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## Towards Circular Economy: Conceptualization and Common Practices in the Food Industry

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### ABSTRACT

Circular Economy (CE) is a newly emerged concept in the food industry and it proposes a system, where resources are allocated in an efficient way ensuring sustainable economic growth and environmental protection. To reduce the waste and energy use in the food industry, proper policies and strategies should be enacted through close cooperation between the government and the business sector.

This article studies the CE concept through an integrated literature review. Specifically, the current conceptualizations by scholars and international organizations are presented, followed by a set of recommended practices from the perspective of waste management, resource and energy use.

### Introduction

Exponential growth of the global population, food shortage and environmental degradation are the major issues the world faces nowadays. To tackle these challenges more complex policies and management practices should be undertaken especially in the agri-food business environment to ensure food security while relaxing the environmental pressure on scarce resources.

Armenia, as a developing country, is more vulnerable to the environmental degradation and climate change, which can have a significant impact on agriculture (Ludwig, et. al, 2007). Thus, adaptation is urgently needed to maintain the economic growth in the country. In this sector, the majority

of the companies have the linear production models, which may not ensure competitiveness and efficient resource allocation for the firms, hence the transition to circular and innovation-run business models is crucial for improved productivity with limited resource depletion.

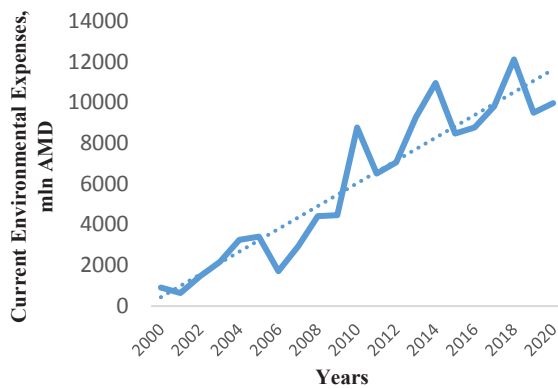
During the recent decade, some local and international organizations have attained rightful recognition on the perks of sustainability and prioritized funding in developing countries. In this context Armenia also took corresponding actions towards a smooth transition and even adoption of circular principles.

Albeit this emerging trend, the number of sustainable firms is not sufficient yet. Currently, structural changes need to

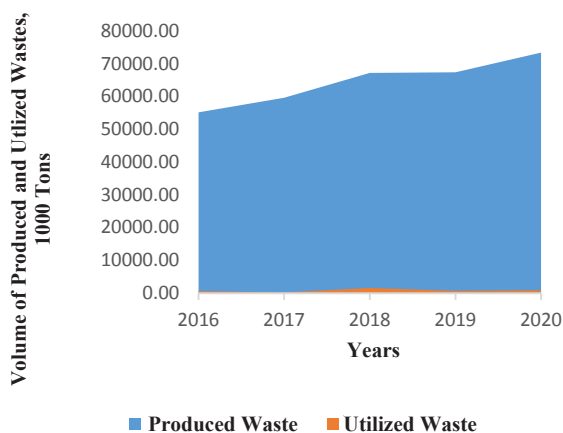
be implemented at a larger scale, so that the firms survive in an extremely competitive environment. This action will help the firms to meet the rising demand for goods and services.

It is noteworthy that the Government of RA has also increased its funding for the environmental protection to mitigate the environmental degradation, which can be noted in Figure 1 (ArmStat, 2022). On the other hand, it is noteworthy that the amount of the produced waste is increasing as well without being treated and reused properly by the organizations (Figure 2).

Back in 2000, the expenditure intended for the environmental protection was only 904 million drams, while in 2020 the same figure was 11 times higher than in 2000.



**Figure 1.** Current expenses for environmental protection and fixed assets by indicators and years (composed by the author).



**Figure 2.** Produced and Utilized Waste by Organizations (composed by the author).

Although there is a lacking data on the waste amount and committed funding for the waste treatment in the agrifood sector, however, the Government of RA has emphasized the role of the environmental sustainability in the policies and state-funded programs. Ensuring sustainability in implementation of new technologies towards innovation is crucial from the perspective of efficient resource allocation, food security, and profit maximization as a major operational value (FoodDrinkEurope, 2020). In addition, addressing the issues of transmission towards circular business models can be leveraged to achieve a few of the Sustainable Development Goals and their respective targets, such as SDGs 2, 3, 8, 9,12.

However, there are a number of barriers for implementing sustainable practices including the principles of CE in Armenia. Particularly, there is a lack of information on circular practices and an enterprise-level analysis in the literature (Gedam, et al., 2021). Some international organizations have promoted the implementation of CE practices through pilot programs, however, transmission at a larger scale is still missing. This study can significantly contribute to the scientific dissemination of this topic and could be applied by the private and public sectors.

The objective of this study is to explore the widely used definitions of circular economy, identify the expected key impact, as well as explore the key circular practices that can be applied by the firms in the agri-food sector within the bigger context of green economy and environmental sustainability. These practices are mainly suggested in the scientific literature by prominent scholars or in the reports prepared by international organizations.

**Materials and methods**

The literature review plays a key role in this research study in order to extract the most widely used definitions of the circular economy by examining articles and documents published in local and international prominent scientific journals. The reports of the international non-governmental organizations were also included in the literature review. The following key words have been applied to find journal articles and other publications with this topic: “circular economy” and “business models”, “circular economy” and “environmental impact”, “circular economy” and “agri-food”. As a result of the study, 5 different definitions of “circular” economy were filtered, and the key words of each were given by the author aligned with the pillar of its major impact.

Due to the rapid development of the concept of circular economy, the chronological order of the papers was also taken into consideration. The reviewed articles are mainly published within the past 20 years.

**Results and discussions**

**1. The concept and definitions of circular economy**

The concept has been originated back in 1966 by Boulding and later by Pearce and Turner (Masi, et al., 2018). It was described as “a closed system with practically no exchanges of matter with the outside environment”. Circular economy has a wide range of practices, and they are strongly interconnected with environmental and ecological economics. Circular economy ensures a close system, where materials, resources and energy can flow for multiple times in production.

In the scientific literature there are more than 100 definitions on the circular economy, since different researchers and professionals from multiple backgrounds apply this concept in their works. The definitions of the “circular economy” often focuses on the 3R model, which is Reuse-Reduce-Recycle. According to Korhonen et al., definitions that highlight the system change for achieving circularity, propose the following elements: closed cycles, renewable energy and systems thinking. It often applies the principles of the closed-loop system. With this regard, during the production cycle there is minimum or zero-waste, as the residuals of the raw materials during the entire production cycle can be considered as a resource for sub-product or the same product in the next cycle maintaining the quality and other characteristics (diagram).

The renewable energy is one of the major components

in circular economy. Nowadays, resource efficiency and application of sustainable energy sources are becoming increasingly viable alternatives to traditional fossil fuels (Rizos, et al., 2017).

Additionally, circular economy requires a system thinking, which is to bridge resource use and waste management practices to design and engineering (SMO, 2020).

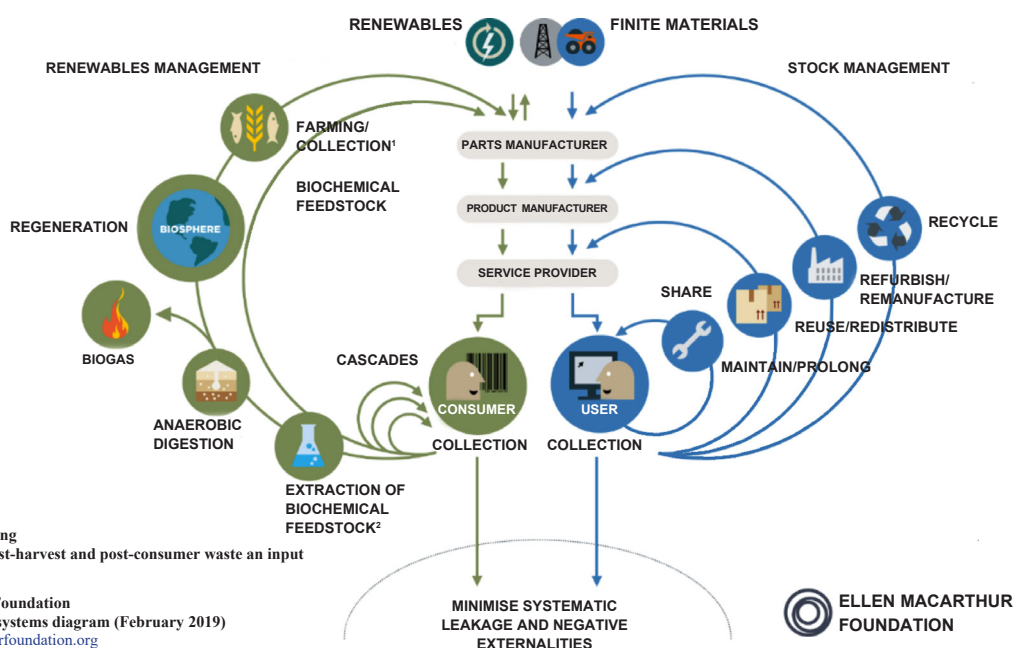
In the introduced Table five definitions of circular economy are chosen from the literature in order to see the interpretations of academicians and international organizations on the concept. In the second column, the key impact is identified by the author based on the definition.

**2. The most common CE practices in food industry**

**2.1 Waste management**

According to the World Economic Forum, the circular economy is a trillion-dollar industry with massive opportunity for innovation, job creation and economic growth. In circular economy, waste is a valuable resource, which not only will benefit the companies to reduce their costs, but also will help to protect the environment.

After the industrial revolution in the linear production model, we have made products, used them and disposed afterwards, especially regarding the agriculture accumulating waste, which are very hazardous for the entire ecosystem. The waste production in Agriculture is presented in Figure 3.



1 Hunting and fishing  
2 Can take both post-harvest and post-consumer waste as an input

SOURCE  
Ellen MacArthur Foundation  
Circular economy systems diagram (February 2019)  
[www.ellenmacarthurfoundation.org](http://www.ellenmacarthurfoundation.org)

Drawing based on Braungart & McDonough  
Cradle to Cradle (C2C)

**Diagram.** Circularity diagram - Source: Ellen MacArthur Foundation.

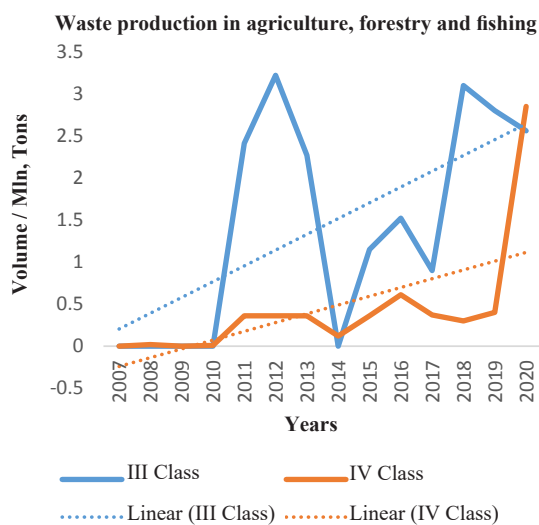
**Table.** Some definitions for circular economy\*

Definition	Key impact	Reference
<p>“A circular economy decouples economic activity from the consumption of finite resources. It is a resilient system that is good for business, people and the environment”</p> <p>The overall aim of the circular economy is “enable effective flows of materials, energy, labor and information so that natural and social capital can be rebuilt”</p>	<ul style="list-style-type: none"> <li>• Resilient system</li> <li>• Regenerative social and natural capital</li> <li>• Effective materials flow</li> </ul>	Ellen Macarthur Foundation (EMF, 2022)
<p>“The circular economy helps to decouple economic growth from resource use, protecting Europe’s natural resources while boosting sustainable growth. It will help the European Union to strive to reduce its consumption footprint and double its circular material use rate in the coming decade”</p>	<ul style="list-style-type: none"> <li>• Sustainable economic growth</li> <li>• Protected natural resource capital</li> <li>• Reduced consumption</li> </ul>	European Commission <a href="http://www.ec.europa.eu">www.ec.europa.eu</a> (EU, 2020)
<p>“A circular economy provides opportunities to create well-being, growth and jobs while reducing environmental pressures. The concept can, in principle, be applied to all kinds of natural resources including water and land.”</p>	<ul style="list-style-type: none"> <li>• Reduced environmental pressure</li> <li>• Well-being</li> <li>• Economic growth</li> </ul>	EEA
<p>“The Circular Economy represents the most recent attempt to conceptualize the integration of economic activity and environmental wellbeing in a sustainable way.”</p>	<ul style="list-style-type: none"> <li>• Economic Integration</li> <li>• Sustainable Economy</li> <li>• Environmental well-being</li> </ul>	Murray, Skene and Haynes, 2015
<p>“Circular Economy is a mode of economic development whose purpose is to protect the environment and prevent pollution, thus facilitating sustainable economic development”</p>	<ul style="list-style-type: none"> <li>• Economic Development</li> <li>• Environmental Protection</li> <li>• Sustainable development</li> </ul>	Ma S., Wen Z., Chen J., Wen Z.C.

\*Composed by the author.

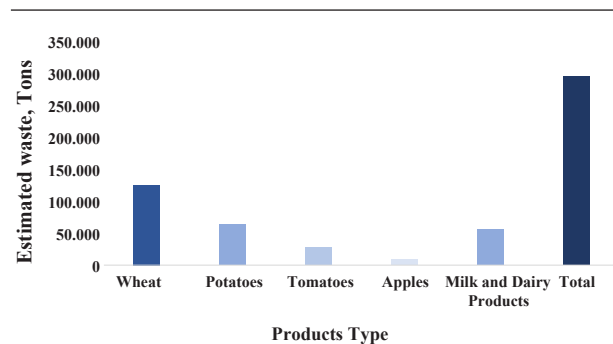
According to the Ministry of Environment, Decree № 430-N of 2006, waste in Armenia is classified according to the following degrees of danger: 1st, 2nd, 3rd, 4th and

5th. The most dangerous wastes are of the first degree, and wastes of the 5th degree are not considered hazardous. On the other hand, waste in agriculture can be in different forms starting from the production of raw agricultural materials and ending with losses in packaging process.



**Figure 3.** Waste generated in Agricultural Sector (composed by the author).

The waste amount generated by the most strategic agri-food chains in the country is depicted in Figure 4, in line with FAO report:



**Figure 4.** Estimated waste amounts and losses of five produce (entire food chain) in 2009 (composed by the author).

As can be noted in the figure, the amount of waste generated has an increasing trend not only in the entire world, but also in Armenia. However, since the size of farms in Armenia is mostly small or medium with low financial situation, the amount of chemicals and animal drugs in the waste is low making it safe to recycle the waste and reuse (Bolagen, 2020).

If all the waste generated in the agri-food sector were recycled, we could have powered around one million households with renewable electricity, as usually leftovers from food are energy and nutrition-rich. Based on the integrative literature review, the following major circular practices can be applied in the food industry through an efficient waste management:

### Composting

Composting is a biological degradation of the organic matter, when aerobic and anaerobic microorganisms break down the waste into manure, which can enrich the soil for improved productivity. This substance improves the soil structure providing the plant with necessary nutrients such as nitrogen (N), phosphorus (P) and potassium (K), it improves the physico-chemical and biological properties of the soil.

Researchers found that the cost of transportation of the organic waste is very high, which is an obstacle for scaling up its use, however, producers and processors can use it on their own farms, which can cut the cost of the fertilizers and improve the quality of the soil (Narasimmalu and Ramasamy, 2020).

### Bioenergy production

Food and agricultural sector are one of the greatest contributors of the greenhouse gas emissions having negative impact on the environment (Barros, et al., 2020). Compared to developed countries, developing countries have more supply chain losses in the food industry. However, recently many companies have adopted their own policies to switch to renewable energy sources. Bioenergy generation is one of the ways that waste in food supply chains can contribute to.

In food industry there is a huge potential to generate bioenergy with the form of biogas through anaerobic digestion, that produces methane (Urutyán, 2013). This entire process is very similar to what happens when the waste is dumped in the landfills. Even small-scale generation of biogas is important especially in those areas, where deforestation is a huge problem.

### Subproducts design

Agricultural production produces high amount of waste and by products, which are very harmful for the environment. In fruit processing, the byproducts which are bagasse, peels, trimmings, stems, shells, bran, and seeds compose around 50 % of the raw fruit product and they are mostly wasted (Torres-León, et al., 2018). However, those byproducts are very nutritious and energy-rich, which can be used in development of other products.

By products generated in food industry can be used to minimize the issue of food security and malnutrition around the globe, since they are rich in proteins, lipids, carbohydrates and microorganisms, which can be used to produce new forms of foods or additives. Many byproducts in fruit processing sector, for instance, can be used in oil production (seeds, peels) for cosmetics, pharmaceutical operations and food industry. Animal feed is among the most frequently made subproducts in the food supply chain.

### 2.2. Energy use

Achieving resource efficiency is an important step towards more circular economy so that the businesses maintain the highest values of the resources and keep those in the production cycle as long as possible, which will allow to reduce waste significantly and the cost associated with incremental resource integration into the production.

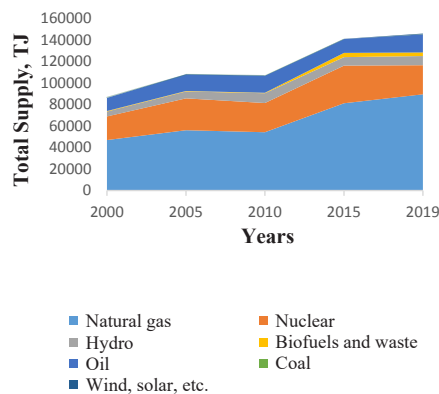
Closed-loop system is one of the major ways of ensuring resource efficiency through minimizing the extraction of materials used in the production, as well as reduce the amount of the waste through treatment activities and material recycling (OECD, 2021). Slowing the resource use, on the other hand, helps to extend the lifespan of the products through repairs, remanufacturing and reuse. In this context, resources are always regenerative and renewable in Circular Economy.

Noteworthy, that energy is one of the key resources in every sector including Agriculture. Currently, our country has three major gaps in the energy sector: supply gap; reliability of the energy supply; and the stability of the tariffs (Figure 5).

Armenia doesn't have oil and gas resources; thus, it is dependent on the imported resources. On the other hand, generation of renewable energy is still emerging in the country and the current volume is not satisfactory (IEA, 2021).

To properly address this issue, Armenia needs to solve the energy disbalance through identifying not only the

needs of the economy, but also that of the society and environment. The following three elements are especially important in the context of “reduce-reuse-recycle” model: energy conservation, efficiency and renewable energy.



**Figure 5.** Total energy supply by source (IEA, 2022) (composed by the author).

**Energy conservation** includes the set of practice meant to use less energy. This happens due to the adjustment in the organizational behavior (Shinduja and Shanmugaraj, 2020).

According to Wang, the following strategies can be applied to reduce the energy demand in food processing (Wang, 2008):

1. Design new methods of food production that don't require energy-intensive preservation technologies
2. Reduce the heat load during the processing
3. Improve the performance of the equipment in use
4. Use waste heat during the processing.

**Energy efficiency** helps to reduce the energy costs through eliminating the waste. Due to efficiency the energy consuming activity can be performed at lower costs (ACE, 2016). It helps to cut the greenhouse gas emissions, the needs for import and compared to the costs of installing renewable energy, the cost of maintaining energy efficiency is considerably low.

To ensure energy efficiency in the production facilities, the following activities should be carried out:

1. Install energy efficient doors and windows
2. Implement thermal insulation (roofs, doors, walls, floor, ground floor, ceilings)
3. Improve the internal thermal distribution.

## Renewable energy

Agri-food industry is one of the biggest consumers of the world energy, which is around 30 % and it is responsible for the one third of global emissions, therefore transformation of energy in the food industry is essential to meet the rising demand of food. Renewable energy is a promising resource in Agriculture, as it can create better job opportunities, cut the losses and support the global actions for the climate mitigation.

According to International Energy Agency, renewable energy composes around 8.8 % in the energy mix of the country, while around 32 % of the electricity generation relies on the renewables.

Renewable energy is one of the core components of the circular economy. The major renewable energy type utilized in Armenia is solar due to the favorable climatic conditions. Solar energy can be used especially in fruit processing sector (dried fruit processing), which can significantly cut the cost of the electricity and gas needed in production. Implementation of the wind energy is limited in Armenia and currently no geothermal energy is extracted in the country.

Generation of biomass and waste energy has a large potential in the country especially in the agricultural sector, however, they are not widely used yet. The application of the bioenergy can reduce the energy costs in the processing sector, improve the welfare of the rural population and overall, increase the energy independence of the country.

## Conclusion

Circular economy is a comparatively new concept in food industry in the Republic of Armenia; thus, this paper is aimed at discovering the current conceptualizations of the circular approach. The major methodology applied in this paper was integrated literature review. The major elements covered in the paper were the widely used definitions from different sources including reports prepared by international organizations and websites specifically committed to circular economy.

Five different definitions of circular economy were extracted from the literature and the key impact of each definition was highlighted. Overall, based on the most common definitions, identified circular economy ensures sustainable economic growth with a regenerative social and natural capital.

This paper contributes to the literature of circular economy through highlighting the widely accepted practices in the pillars of waste management and energy use. As a result,

the following activities can be implemented in circular economy to minimize waste:

- Composting
- Subproduct design
- Bioenergy production.

While, there are many other practices, the ones mentioned above are mostly common in the literature. As for the energy use, the following practices are recommended for the enterprises in the food industry:

- Energy conservation
- Energy efficiency
- Application of renewable energy.

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