A Review of Use of Wastewater for Irrigation in Agroforestry

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Abstract - For agroforestry systems worldwide, freshwater resources are scarce. Increased food grain production from scarce natural resources is required to meet the demands of a rapidly expanding population. As a result, the production potential of agroforestry systems requires to be enhanced in a sustainable way, this has been highlighted by researchers and policymakers. The hard aspect is that as time passes, freshwater bodies are getting smaller, which further reduces crop productivity. In locations with a lack of fresh water, low-quality water could be a good substitute. Beyond a certain threshold level, it should not contain any hazardous contaminants. Unfortunately, there are no or inadequately defined critical thresholds for various pollutants or acceptable quality characteristics for various wastewater kinds. Prior to use in agricultural fields, industrial effluent, and water of questionable quality utilised in crop production should be treated. In order to meet the demands of a growing global population in a climate that is changing, safe wastewater reuse for food material cultivation is required.

I. Introduction

The effects of drought in arid and semi-arid countries are intensifying due to global variations in rainfall frequency and amount, and these effects are expected to intensify under climate change scenarios. The safe use of wastewater for irrigation of some agricultural and forestry crops can be an alternative in water-scarce settings, helping to conserve freshwater. In order to safely use wastewater for irrigation and soil improvement in forestry and agroforestry systems on dry, degraded soils, this study aims to advise land and forest managers. The goal of the paper is to help readers plan reforestation and afforestation on drylands using water generated in artificial wetlands and fertigation plants (FAO). The most crucial growth component, according to some, is water. The proposed concepts for waste management could provide effective treatment without harming the soil, groundwater, or plants (Hasselgren,1998). Reusing treated wastewater is one of the options that might be dependable and extremely advantageous for irrigation and agricultural at the same time. In fact, using treated wastewater instead of pure water for agriculture can free up fresh water for other uses, such as drinking water supply (WHO, 1989; WHO, 2006). Indeed, the benefits of this reuse for the environment and society can only be realised if water is treated at a WWTP (wastewater treatment plant) to remove contaminants that could be harmful to the environment and society (El Moussaoui et al., 2017). Through carbon sequestration, agroforestry, and wastewater irrigation aid in reducing climate change. Other direct advantages include reducing soil erosion, controlling freshwater flow, lowering surface temperatures, sustaining soil fertility, meeting energy needs, and increasing the accessibility of forest products (Antil et al., 2008). Wastewater has a tremendous amount of unrealized potential for resource recovery and reuse, and when combined with agroforestry, the advantages are even greater when considering the overall economic worth of forestry plantings and crops, as well as their environmental services (Drechsel, 2010).

II. Literature survey

1. TREATED WASTE WATER AS A GROWING RESOURCE

In developing nations, using treated, partially treated, and untreated urban wastewater in agriculture has long been a widespread practice. However, due to the rapid urbanization, this practice is now garnering renewed attention. Cities will account for 88 percent of the additional one billion people added to the world's population by 2015; emerging nations will account for the great majority of this growth (UNDP, 1988).

Given that only 15 to 25 percent of domestic and private water use is exhausted, an increase in urban water supply guarantees an increase in wastewater generation. Growing wastewater volumes provide an affordable and dependable replacement for traditional irrigation systems. Figure 1 shows that, where both absolute population numbers and population growth are highest, Asia has had and will continue to experience the greatest improvements in urban water service coverage, followed by Africa. In this context, wastewater is a resource that may become more significant on a national and international level, especially in peri-urban and urban agriculture (Scott et al.,2004).

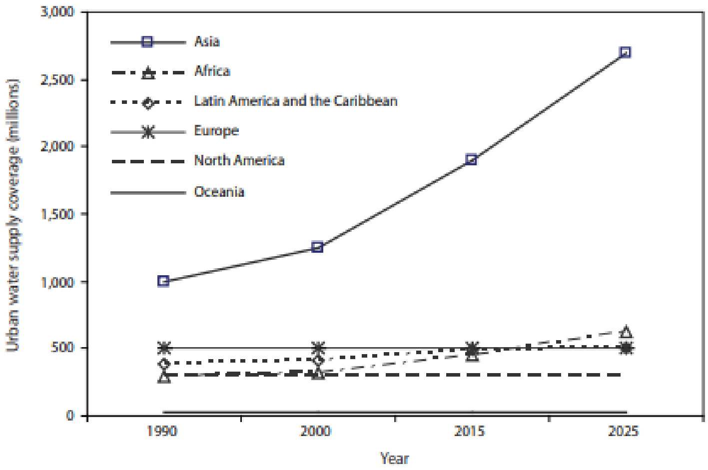

Fig.1. Growth in urban water supply coverage by regions of the world.

(Source: Scott et al.,2004)

1.1 Types of wastewaters

The wastewater utilized for agricultural irrigation comes from numerous sources and includes wastewater produced by diverse urban activities in a variety of states, from raw to diluted (Raschid-Sally and Jayakody, 2008). The most common kinds are listed below:

a) Urban wastewater generally uses a combination of one or more of the following:

- Domestic effluent consisting of black water (excreta, urine and associated sludge) and greywater (kitchen and bathroom wastewater)
- Effluent from commercial establishments and institutions, including hospitals;
- Industrial effluent
- Stormwater and other urban run-off.

b) Treated wastewater - Wastewater that has undergone one or more physical, chemical, and biological processes in a wastewater treatment facility to lessen the number of dangerous compounds in it.

c) Reclaimed water or recycled water - Processed wastewater that is officially permitted to be utilised under strict guidelines for beneficial uses, including irrigation.

d) Greywater - It is produced by houses without sewer connections and can be treated to irrigate backyard gardens and trees like olive trees. Water conservation includes the use of greywater. It makes up 50–80% of domestic wastewater and has a lot of potential as a resource- and money-saving element of integrated water resource management in arid regions.

1.2 Categories of Wastewater Use

There are several uses for wastewater in addition to the various forms of wastewater described above (Ahmed et al.,2021):

a) Direct disposal of untreated wastewater from a sewage outlet on land intended for cultivation is known as "direct usage." When wastewater is treated before being utilised for irrigation, recycling, or other agricultural purposes, it is being used directly.
b) Indirect use of treated or untreated urban wastewater happens when farmers downstream of the urban centre abstract water for agriculture from a river receiving treated or untreated urban wastewater. Cities that lack extensive sewage collection networks and drainage systems that dump collected wastewater into rivers experience this problem.
c) Planned use of wastewater is that has been intentionally and carefully used may be either raw (i.e., untreated) or diluted (i.e., treated). The majority of indirect use, meanwhile, happens haphazardly. Although the resulting wastewater use plans may be extremely varied, common trends can nevertheless be seen across several nations.

1.3 Standards of Wastewater Treatment

Wastewater is often treated on the primary, secondary, and tertiary levels. They are described as followed by the Environment Protection Agency (EPA) (IWMI, 2008):

- Primary Treatment: It involves the process of sedimentation that is a type of treatment used to remove gross and settleable materials, sometimes after screening and grit removal. Sludge, the residual settled solids, is removed and dealt with separately.

- Secondary Treatment: Typically, a level of treatment that employs biological or chemical procedures to remove 85% of the biological oxygen demand (BOD) and suspended solids. Due to algal sediments in lagoon systems, secondary treated reclaimed water typically has a BOD of 100 mg/L. The bulk of organic matter and nitrogen are processed by microorganisms during secondary treatment, which also greatly lowers the number of pathogens present. Most wastewater is treated to a secondary level, and water that has undergone this level of treatment can be utilised for several types of agricultural crops, as well as for the growth of fodder and woody plants (but it cannot be used for horticultural irrigation). Because they can act as extra filters to clean contaminated water and reduce soil or water pollution, trees are ideally adapted to irrigation with low-quality water.

- Tertiary Treatment: The process of treating recycled water after further biological treatment. This typically entails the removal of a significant amount of nutrients and/or suspended particles, followed by disinfection. Coagulation, flocculation, and filtering are a few examples of possible processes. It can be used to address commercial and industrial water needs as well as for landscape irrigation (such as in leisure parks and golf courses). If tertiary-treated wastewater is susceptible to natural soil filtration (such as filtering through sandy soils), it can be used in the drinking supply as well as for groundwater recharging, agriculture, and agroforestry. However, the tertiary treatment of wastewater is frequently energy-intensive.

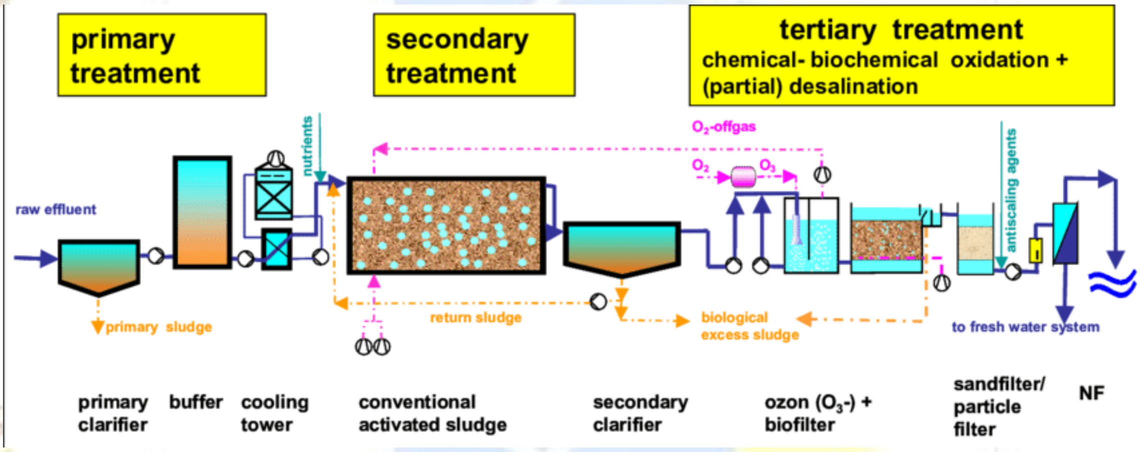

Fig.2. Schematic view of a wastewater treatment plant

(Source: Mobius et al., 2004)

2. Wastewater Quantity and Quality

The improper use of treated wastewater puts both people and ecosystems at risk, and it could also be socially objectionable. To optimize the nutritional and food security benefits for rural populations whose livelihoods depend on wastewater irrigation, wastewater use should be made as safe as feasible. Therefore, it is crucial to make sure that all potential dangers are identified and that precautions are followed to reduce the risk of contamination.

2.1 Quantity

It is well knowledge that plants lose more than 99 percent of the water they take in through transpiration and evaporation from their surface. Therefore, in all actuality, the water demand for crops is equal to the requirement for evapotranspiration. Crop evapotranspiration is mostly influenced by climatic conditions; therefore, it can be roughly predicted using meteorological data. (Pescod, 1992). To account for effective rainfall, leaching requirements, application losses, and other considerations, the actual amount of irrigation water to be applied will need to be changed. In urban and peri-urban settings, it is possible to conduct tree irrigation with treated wastewater close to human populations; in fact, close proximity is preferable because it lowers the cost of pumping. 700 cubic meters of processed wastewater per day are typically produced by a treatment facility serving a village of 5,000 residents. This volume is enough to irrigate more than 15 hectares of a low-density tree plantation and roughly six hectares of a high-density tree plantation in drylands with high rates of evapotranspiration. The seasonality of the irrigation needs of various crop species is a crucial factor to take into account in drylands. For instance, the area of a grass crop should be kept to a minimum so that it can receive complete irrigation during the summer months when evapotranspiration is at its highest. Woody crops, on the other hand, can tolerate periods of water stress, allowing for the irrigation of a broader area (Braatz et al., 2002).

2.2 Quality

The quality of irrigation water needed for crop production is suggestive in nature and will need to be altered based on the local climate, soil characteristics, and other variables. The suitability of irrigation water will also be greatly influenced by farm operations, such as the type of crop to be cultivated, the irrigation method, and agronomic procedures. To reduce the risk of foresters, farmers, and consumers of harvested goods being exposed to pathogens present in wastewater effluents, the majority of which are capable of persisting in soil and contaminating crops, wastewater used for agriculture and forestry should be treated to at least the secondary level. It may be possible to reduce hazards to human health and partially recoup the cost of wastewater treatment by using wastewater in forestry and agroforestry systems when it is unsuitable or undesirable for the cultivation of food crops. (Myers et al., 1996).

3. Wastewater Use in India

3.1 Wastewater Volume of India

According to the Central Pollution Control Board (CPCB), Class-1 cities (with a population greater than 100,000) produce 16 bld of wastewater, and Class-2 cities produce 1.6 bld (population 50,000-100,000). 6,000 km of the 45,000 km of Indian rivers have a bio-oxygen demand above 3 mg/l, rendering the water unsafe for human consumption (CPCB 1998). Around 80% of the wastewater produced by developing nations, particularly China and India, is utilised for irrigation (Winrock International India 2007).

There is no policy structure in place in India, where wastewater is primarily used in agriculture, to address the problems brought on by this practise. In India, it was calculated that 73,000 acres were watered using wastewater (Blumenthal and Strauss 1990).

However, it was also estimated that 40,000 ha of land were irrigated with urban and industrial wastewater diluted with fresh river water just along the Musi River, which runs through Hyderabad city in Andhra Pradesh State, and the canals and tanks off this river, especially during the monsoon season (Mekala and Buechler, 2003).

3.2 Wastewater reuse

Since wastewater in India is typically not purified, it is mostly used in the agricultural sector, where the hazards are much fewer than when it is used in homes or businesses. According to a survey of the literature, the following crops are mostly irrigated with untreated or only partially treated wastewater from India's major cities, including New Delhi, Mumbai, Bangalore, Kolkata, Hyderabad, Ahmedabad, etc.

- Cereals: About 2,100 acres of land are irrigated with wastewater to grow paddy in Hyderabad along the Musi River (Mekala 2006). Wastewater is widely used to irrigate wheat in Ahmedabad and Kapur (Winrock International India 2007).
- Vegetables: Around 12,000 farmers in New Delhi utilise treated wastewater to irrigate 1,700 acres of land to grow vegetables including cucumbers, eggplant, okra, and coriander in the summer and spinach, mustard, cauliflower, and cabbage in the winter. This is done in the areas of Keshopur STP and Okhla STP (Winrock International India 2007). About thirteen different types of vegetables, including spinach, malabar spinach, amaranths, gogu (Hibiscus cannabinus), mint, coriander, bladder dock, okra, colocasia, soya (Glycine max), common purslane, and chennangi, are cultivated with wastewater all year round in Hyderabad (Lagerstroemia parviflora).
- Flowers: Kanpur farmers use wastewater to grow marigolds and roses. Many jobs are created in Hyderabad by the farmers who grow jasmine using wastewater. A jasmine plantation produces blooms for 8 to 9 months out of the year, and 118 farmers can make between Rs. 15,000 and Rs. 20,000 per ha during the 8 to 9 month blossoming period (Buechler et al. 2002).
- Avenue trees and parks: In Hyderabad, street trees and public parks are watered with secondary processed effluent.
- Fodder crops: In Hyderabad, 10,000 acres of land near the Musi River are irrigated with wastewater to grow para grass, a type of fodder grass (Mekala, 2006).
- Aquaculture: The East Calcutta sewage fisheries are the world's largest single aquaculture wastewater utilisation system (Pescod, 1992). 100,000 direct stakeholders and 5,100 acres of agriculture are supported by Kolkata's wetland environment. It generates 128,000 quintals of paddy, 69,000 quintals of fish, and 7.3 quintals of vegetables annually, employing about 70,000 people directly (Chattopadhyay, 2004).
- Agroforestry: Orchards and agrosilviculture, which consists of spatially mixed tree-crop combinations, are the primary wastewater-irrigated agroforestry land uses in the Karnataka villages close to Hubli-Dharwad (Bradford et al., 2003). Sapota and guava are the two most significant tree species, and other popular species include coconut, mango, arecanut, and teak. Neem, tamarind, coconut, and teak are among the species that can be found on agricultural borders. Banana, ramphal, curry leaf, pomegranate, lemon, galimara, and mulberry are additional less prevalent species. In agroforestry, irrigated groundnut is cultivated during the dry season, and sorghum is grown during the kharif season. The

agrosilviculture system underwent numerous changes. Strong weed growth was also cited by farmers in the villages of Budarsingi and Katnur as the main obstacle to agroforestry.

4. Use of treated wastewater in dryland agroforestry systems

Even in drylands with limited surface water and groundwater supplies, treated wastewater is an unusual resource that might be accessible. The irrigation of areas like playgrounds, orchards, urban greenbelts, windbreaks, and shade and fodder trees, for example, can be used for environmental, agricultural, and social purposes. It can also be used to establish and maintain intensively productive planted forests (for the production of wood), as well as for other environmental, agricultural, and social goals.

Numerous investigations and afforestation initiatives have shown that it is technically feasible to grow forest trees using treated wastewater. Trees that serve multiple purposes and grow quickly, like Eucalyptus, Casuarina, Acacia, Pinus, Khaya (African mahogany), and Tamarix, are frequently employed in these programmes (Schleich et al., 1996).

In forestry and agroforestry, two wastewater treatment techniques are frequently in use:

a. Constructed Wetlands
b. Selective modular filtering of secondary treated wastewater

4.1 Constructed Wetlands

It has been demonstrated that bacteria, fungi, algae, and plants can all store and decompose composite molecules and heavy-metal pollution. To clean polluted water and soils and to restore industrial areas that have been contaminated by the discharge of chemicals, phytoremediation uses plants like reeds, weeds, shrubs, and trees. Reeds and marsh plants in wetland areas serve as natural biofilters that remove water sediments. The roots, stems, and leaves of vegetation in wetlands serve as a substratum for the growth of microbes that decompose organic matter. According to studies, plants may remove between 70 and 90 percent of contaminants from wastewater while simultaneously acting as a carbon source for microbial decomposition. Heavy metals can be removed from wastewater that has been released into the environment by wetlands. Artificial swamps called constructed wetlands are made to filter wastewater before it is released into the environment. Reeds, shrubs, and trees chosen for their capacity to remove pollutants from water are grown in ponds that make up these ecosystems. The wastewater settles in a network of linked treatment storage basins before being released in an irrigation-ready state. Built-in wetlands can withstand varying rates of pollutant and hydrological loading. They use little to no energy, are simple to maintain, and are reasonably affordable to build and run (Chaudhary et al., 2011)

For rural towns in isolated, arid regions where economic conditions make the construction of conventional wastewater treatment facilities impractical, constructed wetlands provide a sustainable, cost-effective, and long-term solution. Agroforestry systems and tree plantations can use the secondary-treated water they create to grow profitable crops, lessen (or stop) soil erosion, and provide windbreaks, shade, and fodder. Northern Europe was the forerunner in the usage of constructed wetlands, which are currently being used more frequently in rural communities in arid developing nations. However, constructed wetlands require relatively vast land areas, have a high degree of biological and hydrological complexity, and require a lot of skill to develop. Constructed wetlands, particularly those that are built in drylands, may have lower production than natural wetlands because of losses through evapotranspiration and infiltration, and they may also serve as a mosquito breeding ground, which is dangerous for human health. The usage of artificial wetlands in drylands still lacks knowledge and experience, and genuine data must be gathered for chemical modelling of pollutant removal. We still need to analyse how susceptible built wetland systems are to environmental conditions like strong winds and sandstorms (Neralla et et alal., 2000).

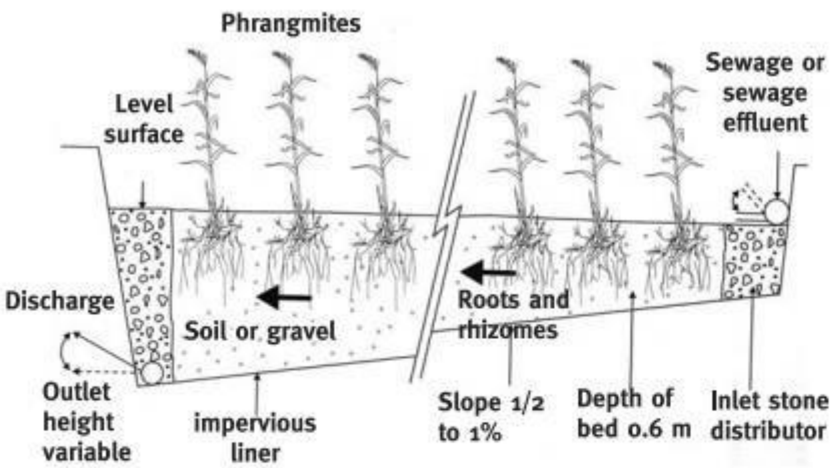

Fig.3: Design of wastewater treatment constructed wetland
(Source: Donde,2017)

4.2 Selective modular filtering of secondary treated wastewater

Tertiary treatment, which creates water with a sufficiently low content of pathogenic microorganisms to be appropriate for human consumption, is the final goal of wastewater treatment. However, managing water effectively is not always achieved with tertiary treatment. All solids and impurities must be removed, which uses a lot of energy, creates a lot of sludge that must be disposed of, and results in the loss of nutrients like organic carbon, nitrogen, and phosphorus that are present in the organic matter (Petala et al., 2006)

Through the selective removal of the majority of pathogens, a portion of the solids fraction, and other pollutants, new treatment procedures enable the generation of safe secondary-quality wastewater. In traditional wastewater treatment plants, selective removal is applied during the secondary stage of treatment by utilising extra physical and chemical filters that remove the majority of pathogens and lower the discharge of nutrients and organic debris. Depending on the requirements of the crop and the soil to be irrigated, water can be filtered at various stages of the secondary treatment to enhance or decrease the quantity of nutrients. Accordingly, selective removal is a streamlined kind of secondary treatment that lowers energy costs and sludge production while enabling the recovery of the majority of soil nutrients and the reuse of water for irrigation as well as "fertigation," which is a method of soil fertilisation. Selective removal is advantageous for soils and enhances soil water and carbon storage. Because it supplies water and nutrients and improves soil water retention, it is particularly viable for non-food crops in drylands, which are frequently characterised by poor soils (for example, woodlots for energy or lumber). To reduce the risk of disease spread and to enable adjustments in the level of fertiliser in accordance with the needs of soils and crops, fertilisation requires ongoing monitoring (Liberti et al., 2000).

4.3 Implications of wastewater use in Agroforestry

Wastewater use in agriculture can be seen as both a benefit, providing water and nutrients for the cultivation of crops and ensuring food supply to the cities, and a source of pollution, a threat affecting the health of users, consumers, and the environment, depending on its composition, the treatment it has undergone, the extent to which it is irrigated, and the regulations and general guidelines under which it is being used.

A summary of the potential advantages and disadvantages associated with the use of wastewater in agriculture. The following list summarises some potential effects that are discussed in more detail in the following subsections (Husain et al., 2001)

- Public health: As it contains bacteria, viruses, and parasites, wastewater has the potential to spread disease. Additionally, the presence of heavy metals in wastewater poses a serious risk to human health. The population living both inside and outside the wastewater irrigation zone faces dangers as a result of wastewater use in agriculture.
- Crops: Because it includes vital minerals for crop growth, wastewater is appealing and economically valuable to farmers. On the other hand, plants could be poisoned by wastewater that contains a lot of chemical contaminants.
- Soil resources: The productivity of the soil and the long-term viability of agricultural land usage are impacted by the buildup of nitrogen, phosphorus, dissolved solids, and other components like heavy metals. Crop production may be negatively impacted by salt buildup in the root zone.
- Groundwater resources: The quality of groundwater may be impacted by the leaching of salts and nutrients found in wastewater. The quality of the groundwater, the depth of the water table, soil drainage, and the volume of wastewater used for irrigation are some of the variables that affect the degree of impact.
- Property values: The land's property values may be positively or negatively impacted by the use of wastewater for irrigation. Low soil productivity brought on by the irrigation of wastewater may have a detrimental impact on land prices and leasing income. The value of wastewater as a source for irrigation, however, might have a favourable impact on the price of land.
- Ecological impacts: Drainage of wastewater from irrigation projects into bodies of water may negatively affect overall biodiversity, including the existence of water birds, and indirectly affect aquatic life.
- Social impacts: Food safety, health and welfare, quality of life, property values, and the sustainability of land usage are only a few of the societal effects of using wastewater in agriculture.

4.3.1 Benefits

The importance of wastewater as a potential resource is sometimes overlooked, despite its apparent high level of utilisation. Well-managed wastewater can have positive effects for society, the economy, and the environment, assuring social fairness and boosting food security, if it is handled appropriately and usage rules are followed.

To begin with, elements found in wastewater can include essential and useful fertilisers that are needed by plants. These nutrients and fertilisers have the potential to reduce the input of artificial fertilisers, which not only reduces the environmental effects connected with their usage and production but also increases farmers' revenues (WHO, 2006). As a result, farmers benefit from higher productivity, higher yields, and quicker growth cycles while using less artificial fertiliser and water (Corcoran et al., 2010).

Secondly, the accessibility of wastewater is another advantage. Wastewater is a useful resource in metropolitan settings when there aren't enough other water sources because it's always available and affordable for farmers. Improved nutrition and food availability in arid and food-insecure areas may also have significant favourable health effects. Positive health benefits vs health dangers will vary greatly depending on the setting, and there has not yet been a thorough global study of the advantages of using wastewater in agriculture (Moussai et al.,2019).

For instance, farmers at the subsistence level who stand to gain the most from increased food security and nutrition also face the greatest risk of adverse health effects, particularly when untreated wastewater is utilised for irrigation. Contrarily, possible benefits are anticipated to significantly outweigh dangers in environments where alternative water sources are scarce, treatment quality is high, and farming and food processing technologies are advanced. In every situation, efforts should be made to quantify the beneficial effects on nutrition and food security on health and compare them to any potential adverse effects on health that are covered in the next section.

Of course, there are still a lot of situations where farmers either have to use low-quality water resources because they have no other choice (like in areas with unstable water supplies where municipal wastewater discharges contaminate water sources) or where they are unaware that they are using wastewater directly (such as when farmers are located downstream of large cities where wastewater is being dumped into open water).

But because of the potential benefits, particularly in peri-urban and urban agriculture, planned wastewater use for irrigation is becoming a more significant resource. Both emerging and industrialised nations are being driven by this, especially in locations with limited access to alternate supplies and water resources.

4.3.2 Risks

Wastewater utilisation has potential benefits, but it also has significant environmental and health dangers if no additional precautions are taken. Untreated wastewater produced by cities and businesses may contain a variety of different components, including pathogens, organic substances, synthetic chemicals, nutrients, organic matter, and heavy metals. The water quality is affected by the suspended or unsuspended substances that are transported in the water from various sources.

Health risks

Farmers, children, and other locals are exposed to bacteria, pollution, and infections through contaminated canals and streams. The biggest risk for occupational exposure has been proven to be intestinal worm infections (Drechsel et al., 2010). Among the most common illnesses associated with wastewater are serious conditions like diarrhoea, ascariasis, and schistosomiasis, which have a significant health impact and may even be fatal. The effects on public health are mostly influenced by the location of farm fields and the type of water used. Farmers and consumers are more at risk the closer they are to the source of the pollution. As a result, those who live close to agricultural areas where untreated wastewater is used, especially consumers and underprivileged people, are at danger. Significant secondary effects may also be caused by health issues related to the use of contaminated and untreated wastewater. High health care expenses and decreased labour productivity impede and sluggish economic growth while escalating poverty. Polluted water directly contributes to child mortality. Consequently, untreated wastewater can be seen as a disease vector (Corcoran et al., 2010).

Environmental risks

Significant environmental effects may result from the generation and release of wastewater into water bodies. Negative effects on irrigated crops, soils, and groundwater are expected where irrigation with untreated, insufficiently treated, and/or diluted wastewater cannot be avoided or is prevalent, which can affect not only human health but also environmental health.

One of the most significant and pervasive global issues affecting the wellbeing and efficiency of freshwater and marine ecosystems is eutrophication. According to studies, present agricultural methods and associated run-off result in an annual discharge of about 80 million tonnes of nitrogen and 10 million tonnes of phosphorous into inland waterways and coastal areas, greatly exceeding all natural contributions. Together, these processes have the potential to increase potentially harmful algal blooms, cause significant biodiversity changes, such as the enlargement of dead zones and catastrophic hypoxic occurrences, and result in enormous economic losses in a variety of industries (Rockstromm et al., 2009). According to estimates, up to 90% of the wastewater produced flows into coastal areas and contributes to the growth of marine dead zones, which already encompass an area of around 245,000 km2, or the size of all coral reefs on Earth (Corcoran et al., 2010).

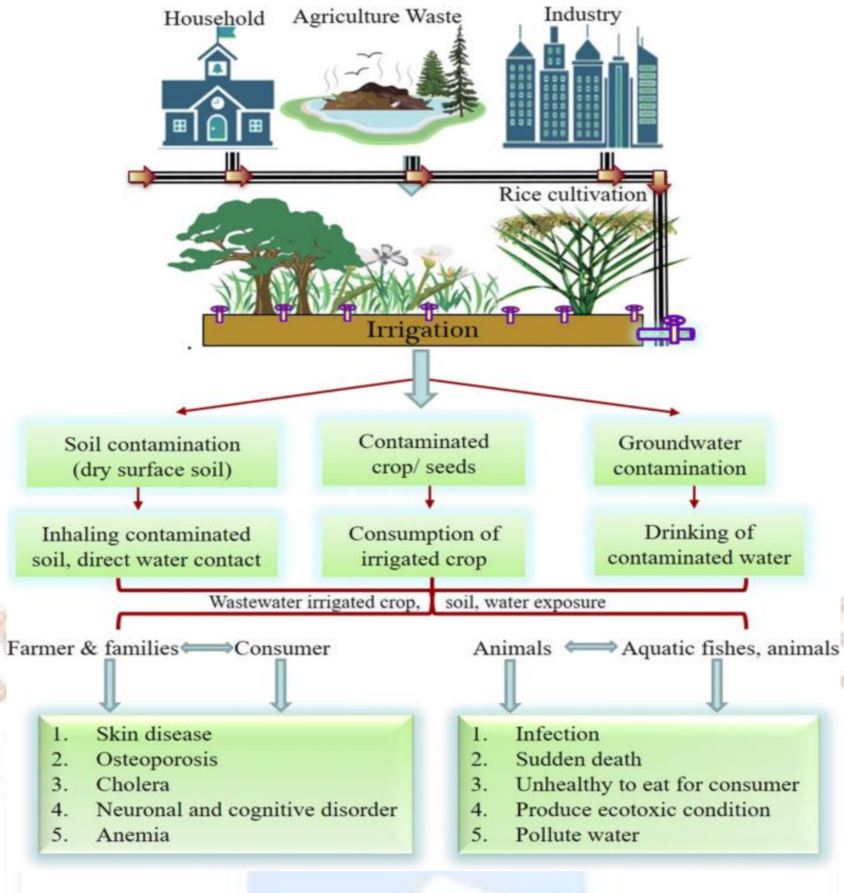

Fig.4. Exposure pathway representing serious health concerns from wastewater-irrigated crops
(Source: Kesari et al., 2021)

III. Conclusion

For more than a century, wastewater use in agriculture and forestry has been a typical practise in a number of developing nations with limited water supplies. Numerous urban and peri-urban farmers have benefited from it and continue to do so. The amount of urban wastewater has, however, greatly increased due to population growth. The issue is made more difficult by the addition of industrial effluents, changing lifestyles of people, and the rising contamination of wastewater with new chemicals (found in shampoos, soaps, and other products). The negative effects of using untreated wastewater on the environment and human health have gained attention. Before this untreated effluent totally contaminates all the rivers and natural water bodies, these issues must be urgently addressed. By properly treating wastewater and disposing of it safely with minimal negative effects on the environment and public health, the majority of developed nations have been able to address this issue. Developing nations have often failed in their attempts to acquire comparable water treatment technologies from the west. This failure has social as well as economic causes. Before a technology is adopted, it is crucial to understand the social and economic background of a society, community, or city. The various social and economic factors that must be taken into account include: how people view water, their level of education, their awareness of the environment, and their willingness and ability to pay for environmental protection. Making wastewater a safe resource for people in impoverished nations also requires political will and institutional support. Wastewater recycling is becoming more important in a number of affluent nations with water shortages, including the USA, UK, Germany, and Australia. But they also deal with a variety of social and economic issues (detailed in the above sections). Developed nations can benefit from the varied data on the quality of the soil, water, crops in wastewater-irrigated areas, and the experiences of farmers in developing nations in using wastewater by setting their own standards for quality. Wastewater recycling is becoming a crucial strategy to supplement the existing water resources for both developing and developed countries, and there are lessons, experiences, data, and technology that can be shared for mutual benefit. This is due to issues with climate change, increases in urban population, and increased demand for water from competing sectors.

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