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IMPACT OF MODERN AGRICULTURAL PRACTICES ON IRRIGATION WATER QUALITY IN AND AROUND RANGA REDDY DISTRICT OF TELANGANA

Gandhi N[*1,2,3,4], Y. Rama Govinda Reddy[*4], K. Rama Naik[*2,4], Vijaya Ch[*3]
[*1]Metagro Pvt, Ltd. Kavuri Hills, Jubilee Hills, Hyderabad, Telangana, India.
[*2]ISAAYU FARMS Pvt. Ltd. Amar Co-Operative Society, Kavuri Hills, Jubilee Hills, Hyderabad, Telangana, India.
[*3]Department of Marine Biology, Vikrama Simhapuri University, Nellore, Andhra Pradesh, India.
[*4]Green Fields Institute of Agriculture Research and Training, Mangalpally, Ibrahimpatnam, Rangareddy, India.
Corresponding author: Prof. Vijaya Ch Email: vijayalch@gmail.com
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ABSTRACT

Modern agricultural practices have significantly transformed the agricultural landscape, leading to increased crop yields and food production. However, these practices have also raised concerns about their impact on irrigation water quality and the subsequent pollution of groundwater resources. This literature review aims to provide an overview of the impact of modern agricultural practices on irrigation water quality and the potential risks of groundwater pollution. The experiment was conducted during Rabi season 2020-2021 at Laboratory conditions of Green Fields Institute of Agriculture Research & Training, Mangalpally, to study the "Impact of Modern Agricultural Practices on Irrigation Water Quality Around Rangareddy District of Telangana"**.** The water is the main source of farming the irrigation facility for the farmers will be from the cyclic source of water storage dam. The water is stored during the heavy rainfall the collected water are stored in the dams the dams will be the source of water main source then the water from the dams are left to the lacks and from the lakes the water is transferred through the canals to the nearby local lakes from there the nearby people over the lakes will be using the water as the source. Due to the increase in the industrialization the water from the industries are transferred to the lakes. So by this the pollutants released from the industry challenges water quality. The nature of the water mainly depends upon the different parameters such as pH, Conductivity, Salinity, Alkalinity, Acidity, hardness, turbidity and heavy metals etc. The heavy usage of inorganic chemicals, fertilizers, pesticides and herbicides in a part of crop production and crop protection, directly showing impact on physico-chemical parameters of water. Taking this factor into consideration the present investigation carried by collecting various water samples from agricultural fields located in and around Rangareddy district of Telangana state, to understand the water chemistry at different sampling zones. The collected water samples were analyzed for various physical and chemical parameters according to standard methods available from literature. The obtained results were compared with soil quality parameters given by WHO for agriculture and concluded that most of the sampling points shown significant changes in their physical and chemical compositions. The obtained results also concluding that the water quality was degraded because of heavy loads of chemicals and fertilizers.

Keywords: Water Quality, Pesticides, Herbicides, Chemical Fertilizers, Irrigation Water Quality And Ground Water Quality.

1. INTRODUCTION

Modern agricultural practices have revolutionized the farming industry, enabling increased productivity and food security. However, the intensive use of agrochemicals, inadequate soil conservation measures, and improper waste management have led to concerns about water quality in agricultural areas. This review aims to analyze the literature on the impact of modern agricultural practices on irrigation water quality and the subsequent contamination of groundwater sources. Several studies have reported the contamination of irrigation water by agrochemicals, including pesticides, herbicides, and fertilizers (Smith et al., 2017; Johnson et al., 2019; Vinusha et al., 2024). These chemicals can leach into water sources, leading to potential risks for human health and the environment. Intensive tillage practices and inadequate soil conservation measures contribute to soil erosion and sedimentation in water bodies (Wu et al., 2018; Priyamvada et al., 2012). Sediment-associated nutrients and pesticides can enter irrigation water, affecting its quality. Improper management of animal waste in intensive livestock farming can result in the runoff of nutrients and pathogens into nearby water sources (Vieira et al., 2020; Priyamvada et al., 2013). The accumulation of nutrients and microbial contamination can impact water quality. Agricultural chemicals can infiltrate the soil and leach into

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groundwater sources (Dai et al., 2016). Nitrate, pesticides, and pathogens can be transported through this pathway, potentially polluting ground water. Studies have highlighted the risks associated with nitrate contamination in groundwater, including methemoglobinemia in infants (Ward et al., 2018). Pesticide residues and heavy metals from agricultural activities can also contaminate groundwater and pose environmental and health risks.

2. MATERIALS & METHODS

2.1 Study Area (Agriculture in Telangana)

In recent years, the agricultural plight in Telangana, marked by numerous cotton farmer suicides in 1997-98, has garnered attention (Parthasarathy and Shameem, 1998; Chowdhary et al., 2002). Two prevailing perceptions highlight Telangana's backwardness and irrigation insufficiency due to government neglect (Simhadri and Rao, 1997). However, district-level growth rates between 1970 and 2001 challenge these notions, revealing substantial increases in groundwater irrigation despite state negligence. This shift towards groundwater irrigation, albeit fostering agricultural growth, poses challenges such as increased farmer debt and long-term sustainability concerns (Revathi, 1998). Data from the Directorate of Economics and Statistics of Andhra Pradesh government underpin these findings, albeit with acknowledged limitations in methodology and data accuracy.

2.2 Ranga Reddy District

Over the past five years, the Indo-French Centre for Groundwater Research (NGRI, Hyderabad) has conducted extensive studies in the Maheshwaram granite aquifer (Ranga Reddy District, Andhra Pradesh), focusing on understanding its structure and functionality (Dewandel et al., 2003; Dewandel et al., 2004; Wyns et al.,2004; Lachassagne et al.,2006). Methodologies have been developed for accurate groundwater balance assessment (Galeazzi et al., 2003; Dewandel et al., 2006; & Lachassagne et l., 2006;), borewell siting (Krishnamurthy et al.,2003; Kumar et al., 2003;), aquifer layer mapping (Ahmed et al., 2007;), and enhancing groundwater modeling techniques (Ahmed., 2001; Engerrand et al., 2004; Ahmed et al., 2003;). Advanced techniques like geostatistics have also been employed to regionalize aquifer parameters and optimize monitoring networks (Ahmed. 2002; Bertrand et al., 2002;). The Maheshwaram watershed, spanning 53 sq. km and situated 35 km south of Hyderabad, serves as the pilot site, typifying South Indian rural catchments in geology and socio-economic aspects. The area features a semi-arid climate with monsoon-driven rainfall and Archean granites dominating its geology.

2.3 Sampling

Fifty representative water profiles were studied at fifty selected study sites across Ranga Reddy district (Figure-1). Of these, few samples were located in

Zone-1: Sirpura, Patloor, Tekulapalle, Lingampalle, Peelaram, Boppanaram, Jangaon, Nagaram, Kerelly, Rampur, Allapur.S, Gundal and Mokila.

Zone–2: which are Nuthankal, Narayanpur, Jeedimetla, Ammuguda, Bogaram, Rajapur, Serilingampally, Boduppal, Gandipet, Nagole, Chandanagar, Balapur and Koheda

Zone-3: Malkangiri, Allapur, Girijapur, Chintalapalle, Kankal, Chityal, Naskal, Khammam Nacharam, Kothapally, Ramnagar, Kondapur and Reddipalle.

Zone-4: Rudraram, Rayannaguda, Madanpalle, Bongloor, Pocharam, Gangaram, Japala, Loyapalle, Bachupally, Madhepur, Gungal and Thakkellapalle.

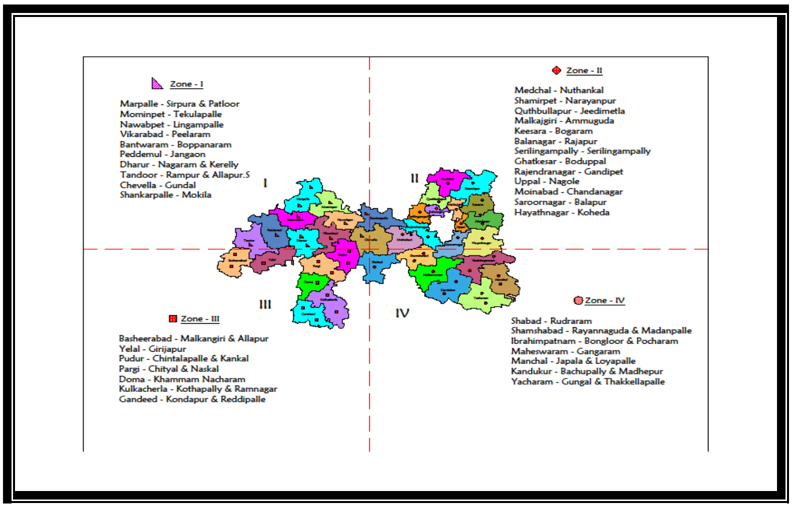

Figure 1: Sampling zones from agricultural lands of Rangareddy district, Telangana, India.

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2.4 Physico-Chemical analysis of water quality

2.4.1 Determination of pH

The pH value of water indicates the concentration of hydrogen ions in water. The concept of pH was introduced by Sørensen in 1909. pH is expressed as the logarithm of the reciprocal of hydrogen ion concentration in moles per liter at a given temperature. The pH scale ranges from 0 (very acidic) to 14 (very alkaline), with 7 corresponding to exact neutrality at 25°C. The pH scale is used in the calculation of carbonate, bicarbonate, CO_2, corrosion, and stability, among other things. While alkalinity or acidity measures the total resistance to pH change or buffering capacity, pH gives the hydrogen ion activity. pH can be measured either calorimetrically or electrometrically (Gandhi et al., 2024; A.fernández-cirelli et al., 2009;)

2.4.2 Determination of alkalinity of water

The alkalinity of water is a measure of its capacity to neutralize acids. It is primarily due to salts of weak acids, although weak or strong bases may also contribute. Alkalinity is usually imparted by bicarbonate, carbonate, and hydroxide. It is measured volumetrically by titration with 0.02 N sulfuric acid and is reported in terms of $CaCO_3$ equivalent. (Montanaro et al., 2009; Vinusha et al., 2023)

Phenolphthalein Alkalinity = $\frac{\boldsymbol{V1XNX50X1000}}{\boldsymbol{Volumeofsample}}$

Total Alkalinity = $\frac{\boldsymbol{V2XNX50X1000}}{\boldsymbol{Volumeofsample}}$

2.4.3. Determination of Acidity of water

Acidity of water refers to its ability to neutralize a strong base to a specific pH. The acidity of water is primarily due to the presence of strong mineral acids, weak acids such as carbonic and acetic, and hydrolysing salts such as ferric and aluminium sulphates. The amount of base required to neutralize a given sample to a specific pH is used to measure the acidity of water. (Tadele, Mesfin. 2020; Gandhi et al., 2018)

Methyl Orange Acidity/Mineral Acidity = $\frac{\boldsymbol{V1X1000XNX50}}{\boldsymbol{Volumeofsample}}$

Phenolphthalein/Total Acidity = $\frac{\boldsymbol{V2XNX50X1000}}{\boldsymbol{Volumeofsample}}$

2.4.4. Estimation of Zinc

Adding an indicator to a solution containing Mg^{2+} forms a red-colored magnesium indicator complex. When the disodium salt of EDTA is introduced, it reacts with the magnesium, forming a magnesium EDTA complex. This reaction releases the previously bound indicator, resulting in a blue color at pH 10. Moreover, EDTA has the capability to displace the indicator from the zinc indicator complex, leading to a noticeable color change that signals the endpoint of the reaction. (Salunkhe & Desai, 1988; Gandhi et al., 2016)

2.4.5. Estimation of Iron (Fe^{+2} ion)

The Fe^{2+} ion undergoes oxidation to Fe^{3+} by $KMnO_4$ in the presence of dilute H_2SO_4. The endpoint is indicated by a faint pink color of permanganate. Additionally, sodium oxalate ion transforms into CO_2 and water in this chemical process. (Salunkhe, & Desai 1988; Smita et al., 2013)

2.4.6. Determination of Nitrite- Nitrogen in water Cadmium reduction method

Nitrate is nearly completely reduced to nitrite when a sample passes through a column filled with Cadmium, which is loosely coated with metallic copper. The resulting nitrite is then determined through diazotization with sulphanilamide and coupling with NNED (N-(1-naphthyl ethylene diamine dihydrochloride), forming a vividly colored azo dye. The extinction of this dye is measured at 543 nm. To account for any initially present nitrate in the sample, a correction can be applied. Alternatively, the nitrate in the sample can be reduced to nitrite using an overnight reduction method. (Gandhi et al., 2015; Arthisree et al., 2013)

2.4.7. Determination of Carbonates and Bicarbonates

Na_2CO_3 reacts with HCl in two drops. The initial stage involves reference half-neutralization up to the bicarbonate stage, with the endpoint detected using phenolphthalein. In the second stage, complete neutralization occurs. To standardize HCl, it is titrated against standard sodium carbonate (Na_2CO_3). (Cooley, Kent Evert.1988)

2.4.8. Estimation of free carbon dioxide

CO_2 reacts with NaOH or Na_2CO_3 to produce $Na(HCO_3)_2$. The completion of the reaction is signaled by the emergence of a pink color, facilitated by the presence of phenolphthalein indicator at a pH of 8.3. (Galan-Martin, Angel, et al.2022)

2.4.9. Estimation of chemical oxygen demand (COD)

The determination of the (COD) or permanganate value in water is typically carried out through alkaline oxidation with permanganate. Chromic and permanganate under acidic conditions are not effective in oxidizing the organic matter in water. These oxidants are prone to converting chloride ions in water into free chlorine. Therefore, to avoid this issue, the preferred method for analyzing COD in water involves the oxidation of organic matter with permanganate under alkaline conditions. (Tang et al., 2020; Gandhi et al., 2022)

2.4.10. Determination of Dissolved oxygen in water (Winkler's Method)

$MnSO_4$ reacts with an alkali to generate a white precipitate of manganese hydroxide. Within this precipitate, oxygen (O_2) oxidizes the manganese hydroxide to form a brown-coloured higher hydroxide. Upon acidification, this higher hydroxide releases iodine equivalent to the amount of O_2 fixed. The liberated iodine is then titrated against thiosulphate, with starch serving as an indicator (Dance, & Hynes, 1980; Gandhi et al., 2024).

2.4.11. Determination of B.O.D of Wastewater Sample

B.O.D. in sewage or polluted water measures the amount of oxygen needed for the biological breakdown of dissolved organic matter under aerobic conditions at standardized time and temperature. Typically, this assessment occurs over a period of 5 days at a temperature of 20°C, following global standards. B.O.D. testing is a crucial method in sanitary analysis, determining the pollution level in sewage, industrial waste, or polluted water. It provides insights into the amount of clean diluting water required for effective sewage disposal through dilution. Widely used, especially in evaluating waste loading for treatment plants, it plays a key role in assessing the efficiency of such treatment systems. (Cooper, 1993; Gandhi et al., 2024)

2.4.12. Determination of Turbidity of Water

The method described below relies on comparing the intensity of light scattered by a sample under specific conditions to the intensity of light scattered by a standard reference suspension under the same conditions. Turbidity increases with higher intensity of scattered light. Formazine polymer, recognized as the standard reference suspension for turbidity, is employed in water testing. It is easy to prepare and offers more consistent light scattering properties compared to clay or natural water standards used previously. The turbidity of a specific formazine concentration corresponds to approximately 100 NTU when measured on a candle turbidity meter. Nephelometric turbidity units based on formazine preparation align with units derived from the Jackson candle turbidimeter, although they may not be identical. (Berman et al, 2022)

3. RESULT

3.1 Temperature

Temperature is a critical factor in environmental conditions, impacting various processes and ecosystems. Zone I (Table 1) (22 to 35 degrees) Encompasses a broad temperature range, indicating potential for both warm and moderate conditions. Zone II (22 to 27.4 degrees) Represents a relatively narrower temperature span (Table 2), suggesting a more specific range within the moderate to warm spectrum. Zone III (22 to 27.4 degrees) (Table 3) shares a similar temperature range with Zone II, indicating consistency in temperature conditions. Zone IV (22.9 to 25.5 degrees) Reflects a slightly more constrained range compared to other zones, suggesting a specific and slightly cooler temperature profile (Table 4).

3.2 pH

The pH scale is a measure of the acidity or alkalinity of a substance, with values ranging from acidic (0) to alkaline (14). Zone I (Table 1) ranges from 6.11 to 8.11 Represents a moderately acidic to neutral range. Zone II (Table 2) ranges from 6.26 to 10.7 Shows a wider pH span, indicating a transition from slightly acidic to moderately alkaline conditions. This zone suggests a potential for both acidic and alkaline influences. Zone III (Table 3) ranges from 7.42 to 10.2 Encompasses a predominantly alkaline range, suggesting a more basic nature. Zone IV (Table 4) ranges from 8.45 to 10.9 Exhibits a higher alkalinity compared to other zones, indicating a more pronounced alkaline environment. The observation reveals that Zone II and Zone IV have higher pH values, signifying a more alkaline nature in these zones. In contrast, Zone I and Zone III exhibit lower pH values, indicating a less alkaline or even acidic character. Understanding these pH zones is crucial for assessing the chemical nature of substances in different environments.

3.3 Electrical Conductivity

Conductivity is a measure of a solution's ability to conduct an electric current, often influenced by the concentration of dissolved ions. Zone I (137.1 to 141) represents a range of relatively lower conductivity, indicating a lower concentration of dissolved ions in the solution (Table 1). Zone II (140.4 to 195.9) Exhibits a broader range of conductivity, suggesting a higher variability in ion concentration (Table 2). This zone generally shows higher conductivity compared to Zone I. Zone III (143.9 to 157.1) Encompasses a moderate range of conductivity, indicating a moderate concentration of dissolved ions in the solution (Table 3). Zone IV (170.7 to 199.5) shows a higher range of conductivity, suggesting an elevated concentration of dissolved ions (Table 4). This zone generally exhibits higher conductivity compared to Zone I and Zone III. The analysis indicates that Zone II and Zone IV generally have higher conductivity compared to Zone I and Zone III. This suggests a higher concentration of dissolved ions in the solutions within these zones. Understanding the conductivity patterns is essential for assessing water quality and understanding the chemical composition of different environmental zones.

3.4 Total Dissolved Solids

TDS measure the concentration of dissolved substances in water, encompassing various ions and other dissolved solids. Zone I (137.2 to 140.4) represents a range of relatively lower TDS values, indicating a lower concentration of dissolved solids in the water. Zone II (140.3 to 166.3) Exhibits a broader range of TDS values, suggesting a higher variability in the concentration of dissolved solids. This zone generally shows higher TDS compared to Zone I. Zone III (145 to 190) Encompasses a moderate range of TDS values, indicating a moderate concentration of dissolved solids in the water. Zone IV (171.6 to 199.5) Shows a higher range of TDS values, suggesting an elevated concentration of dissolved solids. This zone generally exhibits higher TDS compared to Zone I and Zone III. Similar to conductivity, the TDS analysis reveals that Zone II and Zone IV have higher TDS values compared to Zone I and Zone III. This indicates a higher concentration of dissolved solids in the water within these zones. Understanding TDS patterns is crucial for assessing water quality, as higher TDS levels can impact various environmental and ecological factors.

3.5 Turbidity

Turbidity is a measure of the cloudiness or haziness of a fluid caused by large numbers of particles that are generally invisible to the naked eye. Zone I (22 to 35) encompasses a broad range of turbidity levels, suggesting potential variability in the clarity of the fluid in this zone. Zone II (22.6 to 27.4) Represents a narrower range of turbidity levels, indicating a more specific and consistent clarity in the fluid within this zone. Zone III (24.7 to 25.5) Exhibits a relatively small range of turbidity levels, suggesting a more consistent clarity in the fluid in this zone. Zone IV (23.1 to 29) Shows some variability in turbidity levels, but generally comparable to Zone I and Zone III. This zone suggests a moderate range of clarity in the fluid. The analysis indicates that turbidity levels vary across the zones. While Zone II and Zone IV show some variability, overall, the turbidity levels in these zones are generally comparable to Zone I and Zone III. Understanding turbidity patterns is crucial for assessing water quality, as it provides insights into the presence of suspended particles and the clarity of the fluid, which can impact various environmental and ecological factors.

3.6 Zn & Fe

Zone I: Zinc levels range from 0.52312 to 3.07333, while iron levels range from 1.8088 to 6.9148. Overall, there is variability in both zinc and iron levels, with the highest iron concentration observed. Zone II: Zinc levels range from 1.11163 to 4.18496, while iron levels range from 0.952 to 3.7856. There is a moderate range of values, and iron levels are generally lower than those in Zone I. Zone III: Zinc levels range from 1.50397 to 5.2312, while iron levels range from 1.26 to 2.9232. Zinc levels show variability, and iron levels are relatively lower than those in Zone I. Zone IV: Zinc levels range from 1.1424 to 3.33489, while iron levels range from 0.8288 to 1.736. Both zinc and iron levels show variability, with iron concentrations generally lower than those in Zone I. Zone I has the highest iron levels, potentially indicating a higher concentration of this metal compared to the other zones. Zone III has the highest zinc concentration, and both zinc and iron levels are lower compared to Zone I. Zone IV shows variability in both zinc and iron levels, with concentrations generally lower than those in Zone I. Zone II has moderate levels of both zinc and iron, with iron concentrations generally lower than those in Zone I. Again, to provide a more comprehensive interpretation, specific references or standards for zinc and iron levels in water should be consulted.

3.7 Acidity

The acidity levels in the studied water samples exhibit notable variations across the four defined zones. In Zone I, acidity ranges from 17.5 to 100, indicating a diverse spectrum of acidic conditions. Zone II displays acidity levels spanning from 10 to 75, showcasing a moderate range. Zone III demonstrates relatively lower acidity, fluctuating between 10 and 31. Notably, Zone IV stands out with generally higher acidity levels, ranging from 11 to 53. This variation suggests a spatial heterogeneity in water quality, highlighting the need for region-specific interventions and monitoring to address acidity-related concerns in different zones.

3.8 Alkalinity

Alkalinity, a critical water quality parameter, exhibits notable variations across different zones based on the provided data. In Zone I, alkalinity ranges from 20 to 100, showcasing a considerable spread. Zone II displays a lower range,

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fluctuating between 4 and 35, indicating relatively moderate alkalinity levels. Zone III exhibits alkalinity values ranging from 8 to 70, reflecting a diverse range of water conditions. Notably, Zone IV stands out with the highest alkalinity values, spanning from 11 to 72. This variation suggests distinct alkalinity characteristics in each zone, emphasizing the need for targeted water quality management strategies in different geographical areas. Additionally, specific references and established standards should be consulted for a comprehensive understanding and comparison of alkalinity levels in relation to accepted water quality guidelines.

3.9 Chemical Oxygen Demand (COD)

The COD, levels in the analyzed water samples exhibit notable variations across different zones. In Zone I, the COD ranges from 5 to 40, indicating a moderate to high organic pollutant load. Zone II, however, displays a wider range, with values spanning from 1.1 to 39.2. Notably, Zone II contains some exceptionally high COD values, suggesting a potentially elevated presence of organic contaminants. Zone III also shows a diverse COD range, varying from 1.1 to 40, similar to Zone II. In contrast, Zone IV demonstrates a narrower range of COD levels, ranging from 8 to 22, potentially indicating a more consistent, but comparatively lower, organic pollutant load. The higher COD values in Zones II and III warrant further investigation into potential pollution sources and environmental impact.

3.10 Biochemical Oxygen Demand (BOD)

The BOD, levels in the studied water zones reveal notable variations. BOD reflects the amount of oxygen consumed by microorganisms during the decomposition of organic matter in water. In Zone I, BOD ranges from 1.6 to 41.6, indicating a diverse range of organic pollutants. Zone II exhibits lower BOD values, ranging from 1.6 to 24, suggesting potentially reduced organic load compared to Zone I. Zone III shows BOD levels ranging from 3.2 to 24, with a slight increase compared to Zone II. Interestingly, Zone IV demonstrates BOD levels ranging from 1.6 to 17.6, suggesting a potential improvement in water quality with lower organic pollution compared to other zones. These findings underscore the importance of BOD as an indicator of organic pollution and highlight the varying degrees of water quality across the different zones.

3.11 Dissolved Oxygen (DO)

The levels of DO, in the water samples from different zones exhibit notable variations. In Zone I, DO concentrations range from 35 to 165, indicating relatively high levels of dissolved oxygen. Zone II displays a narrower range, spanning from 26 to 75, with values generally lower than those in Zone I. Zone III demonstrates a range of 16 to 59, indicating a further decrease in DO levels compared to the previous zones. Finally, Zone IV exhibits DO concentrations ranging from 25 to 43, suggesting a moderate level of dissolved oxygen. Overall, the Dissolved Oxygen levels follow a decreasing trend from Zone I to Zone IV, with Zone I consistently maintaining higher concentrations. The variations observed in DO levels across these zones may be indicative of differing water quality conditions, potentially influenced by factors such as pollution, organic matter, and other environmental variables. Monitoring and managing these variations are crucial for understanding and maintaining the health of aquatic ecosystems in each respective zone.

3.12 CO_2

The levels of CO_2, in the water samples exhibit notable variations across different zones: Zone I (62.7 to 564.1) Displays a broad range of CO_2 concentrations, indicating potential variability in the sources or environmental conditions affecting carbon dioxide dissolution. Zone II (92.4 to 981.9) Notable for having some of the highest recorded CO_2 levels, suggesting a potential influence of factors such as organic decomposition or anthropogenic activities contributing to elevated carbon dioxide concentrations. Zone III (57.2 to 510.8) Similar to Zone II, this zone demonstrates a range of CO_2 concentrations that may be associated with diverse environmental factors, possibly including natural processes or human-related activities. Zone IV (132 to 294.8) Exhibits a comparatively narrower range of CO_2 concentrations. While still varying, these values may indicate a different set of influences on carbon dioxide levels in this zone. Overall, the observed CO_2 levels highlight distinct characteristics in each zone, emphasizing the importance of understanding local factors and potential sources contributing to water quality variations. Further investigation and consideration of relevant environmental standards are recommended for a comprehensive assessment of water quality in each zone.

3.13 Carbonates & Bicarbonates

The levels of carbonates and bicarbonates in the water samples vary across different zones, as indicated in the provided data. In Zone I, the values range from 0.17 to 0.43, while in Zone II, they range from 0.01 to 0.35. Zone III exhibits a range of 0.25 to 0.6, and Zone IV ranges from 0.24 to 0.52. Notably, Zone IV tends to have slightly higher values in comparison to the other zones. The presence of carbonates and bicarbonates in water is crucial for buffering against changes in pH and maintaining overall water quality. However, specific standards and guidelines should be referenced for a comprehensive assessment of these values in relation to water quality benchmarks.

3.14 Nitrogen

Nitrogen levels in Zone I range from 0.04 to 0.43. Overall, the values show some variability, with the highest value (0.43) potentially indicating a higher nitrogen concentration. Nitrogen levels in Zone II range from 0.01 to 0.42. The values exhibit moderate variability, and the highest value (0.42) is comparable to Zone I's highest value. Nitrogen levels in Zone III range from 0.17 to 0.6. There is a wider range of values in Zone III, and the highest value (0.6) suggests a relatively higher nitrogen concentration compared to Zones I and II. Nitrogen levels in Zone IV range from 0.24 to 0.52. The values in Zone IV are relatively consistent, and the highest value (0.52) is comparable to the highest values in Zones I and II.

Zone III appears to have the highest nitrogen levels overall, potentially indicating a greater nitrogen load in the water. Zone I and Zone II show moderate variability, with Zone II having slightly lower maximum values than Zone I. Zone IV has relatively consistent values, with the highest value comparable to those in Zones I and II. It's crucial to note that specific guidelines or standards for nitrogen levels in water are needed for a more detailed interpretation. Additionally, citing specific references or standards would enhance the credibility of the interpretation. If available, you should refer to local or international water quality standards, environmental regulations, or scientific studies related to nitrogen levels in aquatic ecosystems.

4. DISCUSSION

The impact of modern agricultural practices on irrigation water quality in and around the Ranga Reddy District of Telangana is a multifaceted issue with implications for environmental sustainability, human health, and agricultural productivity. Drawing upon a diverse array of scholarly references, this discussion aims to explore the complexities and challenges associated with this critical issue. Agricultural intensification, driven by factors such as population growth and technological advancements, has led to increased demands for water resources and the widespread adoption of modern irrigation techniques. However, the unintended consequences of these practices on water quality have become increasingly apparent. Madden and Chaplowe (1997) emphasize the importance of sustainable agriculture in mitigating these adverse impacts, highlighting the need for holistic approaches that consider the long-term environmental and socio-economic implications of agricultural practices.

Soil degradation, a consequence of intensive agricultural activities, poses a significant threat to water quality in the region (Richard Young et al., 2015). The Revised World Soil Charter (FAO, 2015) underscores the urgency of addressing soil degradation to safeguard water resources and ensure the sustainability of agricultural systems. Soil erosion, nutrient runoff, and pesticide contamination contribute to the degradation of water quality, adversely affecting aquatic ecosystems and human health (Dubrovsky et al., 2010; Mohanty et al., 2013). Nutrient management practices play a crucial role in mitigating the impact of agricultural activities on water quality. Efficient use of fertilizers and proper nutrient management are essential for minimizing nutrient runoff and eutrophication of water bodies (Ladha et al., 2005; Bijay-Singh, 2016). However, challenges such as overuse of fertilizers, inadequate nutrient cycling, and improper irrigation practices exacerbate nutrient pollution in water sources (Brar et al., 2015; Bijay-Singh et al., 2003).

Heavy metal contamination is another pressing concern associated with modern agricultural practices. The use of agrochemicals, industrial effluents, and improper waste disposal contribute to the accumulation of heavy metals in soil and water (Brigden et al., 2002; Chhabra et al., 2010). These contaminants pose risks to human health and ecological integrity, highlighting the need for stringent regulations and pollution control measures (MPCA, 2007; Kawade, 2012). Furthermore, climate change exacerbates the challenges associated with water quality management in agricultural landscapes. Changes in precipitation patterns, temperature regimes, and hydrological cycles influence the availability and distribution of water resources, thereby affecting water quality dynamics (Pathak et al., 2014; Pedde et al., 2017). Sustainable water management strategies that incorporate climate resilience and adaptive measures are imperative to address these challenges (Sutton et al., 2017).

5. CONCLUSION

The data presented offers insights into the impact of modern agricultural practices on irrigation water quality in the Ranga Reddy District of Telangana. Across multiple parameters, notable variations are observed among different sampling sites (S1-S13). These parameters include pH, conductivity, total TDS, turbidity, temperature, zinc, iron, acidity, alkalinity, COD, DO, BOD, CO_2, carbonates, bicarbonates, and nitrogen. Such variations signify the diverse environmental conditions and anthropogenic influences affecting water quality in the region. For instance, fluctuations in pH levels indicate differences in soil acidity or alkalinity, while conductivity and TDS levels reflect variations in the concentration of dissolved salts, potentially influenced by agricultural inputs and soil composition. Turbidity

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measurements provide insights into the clarity of water and the presence of suspended particles, highlighting potential sedimentation and erosion issues.

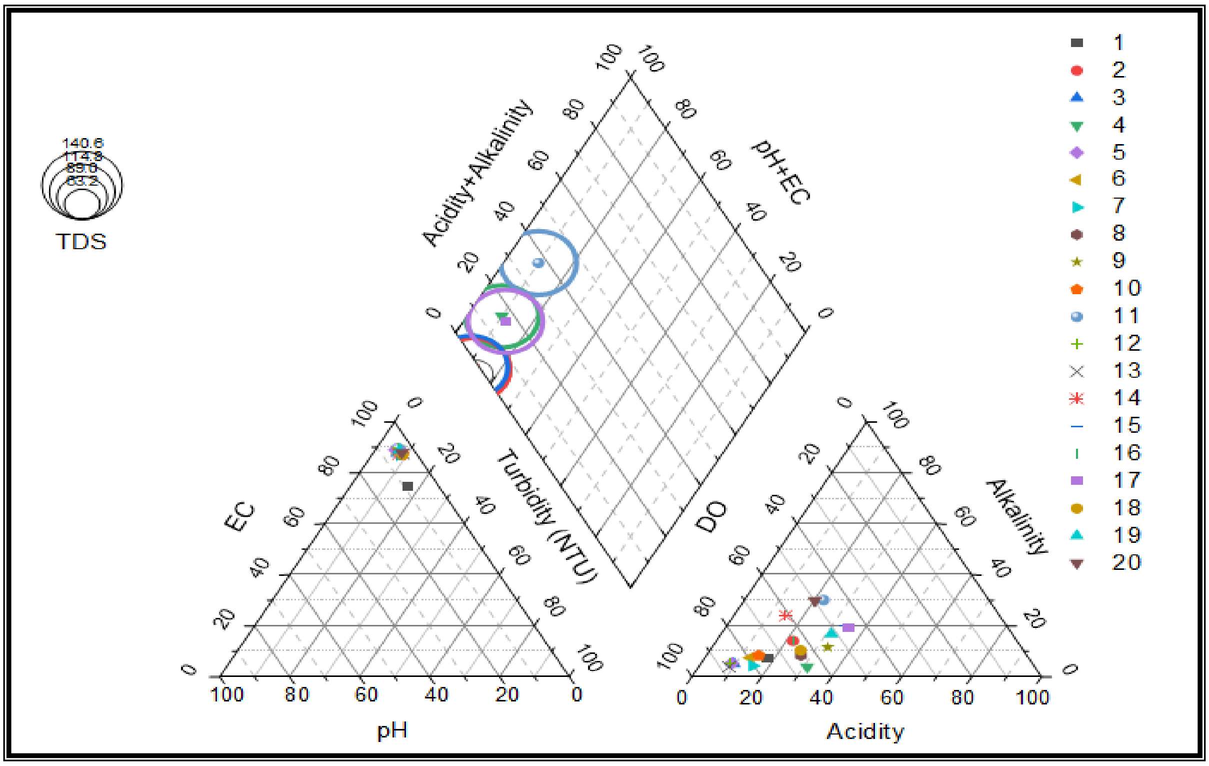

Figure-2: Piper plot for water quality parameters of zone-1-4 samples collected from Rangareddy district of Telangana.

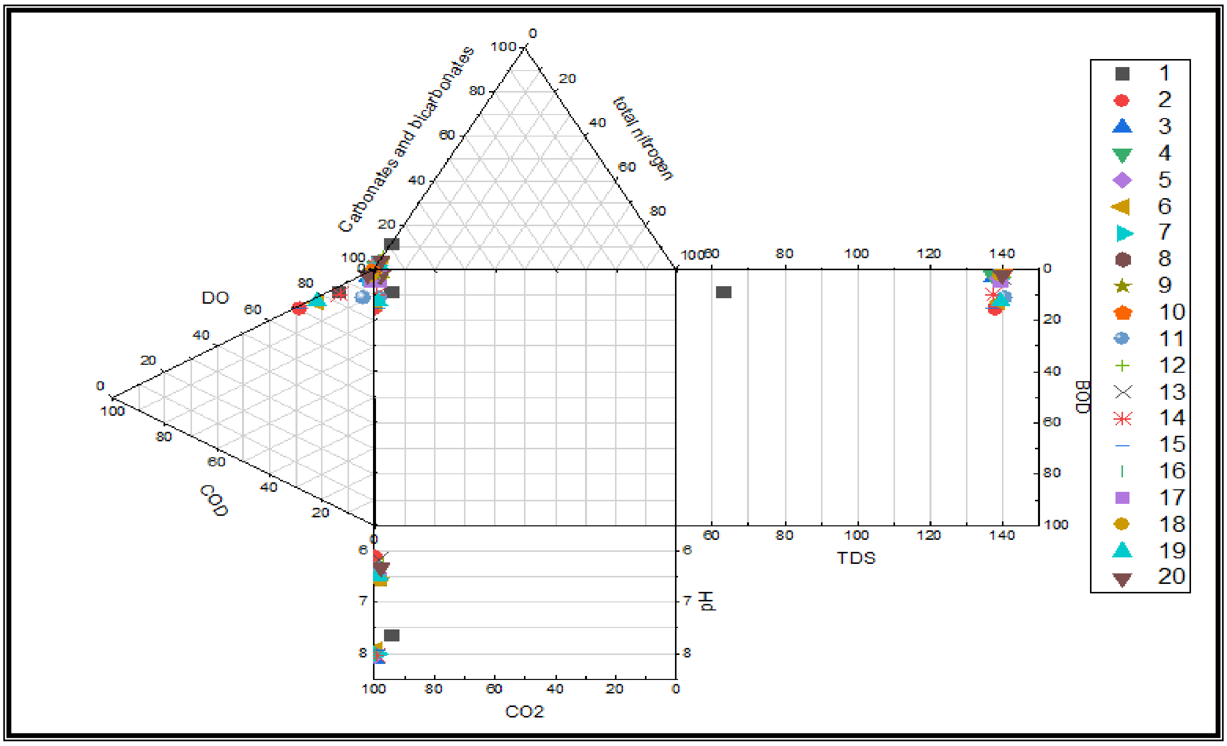

Figure-3: Durov diagram for water quality parameters of zone-1-4 samples collected from Rangareddy district of Telangana.

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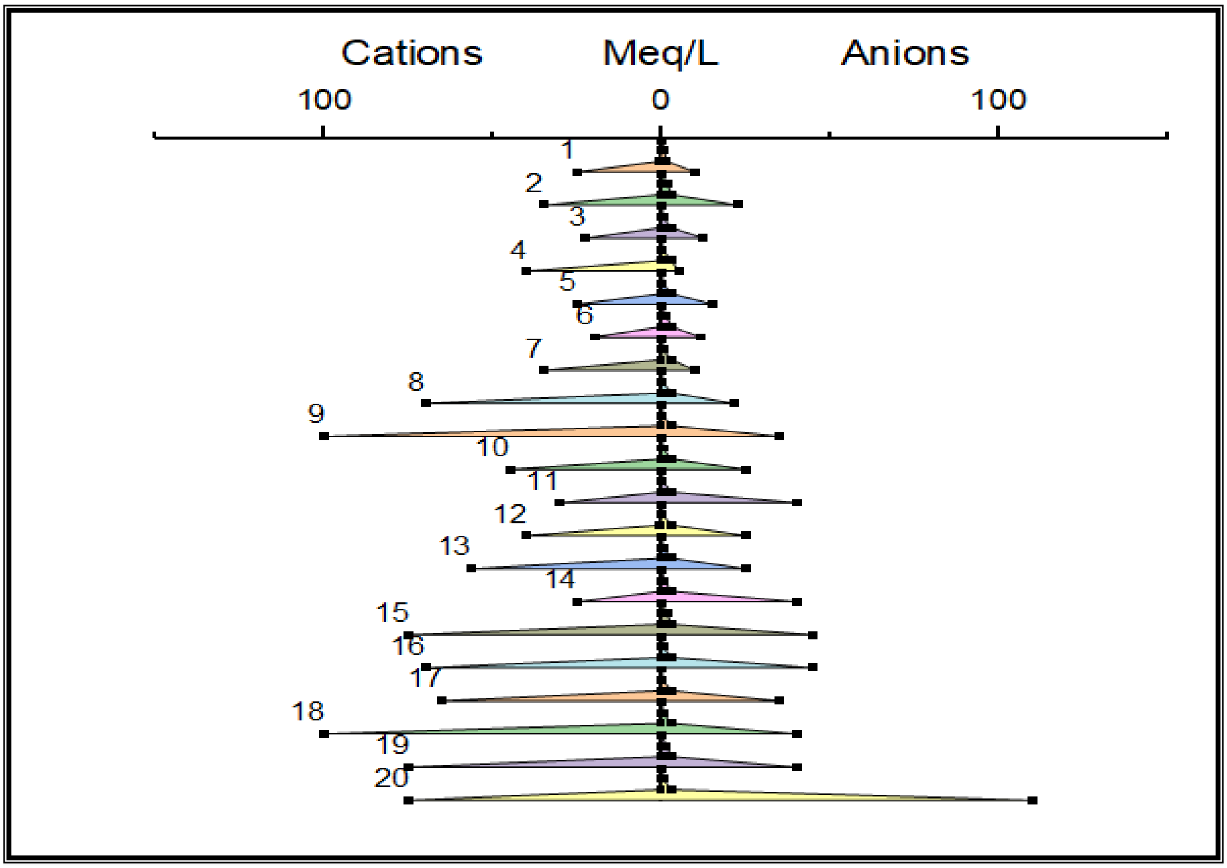

Figure-4: Levels of anio, cations in zone-1-4samples collected from Rangareddy district of Telangana.

Moreover, temperature variations signify seasonal changes and environmental dynamics, which can influence water quality parameters. The data also reveals fluctuations in metal content, including zinc and iron, suggesting potential contamination sources or natural geological influences. Parameters such as acidity, alkalinity, COD, DO, BOD, CO_2, carbonates, bicarbonates, and nitrogen further underscore the complexity of water quality dynamics and the presence of organic and inorganic pollutants. Collectively, these findings emphasize the need for comprehensive monitoring and management strategies to address the challenges posed by modern agricultural practices on water resources in the Ranga Reddy District. Sustainable water management approaches, informed by ongoing monitoring efforts and interdisciplinary research, are essential to safeguarding water quality and promoting ecosystem health in agricultural landscapes. Additionally, stakeholder engagement and policy interventions are crucial for implementing effective mitigation measures and ensuring the long-term sustainability of water resources in the region.

Table 1: Physico-chemical parameters of water samples collected from zone-1 of Rangareddy district, Telangana.

Parameter	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**
pH	7.65	6.11	8.11	6.4	8.04	7.93	8.01	6.51	6.57	6.48	6.33	6.27	6.18
Conductivity	63.3	137.9	137.3	137.1	138.7	139.2	139.7	140	140	140.4	141	141	140.5
Total Dissolved Solids (TDS)	63.2	138	137.6	137.2	139	139.2	139.5	139.6	140	140.3	140.6	140.6	140.4
Turbidity	14679	14952	14260	14348	14243	14530	14332	14326	14229	14305	14377	14180	14296
Temperature	34.1	22	23	23	35	23	24	23	23	22	23	23	23
Zinc	2.87716	1.11163	0.91546	1.89631	0.52312	1.3078	1.50397	3.07333	1.3078	2.09248	2.35404	2.74638	2.48482

Iron	6.9148	2.6342	4.2112	1.8592	3.1752	2.5648	2.8448	2.6824	3.2256	2.632	3.0128	2.632	1.8088
Acidity (M)	25	47.5	17.5	50	30	35	25	75	70	65	100	75	75
Acidity (P)	25	35	22.5	40	25	20	35	70	100	45	30	40	56.5
Alkalinity (P)	10	22.5	12.5	5	15	11.5	10	21.5	35	25	40	25	25
Alkalinity (M)	40	45	45	35	40	40	110	130	165	85	80	125	75
COD	16	41.6	4.8	1.6	3.2	35.2	4.8	1.6	3.2	1.6	3.2	1.6	3.2
DO	102.34	102.34	204.6	83.6	245.6	122.8	184.2	167.14	167.14	229.8	62.7	417.9	564.1
BOD	3	1.3	4	1	7	3	3.7	2.6	2	0.6	6.3	12.4	18
CO_2	70.4	1232.2	580.8	220	193.6	176	202.4	105.6	88	114.4	105.6	88	79.2
Carbonates &Bicarbonates	8.99892	1.19928	2.6398	2.99985	0.41997	2.7598	3.9598	2.15989	3.4198	2.5198	3.15824	5.0397	2.5798
Nitrogen	0.34	0.29	0.23	0.31	0.43	0.04	0.25	0.17	0.22	0.29	0.17	0.19	0.16

Table 2: Physico-chemical parameters of water samples collected from zone-2 of Rangareddy district, Telangana.

Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
pH	6.26	8.55	10.6	10.7	8.66	8.64	9.27	10.6	8.91	9.3	9.25	8.46	9.15
Conductivity	140.8	195.9	148	153	157.1	160	162.5	165.5	164.3	164.7	165.2	166.6	140.4
TDS	140.5	193.6	141.1	154.4	159	162.6	162.3	165.3	164	164.4	164.9	166.3	142.1
Turbidity	13989	13776	13976	13736	13619	13804	14097	13226	13526	13746	14013	13656	13484
Temperature	23	24.9	24.2	24	24.7	24.7	24.1	23.6	24.4	24.6	24.3	25	22.6
Zinc	3.59645	4.18496	3.40028	3.07333	2.09248	2.09248	1.70014	2.41943	2.15787	2.41943	2.48482	2.74638	1.63475
Iron	3.7856	2.2568	3.332	1.2208	1.344	1.1872	0.952	1.26	1.428	1.1424	1.3776	1.3048	1.1032
Acidity (M)	75	12	40	30	40	30	18	14	30	40	10	64	16
Acidity (P)	35	14	8	28	8	4	26	10	28	32	14	37	23
Alkalinity (P)	20	24	12	20.4	6	39.2	11	13	12	14	13	15	8
Alkalinity (M)	75	45	32	52	35	56	54	43	34	43	28	33	51
COD	16	12.8	17.6	1.6	12.8	17.6	22.4	14.4	24	20.8	24	3.2	24

DO	146.25	480.5	438.7	334.2	355.18	396.9	626.7	585	501.4	752.14	981.9	470.4	662.9
BOD	2.3	1	27	3	6	3	11	6	15	2	9	18.6	13
CO_2	79.2	27.5	23.1	33	22	35.2	23.1	16.5	24.2	12.1	20.9	51.7	28.6
Carbonates& Bicarbonates	3.9598	0.76356	1.71801	3.35151	1.33623	5.985	6.575	7.737	1.0405	0.19089	2.67246	0.3436	1.33623
Nitrogen	0.26	0.3	0.25	0.42	0.21	0.22	0.1	0.07	0.01	0.14	0.14	0.13	0.35

Table 3: Physico-chemical parameters of water samples collected from zone-3 of Rangareddy district, Telangana.

Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
pH	7.42	9.11	9.66	8.99	7.87	7.71	7.58	9.31	8.99	10.2	9.33	8.26
Conductivity	143.9	146.5	148.3	149.9	151.4	152.7	154	155.1	157.1	173.1	175.1	181.2
TDS	145	146.8	148.5	150.2	151.6	152.8	154	155.2	157	173.1	174.5	180
Turbidity	13225	13656	13655	13789	13203	13680	13496	13494	13910	13384	13394	13456
Temperature	24.7	22.2	22	23.4	24.5	24.8	25.4	23.1	22.7	27.4	24.3	24.6
Zinc	2.55021	1.76553	2.28865	2.15787	1.9617	1.76553	2.02709	2.74638	5.2312	4.51191	2.02709	1.50397
Iron	1.4616	1.736	1.26	1.344	1.5456	2.9232	2.856	2.212	1.9376	1.7808	1.3776	2.9232
Acidity (M)	25	25	19	12	10	28	17	31	29	49	30	25
Acidity (P)	70	25	41	39	70	64	58	70	64	58	70	77
Alkalinity (P)	12	12	31	14	13	16	10	8	10	1.1	1.1	14
Alkalinity (M)	40	32	48	43	50	43	52	16	59	31	53	43
COD	16	11.2	14.4	12.8	9.6	20.8	11.2	9.6	16	14.4	14.4	4.8
DO	510.8	92.4	105.6	57.2	105.6	70.4	167.2	96.8	180.4	92.4	140.8	132
BOD	10	13	10	10	19	18.2	15.6	14.5	25	1	5.2	15
CO_2	14.3	23.1	26.4	14.3	26.4	17.6	41.8	24.2	45.1	23.1	35.2	33
Carbonates &Bicarbonates	0.19089	1.14534	0.19089	2.29068	0.38178	4.58136	5.34492	2.02343	0.95445	0.649	5.15403	7.2156
Nitrogen	0.25	0.17	0.42	0.6	0.34	0.34	0.37	0.46	0.42	0.29	0.33	0.47

Table 4: Physico-chemical parameters of water samples collected from zone-4 of Rangareddy district, Telangana.

Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
pH	9.15	8.45	9.3	8.76	8.77	8.45	8.95	8.73	8.79	10.9	8.81	10.2
Conductivity	187.1	187	190	195.4	198.6	170.7	177	191.4	199.2	199	181.2	192.5
TDS	184.7	179.2	190	190.6	198.5	171.6	183.1	191.2	197.5	199.5	183	193.5
Turbidity	13610	13681	13784	14116	13918	13486	13716	13426	13289	13382	13785	13588
Temperature	23.1	23.8	22.9	23	24.9	24.3	24.2	24.4	25.5	24.2	24.8	24.2
Zinc	2.94255	3.00794	2.22326	1.9617	2.15787	3.33489	2.94255	2.68099	2.28865	2.87716	2.74638	3.00794
Iron	1.736	1.428	1.4952	1.3776	1.428	1.344	1.26	0.8288	1.3776	1.1424	1.1424	1.26
Acidity (M)	15	25	29	23	53	36	29	24	18	11	21	38
Acidity (P)	58	70	72	48	46	40	64	29	44	30	52	64
Alkalinity (P)	22	12	19	11	12	11	8	14	10	14	21	17
Alkalinity (M)	41	26	36	33	31	31	29	43	34	35	25	36
COD	6.8	9.6	4.8	1.6	4.8	1.6	6.4	4.8	16	12.8	17.6	4.8
DO	220	167.2	154	184.8	246.4	132	286	294.8	110	184.8	211.2	250.8
BOD	31	15	6	22.8	16.3	21.5	16	10	7.5	18	9	2.5
CO_2	55	41.8	38.5	46.2	61.6	33	71.5	73.7	27.5	46.2	52.8	62.7
Carbonates &Bicarbonates	4.77225	1.33623	2.4815	2.9015	0.76356	3.05424	0.57267	3.43602	0.19089	0.38178	1.14534	3.8178
Nitrogen	0.37	0.33	0.37	0.24	0.35	0.41	0.52	0.33	0.41	0.37	0.32	0.37

6. DECLARATION

6.1. Study limitations

The study on modern agricultural practices' impact on irrigation water quality in Ranga Reddy District, Telangana, notes various limitations. These include potential sampling bias, data collection constraints like time and access, and a possibly insufficient sample size. Generalizability beyond the study area may be limited due to regional variations. Concerns arise regarding data accuracy and external factors like weather changes. Methodological constraints and resource limitations, such as funding and equipment, could affect the study's depth. Natural variability in soil and water properties and subjectivity in result interpretation further add complexity. These limitations stress the need for cautious interpretation and suggest areas for future research.

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