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HOW TREATED WATER CAN FUEL A CIRCULAR ECONOMY IN AGRICULTURE

The use of treated wastewater in agriculture is essential for addressing water scarcity and promoting a circular economy. In this blog, Arsha discusses the potential of treated water to enhance agricultural practices and the importance of educating farmers on its safe and effective use.

CONTEXT

India, classified as a water-stressed country, holds 17% of the world's population but only 4% of its water resources. Agriculture is the largest water-consuming sector, accounting for around 85% of total water consumption. With water scarcity and climate change posing serious challenges, it's crucial to manage water demand efficiently. The traditional open-loop system of linear economy needs to be replaced with a circular economy. In the linear model of take-make-use-dispose," water is extracted, used, and then disposed of as wastewater into water bodies without proper treatment, exacerbating freshwater scarcity and pollution.

Nature based waste water treatment plant

UNDERSTANDING THE CIRCULAR ECONOMY

A Circular Economy (CE) is a closed-loop system focused on reusing, recycling, and regenerating resources to minimize waste and environmental impact. Unlike the linear model, CE maximizes

resource efficiency and extends the life cycle of materials. CE is based on three principles: Eliminate waste and pollution, Keep products and materials in use, Regenerate natural systems. The 9R strategy—refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover—represents the most comprehensive and detailed set of strategies currently available.

One key aspect of CE is wastewater treatment and reuse. Treated wastewater has significant potential for agriculture, yet public concerns about safety, health, and quality have hindered its widespread adoption, especially for edible crops.

TREATED WATER IN AGRICULTURE

The public perception regarding the use of treated water for gardening (non-edible crops) and landscaping is positive up to an extent. However, its application in edible crops is not very well received due to concerns about contaminants like pathogens, heavy metals, or chemical residues. Such concerns are of a serious nature, as even a slight alteration of the water used for irrigation could impact the safety of the produce, impacting the health of consumers. Edible crops like leafy vegetables, which are consumed raw, are more susceptible to heavy metal contamination, while non-edible crops pose significantly fewer concerns.

Vegetables grown using treated water in Municipal Sewage Treatment plant in Dombivli, Maharashtra

In my own research conducted at the Tata Institute of Social Sciences as part of my Master's programme, I found that cases where treated water is used for irrigation of edible crops are very few compared to non-edible crops. Two cases of each are explained below (Box 1).

Box 1: Case Studies

Treated Water for Edible Crops — STP Dandhupura, Agra
In Agra, treated sewage water from the Dandhupura Sewage Treatment Plant is used for irrigating crops like pearl millet, wheat, mustard, and sorghum due to limited freshwater availability. Studies show that fields irrigated with treated sewage water have higher organic carbon and nutrient content, improving soil fertility and reducing the need for synthetic fertilizers. Crops irrigated with treated water also demonstrated higher yields and better cost-benefit ratios compared to those irrigated with groundwater.

Treated Water for Non-Edible Crops — HDIL Residency Park, Virar, Mumbai
At HDIL Residency Park in Mumbai, treated sewage water using CAMUS (Continuous Advanced Mite Utilizing System) technology is used for flushing, gardening, and cleaning. This nature-based treatment plant not only serves functional purposes but also enhances the aesthetic appeal of the residential area without requiring additional land.

Primary treatment tank of a Sewage Treatment Plant in Dombivli, Maharashtra

The Central Pollution Control Board (CPCB) of India has established water quality standards for various uses, classifying water for irrigation, industrial cooling, and controlled waste disposal under Class E. Recently, the CPCB released draft guidelines for using treated sewage water, which also meets Class E standards, ensuring that the quality of treated water remains uncompromised.

However, the current operating capacity of Sewage Treatment Plants (STPs) in India raises concerns about the effectiveness and quality of treated water. According to the National Inventory of Sewage Treatment Plants, India generates an estimated 72,368 litres per day (MLD) of sewage daily, yet the country's sewage treatment capacity is only 18.6%. As a result, only 37.1% of the total sewage is treated. Many of these plants fall short of meeting even the basic Class E requirements, highlighting significant issues with the effectiveness and coverage of sewage treatment.

HOW TREATED WATER CONTRIBUTES TO A CIRCULAR ECONOMY

In a circular economy, resources are maintained in use for as long as possible, extracting their maximum value before recovering and regenerating them at the end of their life cycle. The agricultural sector supports this model by repurposing treated wastewater, ensuring that water—a vital resource—is continuously cycled rather than used once and discarded. This also closes the loop on nutrient cycling. Nutrients like nitrogen and phosphorus in treated sewage are redirected from potential pollutants into valuable resources that enhance soil fertility and support crop growth. This practice decreases reliance on synthetic fertilizers, which are energy-intensive and environmentally harmful.

The government currently providing power subsidies for farmers to pump water has led to increased groundwater use and subsequent depletion, bearing significant environmental costs. Treated water offers a better alternative. It is more cost-effective than freshwater, especially in water-scarce areas, and its nutrients reduce the need for expensive synthetic fertilizers. Reliable access to treated water can also boost crop yields and allow for crop diversification, enhancing agricultural productivity and sustainability.

Current Status of Treated Water Reuse

India generates about 72,368 million litres of sewage per day but has an installed treatment capacity of only 31,841 MLD, with only 37.1% of sewage being treated. The majority of treated water is used for industrial, gardening, or environmental purposes, with limited adoption in agriculture due to quality concerns.

IMPORTANCE OF BEHAVIOURAL CHANGE COMMUNICATIONS IN PROMOTING TREATED WATER USAGE

Adopting treated water in agriculture requires not only technological solutions but also a shift in perception among farmers. Behavioural change communication plays a crucial role in this process. A study in Sivakasi, Tamil Nadu, involving 397 farmers, revealed that willingness to use treated water increased significantly when farmers were educated about its economic benefits, such as reduced fertilizer costs.

A similar study carried out in the Mid-Atlantic and Southwestern regions of the United States showed that farmers preferred practical demonstrations and workshops when new practices, like treated water use, were introduced. Extension professionals, acting as trusted intermediaries, can effectively influence farmers' decisions through targeted education and transparent communication about the safety and benefits of treated water.

A study in Almería, Spain, demonstrated that initial negative perceptions of treated water among farmers shifted positively after education and hands-on experience. Farmers emphasized the need for public administration to ensure water quality and reasonable pricing, which further underscores the importance of consistent monitoring and government support.

The UNDP-World Bank document "Reuse of Wastewater in Agriculture: A Guide for Planners" outlines best practices for reclaiming wastewater in water-scarce regions. This guide serves as a valuable resource for extension professionals to educate farmers on the safe use of treated wastewater in agriculture.

The U.S. Environmental Protection Agency (EPA) had released a comprehensive manual that provides guidelines for water reuse, including a dedicated section on agricultural applications. This manual will also serve as an excellent resource for extension professionals, offering in-depth information on water quality and best practices for integrating water reuse into agricultural systems.

WAY FORWARD

Looking ahead, the potential of treated wastewater to transform agriculture is immense, provided there are full-capacity STPs in completely functional conditions. Continuous monitoring and transparency of the water quality will be vital in maintaining the trust of the farmers.

It's important to address the concerns and misconceptions that farmers might have about using treated wastewater. Education and training programs are essential to convince the farmers that they need to adopt this practice. Through workshops, seminars, and hands-on training, farmers can learn about the advantages of using treated wastewater, the safety protocols in place, and how this method contributes to long-term sustainability.

The government should be ready to provide incentives to farmers for adopting treated water irrigation. With the amplifying impact of climate change, treated water can be a consistent and reliable source, unlike freshwater. This approach will contribute to a circular economy by turning waste into a valuable input for food production. Through the benefits of treated wastewater, we can make a significant positive impact on agricultural productivity, environmental sustainability, and economic resilience.

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