Thinking circular: The impact of innovation on sustainability and food safety

We all need food to survive. For this reason, European nations have done everything in their power to produce food supplies for their population at reasonable prices in the last 50 years, increasing production and fostering efficiency in the agricultural sector and food industries.

The European landscape has changed dramatically from the rural pastoral scenery of small farms into emporiums of agricultural production dedicated to monoculture. But the efficient agricultural production system failed. That can now lead us to destruction.

We did not understand that natural resources were finite in the 20th century. We didn't think the agricultural land would be degraded and that our way of farming would contribute to climate change and catastrophic events. Now that we are aware, we must move towards sustainable agriculture to survive in the long term.

"Half a trillion tonnes of virgin materials. That is the amount of resources consumed globally over the past six years. This means that 70% more virgin materials were extracted than Earth can safely replenish. We must stop this path!" warned Christa Schweng, President of the European Economic and Social Committee (EESC), at the 2022 Circular Economy Stakeholder Conference.

The truth is that we still have a long way to go. Today 8.6 % of the world economy is circular, which means that only a tiny percentage of the population has embraced an economic model that will lead to a fully sustainable zero waste living.

Merging tradition and innovation in urban farming

There are three critical aspects to reversing this dangerous trend of a linear economy, according to Schweng. First, we need to limit the depletion of our planet's finite resources. Second, we need to change the way we consume and produce, and third, we need to optimise how we manage our waste.

The good news is that hundreds of scientists have been working for years to solve our urgent need to produce food without damaging the planet. In the agricultural sector stakeholders are focused on promoting the transition from linear agricultural

BBI JU Bio-based Industries Consortium Horizon 2020 European Union Funding for Research & Innovation

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 887191. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

models to circular food systems. This means that all water, nutrients, and energy resources are reused, minimising waste.

In a circular food system, industries use products for multiple purposes. For example, the inedible parts of vegetables are used as animal feed or as resources to produce biobased products like chemicals and fibres. Currently the textile industry is working with fabrics made from coconut, orange, or pineapple residues. Biomass can also be transformed into bioenergy or used for humus formation or soil cover to reduce erosion and water losses.
"Circular food systems prioritise regenerative production, favour reuse and sharing practices, reduce resource inputs and pollution and ensure resource recovery for future uses," reports the non-governmental organisation Local Governments for Sustainability (ICLEI).
Bastian Winkler, Doctor of Agricultural Sciences and researcher at the University of Hohenheim, is developing a cultivation method for urban food production called 'terrabioponic' based entirely on using and circulating water, nutrients, and energy within the production system.

Winkler says that conventional farming systems rely heavily on fertiliser, pesticides, and monoculture production. The problem is that these systems are economically optimised at the expense of biodiversity, ecosystem services, and our climate. "This leads to the point that more inputs are needed to sustain the same yield. Overall 33% to 50% of the arable soils are 'under degradation,' said Winkler. Conventional agriculture is responsible for about 30% of the global greenhouse gas emissions.

According to this German agricultural scientist, farmers produced circular by default until the early 20th century because they only had locally available resources and a specific climate. "They must have had great knowledge about circularity and efficient resource use to produce diverse biomass for multiple uses without destroying their soils and ecosystem services while supporting their farming activities," said Winkler.

Winkler suggests that the answer lies in a combination of both local traditional knowledge and modern, technical, and globalised innovations to revolutionise agricultural production.

Leaving no trace

The issue of waste represents an enormous challenge for society.

How have we turned the planet into a garbage dump when nature produces no waste? Natural ecosystems are wasteless because they are circular.

BBI JU Bio-based Industries Consortium Horizon 2020 European Union Funding for Research & Innovation

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 887191. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

Nature is a perfect system. Fertile land allows plants to grow, animals eat plants and other animals, animal faeces fertilise the soil, and plant and animal matter are decomposed by fungi and transformed into nutrients to recover the land and start a new life cycle. Sadly, the industrial economy created by humans is linear, a model based on "take, make and dispose."

But many researchers are already trying to change the rules of the game.
Anne Lamp is a process engineer and has a PhD in Biopolymer Science. She created a solution to manage non-biodegradable products. Her answer to waste was inventing a holistic, sustainable alternative to plastic using residues from agricultural food production.
An environmental scientist by conviction and a tech enthusiast by heart, Lamp and Johanna Baare founded Traceless, a circular bioeconomy startup focused on developing a novel generation of biomaterials.

"With our innovative, patent-pending technology, we extract remaining natural polymers together with other ingredients from residues–this way, we make use of their natural properties. Raw materials are transformed into a granular material that can then be further processed, for example, into films, coatings, and rigid products for the plastic converting and packaging industry. That way we for the first time connect the agricultural and the plastics industry!" Lamp said.

According to this German scientist and entrepreneur, traceless materials are cost-effective compared to current alternatives to conventional plastics. Lamp emphasised that their technology is cheaper because raw materials are leftovers from agricultural industries, like starch and brewery residues.Traceless materials look and feel like plastic but are made of natural polymers that are 100% home compostable. Depending on the condition and thickness of the material, composting may take between two to nine weeks.

If Lamp and her team are successful, they will engineer advanced biomaterials that integrate into nature's biological cycle without leaving a trace.

A Decision-Support System for nature

Another essential effort to reutilise food industry residual streams is Model2Bio, a mathematical tool for managing residual streams produced in agri-food companies.

Model2Bio is an innovative concept that using predictive models will be able to select the best ways for valorising the agri-food streams considering their composition,

BBI JU Bio-based Industries Consortium Horizon 2020 European Union Funding for Research & Innovation

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 887191. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

seasonality, and industry location. The project, funded by the European Union and Coordinated by the Asociación Centro Tecnológico (CEIT), is creating an innovative solution to reduce the number of residues in agri-food industries.

CEIT researcher, Tamara Fernández Arévalo, stated that "the goal is sustainability. It is strategic to reuse, transform, renew and recycle materials, products, by-products and the rest." The focus is to change to a circular economy, according to Fernández: "The paradigm so far has been to produce, use and throw away, and the key is to end it and move on to the circular economy. It is important to reuse resources as much as possible: energy, water, the materials themselves…."

For companies that have worked with a different approach, it is not easy to move into the circular economy, as investments are needed to adapt. Fernández explains the obstacles: "Apart from funding, there are also cultural barriers, as we are deeply involved in the culture of consumption. And there are political hurdles because laws and regulations do not require a circular economy. It should be a collaboration between everyone. I think there is a desire and an interest and there is a need, but we need to take steps, for example with grants to encourage companies to transform."

The test and validation of the predictive simulation tool will occur in the complex industrial environments of the meat, vegetable, dairy, and alcoholic beverages sectors in Spain, Belgium/the Netherlands, and Greece.

It is expected that this decision-support system tool will be adopted by food and drinks industries, waste managers and bio-based industries to meet the EU objectives of improving waste management and fostering innovation in recycling food waste while limiting landfilling.

The potential benefits of adopting this mathematical model are enormous for the EU. Theoretically, Model2Bio could decrease by 10% agri-food waste landfilled or incinerated without energy recovery and transform 30% of residual streams in resources for other bio-industries. It could also increase income and business opportunities to agri-food and waste management companies.

The journey ahead

There are many challenges to making circular food systems the rule rather than the exception.
Research centres play a crucial role in developing knowledge, know-how, technologies, and processes required for the transition towards circular food

BBI JU Bio-based Industries Consortium Horizon 2020 European Union Funding for Research & Innovation

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 887191. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

production. It is also essential that scientists work closely with businesses, local governments, ONG, and consumers to make circular food systems a reality.

"This journey is far broader than transforming the agricultural system. It has to consider all aspects of linear food value chains to design complex circular food value webs that comprise multiple production systems, industrial sectors for biomass conversion into various biobased products and their marketing - all embedded in natural resource cycles where every part has its purpose and function," Winkler said.

The key is to emulate nature through scientific innovation to ensure our food security and contribute to the planet's wellness.

7 April 2022

Mariángela Velásquez for ESCI

BBI JU Bio-based Industries Consortium Horizon 2020 European Union Funding for Research & Innovation

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 887191. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.