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Editorial overview: Agricultural wastes or resources?

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Huabao Zheng. He is at the Department of Environmental Science and Engineering, Zhejiang A&F University, China. He obtained his PhD degree at Zhejiang University in 2007. Now the study focuses on the resource utilization of agricultural and forestry wastes. Mainly converting wastes into various fertilizers by microbes under fermentation conditions. Employing fermentation or biotransformation, he is also interested in making valuable chemicals and biofuels by engineered microbes.

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Paola Verlicchi. Degree in chemical engineering, PhD in environmental and safety chemical engineering. Associate professor in environmental and sanitary engineering at the University of Ferrara, Italy. Her main research is in the field of the occurrence and removal of micropollutants from water, wastewater and sludge, and environmental risk assessment due to the presence of micropollutant residues in the environment (water and soil).

Wastes produced in agricultural and zootechnical activities, often called *agricultural wastes*, largely contribute to the total worldwide production of organic wastes. They include food-based portions of crops (fruits, corn, sugarcane, beets, etc.) and non-food parts (stalks, leaves, corn cobs, orchard trimmings, rice straw and husks, etc.), perennial grasses, and livestock wastes and wastewaters.

Their treatment, based on physical, chemical, and biological processes, is a hot topic in fundamental and application research fields: new solutions and alternative treatments are expected to meet stricter environmental conservation requirements and sustainable development requirements. Many efforts are being made in the development of technologies able to remove specific classes of contaminants of emerging concern, mainly hormones, antibiotics, and pathogens.

This special issue collects mini-reviews on the recent findings in agricultural waste treatment processes, by conventional (e.g. composting and anaerobic digestion) and novel technologies (e.g. enzyme-based processes, production of adsorbents, and biofuels), focusing on potential removal mechanisms and efficiencies for specific contaminants as well as the environmental impacts of the treatments.

In this context, **Zhou et al**. give an overview on the removal of natural and synthetic hormones from livestock wastewaters by enhancing the microbial activities or (hydrophobic) compound immobilization. They analyze five different bioprocesses: *manure composting* enhanced by the addition of biochar; *mesophilic anaerobic digestion,* combined with a microwave pretreatment at 120−160 °C; *constructed hybrid wetlands* enhanced by the adoption of an artificial aeration and baffles in the tanks; *MBRs* combined with reverse osmosis, UV/H_2O_2, or activated carbon in powder or granules; and, finally, *microalgae-based systems*, including an algal-bacterial bioreactor combined with hydrothermal processes and microalgae immobilized on a specific matrix.

The effects of the presence of antibiotics in (swine) manure on the anaerobic digestion performance are the subject of the review by Wang et al**.** They overview the changes in the microbial groups developed in the reactor; the biogas/methane production and degradation processes; and the trend over time of the inhibition effects related to the degradation of antibiotics. They remark on the importance of knowing the maximum concentrations of antibiotics that do not affect the process and the necessity to identify the most adequate pretreatments to guarantee these "threshold" concentrations. The review also presents countermeasures to promote and optimize antibiotic removal by anaerobic digestion: acclimatization of selected inoculum; bioaugmentation with functional groups; and development of new anaerobic digestion-based techniques.

The attention of the study by **Cai et al.** is on the proper management practices and adequate treatments of manure to reduce the environmental risks in the case of its agricultural use. The authors focus on the expected increment of the demand of livestock products related to population growth worldwide and thus on the increased amount of excreta to manage and treat, total greenhouse gas emissions, ammonia volatilization, as well as the release of veterinary antibiotics and the spread of antibiotic-resistant bacteria and genes.

The anaerobic digestion systems are the most common treatment for agricultural wastes. They produce a large amount of digestate, the so-called biogas slurry: a liquid with high turbidity, high concentrations of ammonia, organic matter, microorganisms, and heavy metals. Its nutritional content can be utilized by microalgae, serving the dual scope of biogas slurry remediation and microalgae biomass production. Huang et al. overview the main challenges to be faced in its management and treatment due to its high pollutant strength and analyze pretreatments able to guarantee the characteristics required for its employment in microalgae cultivation. The authors remark on the need for future research on economic feasibility issues related to microalgae-biogas slurry treatments, particularly the downstream processes of water reuse and algal biomass disposal.

A promising treatment for various biomasses is thermal conversion which leads to the production of biochar, a carbon-rich material, characterized by multiple uses: carbon sequestration, energy source, feed additive, manure composting agent, and soil additive. Its quality (namely fixed carbon, nutrient content, pH, and cation exchange capacity) depends on feedstock, production technology (pyrolysis, fast pyrolysis, torrefaction, and gasification) and operational conditions (mainly reaction temperature and heating rate). **James et al.** overview these different production methods and focus on the effects of biochar application on soil for agricultural purposes (changes in soil quality and productivity, reduction of the impact of soil pollutants).

A special attention is given to the agroecosystem-climate-change-sustainability nexus in the study by **Yrjaia et al.**, who present the most promising technologies for agricultural waste streams considered as resources in the circular economy for biochar production. This resource management approach may also provide possibilities for local energy production.

Biofuel production is expected to increase in the near future. Regardless of its sugar substrates (such as plant-derived and lignocellulosic biomass-derived), its production is accompanied by CO_2 generation, which implies carbon loss and greenhouse gas emissions. The review by **Godar et al.** deals with the current strategies to face waste CO_2 loss during biofuel production. They include diverse metabolic engineering and synthetic biology approaches to decrease CO_2 generation; and to recycle it through various biochemical mechanisms. Synthetic biology strategies, still currently at the proof-of-concept level, have been developed in order to discover more-sustainable and economically-viable microbial biofuel production processes.

Wang et al. focus on the microbial production of succinic acid from agricultural wastes. It is a versatile compound largely used in food, pharmaceutical, cosmetic, agricultural, chemical, and polymer industries characterized by an increasing worldwide demand. The authors compare the performances of the four promising microorganisms: *Actinobacillus succinogenes*, *Basfia succiniciproducens*, *Escherichia coli*, and *Mannheimia succiniciproducens*, and discuss how to select and treat feedstock, develop succinic-producing microorganisms, optimize fermentation processes, improve recovery and purification steps, and enhance succinic acid producers by means of engineering strategies.

And finally, in his contribution, **Viaggi** focuses on the potential of biomass value webs to provide a snapshot of waste and byproducts considerations into bioeconomy concepts. Through the analysis of some case studies, he remarks on the potential of value webs in the field of agricultural waste management and valorization.

We think that this special issue will promote discussion among the experts in the fields, and will provide ideas for their research aiming at the optimization of available treatment systems, the development of new systems bearing in mind the principles of sustainability, and economic and technical feasibility in the context of the circular economy.

Conflict of interest statement

Nothing declared.