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AGRICULTURAL GROWTH THROUGH WASTEWATER REUTILIZATION

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Abstract

Water scarcity has emerged as a critical global challenge, with projections indicating that by 2030, water demand could surpass available supply by twofold. This impending crisis carries significant socio-economic implications, as evidenced by reports forecasting a potential 6% reduction in a country's GDP due to severe water scarcity. Governments worldwide are actively responding to this crisis through various strategies including rainwater harvesting, desalination, water transfers, and wastewater treatment. Among these strategies, wastewater treatment stands out as a sustainable and environmentally friendly solution that addresses both short-term and long-term water scarcity challenges. This study focuses on the significance of wastewater treatment as a fundamental approach to combat water scarcity. Notably, regions like Rajasthan and Maharashtra in India, grappling with acute water shortages, highlight the dire need for water reuse solutions. Historically, wastewater was indiscriminately discharged into water bodies without any treatment, resulting in widespread pollution of natural systems. This deleterious impact on ecosystems has led environmental protection agencies to impose stringent regulations for wastewater treatment to achieve acceptable discharge standards. Wastewater treatment plants play a pivotal role in alleviating the pollution burden of wastewater before it enters the natural environment. While these plants may not entirely eliminate all pollutants, they significantly reduce pollutant levels to levels manageable by natural processes. In this context, this research explores the effectiveness of wastewater treatment in enhancing water quality, minimizing environmental degradation, and ensuring sustainable water management practices. By reviewing relevant literature, policy documents, and case studies, this paper underscores the urgent need for integrated wastewater treatment systems. Such systems not only contribute to ensuring water security but also align with the broader goals of environmental preservation and economic stability. Furthermore, this study delves into the economic viability of wastewater treatment investments by weighing the potential loss in

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GDP against the benefits of sustained water availability. In conclusion, wastewater treatment emerges as a pragmatic solution to the impending water crisis, offering manifold benefits for water-stressed regions and the global community at large. By embracing this approach, governments can take a decisive step toward achieving the United Nations' millennium development goals and safeguarding the future of water resources.

Introduction: One of the largest threats society is facing today is water scarcity. It is UN's main millennium development goals to cope up with this crisis. "By 2030, the country's water demand is projected to be twice the available supply, implying severe water scarcity for hundreds of millions of people and an eventual 6% loss in country's GDP," the report released by union minister for water resources (*Daily Pioneer,10 July,2018*). All governments have started to mitigate these effects by rain water harvesting, desalination, water location transfers and waste water treatment. Out of these, waste water treatment is a green and sustainable short term and long term solution to water crisis. Water reuse becomes even essential for water scarce states like Rajasthan, Maharashtra, and other states in India where water availability is highly critical. Earlier most of wastewater generated was discharged into water bodies like rivers, oceans etc. without any treatment and resulted in pollution of these huge systems. Environmental protection agencies have now started to impose very strict regulatory prohibitions of wastewater treatment for attaining the discharge quality. Treatment plants just reduce the pollutant level in waste water to a level nature can handle.

Findings of wastewater reuse: The physicochemical and microbiological characters in the raw sewage are unacceptable and the treatment process reduces the undesirable characters to a sufficient extent and the sewage characteristics of treatment plants should be regularly monitored to know the pollutant levels upon the various time scales (Velusamy and Kannan2016). Treated wastewater can be used for many purposes like irrigation of agriculture land, landscape irrigation, recreational activities, urban and industrial use, aquaculture and artificial ground water recharge (Asanoetal. 2007). The treated waste water (TWW) can constitute a reliable water and nutrient source for crops (B. Jimenez-Cisneros 1995) and its use for irrigation reduces the amount of nutrient-rich water returned to rivers or sea. In comparison to applying ground water with fertilizers, application of the domestic waste water with fertilizers showed improvements in the crop yield and physicochemical properties of the soil besides slight changes in salt solubility and alkalinity on a clay soil (Singh, Deshbhratar and Ramteke 2012). Research conducted in Riyadh, Saudi Arabia on the reuse of treated municipal wastewater to determine the effect of irrigation on crop yield, plant composition and soil properties with special emphasis on accumulation of trace metals showed that treated municipal waste water can be used safely for irrigation of a selected group of crops (Ali A. Aljaloud2010). It enriched the soil in minerals, increased plant nutrient uptake, promoted crop yield, & improved the overall profit. Developing countries are using treated wastewater mainly for crop irrigation (Kansel and Singh 1983; Bahri 1988).

Sewage and other industrial effluents are rich in organic matter and plant nutrients and find cheaper way of disposal in high water demand sector of agriculture (Nath *etal*., 2009; Nagajyothi et al. 2009).Urban and peri-urban areas in most of the developing countries are using treated, poorly treated, diluted or even raw waste water for irrigation (Hamilton et al.2007; Keraita et al.2008; Scott et al.2004). There are several advantage and disadvantage in using sewage water for irrigation purpose (Ramana *et al*. 2002; Saravanmoorthy and Kumari 2007). Sewage water is rich in plant nutrients that increase crop yield substantially and reduce the need for fertilizer.It ultimately decreases overall cost of production. Due to rich organic as well as inorganic matter (N,P,K) and other micronutrients sewage water application is a low priced fertilizer (Hundal and Sandhu1990). According to Otobbang *etal*. (1997) sewage sludge is used commonly as manure due to presence of multi-element organic wastes. Secondary treated wastewater finds safe application for root and leafy crops irrigation (Farhadkhani *et al.* 2018). Sewage waste water should not be continuously used as it may lead to many environmental problems like soil sickness and ground water contamination and phytotoxicity (Hicks and Hird 2000).

Socio-economic growth of a country demands industrial activities which in turn generate huge amounts of solid and liquid wastes. It is leading to more and more discharge of pollutants into the water environment such as rivers and lakes, and more water pollution disasters have happened. Improvement in soil properties due to soil waste interactions opens up the way to use the industrial wastes as soil stabilizers (Abhilashand Tharani,2016). It becomes important to detect the pollution timely for conservation of water environment. It is the precondition to locate and find the pollution source as well. The wastewater characteristics mainly depend upon the living standards of the people, agricultural runoff, and commercial activities in the city. If industrial wastewater is included in influents of wastewater treatment facilities, then contaminant range becomes very broad (Ratola et al. 2012). Poorly treated wastewater will affect water users adversely and contaminate surface as well as ground water. Long term use of such water may have acute or cumulative toxic impacts. Monitoring of physicochemical parameters of treated wastewater helps in safe release of final effluent as it is a health and environment concerned issue.

Kushwah etal. (2011) showed distinct seasonal variation in physicochemical parameters of the influent and effluent water and suggested continuous monitoring of STP. Evaluation of the final effluents of two wastewater treatment plants (WWTPs) in the Eastern Cape Province of South Africa for their physicochemical and microbiological qualities over a period of 12 months led to the conclusion that these WWTPs are important point sources of pollution in surface water with potential public health and ecological risks (Osuolale and Okoh 2015). Investigations of the wastewater pollution level by analyzing its chemical characteristics at five wastewater collectors remarked that pollution level greatly depends on the origin site of the wastewater (Popa and coworkers 2012). Correlation analysis was used in order to identify possible relationships between concentrations of various analyzed parameters, which could be used in selecting the appropriate method for wastewater treatment to be implemented at wastewater plants. Sugar Industries are the primary source of water pollution. The results of the study on composition of effluents of four sugar industries showed that the effluents in general exceed the limits specified by CPCB with reference to parameters such as BOD, COD, oil &greases, total suspended solids, so suggested recommended measures should be worked upon (Jadhav et al.2013).

Research on the performance of Activated Sludge Wastewater Treatment Plant (ASWTP) investigated the level of effectiveness of the activated sludge process (Ukpong2013). The result showed that wastewater had no smell with clear color at normal temperature and equilibrium pH value of 7. Wastewater treatment plant with this technique has good potential to produce high quality effluent on a continuous basis. Seven small wastewater treatment plants working on the principle of anaerobic pre-treatment and aerobic post-treatment were chosen (Gasparikova et al. 2005) for evaluation. An integrated system originated from the combination of anaerobic and aerobic technologies and following operational experiences it is concluded that the properly operated two-stage technology is effective for the removal of organic pollution and suspended solids. It confirmed the viability of an integrated anaerobic- aerobic system for municipal wastewater treatment, even in a country with a temperate climate. To study the seasonal differences of wastewater treatment employing screens, trickling filters and oxidation ponds, analysis of water samples from four different points was carried out (Cheboretal.2017) during the dry and wet seasons. The researchers recorded lower figures for most of the parameters during wet season.

Studies on treatment operations of 17 wastewater treatment plants (WTPs) in cold and hot climate were carried out, in order to examine their potential environmental impacts and assess their disposal options (Mahgoubetal. 2015). The results of the quality of wastewater in drainages that discharge from these WTPs distributed in the province of Al-Sharqiya, in Egypt indicated that the treatment plants had a significant role in pollution control. The results of 3-year study (2010– 2012) based on principal factor analysis technique (PFA) on two urban wastewater treatment plants (WWTPs) situated in Murcia, Southeast of Spain were presented (Bayo et al 2016). These findings show that to prevent any long term risk associated with human and environment, proper monitoring and continuous assessments of the secondary treated wastewater irrigation are required.

Treated wastewater irrigation of olive trees in arid and semi-arid regions is becoming a necessary alternative to address the issues of water shortage. The irrigation requires a careful monitoring of soil and plants for a range of parameters including salts, nutrients, microelements, heavy metals, toxic pollutants, and pathogens. A 3-years monitoring of the above parameters in soil and leaves of olive trees in Crete, Greece was conducted (Petousi etal.2015) using trees that were irrigated with three types of water: secondary treated wastewater (STW), tertiary treated wastewater (TTW), and tap water (TW). The results of this study suggest that STW and TTW can be applied successfully for the safe irrigation of the olive groves. Physicochemical analysis of the wastewater collected from rubber processing factory inferred substantial reduction in the solid concentration, BOD and COD, nitrate, phosphorus, and bacteria counts (Asia etal.2007) and inferred that treated effluent could be discharged safely into the environment without the fear of pollution.

Benefits of wastewater reuse

- No doubt, water treatment process produces clean reusable water. It ensures reliable and cheaper irrigation water supply.
- Treated water nutrient content is higher, so increased crop yield contributes to food security.
- If wastewater treatment schemes are properly managed, have high potential to reduce waste production and improve environmental health (Mara and Cairncross1989).
- Surface water pollution can be avoided and thus saves money spent on projects required to battle environmental pollution.
- Sludge produced during treatment process is used as manure (Otobbang*etal*.1997).
- Low cost drought-proof water supply reduces storage, water transfer, deslination etc. and makes local sourcing of water.
- Not only this, treatment plants can be a source of energy production. As-Samra WWTP in Jordan produces 40% of the energy required through burning the methane produced by treatment process. It helps making WWTP self-sustainable and reduces country's expenditure on energy production.

Potential Risks of wastewater reuse

- When the treatment is not adequate, potential risks are associated with reclaimed water reuse especially for irrigation. Food chain may get contaminated with pathogens (bacteria, virus, helminthus, and protozoa). These pathogens may cause endemic or epidemic diseases especially when untreated wastewater irrigated foods are eaten uncooked (e.g. salad crops and some vegetables) (Shuval et al.1986). This was confirmed for geohelminthic and bacterial diseases by Blumenthal and Peasey (2002).
- Heavy metals like lead, cadmium, mercury etc. and many organic compounds (pesticides) cause health effects (cancers) on prolonged exposure. As the toxic and hazardous substance discharge is not controlled in the waste, it may cause lethal effects to consumers and environment.

- Soil may get salinated or various unknown constituents get accumulated in soil which may adversely affect agriculture. These may reduce crop yield either by directly inhibiting plant growth or indirectly by reducing the plants ability to absorb nutrients.
- Algae or other vegetation can grow in canals carrying treated water. Various contaminants may get accumulated in aquifers and ultimately leading to degradation of ground water quality.

Recommendations: The WHO's 2006 guidelines for the safe use of wastewater, excreta and grey-water constitute atool for the preventive management of wastewater in agriculture and provide clear guidelines for policy-makers on wastewater application in different local contexts. FAO has given guidelines to evaluate irrigation water quality applicable to the local conditions (Ayers and Westcot 1985). Further attention should be given to selection of crop and irrigation system. Attention should be paid on following points before deciding use of treated sewage in agriculture:

- Agrarian economy of India demands compulsory use of treated sewage for irrigation but should never be used for millet production and edible crops.
- Crop grown should be selected on the basis of type of soil and composition of treated sewage available (Ali A. Aljaloud 2010).
- Rotational crop pattern should be practiced for an all the year round utilization.
- Irrigation management is very important that is to irrigate only when it is required and also to the extent it is required by the crop. Deposition of nutrients, chemicals, pathogens or heavy metals in the soil and deep percolation risks can be reduced if surface ponding or stagnant effluents are avoided. For this, careful leveling and controlled water application by advanced irrigation systems (Humpherys 1986) should be practiced.
- The soil should be opened up by deep ploughing and cultivated properly before the next crop is raised.

Other Applications of Reclaimed Water

- Treated sewage can be used in many more ways other than agriculture and is being used in world and in many cities of India.
- Horticulture needs of green areas and emergency purpose like fire brigade should be met with treated sewage.
- An irrigation method for sewage fed tree plantation has been recommended by the Indian Agriculture Research Institute, Karnal.
- Special supply lines must be laid for TWW supply to new developing construction sites and it mandatory use TWW for construction activities.
- TWW price must be kept sufficient lower than fresh water price.
- Public fear about reuse system should be overcome through education and awareness program.
- From as early as 1991, the major Industries like Madras Refineries, Madras Fertilizers and GMR Vasari Power Plant, Chennai etc. are using secondary treated sewage in cooling water makeup.
- Major metropolitan cities like Bangalore, Chennai, Mumbai and Delhi are using treated grey water for toilet flushing in some of the high rise apartment complexes on a pilot scale.

Conclusion: Properly managed wastewater treatment schemes have high potential to reduce waste production and improve environmental health. To improve wastewater use in irrigation, good agriculture practices should essentially be adhered. Crop irrigation water used should always be in accordance with reference document on the physico-chemical quality of water, including wastewater, used for crop irrigation FAOs water quality for agriculture. There should be careful evaluation at the project planning stage and properly treated wastewater should be used for edible crops. Multidisciplinary research, training programs for the treatment plant operators and awareness programs for farmers would definitely help in better management of health and environmental impacts. Adequate control of non-biodegradable and toxic industrial wastewater can solve the issues to a great extent.

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