Importance of circularity in agriculture. Circular Agriculture Practices

Circular agriculture focusses on optimizing resource utilization, minimizing waste and fostering sustainable food production [41]. Some benefits of adopting circularity in agriculture are: reducing the needed resources (energy, water, nutrients), producing less waste, use of close nutrient loops, ensuring biodiversity, lowering greenhouse gas production and boosting carbon sequestration [13] etc.

Some examples of good practices in circular agriculture are given by [29].

An illustrated presentation of the directions where good practices of circular economy are oriented are shown in Fig. 4.

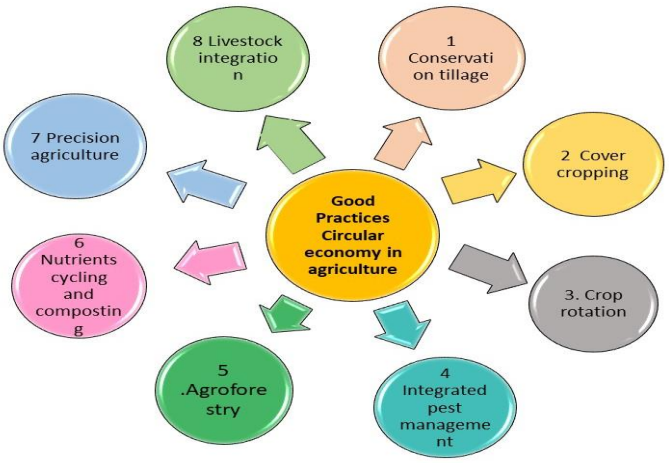

Fig. 4. Good practices of circular economy in agriculture
Source: Own design.

Conservation Tillage: Instead of traditional plowing, conservation tillage minimizes soil disturbance, preserving soil structure and organic matter. This practice reduces erosion, improves water retention, and promotes soil health [7, 4].

No-tillage associated with fertilization had a positive effect on wheat yield and grains quality in terms of protein and gluten content [30, 31, 32].

Cover Cropping: Planting cover crops between cash crop seasons helps prevent soil erosion, suppress weeds, and improve soil fertility. Cover crops also enhance biodiversity and provide habitat for beneficial insects [43].

Legume cover crops protect soil against compactation and erosion, improve its fertility, reduce weeding degree, assure nitrogen captation and a better biological and physical features [37].

Double and multicropping. In the USA, after winter wheat it is practice to cultivate soybean to intensify the use of land and increase production based on healthier and richer soils, a higher soil fertility and farm resilience [5].

Compared to mono-cropping, a three-crops systems could assure an additional USD 100 per acre [27].

Crop Rotation: Rotating crops on a field over time helps break pest and disease cycles, improve soil structure, and maintain nutrient balance. Different crops have varying nutrient needs, reducing the risk of nutrient depletion and promoting soil health.

In Romania, wheat yield was increased practicing a three crop rotation, using peas like ameliorative plant [2].

Integrated Pest Management (IPM): IPM combines biological, cultural, and mechanical methods to manage pests, minimizing reliance on chemical pesticides. Practices include crop diversification, habitat manipulation, and use of natural predators to control pest populations [3, 35].

Agroforestry: Integrating trees and shrubs into agricultural landscapes enhances biodiversity, improves soil health, and provides additional income streams [43]. Agroforestry systems can include alley cropping, silvopastures, and windbreaks, among others [28, 38, 39, 40].

Nutrient Cycling and Composting: Recycling organic matter through composting and nutrient cycling reduces the need for synthetic fertilizers and improves soil fertility. Compost can be made from crop residues, animal manure, and food waste, returning nutrients to the soil in a closed-loop system [43].

Animal manure could be a good soil amendment after composting [26].

Valorization of biocompost of ornamental plants could also sustain circular economy [48].

Precision Agriculture: Using technology such as GPS, sensors, and data analytics, precision agriculture optimizes inputs such as water, fertilizer, and pesticides, minimizing waste and environmental impact while maximizing crop yields [34, 1].

Livestock Integration: Integrating livestock into cropping systems through rotational grazing or mixed farming systems can improve soil fertility, reduce weed pressure, and enhance nutrient cycling. Livestock manure can be used as fertilizer, closing nutrient loops within the farm [21].

These circular agriculture practices contribute to sustainable food production by conserving resources, protecting ecosystems, and promoting resilience in the face of environmental challenges [49]. By adopting these practices, farmers can enhance productivity, reduce environmental impact, and contribute to the transition towards a circular economy.

CONCLUSIONS

The transition to the circular economy will be systemic, profound and transformative, both in EU and outside it. Most of the times the transition will be destabilizing.

This will require the cooperation of all stakeholders at all levels – from international to local ones.

There are a large number of barriers to adopting circular agriculture practices and the main ones are specified below:

-The lack of education and awareness regarding the promotion and adoption of circular economy. For example, in the field of agriculture, it is needed to pay more attention

to organic farming, which has to be extended on larger surfaces in the EU member states; regenerative agriculture had to maintain land structure, quality, fertility, promoting modern technologies friendly with the environment and other sustainable practices.

-Resistance to change is a matter of mentality and a common barrier to accept and implement sustainable agricultural practices. A part of the people are reluctant to change due to their working routines, long practice technologies, or mind-sets due to various reasons.

-Lack of infrastructure is also a barrier in promoting new technologies.

-Also, the lack or non sufficient funding are restrains in implementing and expanding modern technologies, and applying innovations.

-Limited access to markets is favoured by the weak the cooperation between government organizations, private sector stakeholders, farmer organizations, and civil society.

But circularity in agriculture should not be seen merely as a concept but a necessity for building a sustainable and resilient economy of the future.

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