



*One third of all the food produced is wasted.*

# Thinking circular

## The impact of innovation on sustainability and food safety

European nations have done everything in their power to produce food supplies for their population at reasonable prices over the last 50 years, increasing production and 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 systems have their drawbacks.

In the 20th century we didn't think agricultural land would be degraded and that our way of farming would contribute to climate change and catastrophic weather events. Now that we know,

we must move towards sustainable agriculture and food processing.

"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

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the European Economic and Social Committee (EESC), at the 2022 [Circular Economy Stakeholder Conference](#).

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 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.

### Circular production at scale

In the agri-food sector stakeholders are already focused on promoting the transition from linear production models to circular food systems. This means that all water, nutrients, and energy resources are reused, minimising waste.

In a circular food system, agri-food 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. The textile industry is working with fabrics made from coconut, orange, or pineapple residues. Biomass can also be transformed into bioenergy or form humus (soil organic matter) or soil cover to reduce erosion and water losses.

Bastian Winkler, Doctor of Agricultural Sciences and a researcher at the [University of Hohenheim](#), is developing an urban cultivation method called '[terrabioponics](#)' based on using and circulating water, nutrients, and energy within the production system.

Winkler says that the modern systems we use to produce food rely heavily on fertiliser, pesticides, and monoculture production. 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 Winkler, 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

Both Lamp and Johanna Baare founded Traceless, a circular bioeconomy startup focused on developing a novel generation of biomaterials.

Lamp explains that their patent-pending technology extracts any remaining natural polymers from food residues and ingredients usually thrown away during processing. The natural properties of these residues can then be used for something else in the production process.

"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

“**We for the first time connect the agricultural and the plastics industry.**”

knowledge and the agri-food industry's modern, technical, and globalised innovations to revolutionise agricultural production.

### Sustainable packaging

The waste produced in the agri-food industry is also ripe for innovation. Anne Lamp is a process engineer and has a PhD in Biopolymer Science. She created a solution to manage non-biodegradable products like plastic packaging. Her answer to waste was inventing a holistic, sustainable alternative to plastic using residues from agricultural food production.

converting and packaging industry," said Lamp. "That way we for the first time connect the agricultural and the plastics industry."

According to Lamp, traceless materials are cost-effective compared to current alternatives to conventional plastics. She 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.

### Using a decision-support tool to become circular

Another essential effort to reutilise residual streams from the food industry is made by the research project [Model2Bio](#). The goal: a mathematical tool for managing residual streams produced in agri-food companies.

The Model2Bio tool is an innovative decision-support programme that will be able to select the best ways for valorising agri-food by-products. The tool will use predictive models and will consider the stream's composition, seasonality, and industry location.

The project, funded by the European Union and

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coordinated by the [Asociación Centro Tecnológico \(CEIT\)](#), is creating an innovative solution to reduce the number of residues in agri-food industries. The predictive simulation tool will be tested and validated in the complex industrial environments of the meat, vegetable, dairy, and alcoholic beverages sectors in Spain, Belgium, the Netherlands, and Greece.

The decision-support system tool is developed to help both food and drinks industries and 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 goal is sustainability,” [said](#) CEIT researcher Tamara

Fernández Arévalo. “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. “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, and 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.



*Team of the Model2Bio project with the coordinator Tamara Fernández Arévalo (fourth from the left)*

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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 Model2Bio tool has great potential for the EU to progress towards a more circular agri-food industry. According to estimations, the tool 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 for the agri-food industry.

Research centres play a crucial role in developing knowledge, know-how, technologies, and processes required for the transition towards circular food production. It is also essential that scientists work closely with agri-food businesses, local governments, NGOs, and consumers to make circular food systems a reality.

“This journey is far broader than transforming the agri-food 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.

*Mariángela Velásquez*



**Bio-based Industries  
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