AGRICULTURE, WATER, AND CIRCULAR ECONOMY. SCIENTIFIC RESEARCH TO THE RESCUE

Ana Isabel López Sesé and Vicente Manuel García Cañizares

Jane's Walk 2022. "Making the invisible visible"

The current economic system is linear, based on using and throwing away products, and leading to the generation of a huge amount of waste. In fact, less than 20% of the materials used in Europe come from recycling. Faced with this system, circular economy is proposed as an alternative to this waste, seeking to alleviate its effects on a planetary level. Although the concept of circular economy appeared four decades ago, this term became popular since 2012. This type of economy aims to get a better relationship between society and nature, trying to avoid the depletion of resources and achieving a more sustainable development by closing the cycles of materials and energy. It is not just about small gestures such as setting filters in drains and chimneys, burying waste or recycling partially, but about doing things in a different way, and compatible with nature.

Although this form of economic development is still far from being globally established, some proposals have already been put on the table, such as the European Circular Economy Plan, valid since 2015, as well as the Spanish Circular Economy Strategy.

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The circular economy is based on three principles:

1. No waste: design and optimization of products in order to be reused at the end of their useful life.

2. Management of biological and technological materials for their reincorporation into the ecosystem and the industrial system, respectively, minimizing the environmental impact.

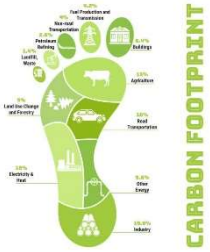
3. Use of renewable energies in the processes.

It is about rethinking the way to reduce the use of resources, revalue waste and even encourage industrial collaboration, so that the waste of one company become resources for another one in a joint design (symbiosis). This also minimizes the waste that contaminates marine and terrestrial ecosystems and puts health at risk. Citizens can contribute in many ways: consumption of local products, reducing waste, using collective and/or carpool... The challenge, obviously, is not easy.

Agriculture, food producer and basic pillar of society, like livestock and its processing industries, generates a great impact on the environment due to the significant volume of by-products and waste. These products could be used as secondary raw materials, being the agri-food industry one of the key

sectors in terms of resource reuse. Thus, recycling and reuse play a fundamental role in agriculture, seeking a balance between production and distribution. The management of irrigation water is very important, with a more efficient use in agriculture. Its reuse could be an alternative and a way of recycling nutrients in agriculture, reducing the need for mineral fertilizers. About three quarters of the water extracted from the natural system is used for irrigation, sometimes leading to the overexploitation of aquifers, as if it were an infinite resource.

The invisible water used in the production process (agricultural, food or industrial) is called "water footprint", and that one from crops varies greatly depending on place, time of year, variety and agricultural production system. In addition, the "carbon footprint", meaning the CO_2 emissions necessary for the product to reach our table, depends, among other things, on the use of cold storage, transport, and the use of heating in certain areas. However, sometimes product imports do not increase water and/or CO_2 footprints if they come from regions where they have grown in season and with more abundant resource endowments (water and sun), or if production generates less waste.



The knowledge provided by scientific research and technology generated nowadays is available to produce more and in a better way, reducing the use of resources like energy and facilitating a smarter water management. The digital transformation seeks to provide the best information so that the best possible decisions can be taken. The European Green Deal includes initiatives that particularly affect agriculture, such as the Biodiversity Strategy and the Farm to Fork Strategy. The planned strategic actions must consider the binomial "water and energy". Here it is where the new information technologies (Big Data, Internet of Things, artificial intelligence), remote sensors, the control of data monitoring systems (Agriculture 4.0) open up new possibilities for optimization and more rational and sustainable management of water and energy.



Many projects led and managed by scientists around the world are currently being carried out, putting into practice elements of precision agriculture, and using of microbiological resources and botanical diversity, among many other topics, and they indicate that many options remain to be explored for a more sustainable food system. Some of these projects include, for example, the use of drones provided with sensors in order to estimate the need for fertilizers, as well as proposals for the reuse of wastewater in a profitable way. Also, for example, the more widespread use of mycorrhizal fungi that might improve plant resilience against future environmental conditions (climate change), providing a more efficient absorption of water and minerals from the soil, and even being able to

increase resistance to drought. The results derived from this type of studies could provide valuable information for advising to farmers.

Increasing the diversity of foods, recovering forgotten foods and introducing new varieties might offer possibilities for a more sustainable development. Three quarters of the food produced in the world comes from only twelve plant and five animal species, and it is estimated that more than 900 cultivated plant species are in danger of extinction. Possibly there are many foods that are resistant to climate change, loaded with nutrients and that could be produced sustainably.

It is clear that there are more and more projects underway to seek solutions based on nature and applied to the sustainability and protection of water resources, as well as the reuse of materials and waste. It is an emerging and very promising area that demands new and economically viable strategies. Some of these scientific projects, related to plant breeding and circular bioeconomy of plants, are being developed very close. For instance, at the Institute of Subtropical and Mediterranean Horticulture "La Mayora" (IHSM, CSIC-UMA), a research line is being developed focused on the manufacture of sustainable bioplastics from plant residues and by-products of the agri-food industry, within the framework of the circular economy, in order to replace the use of petroleum-derived plastics in agriculture and food packaging. The development of environmentally friendly chemical procedures is essential for the transformation of plant biomass into biodegradable polymers, and could help reduce the use of non-renewable sources and the accumulation of toxic and non-degradable waste. In particular, the waste resulting from the tomato industrial processing will be used as a bio-renewable raw material, in combination with other materials such as paper, in order to manufacture biodegradable products of biological origin by using ecological and easily scalable technologies for large production volumes.

Other projects are related to the use of new technologies in under plastic horticulture (greenhouses), studying the physiological plant response in situations of high environmental water demand, as well as changes in flowering periods and the adaptation of subtropical fruit species to climate change.

Scientific research thus becomes, not only an ally, but a key factor in achieving appropriate management of water and energy resources to develop a circular and sustainable economy on our planet.