The Role of Treated Wastewater in Sustainable Agriculture: Insights from the SAFE Project at AGIC 2025

Description

At the **5th Atlas Georesources International Congress (AGIC 2025)** in Hammamet, Tunisia, the SAFE project team, supported by CERTE and the PRIMA initiative, presented their research on *“The Impact of Irrigation with Treated Wastewater on Agricultural Soils: Challenges and Perspectives.”* Their findings highlight the potential of treated wastewater (TWW) as a sustainable irrigation resource, particularly in Mediterranean regions facing water scarcity.

1. Effects of Treated Wastewater on Soil Health

Irrigation with TWW introduces **organic matter, nutrients, and microbial communities** that can enhance soil fertility. However, long-term use requires monitoring due to potential risks:

- **Soil Fertility and Structure:** Treated wastewater (TWW) can enhance soil structure by improving aggregation and water retention, which helps reduce reliance on synthetic fertilizers. The high organic carbon content in wastewater supports microbial activity, leading to more efficient nutrient cycling. However, long-term use may contribute to soil compaction and shifts in

microbial communities, potentially affecting soil productivity over time.
- **Salinization and Heavy Metal Accumulation:** Long-term irrigation with TWW can raise soil salt levels, causing osmotic stress in plants and lowering their water uptake efficiency. Additionally, heavy metals such as cadmium (Cd), lead (Pb), zinc (Zn), and nickel (Ni) may accumulate in the soil, potentially disturbing microbial ecosystems and decreasing soil biodiversity.

Several studies indicate that while moderate wastewater reuse can enhance soil quality, excessive or poorly managed application can lead to soil degradation, reduced permeability, and potential toxic accumulation.

2. Impact on Crop Quality and Yield

TWW irrigation provides crops with essential macro- and micronutrients (N, P, K, Ca, Mg), often reducing dependency on commercial fertilizers. However, the quality of treated wastewater plays a crucial role in crop safety and productivity:

- **Yield Improvement and Nutrient Supply:** Yield Improvement and Nutrient Supply: Nutrient-rich wastewater enhances biomass production and boosts yield in water-limited environments. Research on wheat, tomatoes, and leafy vegetables indicates that TWW irrigation can improve plant growth and chlorophyll content.
- **Contaminant Uptake in Plants:** Some persistent organic pollutants (POPs), pharmaceutical residues, and pathogens in TWW can be taken up by plants, posing food safety risks. Leafy greens and root vegetables are especially susceptible to accumulating heavy metals and emerging contaminants, raising concerns about long-term human exposure through consumption. Advanced filtration and post-treatment methods, including activated carbon adsorption, ozonation, and constructed wetlands, are being explored to reduce contaminants in irrigation water.

3. Long-Term Agricultural Sustainability: Balancing Benefits and Risks

The adoption of TWW in irrigation supports climate-resilient agriculture, particularly in arid and semi-arid regions. However, regulatory frameworks, advanced monitoring strategies, and tailored irrigation practices are essential to ensure sustainability.

- **Water Security and Climate Adaptation:** In water-stressed regions, using TWW can help reduce pressure on groundwater reserves and surface water sources. The SAFE project supports the development of integrated water reuse policies, ensuring that irrigation standards comply with EU and WHO guidelines for safe agricultural use.
- **Challenges in Wastewater Treatment and Reuse:** Technological advancements like nanofiltration membranes, electrocoagulation, and biochar-based filtration are being incorporated into treatment processes to improve effluent quality. Research on plant-microbe interactions is aiding in risk mitigation by enhancing the biodegradation of organic pollutants within rhizosphere ecosystems.

The research presented at AGIC 2025 underscores the potential of treated wastewater as a valuable resource for sustainable agriculture, provided that proper treatment, monitoring, and regulatory

measures are implemented. By addressing both the opportunities and risks, the SAFE project is contributing to a scientific and policy-driven approach to water reuse in agriculture, ensuring long-term soil health, food safety, and environmental sustainability.

Category

1. Senza categoria

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