Soil and Water Quality Status of Different Villages in Kovur Block of Nellore District, Andhra Pradesh

काशी हिन्दू विश्वविद्यालय BANARAS HINDU UNIVERSITY

THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF

Master of Science (Agriculture)

in

Soil Science – Soil and Water Conservation

Supervisor
Dr. Y.V. Singh

Submitted by
Haneesha Padarthi

DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
INSTITUTE OF AGRICULTURAL SCIENCES
BANARAS HINDU UNIVERSITY
VARANASI - 221 005
INDIA

ID. No. 20430SAC012 **2022** **Enrolment No. 429514**

काशी हिन्दू विश्वविद्यालय BANARAS HINDU UNIVERSITY

कृषि विज्ञान संस्थान INSTITUTE OF AGRICULTURAL SCIENCES

DR. Y.V. Singh
Associate Professor
+919454280586
Email yvsingh59@rediffmail.com

Department of Soil Science & Agricultural Chemistry
Institute of Agricultural Sciences
Banaras Hindu University
Varanasi - 221005

Ref. No. .... ***Date ....***

CERTIFICATE

To,
The Registrar (Academic)
Banaras Hindu University,
Varanasi-221005 (India)

Through: **The Head,**
Department of Soil Science and Agricultural Chemistry,
Institute of Agricultural Sciences, Banaras Hindu University,
Varanasi-221005 (India).

Dear Sir,

I have great pleasure in forwarding the thesis entitled **"Soil and Water Quality Status of different Villages in Kovur Block of Nellore District, Andhra Pradesh"** submitted by **Ms. Haneesha Padarthi** (ID. No. 20430SAC012) in partial fulfilment of the requirements for the award of the degree of **Master of Science (Agriculture)** in **Soil Science – Soil and Water Conservation**, Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University.

I certify that the entire scheme of investigation reported here in, was planned and carried out by the candidate under my guidance. To the best of my knowledge and belief, the data presented in the thesis are genuine and original. No part of the work has been submitted for any degree or distinction.

Thanking you,

Forwarded **Forwarded** **Yours sincerely**

Head **(Course Coordinator)** **(Y.V. Singh)**
Chairman of the Advisory Committee

Soil and Water Quality Status of different Villages in Kovur Block of Nellore District, Andhra Pradesh

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

Master of Science (Agriculture)

in

Soil Science- Soil and Water Conservation

By

Haneesha Padarthi

ID. No. 20430SAC012 **2022** **Enrolment No. 429514**

APPROVED BY ADVISORY COMMITTEE

1. **Dr. Y.V. Singh (Supervisor)**
   Associate Professor
   Dept. of Soil Science and Agricultural Chemistry
   Institute of Agricultural Sciences
   Banaras Hindu University, India.

2. **Dr. S.K. Singh (Member)**
   Professor
   Dept. of Soil Science and Agricultural Chemistry (RGSC)
   Institute of Agricultural Sciences
   Banaras Hindu University, India.

3. **Dr. R Meena (Member)**
   Asst. Professor
   Dept. of Agronomy
   Institute of Agricultural Sciences
   Banaras Hindu University, India.

4. **Dr. Pawan Kumar Anand (Member)**
   Asst. Professor (Horticulture)
   R.G.S.C., Barkkachha, Mirzapur.

5. **External Examiner**

ACKNOWLEDGEMENT

I bow my head before the feet of the “Lord Shiva”, the „Almighty ‟ due to whose blessings I am able to reach at this stage and I feel that everything on this earth could be possible only with the blessings of this invisible but omnipresent supreme force.

At the outset, being the student of this great Institute, I bow my head with great reverence to the lotus feet of Bharat Ratna Mahamana Pandit Madan Mohan Malaviya Ji, the founder of the Banaras Hindu University, whose everlasting desire was to serve mankind. I am fortunate to perceive the prodigious path to tread upon precisely through precious guidance in this university.

I would like to express my profound sense of reverence and indebtedness to my Supervisor, Dr. Y.V. Singh, Associate Professor, Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University for his meticulous guidance, compassionate initiation, congenial discussion, constructive criticism and soothing affection during the course of this investigation and preparation of this manuscript. It was a matter of sheer luck and opportunity to work under his guidance.

A special word ofacknowledgement for Prof. Nirmal De, H.O.D (SWC) Soil Science & Agricultural Chemistry, Banaras Hindu University. Significant inputs from him have helped to enrich my work.

I offer my heartfelt gratitude to Dr. Ashish M Latare (Assistant Professor, Department of Soil Science and Agricultural Chemistry) R.G.S.C. (BHU) Barkkachha, Mirzapur, Institute of Agricultural Sciences, Banaras Hindu University for their constant encouragement, critical suggestions and inspiration during entire period of investigation and the members of the advisory committee Prof. S. K. Singh Assistant Professor Department of Soil Science and Agricultural Chemistry Institute of Agricultural Sciences, Banaras Hindu University.

I would like to convey my gratitude to Pawan Kumar Anand (Horticulture), R.G.S.C. (BHU) Barkkachha, Mirzapur, Dr. R. Meena (Assistant Professor, Department of Soil Science and Agricultural Chemistry), Institute of Agricultural Sciences, Banaras Hindu University.

I am grateful to Prof. P. Raha, Prof. A.K. Ghosh and Dr. A. Rakshit. I am thankful to non-teaching staff members of Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University for all kinds of help to me during my study period.

My special thanks to Dr. Triyugi Nath, Dr. Savita Dewangan, for their guidance, construction criticism, affectionate behavior and moral support during investigation of this research work.

I would like to thank sincerely from the bottom of my heart to my dearest friends Jaydeep, Gangothri, Anu Kurian, Shreshta Yadav, Sravani.N, Kethan, Sravani.p, Himansi, Asha latha, for their kind encouragement and support during the conduct of research as well as while writing thesis.

Words with me are insufficient to express my feelings of my heart to acknowledge my gratitude to my beloved Father Shri. Subbaiah and my mother Smt. Pavani and my dearest sibling Ms. Geethika. P For their co-operation, inspiration and support in all the way and other family members who have providing all kinds of help and love.

Without the help of seniors none can learn the lesson of life and cannot teach the same to loving juniors. So, heartfelt and special thanks to my seniors for their cooperation during the study and investigation.

I would like to thank my juniors and others for always being supportive and helping and also thank to everyone who was involved in completing this work.

I would like to extend my sincere thanks to Sita Ram Yadav, Lab attendant, SS-SWC, RGSC, BHU. Last but not the least, I record my sincere thanks to all beloved and respected people who helped and could not find separate mentions. I still solicit their benediction to proceed at every step of respected destined life.

It's like drop in the ocean by my all regards to Maa Vindhyavasini and Baba Vishwanath, for providing me energy and patience without which I would have been none.

Date:
Place: Varanasi **(Haneesha Padarthi)**

CONTENT

LIST OF SYMBOLS AND ABBREVIATIONS

%	Per cent
Agri.	Agriculture
B.D.	Bulk density
BIS	Bureau of Indian standards
Ca	Calcium
Cm	Centimeter
Cmol (P+) kg^{-1}	Centimol per kilogram
Cu	Copper
DSm^{-1}	Deci Seimen per meter
DTPA	Diethyline Triamine Penta acetic acid
EC	Electrical conductivity
EDTA	Ethylene di amine tetra acetic acid
Et al.	Et alia, and others
Fe	Iron
G kg^{-1}	Gram per kilogram
Ha.	Hectare
i.e.	Id est. that is
J.	Journal
K	Potassium
Kg ha^{-1}	Kilogram per hectare
Meq $100g^{-1}$	Milli equivalents per 100 gram of soil
Mg kg^{-1}	Milligram per kilogram
Mg	Magnesium
Mha	Million hectare
Mm.	Millimeter
Mn	Manganese
N	Nitrogen
Na	Sodium
NIV	Nutrient index value
O.C.	Organic carbon

P	Phosphorus
P.D.	Particle density
pH	Puissance de hydrogen
S	Sulphur
Sq. km	Square kilometer
viz.,	Vide licet, namely
WHC	Water holding capacity
Zn	Zinc

LIST OF TABLES

Chapter I

INTRODUCTION

Soil is a free asset to every life on the planet, as well as a source of sustenance, and will continue to be so in the future. It is a dynamic natural body found on the earth's outermost solid layer (Crust). It is made up of a vertical succession of layers (Soil Horizons) that are made up of weathered mineral components (45%), organic matter (5%), soil air (25%) and soil water (25%). Soil is the result of the long-term effects of temperature, terrain, and organisms (flora and fauna, humans) on parent material (initial rock and mineral). As a result, the texture, structure, consistency, chemical, biological, and physical features of this soil differ from those of its parent material. It serves as a natural substrate for plant growth as well as a water and nutrient reservoir. Soil has a wide range of chemical, biological, and physical properties, and processes like leaching, weathering, and microbial activity combine to produce a variety of soil types such as acidic, saline, and alkaline soils. For agricultural output, each variety has distinct strengths and weaknesses.

Soils are ecosystem service providers soils store and deliver water to plants while also preventing floods by slowly transporting water to streams and ground water. Pollutants are filtered and remedied by them. They recycle nutrients and trash by cycling them. Changing them into biologically useful forms and storing them for future use. Soils are home to a diverse range of organisms. They regulate gas emissions by absorbing and releasing vital gases such as oxygen and greenhouse gases. One of humanity's greatest concerns in the twenty-first century is the protection, restoration, and maximization of ecosystem services given by soil.

Soil quality and soil health Although the two terms are often used interchangeably, it is important to note that it can be defined as a soil's ability to function within its capacity and within natural or managed ecosystem boundaries in order to sustain plant and animal productivity, maintain or exchange water and air quality, and support human health and habitation.

It is defined as the soil's ability to function as a vibrant living system within eco-system and land-use boundaries in order to maintain biological productivity, maintain or improve air and water quality, and promote plant, animal, and human health.

Soil quality varies slowly owing to natural processes like weathering and more quickly due to human activities like land usage and farming techniques, all of which can increase or deteriorate soil quality. It has both static and dynamic properties. Sandy soil drains faster than clayey soil, for example. Inherent soil quality is the natural ability to function. These properties are difficult to change, and dynamic soil quality refers to how soil changes as a result of how it is maintained. Management decisions have an impact on soil organic matter, soil structure, soil depth, and water and nutrient holding capacity.

Wind and water erosion, organic matter loss, soil structure disintegration, salinization, and chemical contamination all degrade soil health. Soil fertility and soil productivity are two more synonyms. Soil fertility refers to the soil's inherent ability to provide all essential plant nutrients in readily available form and in a suitable balance, while soil productivity refers to the soil's ability to produce a specified crop yield under well-defined and specified input and environmental management systems.

These nutrients are required for plants to complete their life cycle, metabolic processes, and chemical processes that occur within living organisms such as photosynthesis. These components are required for the plant to develop and reproduce. Because carbon, oxygen, and hydrogen are available through air and water, they are classified as non-mineral elements. The macro and micro nutrients are separated into two categories. Macronutrients are those that are required in significant amounts and include (C, H, O, N, P, K, Ca, Mg, and S). Some are available through the atmosphere and water, while the others are divided into - Plant growth is impossible without the primary nutrients N, P, and K, which are required in considerable quantities. Ca, mg, and s are secondary nutrients that are required in moderate amounts.

Micronutrient deficiencies are more common in highly leached sands, organic soils, and extremely alkaline soils because they are required in lesser amounts. When micronutrients are present in large levels, they can be toxic or damaging to plant growth.

There are a few aspects that do not match the exact definition of essential but are nonetheless crucial. These elements are either required by some plant species but not all, or are extremely advantageous to plant growth. For example, sodium, cobalt, silicon, and selenium.

The quality of the water, like the condition of the soil, has an impact on plant growth and development. Water quality refers to the physical, chemical, and biological qualities of water. The kind and grade of dissolved salts in irrigation water can significantly influence its quality. The amount of salt in irrigation water differs by location. Salts in water are produced by the dissolution or weathering of rocks and soils, including the dissolution of lime, gypsum, and other slowly dissolved soil minerals. Water's appropriateness for irrigation is determined by the total amount of salt present as well as the type of salt present.

Total salt concentration, SAR, residual sodium carbonate or bicarbonate ion concentration, and boron content are all water quality metrics. The usage of groundwater in dry locations with minimal rainfall causes groundwater salinity to rise, limiting the types of crops that may be grown.

The overall concentration of soluble salt, relative proportions of sodium, calcium, magnesium, SAR, and residual sodium carbonate, as well as the amount of hazardous components, are all used to determine the quality of irrigation water.

Red soils (66 %), red sandy soils, laterite soils, black soils (25 %), alluvium, and saline soils make up Andhra Pradesh's soils. The state has a diverse range of soil types, from less fertile coastal sands to very fertile and productive deltaic alluviums of river basins formed from various parent materials. Weathering of granites, genesis, and crystalline rocks produces red soil, which is often reddish to brownish in appearance. They have a somewhat acidic pH. Fe concentration is high, whereas P, N, and organic content are low. Heavy rainfall and high temperatures make laterite soil rich in Fe and Al oxides, emptying it completely of silica. Laterites are the remains of such oxides. They have an acidic pH, are low in calcium and magnesium, and are well-drained and porous. Black/Regur soils- These are self-ploughed soils in which loosened particles fall into crevices and the soil swallows itself, retaining soil moisture. At lower depths, we observed the production of kankar nodules due to calcium carbonate segregation. The capacity to store water is greater.

Nellore is one of Andhra Pradesh's nine coastal districts, located in the state's south eastern corner. It is a significant agricultural district. It has abundant rainfall and surface water. On the east, the district is bordered by the Bay of Bengal, which runsfor 163 kilometers. Sriharikota Island is home to India's famed and only satellite launch center, known as SHAR. Nellore, Gudur, and Kavali are the three revenue divisions of the district. There are 46 revenue mandals in these divisions. The district's soils are divided into three categories: black, red, and sandy. Red soil covers 40 % of the land in the area, while a sand belt runs parallel to the ocean's edge. The dark cotton soil and sandy top soils each have 23 % and 34 % of the zone, respectively. The mineral silica sand is found across the coastal settlements, reaching 35 kilometers long and 12 kilometers wide and covering around 42000 hectares. Agriculture grounds, habitations, and forest land covered the majority of the silica sand yielding area. Silica mines have been assigned to a vacant area of barren terrain with sand dunes that is undulated and unsuitable for agricultural purposes. Quartz, mica, feldspar, laterite, and vermiculite are the minerals.

The Pennar is the principal river that flows through the district. All of the rivers are non-perennial and flow eastward to join the Bay of Bengal. Due to the north-east monsoon, the period from December to the middle of February sees the highest rainfall, with 70 per cent of it falling during this time. Both surface and ground water irrigation are available in the district. Groundwater quality is just as essential as quantity. The quality of ground water in the district's consolidated formations, both shallow and deep, is generally good. There are cases where EC levels exceed the permitted limit. The levels of arsenic and fluoride in the district's ground water are within acceptable standards. In the district's deltaic area, coastal salinity is a major issue. Groundwater salinity is primarily created by the depositional environment, although other factors such as geomorphic landforms, excessive fertilizer use, and unregulated aquaculture growth in coastal areas also play a role. Fluoride levels over the allowable limit, as well as nitrate contamination, are both issues in the district, owing to excessive fertilizer use, inappropriate urban wastewater disposal, and a faulty drainage system. Because of the foregoing, an attempt has been made to assess the fertility status of the soil and the quality of irrigation water in kovur, Nellore district, Andhra Pradesh, employing different soil and water quality properties with the following specific objectives,

1. To examine the fertility status of Kovur block of Nellore district and identification of nutrient deficient areas of block by using statistical data.

2. To determine the soil and water quality status of different villages in Kovur block of Nellore district.

3. To study the correlation between soil and water quality parameters of Kovur block.

Chapter II

REVIEW OF LITERATURE

The fundamental components of agriculture is soil and water, this are essential for production of crops. This two are inter related to each other change in one system automatically effects the other system also. For better crop production effective management of this component is necessary. Therefore, an attempt has been made for assessment of status of soil and water quality of Kovur block. Based on available source and information the literature is reviewed under following division.

2.1 Physico-Chemical properties of soil

- Soil pH
- Electrical conductivity
- Soil organic carbon
- Bulk density
- Particle density
- Porosity
- Water holding capacity

2.2 Availability of primary Macro-nutrients in soil

- Nitrogen
- Phosphorus
- Potassium

2.3 Availability of secondary macro-nutrients in soil

- Sulphur
- Calcium
- Magnesium

2.4 Availability of macronutrients in soil

- Copper
- Zinc
- Manganese
- Iron

2.5 Parameters of water quality

- pH
- Electrical conductivity
- Calcium and Magnesium
- Carbonates and Bicarbonates
- Sodium and Potassium
- Chloride

2.6 Quality parameters of irrigation water

- Soluble sodium percentage
- Sodium absorption ratio
- Permeability index
- Residual sodium carbonate
- Kely's ratio

2.1 Physico-chemical properties of soil

Sashikala *et al.* (2021) Studied the nutrient status in Tatrakallu Village of Anantapur District of Andhra Pradesh using Geographic Information System. In this study 250 soil samples (0-15 cm) were collected. Results shows that soils were neutral to highly alkaline, non-saline, and low to medium in organic carbon (OC). AvailableN was low, available P and K was low to high, and available S was deficient to sufficient.

Singh *et al.* (2021) Studied the Effect of in stubble burning on physico-chemical properties of soil, yield and environmental qualities. Results show that Manure from the farm, reduces the bulk density of the soil and enhances its porosity and Organic matter in the soil works as a storage for critical plant nutrients, preventing leaching and increasing cation exchange capacity. The residue has a variety of consequences on the soil's physical, chemical, and biological qualities.

Yavanika *et al.* (2021) studied the Soil physical and physico-chemical properties of soil in Chittoor district, Andhra Pradesh. In this study 60 soil samples (15 from each cropping system) were collected and analysed for four primary cropping systems: groundnut-red gram intercropping, sugarcane-sugarcane sequence cropping, paddy monocropping, and perennial fodder. The result shows that Perennial fodders had a pH that was slightly alkaline. In comparison to other cropping systems, perennial fodder soils had higher electrical conductivity (0.20 dSm^{-1}), organic carbon (0.58 %), and lime concentration (5.8 %).

Bhakti *et al.* (2021) studies shows experiment was set up in a Randomized Block Design (RBD) with sixteen treatment combinations. The study was conducted on that impact of different inorganic fertilisers, alone or in combination with organic manures like Farm yard manure, vermicompost, and poultry manure and Biofertilizers (Rhizobium and PSB) on soil chemical properties, growth, yield, quality, and nutrient content of lablab bean. The result shows that the availability of macronutrients (N, P, K) and micronutrients (Fe, Mn, Zn, Cu) improved significantly as a result of different treatment combinations. The soil pH, EC, and OC status were not affected by different fertiliser management strategies.

Kumar *et al.* (2021) A study was conducted in the Meerut district of western Uttar Pradesh to evaluate the Soil characterization of sugarcane- ratoon- wheat cropping system. The study was conducted on the availability of NPK in soils was evaluated, as well as other soil parameters such as pH, electrical conductivity (EC), and organic carbon (OC) concentration. The results shows that the availability of nitrogen is low in surface (0-15 cm) and subsurface (15-30 cm) soil, while phosphorous and potassium are low to medium in ranges at surface and subsurface.

Mohan *et al.* (2020) Studied shows the Classification and Mapping of Rice Growing Soils in Tirupati of Chittoor District, in Andhra Pradesh. In this study soils are collected from 15 different blocks of Tirupati region. The samples were then processed and analysed for physical properties such as particle size distribution, bulk density, particle density, and maximum water holding capacity; physico-chemical properties such as soil pH, EC, and organic carbon; and electrochlorination.

Mishra *et al.* (2021) Studied the Understanding the effect of shifting cultivation practice (slash-burn-cultivation-abandonment) on soil physicochemical properties in the North-eastern Himalayan region. In this study soil samples are collected from surface (0-30 cm) and subsurface (30-70 cm) layers of soils in the forest, jhum land, and jhum fallow areas. Results shows that the Clay content, SOC (soil organic carbon), exchangeable Mg and K, CEC (cation exchange capacity), and the Ca/Mg relationship had the most variation among land uses. Bulk density (BD), porosity, and pH, on the other hand, showed the least fluctuation.

Singh *et al.* (2013) The study shows the Tillage changes the structure of the soil and has been recommended for improving the physical, hydrological, and chemical aspects of compacted soils. In this study samples ranging in depth from 0 to 10 cm and 10 to 20 cm. results shows that Bulk density (Bd), carbon-to-nitrogen ratio (C:N), and calcium-to-carbon-oxide-to-carbon-oxide-to-carbon-oxide-to-carbon-oxide In all of the lands, BD, pH, EC, and $CaCO_3$ levels increased with depth, whereas PD, porosity, water holding capacity, hydraulic conductivity, organic carbon, Nt, Navail, Pavail, and Exch. Ca^{2+} levels declined.

Narsaiah *et al.* (2018) analyzed the physico- chemical parameters of the soils of Jangon district in Telangana state. Soils are collected at depth of (25 -50 cm). The result shows that pH ranges from neutral to very strongly alkaline, the electrical conductivity ranged from from 0.03 to 2.5 dSm^{-1}, the organic carbon content in study area was found to be very low to medium and ranged from 0.17 to 0.80 per cent.

Supriya *et al.* (2021) study shows the Soil samples were taken from three blocks in Guntur District, in Andhra Pradesh. In this study samples are collected at three depths: 0-15, 15-30, and 30-45 cm for physical and chemical investigation. The results show that the soil is in excellent physical condition and is alkaline in nature and Organic carbon concentration is low, nitrogen content is low to medium, phosphorus, potassium, exchangeable calcium and magnesium, and accessible sulphur content is high.

Nayak *et al.* (2019) analysis the physico-chemical properties by Geospatial techniques were used to map soil in the Kurnool revenue division in the Kurnool district of Andhra Pradesh. soil samples were collected at a depth of 0-15 cm. result shows that pH (1:2.5) and electrical conductivity (EC) (1:2.5).

Yavanika *et al.* (2021) studied the physico-chemical parameters of the soil of Chittoor district of A.P. in this study 60 soil samples (15 from each cropping system) were collected from four primary farming systems: groundnut-redgram intercropping, sugarcane-sugarcane sequence cropping, paddy monocropping, and perennial paddy monocropping. The Results showed that in all of the agricultural systems studied, soils were found to be neutral to slightly alkaline in response, non-saline, low to medium in organic carbon, and non-calcareous. Perennial fodders had a slightly alkaline pH (8.31), while annual fodders had a neutral pH.

Ganorkar *et al.* (2013) studies on soils with physical qualities, chemical properties, and micronutrients. Six distinct places in Rajura Bazar, Warud Tahsil, Amravati District (Maharashtra) India, were sampled for soil. Studies the parameters like Soil moisture, pH, EC, Carbon, Calcium carbonate, TDS, Magnesium, Calcium, Nitrogen, Copper, Potassium, and Phosphorous content were all measured in the range 7.80–8.46 study reveal that all soil samples were alkaline and had a modest amount of accessible micronutrients.

2.2 Primary Macro-nutrients in soil

Kumar *et al.* (2014) studied the analysis of physical and chemical properties of Kabeerdham District of Chhattisgarh, India. In his study soil samples where collected at a depth of 0 -15 cm. result showed that N content of Vertisols ranged from 112.9 to 338.69 Kg ha^{-1}, with an average of 185.16 Kg ha^{-1}. In the Vertisol of Kabeerdham, the majority of the sampled area (99.10 per cent) is classified as low (280 Kg ha^{-1}). Only 0.90 per cent of the soil is classified as medium (280-560 Kg ha^{-1}). As a result, the soil samples analysed were determined to be

Kumar *et al.* (2021) carried out research on physico- chemical properties of soil in Leh-Ladakh region. In his study total 55 no. of soil samples were collected from the eleven villages. The result showed that nitrogen and phosphorus content during Sowing and after Harvesting of Crop at High Altitude, at the time of sowing Nitrogen and Phosphorus 171.54±11.40, 75.62±8.16 and after the harvesting 212.03±13.18, 96.32±11.56.

Reddy *et al.* (2021) A research was conducted by using GPS-GIS technology, in the year 2020-2021 to determine the soil fertility status of the Nagarjuna Sagar Left Bank Command region in the Nalgonda district of Telangana. The accessible nitrogen, phosphorus, and potassium in the soil in the research region ranged from 100.0 to 450.0 Kg ha^{-1}, 10.3 to 71.2 Kg ha^{-1}, and 25.5 to 1115.9 Kg ha^{-1}, respectively. Available nitrogen was low (50.1%) and medium (49.9%) in the soils, while available phosphorus was low (0.1%), medium (87.2%), and high (87.2%). (12.7 %).

Rao *et al.* (2014) carried out research on physico-chemical properties of soil at Machilipatnam coastal regions during the year 20012-2013 at four-seasonal intervals. At a depth of 30 cm, soil samples were taken. The available nitrogen ranged from 29.4 to 81.2 ppm, while phosphorous ranged from 3.32 to 5.89 ppm. Available nitrogen was highest in the monsoon and lowest in the summer, according to the findings.

Rajeshwar *et al.* (2007) carried out research on Physico-chemical properties of soil of Kamareddy and Kammarpalli forest ranges of Nizamabad districtsof Andhra Pradesh. Study was conducted by collecting 32 surface samples representing eight forest range soils. The result stated that nitrogen and phosphorus content was lowest 83 to 315 Kg ha^{-1}, 3.0 to 17.1 Kg ha^{-1}.

Ghosh *et al.* (2020) study shows the physico-chemical properties of the soil of Jaldapara National Park (JNP) of West Bengal. Soil samples (0-30 cm) were collected. Result shows that pH of the soil was primarily determined to be acidic [pH values ranged from 7.97 to 4.21 in top soil and 7.50 to 4.26 in subsoil, and the total Nitrogen content [0.037–0.525 per cent], Potash content [10–35 ppm], Phosphate content [2-32 ppm].

Srinidhi *et al.* (2020) analysed the Physico-chemical of soils in Madanapalle block, Chittor district of Andhra Pradesh. Soils were selected from eight different villages and from each village 3 surface (0-15cm) soil samples. Result shows that Accessible nitrogen and available sulphur levels in soils are low, with mean values of 248.7 Kg ha^{-1} and 0.25 mg kg^{-1}, respectively. Available phosphorus is medium to low, with a mean value of 13.7 kg/ha, and exchangeable potassium is medium to high, with a mean value of 481.6 Kg ha^{-1}, also shows that low for nitrogen (1.41), low for phosphorus (1.62), high for potassium (2.58).

Khan *et al.* (2013) studied the physico-chemical parameters of soil samples from in Samarbagh, District in Tamilnadu. Soil samples were taken from top-slope, mid-slope, and bottom-slope locations on horizons A, B, and C to determine the physicochemical parameters of top, mid, and bottom slope soils. Result shows that phosphorus (3.40 mg kg^{-1}), potassium (118.8 mg kg^{-1}).

Vilakar *et al.* (2021) analysis the fertility level of sesame-growing soils is shown in this study. A survey was undertaken in Telangana's Northern Telangana Zone's primary sesame-growing soils. The researchers took 30 representative surface soil samples (0-15 cm) in total. Result shows that accessible nitrogen, and medium to high in phosphorus and potassium.

Jyothi *et al.* (2017) studied analysis the Physico-chemical Properties and Soil Fertility Status of Maize Growing Areas of Krishna delta, Andhra Pradesh. The soil samples are collected from surface (0-25 cm) and sub-surface (25-50 cm). result shows that nitrogen content is varied from 98.8 to 298.3 Kg ha^{-1} at surface and at sub- surface with mean values of 212.2 and 159.4 Kg ha^{-1}. phosphorus content in surface and sub-surface samples varied from 27.15 to 99.70 Kg ha^{-1} and 9.7 to 72.60 Kg ha^{-1} with a mean value of 81.25 Kg ha^{-1} and 47.59 Kg ha^{-1}, respectively.

2.3 Secondary Macro-nutrient in soil

Singh *et al.* (2012) studied the analysis of physico chemical properties of Chiraigaon block of district Varanasi in his study Ten representative villages were chosen and different number of surface soil samples (0-15 cm) were collected. Results revealed that About 62 % of samples were found deficient in available sulphur and also Soil samples were found low in organic carbon, available nitrogen and phosphorus while medium in potassium.

Lelago *et al.* (2016) studied the physico- chemical parameters of soils in Ethopia with the help of grid survey approach, 463 geo-referenced soil samples were gathered. The exchangeable K, Ca, and Mg levels ranged from 0.39 to 4.24, 4.9 to 19.5, and 0.68 to 6.09 Kg ha^{-1}, respectively. Available S ranged between 3 and 63ppm, and approximately 98 per cent of the agricultural soils in the research locations had below optimal sulphur concentrations.

Ramana *et al.* (2015) studied the fertility status of sustainable agriculture production. Soil samples (0-15 cm) collected from Raisingh Nagar block in the district Sri Ganganagar of Rajasthan. Result shows that medium to high in available sulphur, however, Ca and Mg are found sufficient.

Adeleye *et al.* (2010) studied the Effect of Poultry Manure on Soil Physico-Chemical Properties, Leaf Nutrient Contents and Yield of Yam (Dioscorea rotundata) on Alfisol in Southwestern Nigeria. Here soil samples are collected from (0-15 cm). Results shows that poultry manure application increased Ca and Mg concentration by 20 % and 21 % respectively.

Ramana *et al.* (2015) analyzed the Available Macro Nutrient Status and their Relationship with Soil Physico-Chemical Properties of Sri Ganganagar District of Rajasthan, India. In this study soils are collected from (0-15 cm) depth. The result stated that status of available S, exchangeable Ca^{2+} and Mg^{2+} in soils of Raisingh Nagar block of Sri Ganganagar district, Available S (Kg ha^{-1}) low-<10, medium- 10- 20, high ->20, calcium (ca) low- <1.5, medium- >1.5, magnesium (mg) low-<1, and medium->1 respectively.

Umeri *et al.* (2017) studied the analysis of physico chemical properties of soils of rain forest zones of delta state in Nigeria. In this study soils are collected at a depth of 0-15 and 15-30 cm. result showed that calcium content ranged from 1.12-3.44 cmol(p^+) kg^{-1} at surface depth, whereas magnesium content of soil ranges from 0.16-0.80 cmol(p^+) kg^{-1} at surface depth and for subsurface ranged from 0.80 to 1.92 cmol(p^+) kg^{-1}.

2.4 Available Micro-nutrients in soil

Ismail *et al.* (2018) analysed the Physico-Chemical Properties of Soil Samples in Pathikonda Region, Kurnool District, Andhra Pradesh. Soils are collected at six different samples of soil in six villages. The result shows that Sulphur is 9.0-10.1, Zn is 0.72-0.95, Mn is 12.13-14.99, Fe is 21.43-23.04.

Chaudhari *et al.* (2013) carried out research at Coimbatore Soils in Tamiladu. In this study soils samples are collected from (0-15 cm). the result shows that availability of Iron (Fe) is (0.12- 5.53 ppm), Mn (2.31- 23.16 ppm), Zinc (Zn) as 0.5 to 1.00 ppm, available Cu (0.11- 1.08 ppm) respectively.

Wagh *et al.* (2015) studied the Physicochemical Analysis of Soils from Eastern Part of Pune City. In this study soils samples from 12 representative locations were collected for their analysis. Results shows that Cu, Fe, Mn and Zn concentration has been seen higher than the normal range and due to poorer drainage conditions of this area making soil alkaline. The Cu range from 2.02 ppm to 36.51 ppm, Iron content from 3.08 ppm to 23.04 ppm, manganese content in the Soils ranges from 12.36 ppm to 23.28 ppm, Zn content ranges from 0.32 ppm to 5.62 ppm, boron range from 0.08 ppm to 0.54 ppm.

Bhatt *et al.* (2019) studied the Long-term effect of organic and inorganic Fertilizers on soil Physico-chemical properties of a silty clay loam soil under rice- wheat cropping system in Tarai region of Uttarakhand. Study revealed that Sulphur ranges from 16.87 to 30.41 ppm and 15.07 to 22.51 ppm respectively, calcium ranges from 141.87 to 268.53 ppm at the surface soil and 108.21 to 308.61 ppm at the sub- surface soil.

2.5 Water quality parameters

. pH and EC

Brian *et al.* (2018) studied the Water Quality Parameters for Citrus Irrigation and Drainage Systems. Study was conducted by collecting the samples from a surface water source like a ditch, river, or reservoir, take them near the middle and below the water's surface. The result shows that pH range of 6.0 to 9.0 and EC ranged from 0.1 to 5.0 µS cm^{-1}.

Bilali *et al.* (2020) studied the irrigation water quality parameters using machine learning models in a semi-arid environment in Bouregreg of Morocco. In this study 300 water samples were collected. Result stated that pH ranges from 6.30 – 9.55, and EC ranged from 6.02 – 11.2 µS cm^{-1}.

Mandal *et al.* (2018) studied the assessment of river water quality for agricultural irrigation. Samples was collected from middle of river and one discharge point of four different locations of west Bengal. Results showed that the pH of samples were range from 6.85–8.47, EC ranges from 0.15–0.88 dS m^{-1} and 0.07–2.84.

Shah *et al.* (2013) studied the Groundwater Quality Assessment for Irrigation Use in Vadodara District, Gujarat, India. Here 12 water samples are collected from open wells. Result of the study concluded the pH of water samples ranged from 7.0 to 8.8 and Electrical Conductivity in groundwater varies from 270 to 3200 mohs cm^{-1}.

Kumar *et al.* (2017) studied the Assessment of Water Quality of Lakes for Drinking and Irrigation Purposes in Raipur City, Chhattisgarh, India. Study was conducted by taking 27 samples from prominent lakes. Here result stated that pH ranges from 6.59-8.29, EC ranges from 382-2330 µS cm^{-1}.

Lingaswamy *et al.* (2015) studied the assessment of Water Quality of Fox Sagar Lake, Hyderabad, Telangana State, India. Here 14 samples were collected. Results shows that pH ranges from 6.5 to 8.4, EC varied from 1047 to 1467 µS cm^{-1}.

Simpi *et al.* (2007) studied the Analysis of Water Quality Using Physico-Chemical Parameters Hosahalli Tank in Shimoga District, Karnataka, India. Here 12 water samples are collected. Result of the study concluded the pH of water samples ranged from 7.5 to 8.4, the total dissolved solids fluctuate from 120 mg L^{-1} to 256.4 mg L^{-1}.

Devojee *et al.* (2018) analyzed the Assessment and Mapping of Irrigation Water Quality Index of Bapatla Mandal, Guntur District, Andhra Pradesh, India. Inthis study 3 samples of water from each village of about 26 villages of Bapatla region. Results shows that pH less than 6.5 to more than 8.5, EC ranges from 300 to 1000 mg L^{-1}.

Veeraswamy *et al.* (2019) studied the ground water quality assessment for drinking and irrigation in yerpedu area chittor district, Andhra Pradesh. In this study 25 water samples have been collected with different locations. Results shows that pH ranges from 7.2 to 8.3, EC values are ranging from 790 to 3270 µ mhos cm^{-1}.

Basha *et al.* (2016) studied the Assessment of Drinking and Irrigation Water Quality of Surface Water Resources of South-West Kashmir, India. In this study Surface water samples were collected from different streams. Results shows that pH ranging from 6.92 to 8.24, EC ranges from 80 to 364 µS/cm, at an average of 242.75 µS cm^{-1}, TDS ranges from 55 to 225 mg L^{-1}.

Kankal *et al.* (2012) studies the Water Quality Index of Surface Water Bodies of Gujarat, India. In this study shows the 7 samples are collected. Results are shows that pH ranges from 7.5 -9.0, EC ranges from 240-11200 µS cm^{-1}.

. Cations (Na^+, K^+, Ca^{2+} and Mg^{2+})

Bataiya *et al.* (2017) Analysis of Water Quality Using Physicochemical Parameters of Boreholes Water Taken from Areas Around Dala Hills, Northwestern Nigeria. In this Five samples of ground water from areas located around Dala hills were collected from Rijiya Biyu (D1), Kantudu (D2), Makwalla (D3) Kabawa (D4) and Dala (D5) for physicochemical analysis. The result stated that Calcium 62.37 mg L^{-1} and magnesium of 92.99 mg L^{-1}.

Dirican (2015) studied the Assessment of Water Quality Using Physico-chemical Parameters of Çamlıgöze Dam Lake in Sivas, Turkey. In this study 15 samples were collected from surface and 10 m depth in Çamlıgöze Dam Lake. Resultsshows that Calcium (Ca) surface -37.70 and 10m depth -38.70, Magnesium (Mg) surface- 15.20 and 10m depth- 14.60.

Sajitha *et al.* (2016) Studied the Physico-Chemical Properties of Pond in Panchayath, Kerala, India. In this study 9 water samples were collected. Result shows that concentrations of sodium ranges between 3 to 19 mg L^{-1}, concentration of potassium ranges from 0 to 4 mg L^{-1} and concentration of magnesium ranges from 0 to 7.24 mg L^{-1}.

Kumar *et al.* (2010) studied the physicochemical parameters of Drinking water s at Moradabad, India. The study was conducted by collecting 12 water samples for analysing. The result showed that calcium concentration of the samples ranged from 90 ppm-250 ppm.

Yadav *et al.* (2012) studied the Physico-chemical analysis of selected ground water samples of Agra city, India. In this study 12 water samples were collected. The study revealed that the calcium and magnesium ranges from 126.5 mg L^{-1} to 1254.9 mg L^{-1}.

Kumar *et al.* (2013) studied the physico-chemical parameters of ground water in thirupathur district in tamil nadu, India. In this study 8 samples were collected to analysis the calcium, magnesium and potassium content in ground water. The results showed that potassium of 4 to 30 mg L^{-1}, calcium ranges of 12-28 mg L^{-1} and the magnesium was ranged from 31 to 63 mg $L^{-1}$and 32 to 175 mg L^{-1}.

Pandey *et al.* (2009) studied the Physico-chemical analysis of ground water of selected area of Ghazipur city, India. In this study 5 samples were collected from polluted urban areas. The results shows that sodium and potassium ranges from 23.17 to 46.23 mg $L^{-1}$and potassium of 4 to 10 mg L^{-1}.

. **Anions (CL, CO_3^{2-} and HCO_3^-)**

Manjare *et al.* (2010) carried out research on Analysis of water quality using physico-chemical parameters Tamdalge tank in Kolhapur district, Maharashtra. The study was conducted by taking 12 Water Samples from different locations. The result showed that the chloride ranges from 31.06 mg L^{-1} to 57.61 mg L^{-1}. The highest value (57.61 mg L^{-1}) was found in the month of May. In the month of February the lowest value (31.06 mg L^{-1}) was recorded.

Saravanakumar *et al.* (2011) Analyse the water quality parameters of groundwater in Ambattur industrial area, Tamil Nadu, India. The study was conducted by taking 10 samples. The result showed that the Chloride concentration of samples ranged from 325-380 mg L^{-1} and Alkalinity of water samples varied from 270-320 mg L^{-1}.

Ramanaiah *et al.* (2006) studied the Physico-chemical Parameters in Ground Water of Prakasham District in India. The study was conducted by taking 13 samples. The result showed that the chloride concentration of water samples, minimum was found to be 91.3 mg L^{-1} and Maximum concentration was 614.7 mg L^{-1}, and Alkalinity of samples minimum concentration- 40 mg L^{-1}, maximum- 168 mg L^{-1}.

Shrivastava *et al.* (2013) investigate the Physico-Chemical Analysis of Pond Water of Surguja District, Chhattishgarh, India. The study was conducted by taking water samples from 10 sampling points of Surguja district. The result of the study concluded that the chloride content minimum of 21.46 mg L^{-1} to a maximum of 49.97 mg L^{-1}, and the alkalinity content minimum of 134.70 mg L^{-1}, and maximum of 205.00 mg L^{-1}.

Magadum *et al.* (2017) carried out research on Assessment of Physicochemical parameters and Water Quality Index of Vishwamitri River, Gujarat, India. In this study 10 water samples were collected. The result shows that chloride concentration ranges from 20.9 to 109.9 mg L^{-1}.

Lokhande *et al.* (2011) studied the Physico-Chemical Parameters of Waste Water Effluents from Taloja Industrial Area of Mumbai, India. The study was conducted by collecting 10 water samples. The result showed that chloride concentration from engineering units 167.0- 218.0 mg L^{-1}, paper mill 125.0-210.0 mg L^{-1}, fine chemicals 162.0-241.0 mg L^{-1}, textile 218.0-273.0 mg L^{-1}.

Sharma *et al.* (2015) studied the Water Quality Assessment Using Physico-Chemical Parameters and Heavy Metals of Gobind Sagar Lake, Himachal Pradesh (India). The study was conducted by collecting water sample from Gobind Sagar Lake. The result shows that chloride varied between 36.795 to 71.677 mg L^{-1}, and alkalinity ranges from 24.333 mg L^{-1} to 138.750 mg L^{-1}.

Sujitha *et al.* (2012) studied the physico-chemical properties of karamana river in trivandrum district, india. The study was conducted by 5 samples. The result showed that total alkalinity observed >120 mg L^{-1}.

Alagumuthu *et al.* (2018) studied the physico-chemical parameters of ground water in kadayam block of Tirunelveli district, Kerala. In this study water samples of ground water were collected in clean and high density polyethylene bottles for analysis. The study shows that chloride concentration 114 mg L^{-1} ranging up to 823 mg L^{-1}.

Mohan *et al.* (2013) studied the water quality assement and physico-chemical parameters of groundwater in hapur district-up, India. In this study water samples of were from different locations of hand pumps. The results showed that concentration of chloride of 85.50 mg L^{-1} and fluoride of 0.77 mg L^{-1}.

2.6 Irrigation water quality parameters

Acharya *et al.* (2019) studies the Assessment of groundwater quality by water quality indices for irrigation and drinking in South West Delhi, India. In this study 50 water samples were collected for analysis. The results showed that SAR concentration of the samples ranged from 0.34 – 6.52 meq L^{-1}, whereas RSC concentration ranged from 0.98 to -35.32 mg L^{-1}.

Kumaraswamy *et al.* (2013) studied the Irrigation water quality assessment— an example from the Tamiraparani river, Southern India. In this study waters from rivers depend on river flow, lithology, land use patterns, and other anthropogenic activities. The results shows that SAR ranges from —0.14 to 9.23 meq L^{-1}, RSC from —0.32 to 5.64 meq L^{-1}.

Kumar *et al.* (2016) studied the water quality and hydro geochemistry of surface and groundwater, Tiruvallur District, Tamil Nadu, India.in this study 30 water samples were collected including 8 surface water (S), 22 groundwater samples [15 shallow ground waters (SW) and 7 deep ground waters (DW)]. The results shows that the SAR ranges from 0.28 to 8.49 and the RSC ranges by−12.29 to 2.51.

Sudhakaran *et al.* (2020) studied the multivariate statistical approach in assessing the quality of potable and irrigation water environs of the Netravati River basin in India. In this study water samples are collected from both river and well. The results shows that SAR ranges from medium to high and RSC ranges by low to medium.

Seth *et al.* (2014) studies the Water quality evaluation of Himalayan Rivers of Kumaun region, Uttarakhand, India. In this study water samples are collected from rivers in Himalayan regions. The results shows that SAR were found within the range 0.03–0.06 mg L^{-1}, RSC values of all the rivers ranged from −0.69 to 1.20 mg L^{-1}.

Lingaswamy *et .al* (2015) studied the Water Quality of Fox Sagar Lake in Hyderabad, India. In this study 14 water samples were collected from different locations of lake. The result shows that SAR ranges from 4.0- 7.6 mg L^{-1}, RSC ranges from 0.9 – 3.0 mg L^{-1}.

Chapter III

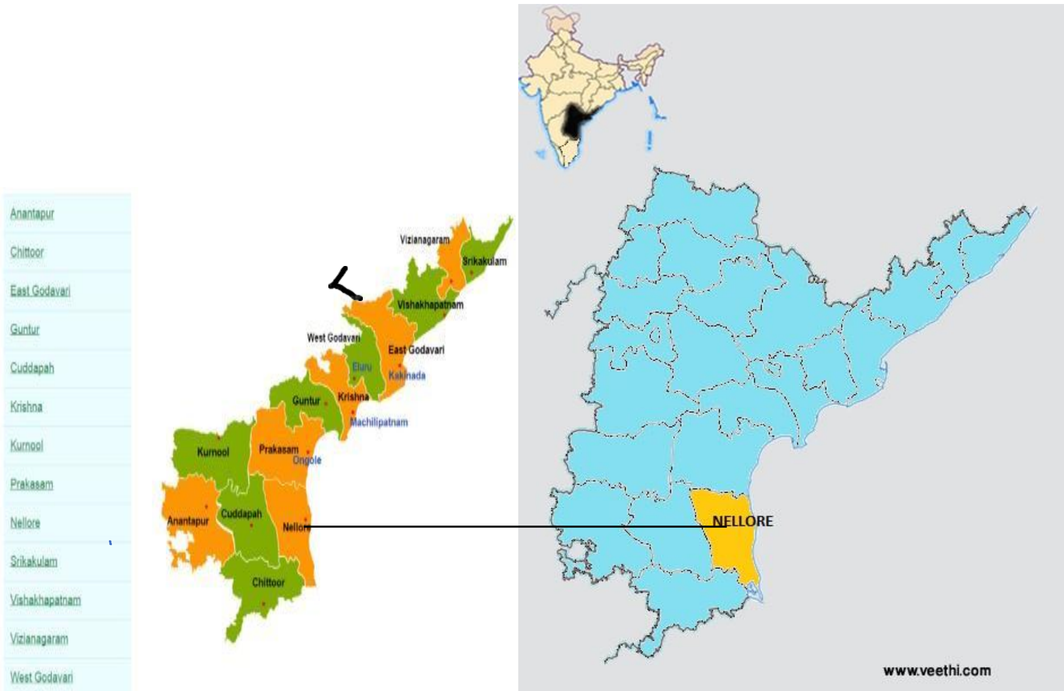
MATERIAL AND METHODS

This chapter explains the materials and methods used during examination of soil and water quality status in Kovur block of Nellore district. The following sections and sub-sections going to explain about information on field survey of area, collection of soil and water samples, types of procedures and techniques followed for their analysis.

3.1 Description of site

3.1.1 Location and Geography

Kovur is a Block 6 kms near to Nellore district, which is well known for ISRO (Rocket centre). It is located at 14.50°N to 79.98°E altitude. The Block is famous for penna river, temples and handmade silk sarees. This area is situated in east costal region near to Bay of Bengal.



3.1.2 Climate and Weather

Due to situated near Bay of Bengal the climate is hot and humid with extreme temperature of (21-40^{o}c) and on rainfall of about 524 mm in a year. The average annual temperature for Kovur is 30^{o}c and it is dry for 140 days a year with an average humidity of 77 %. Onset of monsoon takes place from July to august of south-west monsoon and November-December of north-east monsoon. Summer season starts from April starting week and continues upto July. May is the warmest month with an average temperature of about 40.3^{o}c where as coldest month of the block is January and February with average temperature of 21^{o}c.

3.1.3 Soils and Agriculture

The block comes under Agro-ecological zone-15. It abjoins eastern ghats. The soils of this area are Red soils, costal sandy soils, black cotton, alluvial and laterite soils. The soils are deficient in nitrogen, phosphorus and organic matter. The major crops grown in this are is paddy, black gram, red gram. The important cash crops are sugarcane, groundnut, cotton. The major vegetable cultivated crops are chillies, bhendi and brinjal and important fruit crops are lemon, mango, cashew and banana.

3.2 Experimental sites

Five samples of both soil and irrigation water from 6 villages i.e., total of thirty samples were collected from Kovur block, Nellore district, Andhra Pradesh. All the samples are collected from cultivating fields of different farmers water samples are taken from tube wells and ponds which are used for irrigation purpose. Collected samples of both soil and water kept in jute bags and plastic bottles.

3.2.1 Method of Sampling and Processing

3.2.2 Collection of soil samples

All samples of soil collected randomly from 6 different sites by making V- shape notch at depth of 15 cm. At first remove both stones and surface litter in sampling spot itself, collect five-six representative samples in zig-zag pattern to ensure homogeneity. On an average 2 to 3 kg of sample were collected and thoroughly mix together and reduce upto 1 kg by quartering into a composite sample.

Table 3.1.2a: Climate data of Kovur block

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (F$^{o)}$)	24.65	26.1	29.45	32.35	34.95	33.75	32.35	31.55	30.7	29.65	26.75	25.1
Min. Temperature °C (F$^{o)}$)	20.3^{o}C (68.5^{O}F)	20.9^{O}C (69.6^{O}F)	23.9^{0}C (75^{0}F)	26.6^{0}C (79.9^{0}F)	29.6^{0} (85.3^{0}F)	29.7^{0}C (85.5^{0}F)	28.5^{0}C (83.3^{0}F)	27.8^{0}C (82^{0}F)	26.9^{0}C (80.4^{0}F)	26^{0}C (78.8^{0}F)	23.7^{0}C (74.7^{0}F)	22^{0}C (71.6^{0}F)
Max. Temperature °C (F$^{o)}$)	29^{O}C (84.2^{O}F)	31.3^{O}C	35^{0}C (95^{0}F)	38.1^{0}C (100.6^{0}F)	40.3^{0}C (104.5^{0}F)	37.8^{0}C (100^{0}F)	36.2^{0}C (97.2^{0}F)	35.3^{0}C (95.5^{0}F)	34.5^{0}C (94.1^{0}F)	33.3^{0}C (91.9^{0}F)	29.8^{0}C (85.6^{0}F)	28.2^{0}C (82.8^{0}F)
Precipitation/Rainfall Mm(in)	8 (0.31)	3 (0.12)	5 (0.2)	4(0.16)	28(1.1)	24(0.94)	34(1.34)	36(1.42)	47(1.85)	88(3.46)	134(5.28)	56(2.2)

Table 3.2.2b Description of soil sampling site

Sample.no	Village Name	Latitude	Longitude	Farmer Name	Previous Year Crop	Present YearCrop
1	Gummaldibba	14.51097	79.96668	Venkateswarlu	Paddy	Paddy
2	Gummaldibba	14.51123	79.96721	Nagapaa	Paddy	Paddy
3	Patur	14.50912	79.96049	Sridheer Reddy	Paddy	Paddy
4	Patur Road	14.50842	79.97062	Shiva kumar	Paddy	Paddy
5	Gummaldibba	14.51071	79.95283	Srinivasulu	Paddy	Paddy
6	Patur Road	14.51093	79.94946	Prasad kumar	Paddy	Paddy
7	Patur	14.51121	79.94975	Kottaiah	Paddy	Paddy
8	Patur	14.5136	79.94288	Ramanjulu	Paddy	Paddy
9	Patur Road	14.51235	79.94565	Krishnappa	Paddy	Paddy
10	Yellayapalem	14.51606	79.94169	Kukuteswar rao	Paddy	Paddy
11	Yellayapalem	14.53667	79.94947	Lakshmamma	Paddy	Paddy
12	Yellayapalem	14.53423	79.95232	Prasad naidu	Paddy	Paddy
13	Yellayapalem	14.53037	79.95442	Madhu sudhan	Paddy	Paddy
14	Yellayapalem	14.53124	79.95521	Srinivasulu Naidu	Paddy	Paddy
15	Yellayapalem	14.53189	79.96121	Rammapa	Groundnut	Groundnut
16	Rajupalem	14.52609	79.96042	Suresh	Groundnut	Groundnut
17	Rajupalem	14.52573	79.96197	Abdul razak	Chilli,Groundnut	Groundnut
18	Rajupalem	14.52496	79.96311	Ramakothaiah	Chilli,Groundnut	Groundnut
19	Rajupalem	14.52335	79.96577	Anand bhupati	Paddy	Paddy
20	Rajupalem	14.52256	79.97029	Rameshwar rao	Paddy	Paddy
21	Kovur	14.52298	79.97128	Subbaiah	Paddy	Paddy
22	Kovur	14.51871	79.9887	Mallapa	Paddy	Paddy
23	Gangavaram	14.51828	79.9474	Kumara swami	Paddy	Paddy
24	Kovur	14.52044	79.98921	Verandhra	Paddy	Paddy
25	Kovur	14.53335	79.99043	Prasanna gowada	Paddy	Paddy
26	Kothur	14.52685	79.98973	Arikala gowada	Paddy	Paddy
27	Kothur	14.50888	79.97979	Rammama	Paddy	Paddy
28	Kothur	14.51448	79.97819	Bharat Gowada	Paddy	Paddy
29	Kothur	14.51526	79.97662	Rakesh reddy	Paddy	Paddy
30	Kothur	14.52083	79.9744	Rajulu	Paddy	Paddy

3.2.3 Processing of soil samples

The collected soil samples were kept in shade for air drying, at normal room temperature, after complete drying take to laboratory for further processing. Dried samples were crushed with the help of wooden roller. Later, samples were sieved by using 2 mm mesh sieve. After sieving samples were stored in plastic bags with labelling on it like collection of data and time were specified. Labelled samples were finally analyzed for physico-chemical properties.

3.3 Physical and Chemical analysis of soil samples

Collected soil samples are analyzed for various physical and chemical properties in laboratory. It includes pH, EC, BD, PD, Porosity, Water holding capacity, primary macro nutrients (N, P, K) secondary macro nutrients (Ca, Mg andS) and micro nutrients (Zn, Cu, Mn, Fe).

3.3.1 Determination of soil pH

Take soil and water at ratio of 1:25 (10g soil + 25ml distilled water) analyzed the soil pH by using pH meter Backman model, 1960.

Table 3.3.1a: Classification of soil samples under pH ranges

pH Range	Soil Reaction Rating
>4.5	Extremely acid
4.5-5.0	Very strong acid
5.1-5.5	Strong acid
6.6-7.3	Neutral
7.9-8.4	Moderately alkaline
8.5-9.0	Strongly alkaline

3.3.2 Determination of soil electrical conductivity

A suspension of soil and water prepared in the ratio of 1:2.5 (10 g soil and 25 ml of distilled water) in 50ml beaker for measuring soluble salts concentration by using conductivity meter as illustrated by Jackson 1973.

Table 3.3.2a: Classification of soil samples under EC ranges

Classification	EC dSm^{-1}
Non saline soils	0-2
Slightly saline soils	2-4
Saline soils	4-8
Strongly saline soils	8-16
Extremely saline soils	>16

3.3.3 Determination of organic carbon

For estimation of organic carbon, walkey and black (1934) method of wet oxidation was acquainted. 1g of soil sample was taken in a conical flask of 500ml capacity and 10ml of potassium dichromate solution followed by 20ml of concentrated sulphuric acid were added. The solution was swirled for a minute and kept aside for 30 minutes for redox reaction to be completed. Then, the solution was diluted with 200ml of distilled water. 0.2 g of sodium floride and 1ml of diphenylamine indicator was added to the solution. Titration of the solution was done with ferrous ammonium sulphate till the violet color changes to green.

$$\% \text{ Organic Carbon} = \frac{B-T \times 0.003 \times 100}{2 \times wt\ of\ soil}$$

% Organic matter = organic carbon x 1.724 (Van Bemmelen factor)

Where, B = Volume of 0.5N FAS solution used for blank titration

T = Volume of 0.5N FAS solution used for sample titration

3.3.4 Determination of available nitrogen

For estimation of available nitrogen, subbaiah and asija (1956) method of alkaline potassium permanganate was acquainted. 5g of soil and 5ml of distilled water were placed in a distillation tube, and 25ml of 0.32 per cent $KMnO_4$ was added to the tube. The semi-automated analyzer was set up for the distillation process, and a distillation tube was inserted. 20ml of 2 per cent boric acid, pH 4, was placed under a receiver tube in a 250ml conical flask containing boric acid, and the tube was dipped in the conical flask containing boric acid. When the button was clicked, the device introduced 25ml of 2.5 per cent NaOH solution to the distilled tube. The distillation was designed to last 9 minutes. Nitrogen is released in the form of ammonia during this process, and the ammonia is trapped in boric acid, resulting in a green colour. The contents were then titrated against 0.02N sulphuric acid until the green colour changed to pink.

$$\text{Available N (Kg ha}^{-1}) = \frac{(S-B)\times 0.02\times 14\times 2.24\times 106}{1000\times 5}$$

Where, S = Sample titration reading

B = Blank titration reading

3.3.5 Determination of available phosphorus

By using Olsen's method we analyse the availability of phosphorus. Firstly reagent A i.e. molybdate tartarate solution and reagent B i.e. murphy riley solution were prepared. In a 250 mL conical flask, 2.5g of soil sample was added to 50mL Olsen's reagent and a pinch of Darco G-60 charcoal. The contents were filtered through whatman No.1 filter paper after being agitated for 30 minutes on a mechanical shaker. For colour development, 10ml of extracted soil filtrate was added to a 25ml volumetric flask with 2-3 drops of p-nitro phenol indicator, which produced a yellow hue. To remove the yellow colour, 5N sulphuric acid was added drop by drop. The volume was made up to 25ml with distilled water after 8ml of reagent B (ascorbic acid solution) was added. After a few minutes, a blue colour developed, which was detected at 730nm using a spectrophotometer. A blank was also completed. Using standard solutions of 0, 1, 2, 3, 4, and 5 ppm, a standard curve was also created.

$$\text{Available phosphorus (Kg ha}^{-1}) = \frac{R\times Volume\ of\ extract\times 2.24\times 10^{6}}{volume\ of\ aliquot\ \times \text{wt.(g)} of\ soil}$$

Where, R = µg P in the aliquot (obtained from standard curve)

3.3.6 Determination of available potassium

For estimation of available potassium in the soil sample neutral normal ammonium acetate extractant (Schollenberger and simon, 1945) was used. 5 g of soil sample was placed in a conical flask with a capacity of 100 ml, and 25 ml of 1N neutral ammonium acetate was added. After shaking for 5 minutes on a mechanical shaker, the solution was promptly filtered using Whatman No. 1 filter paper. On a flame photometer, the potassium-containing aliquot was calculated. Before estimating samples, the equipment was calibrated using a 0 and 40 ppm standard made from1000 ppm KCL solution.

Dilution factor =25/5 = 5 times

Reading of the flame photometer for the test sample = C

Available potassium (Kg ha^{-1}) = Cx5x2.24

3.3.7 Determination of exchangeable calcium

The estimation of exchangeable calcium was done by neutral normal ammonium acetate solution described by Jackson's 1973. 5 g of soil was placed in a conical flask with a capacity of 100 ml, and 25 ml of extractant was added. The solution was agitated for 5 minutes on a rotatory shaker before being filtered using Whatman filter paper-1. Then 5ml of aliquot was put to a 150 ml conical flask, along with 5 drops of 4 N sodium hydroxide buffer solution and 50 mg of muroxide indicator. After that, the contents were titrated with a 0.01N EDTA solution until the colour changed from orange to red to purple.

$$\text{Amount of Ca (Meq L}^{-1}) = \frac{R \times Normality\ of\ EDTA \times 1000}{Aliquot\ (ml) taken}$$

$$\text{Amount of Ca (Meq 100g}^{-1}) = \frac{100}{soil\ weight\ (g)} \times \frac{extract\ volume\ (ml)}{100} \times \text{Ca in Meq L}^{-1}$$

Where, R = volume (ml) of standard EDTA used in titration

3.3.8 Exchangeable calcium + magnesium

The estimation of exchangeable calcium + magnesium was done by neutral normal ammonium acetate solution described by Jackson's 1973. 5 g of soil was placed in a conical flask with a capacity of 100 ml, and 25 ml of extractant was added. The solution was agitated for 5 minutes on a rotatory shaker before being filtered using Whatman filter paper-1. Then, in a 150 ml conical flask, 5 ml of the aliquot was added to 25 ml of distilled water, followed by 0.5 ml of ammonium chloride- ammonium hydroxide. A total of four drops of eriochrome black T indicator were added to the sample, resulting in a red colour. The sample was titrated with 0.01 EDTA till the blue colour appeared. Exchangeable calcium and magnesium was calculated by using the Following: -

$$\text{Amount of Ca + Mg (Meq L}^{-1}) = \frac{R \times Normality\ of\ EDTA \times 1000}{Aliquot\ (ml) taken}$$

$$\text{Amount of Ca + Mg (Meq 100g}^{-1}) = \frac{100}{soil\ weight\ (g)} \times \frac{extract\ volume\ (ml)}{100} \times Ca\ in\ \text{Meq L}^{-1}$$

$$\text{Amount of Mg (Meq L}^{-1}) = \text{Ca + Mg (Meq L}^{-1}) - \text{Ca (Meq L}^{-1})$$

Where, R= volume (ml) of standard EDTA used in titration

3.3.9 Available Sulphur

For estimation of available sulphur in soil samples turbidimetric (Chesnin and Yien, 1950) method was followed. 10g of soil and 50ml of 0.15 per cent calcium chloride extractant were placed in a 250ml conical flask. The solution was then filtered using Whatman filter paper-1 after being agitated for 30 minutes on a rotatory shaker. A 20ml aliquot was placed in a 25ml volumetric flask and 1g of barium chloride and 1ml of gum acacia were added. The mixture was allowed for 5-10 minutes to induce turbidity. At 340nm, turbidity was measured using a spectrophotometer. From 100ppm AR grade potassium sulphate solution, working standards of 0.25, 0.5, 1.0, 2.5, and 5.0 were also created.

Available Sulphur (mg kg^{-1}) = R x $\frac{50}{10} \times \frac{1}{10}$

Where, R stands for S content in µg as read on X-axis

3.3.10 Determination of Bulk density

The bulk density of the soil sample was determined by using pycnometer described by Black, 1965. The weight of the clean and dry pycnometer was first determined using a weighing balance. The pycnometer was then filled to the full with soil sample using a spatula and tapping it. The total weight of the soil plus the pycnometer was calculated, and the soil was then decanted from the pycnometer. Water was filled drop by drop in the same pycnometer using a burette until it was entirely filled, and the volume of the burette was recorded. Then the bulk density of soil samples was Calculate by using formula given below:

$$\text{Bulk density} = \frac{mass\ of\ the\ soil}{volume\ of\ the\ soil}$$

3.3.11 Determination of Particle density

The particle density of the soil sample was estimated by Black method (1965), using pycnometer. A weighing balance was used to weigh the clean and dry pycnometer. Water was poured into the pycnometer with the help of a burette. The pycnometer was then weighed after being filled with water. To release trapped air, 10g of soil and 10ml of water were put in a beaker and heated over a hot plate. The suspension was then transferred to a pycnometer and completely filled. The pycnometer and the stopper were then weighed.

$$\text{Particle density} = \frac{10}{(W2+10)-W3}$$

- Mass of empty, clean, dry pycnometer (g) = W1
- Mass of pycnometer + water (g) = W2
- Mass of pycnometer + water + soil (g) = W3
- Mass of soil (Ws) = 10g

3.3.12 Determination of porosity

Determination of porosity can be done using value of bulk density and particle density. Porosity of soil can be calculated by using formula given below:

$$\text{Porosity (\%)} = [1 - \frac{bulk\ density}{partical\ density}] \times 100$$

3.3.13 Determination of water holding capacity

Determination of water holding capacity was done by method described by Piper (1966), using a keen box. A circular filter paper was placed in the keen box, and the weight of the keen box with the filter paper was recorded. By tapping 20-30 times,the soil sample was filled to the top of the box. The keen box, together with the soil and filter paper, was placed in a petri dish filled with water and left for an hour to allow the soil in the keen box to absorb as much water as possible. The surplus water was then evacuated by placing the keen box on filter paper and recording the weight of the moist soil in the keen box. Wet soil in keen box was oven dried for 24hrs at 105°C and the weight of oven dried soil was recorded.

$$\text{Saturation \%} = \frac{Wet\ wt - dry\ wt.}{dry\ wt.} \times 100$$

3.3.14 Available Micronutrient

An atomic absorption spectrophotometer was used to assess the cationic micronutrients iron, copper, zinc, and manganese in soil samples. 0.005 M DTPA (Diethyline Triamine Penta Acetic Acid), 0.01M calcium chloride dehydrate and 0.1M triethanol amine buffered at pH 7.3 (Lindsay and Norvell, 1978) were used as extractant.

Table 3.4. Nutrient rating of the soil test values

	Low	**Medium**	**High**
Organic carbon (%)	<0.5	0.5-0.75	>0.75
Available N (Kg ha^{-1})	<280	280-560	>560
Available P (Kg ha^{-1})	<12.5	12.5-25	>25
Available K (Kg ha^{-1})	<135	135-335	>335
Available S (Kg ha^{-1})	<10	10-20	>20
Micronutrient	**Deficient**	**Sufficient**	**High**
Zinc (mg kg^{-1})	<0.6	0.6-1.2	>1.2
Copper (mg kg^{-1})	<0.2	0.2-0.4	>0.4
Iron (mg kg^{-1})	<4.5	4.5-9	>9
Manganese (mg kg^{-1})	<3	3.5-7	>7

3.5 Evaluation of soil nutrient status

To compare the levels of soil fertility in different areas, a single value for each nutrient has to be calculated using the nutrient index proposed by Parker *et al*(1951). The nutrient index is a three-tiered system for determining soil fertility based on the percentage of samples in each of the three classes: low, medium, and high. Sanganer block has low organic carbon and nitrogen nutritional index values, high phosphorus, medium potassium, and low sulphur nutrient index values.

Nutrient Index (N.I.) (NL x 1 + NM x 2 + NH x 3) /NT

Where, NL: Indicates number of samples falling in low class of nutrient status

NM: Indicates number of samples falling in medium class of nutrient status

NH: Indicates number of samples falling in high class of nutrient status

NT: Indicates total number of samples analysed for a given area.

The nutrient index with value less than 1.67 denotes low category and that falls between 1.67 and 2.33 denotes the medium fertility class. Value of NI more than 2.3 and above represent a high fertility class. As per the NIV developed by

Ramamoorthy and Bajaj (1969) the nutrient index values were calculated according to the above mentioned limits.

Table 3.5a: Rating chart of nutrient index

S.No	Nutrient Index	Value	Interpretation
1	Low	<1.67	Low fertility status of the area
2	Medium	1.67-2.33	Medium fertility status of the area
3	High	>2.33	High fertility status of the area

3.6 Collection of ground water samples

The ground water samples were gathered in plastic bottles from various places. In the Kovur block of Nellore district, a total of thirty groundwater samples were taken for irrigation purposes. 2-3 drops of toluene were added to the samples to prevent microbial development. Appendix 1 contains a brief summary of the water samples.

3.7 Water quality analysis

The ground water samples collected were analysed for water quality parameters such as pH, EC, potassium, sodium, calcium, magnesium, chloride, carbonate, bicarbonates, RSC, SAR, PI, SSP, and KR were measured in the laboratory using conventional procedures described by APHA in 1992. Table 3.8b contains a summary of the analytical procedures and equipment utilised in the investigation, while Table 3.7 has a list of all properties.

3.7.1 Measurement of pH

For estimation of pH of water sample, 50ml beaker was taken to which appropriate amount of water sample was added and pH was measure by pH meter (APHA, 1992).

3.7.2 Electrical conductivity

For estimation of electrical conductivity of water sample, 50ml beaker was taken to which appropriate amount of water sample was added and EC was measured by using conductivity meter, expressed in dSm^{-1} (APHA, 1992).

3.7.3 Determination of chloride

Chloride concentration in water samples was estimated by using Mohr's method (APHA, 1992). In a 250ml conical flask, 5ml of water was taken. The flask was filled with 25ml of distil water and 5-7 drops of potassium dichromate (K_2CrO_4) indicator. The colour appeared to be dark yellow at first. The contents were then titrated with 0.02N silver nitrate solution till brick red or Reddish brown color appeared.

$$C1^{-} Meq\ L^{-1} = \frac{Normality\ of\ AgNo3\ \times vol\ of\ AgNo3 \times 1000}{ml\ of\ aliquot\ taken}$$

$$C1^{-} Meq\ L^{-1} = \frac{Normality\ of\ AgNo3 \times vol\ of\ AgNo3}{ml\ of\ aliquot\ taken} \times Eq.wt\ of\ Cl^{-} (35.5)$$

3.7.4 Determination of Alkanity [carbonates (CO_3^{2-}) and bicarbonates (HCO_3^{-})]

The concentration of carbonates and bicarbonates in water samples was determined using a simple acidimetric titration method (APHA, 1992). 2 drops of phenolphthalein indicator were added to 5 ml of water sample and 20 ml of distil water in a 100 ml capacity conical flask. Some of the samples turned pink, indicating the presence of carbonate in the sample. The solution was then titrated with 0.01N sulphuric acid until the pink tint faded and the acid volume was measured. The same solution was used for bicarbonate, with 2-3 drops of methyl red added. With 0.01N sulphuric acid, the titration was maintained until the yellow hue turned to red.

$$CO_3^{2-}\ Meq\ L^{-1} = \frac{\text{Normality of H2S04Xvol of H2S04X1000}}{ml\ of\ aliquot\ taken}$$

$$CO_3^{2-}\ gram/lit = \frac{Normality\ of\ H2S04xvol\ of\ H2S04}{ml\ of\ aliquot\ taken} \times Eq.\ Wt\ of\ CO_3^{2-}\ (30)$$

$$HCO_3^{-} = \frac{\text{Normality of H2S04Xvol of H2S04X1000}}{ml\ of\ aliquot\ taken}$$

$$HCO_3^{-} = \frac{\text{Normality of H2S04Xvol of H2So4}}{ml\ of\ aliquot\ taken} \times Eq.\ Wt\ of\ HCO_2^{3-}\ (61)$$

3.7.5 Determination of calcium + magnesium

For estimation of calcium and magnesium in water samples complexometric titration method was used. A 5ml water sample was placed in a 150ml conical flask and diluted with 25ml distil water for complexometric measurement of calcium and magnesium in water samples. 3-4 drops of Erichrome Black-T indicator and 0.5ml or 10 drops of ammonium hydroxide ammonium chloride buffer solution were added to the solution. To avoid interference with other metal ions, a pinch of carbamate crystals was added to the solution. With 0.01 EDTA solution, the contents were titrated until the colour changed from pink to blue.

$$Ca^{2+} \text{ and } Mg^{2+} \text{ Meq } L^{-1} = \frac{Normality\ of\ EDTA \times vol\ of\ EDTA \times 1000}{ml\ of\ aliquot\ taken}$$

$$Ca^{2+} \text{ and } Mg^{2+} \text{ gram/lit } = \frac{Normality\ of\ EDTA \times vol\ of\ EDTA}{ml\ of\ aliquot\ taken} \times \text{Eq. Wt of } Ca^{2+} \text{ and } Mg^{2+}$$

3.7.6 Determination of calcium

For estimation of calcium in water samples Complexometric titration method was used. In a 150 mL conical flask, 5 mL of water was taken and diluted with 25 mL of distil water. The solution was spiked with 5 drops of 4N sodium hydroxide and 50 mg of ammonium purpurate indicator. With 0.01 EDTA solution, the contents were titrated until the colour changed from orange red to lavender purple.

$$Ca^{2+} \text{ Meq } L^{-1} = \frac{Normality\ of\ EDTA \times vol\ of\ EDTA \times 1000}{ml\ of\ aliquot\ taken}$$

$$Ca^{2+} \text{ gram/lit } = = \frac{Normality\ of\ EDTA \times vol\ of\ EDTA}{ml\ of\ aliquot\ taken} \times \text{Eq. Wt of } Ca^{2+} \text{ (20)}$$

3.7.7 Determination of potassium

The estimation of potassium in the water samples was done my method described by APHA, 1992, by using flame photometer. KCL was used to make a 1000 ppm standard stock solution. For a 100ppm concentration standard, 10 mL of standard concentrate was placed in a 100 mL volumetric flask and the volume was adjusted.

Similarly, using a 100ppm stock solution, standards of 0, 20, 40, 60, and 80 ppm were created, and the instrument was calibrated with these standards before measuring the concentration of the samples.

3.7.8 Determination of Sodium

The estimation of sodium in the water samples was done my method described by APHA, 1992, by using flame photometer. NaCl was used to make a 1000 ppm standard stock solution. For a 100 ppm concentration standard, 10 mL of standard concentrate was placed in a 100 mL volumetric flask and the volume was adjusted. Similarly, using a 100ppm stock solution, standards of 0, 20, 40, 60, and 80 ppm were created, and the instrument was calibrated with these standards before measuring the concentration of the samples.

Table 3.7: Rating chart of water properties

Properties	Suitable	Moderately suitable	Not suitable
pH	6.5-8.4	0-5.0	>9.5
EC (dSm^{-1})	<0.3	3.0-7.0	>7.0
C1^{-}(Meq L^{-1})	<4.0	4.0-10.0	>10.0
HCO_3^-(Meq L^{-1})	>1.25	1.25-8.5	8.5
Na^+ (Meq L^{-1})	<3.0	3.0-9.0	>9.0

3.8 Irrigation water quality index (IWQI)

Irrigation water quality is highly dependent upon both the type and quantity of salts dissolved in it. The irrigation water quality index is used to determine the basic parameters of water quality. The quality of irrigation water differs from place to place, in regions, countries, and so on. The salinity and alkanity characteristics of the irrigated region are major elements that influence water quality. Water quality is the most critical factor in ensuring long-term water utilisation for irrigated agriculture. The following are the basic parameters for evaluating water quality for irrigation: Sodium's relative percentage to other cations, given as Sodium absorption Ratio (SAR), total salt concentration expressed by electrical conductivity, bicarbonate content, Residual sodium carbonate (RSC), permeability index (PI), Soluble sodium percentage, Kelly’s ratio (KR).

Computation of WQI

WQI is generally calculated by following two method:

First Method

1st step: Give priority (from 1 to 5) to the selected parameter according to there importance in the overall quality of water is value of Wi.

Ex: pH - 5

EC -4

CO_3^{2-}- 3

HCO_3^- - 3 and remaining gave 2 rating.

2nd step: Computation of relative weight

$$Wi=\frac{Wi}{\sum Wi}$$

Where, Wi= Relative weight

Wi= Rating gave by us to the water parameter

Wwi= Total no.of parameter selected for water quality. Like, if we take pH, EC, CO_3^{2-}, HCO_3^-, Ca^{++}, Mg^{++}, Cl^-, Na^+ and K^+

It means $\sum wi=9$

3rd step: Assigning quality rating (qi) for each parameter

$$qi = \frac{Ci}{Si} \times 100$$

where, qi = quality rating

ci = value of each parameter we get during analysis.

Si = Value of each parameter given by BIS (Bureau of Indian Standard) 1991.

For example if

$$Qi=\frac{value\ of\ any\ parameter\ during\ analysis}{value\ of\ that\ parameter\ given\ by\ BIS\ 1991}$$

4th step: For calculate SIi

SIi= wi X qi

Where, Wi = Rating gave by us to the water parameter.

Qi = Value of that parameter only which we taken for wi

5th step: WQI= (∑ SIi)- no.of parameter (∑wi)

Where ∑SIi is get by addition of 9 parameter value of SIi and then substract no. of parameter i.e., no. of parameter taken by us for water quality.

Second Method

1. Calculation of quality rating for selected water parameters

$$Qi = \frac{(VA-VI)}{(VS-VI)} \times 100$$

Where, Qi = Quality rating of ith parameter for a total of n water quality parameters.

VA = Actual value of the water quality parameter obtained from laboratory analysis

VB = Ideal value of that quality parameter can be obtained from the standard table by BIS.

VI for pH = 7 and for other parameters it is equating to zero and DOV ideal =14.6 mg/L

Vs = Recommended BIS standard of the water quality parameter.

2. Calculation of Unit weight (Wi)

Calculation of unit weight is done by value inversely proportional to the recommended standard (Si) for the corresponding parameter using the following equation:

$$WI = \frac{K}{SI}$$

Where, WI = Unit weight of nth parameter,

K = Proportionality constant assumed as 1,

SI = Standard permissible value for nth parameter

3 Calculation of WQI is done by aggregating the quality rating with unit weight linearly using the following equation

$$WQI = \frac{\sum WIQI}{\sum WI}$$

Where, QI = Quality rating,

WI = Unit weight

Table 3.8a: The range of WQI, quality status and conceivable usage of water

WQI	**Water Quality Status**
<50	Excellent
50-100	Good
101-200	Poor
201-300	Very poor
>300	Unsuitable

(Source: ICAR research bulletin)

Table 3.8b: Water quality parameters as per BIS standards (All are in mg/l except pH and EC)

Parameters	**BIS Standards**
pH	7.5
Electrical conductivity	0.3
Total hardness	300
Calcium	75
Magnesium	30
Alkalinity	200
Bicarbonate	300
Sodium	200
Potassium	20
Chloride	250

(Source: BIS 1991)

3.8.1 Sodium absorption ratio

SAR is an important parameter for measuring the relative proportion of sodium to calcium plus magnesium i.e., sodium or alkali hazard to crops. SAR is calculated using the following formula given by Richard, 1954, expressed in Meq L^{-1}.

$$SAR = \frac{Na+}{\sqrt{\frac{Ca2++Mg2+}{2}}}$$

Table 3.8.1a: Classification of irrigation water based on SAR (Richards)

SAR	Class
0-10	Low sodium
10-18	Moderate
18-26	High
>26	Very high

3.8.2 Residual sodium carbonate

Alkanity hazard in water is measured by residual sodium carbonate index which indicate concentration of carbonates and bicarbonates. When sodium is high in water in comparison to calcium and magnesium clay soils get swell and undergoes dispersion. The RSC is calculated by using the following formula given by Eaton (1950), expressed in Meq L^{-1}.

$$RSC\ (Meq\ L^{-1}) = (CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})$$

Table 3.8.2a: Classification of irrigation water based on RSC

RSC	Class
<1.25	Suitable
1.25-2.50	Moderately
>2.50	Not suitable

3.8.3 Soluble sodium percentage (SSP)

SSP index is used to measure sodium hazard in water. Irrigation water quality and suitability can be measured by studying soluble sodium percentage. Alkaline soil reduce the permeability of water which retards the growth of plant. The SSP was calculated by using following formula given by (Todd 1980) expressed in Meq L^{-1}.

$$[100x\ (Na+K)] / (Ca^{2+} + Mg^{2+} + Na^{+} + K^{+})$$

Table 3.8.3a: Classification of irrigation water based on SSP (Todd)

SSP	Class
<20	Excellent
20-40	Good
40-60	Permissible
60-80	Doubtful
>80	Unsuitable

3.8.4 Permeability index (PI)

PI index is used to assess the groundwater quality and its suitability for irrigation purpose. The concentration of Ca^{2+}, Mg^{2+}, Na+ and HCO_3^- influence the water movement capacity i.e., permeability of soil profile. PI values of water is calculated by these Cations to evaluate the quality of groundwater. (Singh *et al.* 2012). The PI of water samples were calculated by using formula given by Doncen 1964, expressed in Meq L^{-1}.

$$PI = \frac{Na + \sqrt{HC03}}{Ca + Mg + Na} \times 100$$

Table 3.8.4a: Classification of irrigation water based on PI

PI	Class
>75	Suitable
25-75	Moderately suitable
<25	Not suitable

3.8.5 Kelly's ratio (KI)

Kel y's ratio can also be used to determine the quality and suitability of water for irrigation purpose. It is the ratio of concentration of sodium to concentration of calcium plus magnesium. Kel y's ratio less than one is suitable for irrigation while more than one indicate presence of excessive sodium which is unsuitable for irrigation. Kel y's ratio was calculated by using formula given by Kel y 1953, expressed in Meq L^{-1}

$$K = \frac{Na}{Ca + mg}$$

3.9 Reagents and instruments used in soil analysis and water analysis

Table 3.9a: Reagents and solutions used in soil analysis

Analysis	**Reagents used**
Soil nitrogen	• 2.5 % of sodium hydroxide • Mixed indicator(0.1 of bromocrosol green and 100 ml ethanol) • 2.5 % of boric acid • 0.32 % of potassium chromate
Soil phosphorous	BASIC MEDIUM • 0.5 N sodium bicarbonate solution. • Dacro-g-60 or charcoal • Ammonium molybdate solution • Ascorbic acid • Antimony potassium tartrate solution. • 2.5 M sulphuric acid P-nitro phenol indicator
Soil potassium	• Standard potassium chloride solutions • 1 N Ammonium acetate solution
Soil Ph	• Buffer solutions of 4.0, 7.0 and 9.2 • Soil and distilled water suspension in the ratio of 1:2.5
Soil electrical conductivity	• Soil and distilled water suspension in the ratio of 1:2.5
Soil organic carbon Walkey and Black rapid titration method	• 1N potassium dichromate • 0.5 N ferrous ammonium sulphate • Diphenylamine indicator • Concentrated H_2SO4 (sp.gr.1.84) • Orthophosphoric acid or sodium fluoride .
Soil calcium and magnesium	• Ammonium acetate solution • Aqua regia (HCL + HNO3) • Erichrome black-T indicator • EDTA (ethylene diamine tetra acetic acid) • Muroxide indicator • 4 N NaOH buffer solution • Ammonium chloride – ammonium hydroxide buffer solution
Soil sulphur	• 0.15 % of calcium chloride • Barium chloride crystals • 0.25 g of gum acacia • Standard potassium sulphate solutions
Sodium	• Standard sodium chloride solution.
Available Cationic Micronutrients (Lindsay and Norvell, 1978)	• 0.005 M DTPA (Diethyline Triamine Penta AceticAcid) • 0.01M calcium chloride dehydrate and • 0.1M triethanol amine buffered at pH 7.3.

Table 3.9b: Reagents and solutions used in water analysis

Analysis	**Reagents used**
Water pH	• Buffer solution of pH 4.0, 7.0 and 9.2
Water electrical conductivity	• 0.01N KCL solution
Calcium and magnesium	• 0.01N EDTA solution • Muroxide indicator • Sodium diethyl dithio carbamate crystals • 4 N NaOH buffer solution • Erichrome black-T indicator • Ammonium chloride-ammonium hydroxide buffer
Chloride	• 0.02 N silver nitrate solution • 0.02 N sodium chloride solution • Potassium chromate indicator
Carbonates and bicarbonates	• 0.05 N standard sulphuric acid • Methyl red indicator • Phenolphthalein indicator
Sulphate	• 0.15 % of calcium chloride • Barium chloride crystals • 0.25 g of gum acacia • Standard potassium
Potassium	• Standard potassium chloride solution
Sodium	• Standard sodium chloride solution

Table 3.9c: Instruments and apparatus used in soil and water analysis

Instruments	
pH meter	For measuring soil and water pH
Electrical conductivity meter	For measuring salinity in soil and total dissolved salts (TDS) in water.
Flame photometer	For measuring the soil and water potassium, sodium & calcium content.
Hot air oven	For drying the soil samples for 24hrs @105°C.
Water bath	To evaporate the contents.
Spectrophotometer	For measuring phosphorus content in soil.
Shaker	For uniform mixing
Weighing balance	To measure the chemicals in grams or kilograms. For estimation of available nitrogen in soil.
Semi-Auto Nitrogen analyser	For estimation of available nitrogen in soil
Atomic Absorption Spectrophotometer	For estimation of Micronutrients and heavy metals.

3.10 Statistical analysis

SPSS statistical software was used for computation of statistical data i.c. an, range, coefficient of variation, standard deviation and correlation coefficient. The statistical data was estimated by formulas given below:

1. Range = Largest value (L)-Smallest value (S)

2. Coefficient of Variation $= \frac{Standard\ Deviation}{Mean}$ x 100

3. Mean = $\frac{sum\ of\ all\ samples}{total\ number\ of\ samples}$

4. Coefficient of Correlation (Pearson) = $\frac{SS\ (\mathrm{KF})}{\sqrt{[ss(x)][ss(y)]}}$

Where, SS (XY) = Sum of the product of x and y

SS(X) = Sum of squares of x

SS(Y) = Sum of squares of y

5. Standard Deviation = $\sqrt{\frac{\sum x^2 \frac{\sum x^2}{n}}{n-1}}$

Where, $\sum x^2$ = Sum of all samples

$(\sum x)^2$ = Sum of squares of all samples

n = Total number of samples

Chapter IV

RESULTS AND DISCUSSION

The study main goal was to determine the fertility status of soil and the water quality of ground water of Kovur block, Nellore district, Andhra Pradesh. In order to attain this 30, soil and 30 water samples were collected from different villages of the block. Soil samples are collected from farmer's field and water samples from different tube wells used for irrigation purpose. The collected results were analysed, interpreted, correlated, and the various causes of data fluctuation were examined. In this section the results of the present study are presented under the following headings.

4.1 Analysis of soil properties

4.1.1 Physico-chemical properties of soil

4.1.2 Status of available primary macronutrients in the soil

4.1.3 Status of available secondary macronutrients in the soil

4.1.4 Soil nutrient index value

4.1.5 Correlation matrix between physico-chemical properties of soil

4.2 Analysis of water properties

4.2.1 The physico-chemical properties of ground water

4.2.2 Anions status in ground water

4.2.3 Cations status in ground water

4.2.4 Irrigation water quality index

4.2.5 Correlation matrix between water quality parameters of ground water

4.1 Analysis of soil properties

4.1.1 Physico-chemical properties of soil

The data of the physico-chemical properties of soil such as , pH, EC, Organic carbon Bulk density, Particle density, porosity, water holding capacity are present in table-4.1.1 and in appendix 1 and 2.

The pH of the soil samples ranged from 6.1-8.4 with the mean value of 7.3 and Maximum value for pH was observed in sample no: 21 of Kovur village while the minimum was recorded in sample no: 17 of Rajupalem village. The values of standard deviation and coefficient of variation were 0.72 ± and 7.21 % respectively. The data revealed that 50 % of samples are acidic in nature, 31 % of the samples are neutral and 19 % of the samples are alkaline in nature (table-4.1.1 a). The pH of the study area is somewhat acidic in nature.

Table 4.1.1a: Classification of analysed soil samples under different pH ranges

Classes	Range	No. of samples	% of samples
Slightly acidic	6.1-6.5	12	40
Neutral	6.6-7.3	8	26.6
Slightly alkaline	7.4-7.8	5	16.6
Moderately alkaline	7.9-8.4	3	10
Strongly alkaline	8.5-9.0	2	6.6

The EC of the soil samples varied from 0. 112-0.965dSm^{-1} with an average value of 0.45 dSm^{-1} and SD of 0.27 ±, C.V 0.59 %. Maximum value of EC was recorded in sample no: 23 of Gangavarm village while the minimum was observed in sample no: 10 of Yellapalem village. The result shows that 92.3 % of the samples are

in permissible range suitable for all crops and 8.7 % of samples are slightly higher than the permissible range (table-4.1.1b). the EC increases with increased concentration of ions in a soil solution.

Table 4.1.1b: Classification of analysed soil samples under different EC range

Classes	Limit	No. of samples	% of samples
All crops	<0.7	17	56.6
Most crops	0.7-2.0	13	43.3
Salt tolerant	2.0-10.0	-	0
Most halophytes	10-32	-	0
No crops (sea water)	>32	-	0

The organic carbon content of soil samples ranged from 0.25-1.97 % with the average value of 0.87 % the SD 0.43± and CV of 5 %. The values of standard deviation and coefficient variation of organic carbon were. The lowest value of organic carbon was recorded in sample no: 24 of Kovur village and highest was observed in sample no: 10 of Yellapalem. Out of 30 samples collected from Kovur block, 26.6 % of the soil samples are in low organic carbon content, 20 % of soil samples are in medium organic carbon content and 53.3 % of the soil samples are in high organic carbon content (table-4.1.1c).

Table 4.1.1c: Classification of soil samples under different organic carbon range

Classes	Limit	No. of samples	% of samples
Low	<0.5	8	26.6
Medium	0.5-0.75	5	20
High	>0.75	16	53.3

Perusing the data in table 4.1.1, it was discovered that the values of Bulk density of soil samples ranged from 1.14-1.6 Mg m^{-3} with the mean value of 1.34 Mg m^{-3}. The standard deviation and coefficient of variation of bulk density were $\pm$ 0.08 and 5.43 % respectively. The highest bulk density was observed in sample no: 23 Gangavaram village which maybe, due to low organic carbon content in the sampleno: 23 (0.37%) whereas the lowest was observed in sample no: 1 and 10 of Yellayapalem and Gummaldibba which maybe, due to high organic carbon content present in sample no:1 (1.425) and sample no:10 (1.97). this reveal that high amountof organic matter results in low compaction of soil, hence less will be the bulk density of the soil. Such results were also recorded by Lelago and Buraka (2019).

The values of particle density ranged from 2.19-2.91 Mg m^{-3} with the mean value of 2.56 Mg m^{-3}. The standard deviation and coefficient of variation of particle density were ±0.18 and 5.37 % respectively. Maximum value of particle density was recorded in sample no: 21 Kovur village and minimum value was observed in sample no: 23 Gangavaram village.

The water holding capacity of the soil samples ranged from 31.57-49.32 % with the average value of 41.2 %. The standard deviation and coefficient of variation of water holding capacity were ±4.56 and 28.91 % respectively. The lowest water holding capacity was recorded in sample no: 23 and 29 of gangavaram and Kothuru villages due to low organic carbon content in both 23 and 29 samples. The highest water holding capacity of sample number 1 and 10 of Gummaldibba and Yellayapalem villages which may be due to high organic carbon content in this village soil samples. This reveals that WHC of soil increases with increasing level of organic carbon content and increasing percentage of clay and slit particles in the soil as silt and clay particles have much higher surface area than sand particles to hold more amount of water.

Table 4.1.1: Statistical analyzed data on Physico-chemical properties of soil

Soil Parameter	**Mean**	**Range**	**S.D±**	**C.V (%)**
Bulk density (Mg m^{-3})	1.34	1.14-1.6	0.08	5.44
Particle density (Mg m^{-3})	2.56	2.19-2.91	0.18	5.38
Water holding capacity (%)	41.2	31.57-49.32	4.56	28.91
Porosity (%)	37.5	0-53.8	19.5	3.97
pH	7.3	6.1-8.4	0.72	7.21
EC (dSm^{-1})	0.45	0.112-0.965	0.27	27
Organic carbon (%)	0.87	0.25-1.97	0.43	43

The porosity of soil samples ranged from 0-53.8 % with the mean value of 37.5 %. the values of standard deviation and coefficient of variation of porosity were ±19.5 and 3.97 % respectively. Maximum porosity was recorded in sample no: 10 and 18 of Rajupallem and Yellayapalem due to low bulk density i.e., 1.14 Mg m^{-3} and minimum was observed in sample no: 4 and 12 of Patur road and Yellayapalem where there is high bulk density of 1.39 Mg m^{-3}. The result showed that soil porosity is very much influenced by bulk density, more the soil compacted, less will be the pore space.

4.1.2 Status of available macro-nutrients in the soil

The status of available macro-nutrients is shown in the Table-4.1.2 and Appendix-3. The nitrogen content of the soil samples ranged from 12.5-213.24 Kg ha^{-1} with the mean value of 90.73 Kg ha^{-1}. The lowest nitrogen content was recorded in sample no: 21 Kovur village and the highest content was observed in sample no: 12 Yellayapalem village. Out of total soil samples collected 100 % soil samples are low in nitrogen content.

Table 4.1.2a: Classification of soil samples under different nitrogen range

Classes	Limit	No. of samples	% of samples
Low	<280	30	100
Medium	280-560	0	0
High	>560	0	0

The values for available phosphorus content in soil samples ranged from 27.03-46.68 Kg ha^{-1} with the average value of 37.76 Kg ha^{-1} with SD of 5.35± and CV of 0.31 Maximum value of phosphorus was recorded in sample no: 25 of Kovur village and the minimum value was observed in sample no: 29 of Kothur village. outof 30 soil samples collected, it was found that of soil samples were in medium range and were in high range in phosphorus content and majority of the samples of the study area are high in available phosphorus and can be consider suitable for crop production (table-4.1.2b)

Table 4.1.2b: Classification of soil samples under different phosphorus range

Classes	Limit	No. of samples	% of samples
Low	<12.5	0	0
Medium	12.5-25	0	0
High	>25	30	100

The values of available potassium content in soil samples ranged from 145.6-548.8 Kg ha^{-1} with the average value of 315.8 with SD of 99.2± and C.V of 0.31 %.

Maximum value of potassium was recorded in sample no:9 of Patur road and minimum was observed in sample no:12 of Yellayapalem village. Here 100 % of samples are in high potassium content.

Table 4.1.2c: Classification of soil samples under different potassium range

Classes	Limit	No. of samples	% of samples
Low	<135	0	0
Medium	135-335	20	66.6
High	>335	10	33.3

4.1.3 Status of available secondary macronutrients in the soil

The data examined on the secondary macronutrients of soil is given in the Table-4.1.3. and Appendix 5. The calcium content of soil samples ranged from 2.96- 32 Meq $100g^{-1}$ with the mean value of 15.07 Meq $100g^{-1}$ with SD of 7.84 ± and C.V of 0.52 %. Maximum value for calcium was recorded in sample no: 22 of Kovur and the minimum was observed in sample no: 5 of Gummaldibba village. The values of standard deviation and coefficient of variation for calcium were ±7.84 and 0.52 % respectively.100 % of soil samples were in high levels of calcium content were in (table-4.1.3a).

Table 4.1.3a: Classification of soil samples under different calcium range

Classes	Limit	No. of samples	% of samples
Low	<1.5	0	0
High	>1.5	30	100

The magnesium content of the soil samples ranged from 1.9-93 Meq 100 g^{-1} with the mean value of 39.7 Meq $100g^{-1}$. The values of standard deviation and coefficient of variation for magnesium were ±27.1 and 63.42 % respectively. Maximum value of magnesium was observed in sample no:6 of Patur road and minimum was observed in sample no: 21 of Kovur village. The data showed that the magnesium content of all the samples (100 %) were in high range (table -4.1.3b)

Table 4.1.3b: Classification of soil samples under different magnesium range

Classes	Limit	No. of samples	% of samples
Low	<1.0	0	0
High	>1.0	30	100

The sulphur content of soil samples ranged from 0.26-15.35 mg kg^{-1} with the average value of 7.22 mg kg^{-1}. The values of standard deviation and coefficient of variation for sulphur were ± 3.8 and 49.13 % respectively. Maximum value of sulphur was recorded in sample no:28 of Kothur village and minimum value was observed in sample no:4 of Patur village. 97 % of the soil samples were in low range of sulphur and only 2.5 % samples were in medium range (table-4.1.3c).

Table 4.1.3c: Classification of soil samples under different sulphur range

Classes	Limit	No. of samples	% of samples
Low	<10	24	80
Medium	10-20	6	20
High	>20	0	0

Table 4.1.3: Statistical data on secondary macronutrients of soil

Soil parameters	Range	Mean	SD±	C.V (%)
Calcium (Meq $100g^{-1}$)	2.96-32	15.07	7.84	75.8
Magnesium (Meq $100g^{-1}$)	1.9-93	39.7	27.1	63.42
Sulphur mg kg^{-1}	0.26-15.35	7.22	3.8	49.73

4.1.4 Status of Available micronutrients Viz. Fe, Mn, Zn and Cu in soil

The data examined on available micronutrients of soil is given in the table-4.1.4 and Appendix 5. use of harmful fertilizer and high yielding varities under intensive cropping system leads to micronutrient deficiency in soil. Therefore, it is important to monitor the concentration of micronutrients (Fe, Mn, Zn and Cu) in soil. The DTPA-iron content in the soil samples ranged from 0.21-6.1 mg kg^{-1} with an average value of 1.37 mg kg^{-1}. Maximum Fe content was recorded in sample no: 6 of Patur road while the minimum was observed in sample no: 22 of Yellayepalem village. The values of standard deviation and coefficient of variation of iron were 89

% of soil samples were in high concentration of iron and 11 % of soil samples are in low concentration of iron (table- 4.1.4a).

Table 4.1.4a: Classification of soil samples under different Iron range

Available Fe (mg kg^{-1})		No. of samples	% of samples
Deficient	<4.50	26	86.6
Sufficient	4.50-9	4	13.4
High level	>9	0	0

The DTPA- manganese content in soil samples ranged from 0.12-4.7 mg kg^{-1} with a mean value of 1.37 mg kg^{-1}. Maximum content was observed in sample no: 9 of Yellayapalem village while minimum was observed in sample no:22 of Kovur village. The values of standard deviation and coefficient of variation were 1.07 ± and 7.8 % respectively. It was found that 100 % of samples were deficient in Mn content (as per critical limit suggested by Lindsay and Norvell, 1978).

Table 4.1.4b: Classification of soil samples under different manganese range

Available Mn (mg kg^{-1})		No. of samples	% of samples
Deficient	<3.5	29	96.6
Sufficient	3.5-7.0	1	3.3
High level	>7.0	0	0

The DTPA- Zn content in soil samples ranged from 0.04-0.89 mg kg^{-1} with a mean value of 0.37 mg kg^{-1}. Maximum content was observed in sample no: 21 of Kovur village while minimum was observed in sample no:13 of Yelayelpalem village. The values of standard deviation and coefficient of variation were 0.21± and 5.8 % respectively. It was found that 100 % of samples were deficient in Zn content (table-4.1.4c).

Table 4.1.4c: Classification of soil samples under different Zinc range

Available Zn (mg kg^{-1})		No. of samples	% of samples
Deficient	<0.60	25	83.3
Sufficient	0.60-1.2	5	16.6
High level	>1.2	0	0

The DTPA- Cu content in soil samples ranged from 0.13-3.67 mg kg^{-1} with a mean value of 0.38 mg kg^{-1}. Maximum content was observed in sample no:1 of Gummalididibba village while minimum was observed in sample no:20 of yellayelpalem village. The values of standard deviation and coefficient of variation were 0.65± and 16.9 % respectively. It was found that 30 % of samples were deficient in Cu content (table-4.1.4d).

Table 4.1.4d: Classification of soil samples under different copper range

Available Cu (mg kg^{-1})		No. of samples	% of samples
Deficient	<0.20	18	60
Sufficient	0.20-0.40	12	40
High level	>0.40	0	0

Table 4.1.4: Statistical data on available micronutrients of soil

Soil parameters	Range	Mean	SD±	C.V (%)
Available Fe (mg kg^{-1})	0.21-6.1	1.6	1.7	102
Available Mn (mg kg^{-1})	0.12-4.7	1.37	1.07	7.8
Available Zn (mg kg^{-1})	0.04-0.89	0.37	0.21	5.8
Available Cu (mg kg^{-1})	0.13-3.67	0.38	0.65	16.9

4.1.5 Soil nutrient Index

To compare the levels of soil fertility in different areas, a single value for each nutrient has to be calculated using the nutrient index proposed by Parker *et al.* (1951). The nutrient index is a three-tiered system for determining soil fertility based on the percentage of samples in each of the three classifications (low, medium, and high). The nutrient index values of Kovur block were low of Nitrogen, phosphorus, zinc, manganese and iron, medium for potassium and organic carbon and copper (table 4.1.5).

Table 4.1.5: Nutrient index values of Kovur block in Nellore district of Andhra Pradesh.

S.No	Available nutrient	Nutrient index values	Category
1	Nitrogen	1	Low
2	Phosphorus	3	High
3	Potassium	2.3	Medium
4	Sulphur	1.2	Low
5	Organic carbon	2.2	Medium

4.1.5 Correlation Matrix between Physico-chemical Properties of Soil of Different Villages of Kovur Block of Nellore District, Andhra Pradesh.

Table 4.1.5 displays the data of the correlation matrix between soil physico-chemical parameters.

The bulk density of the soil were found positive with non-significantly correlated with Porosity (r = 0.162), Organic Carbon (r = 0.044) and Nitrogen (r = -0.097) of the soil. The BD of soils is negatively non-significant related with Phosphorus (r = -0.059), Water holding capacity (r = -0.004), and Magnesium (r = - 0.007).

The particle density was found positive and non-significant related with Porosity (r = 0.189), calcium (r =0.059) and sulphur (r = 0.239) of soil. It is negative non-significantly related to Organic Carbon (r = -0.187), Nitrogen (r = -0.014), Phosphorus (r = -0.049) of soil

The porosity of soil was observed negative and highly significantly correlated with Nitrogen (r = -0.401*) of soil. It is positively non-significant with WHC (r=0.021), Potassium (r = 0.202) and OC (r = 0.147) of soil whereas negatively non- significant with Phosphorus (r = -0.049), and calcium (r= -0.205).

The WHC of soil was found positive non-significant related with OC (r= 0.334) phosphorus (r= 0.334) and potassium (r = 0.252) of soil while negatively non-significant with nitrogen (r = -0.260), magnesium (r = -0.122) and sulphur (r= -0.122) of soil.

The pH of soil was observed positive and strongly significant related with porosity (r =0.395) of soil. It is positively non-significant related with particle density (r =0.015), potassium (r =0.19), magnesium (r =0.179) and sulphur (r =0.32) of soil whereas it is negatively non-significant with EC (r=-0.33), BD (r=-0.03), WHC (r=-0.012), OC (r=0.09), Nitrogen (r=-0.20), phosphorus (r=-0.12) and calcium (r=-0.24) of soil.

The EC of soil was positively non-significant related with PD (r=0.220), porosity (r=0.39), Nitrogen (r=0.119) and Calcium (r=0.313) of soil while it is negatively non-significant with Phosphorus (r = -0.101), Sulphur (r = -0.295), BD(r=-0.31), WHC(r=-0.172), OC(r=0.041) and Potassium (-0.011) of soil.

The organic carbon of soil was positively significant with potassium (r = 0.505*) of soil. It is positively non-significant related with Nitrogen (r=0.102), phosphorus (r = 0.139) of soil while negatively non-significant with Magnesium (r = -0.214) of soil.

The primary macronutrients of soil i.e, Nitrogen in soils of Kovur block was found negative significant related to Potassium (r = 0.141**) and significantly related with calcium (r = 0.03*) of soil. It is positively non-significant related with Phosphorus (r = 0.163), magnesium (r=0.251) and sulphur (r=0.062) of soil.

Phosphorus of soil was positively non-significant related with Calcium (r = 0.077), potassium (r=0.033) and Sulphur (r = 0.006) of soil whereas it is negatively non-significant with Magnesium (r = -0.278) of soil.

Potassium of soil was positively non-significant related with Magnesium (r = 0.238) of soil while it is negatively non-significant with Calcium (r = -0.212) and Sulphur (r = 0.091) of soil.

The secondary macronutrients i.e, Calcium of soil was found negative and non-significantly related to Magnesium (r = -0.217) and positively non-significant related with Sulphur (r = 0.093) of soil. Magnesium of soil was positively non- significant related with Sulphur (r = 0.114) of soil.

Table 4.1.5a: Correlation between soil physico-chemical properties of Kovur Block, Nellore district of Andhra Pradesh

	pH	*E.C*	*B.D*	*P.D*	*porosity*	*WHC*	*OC*	*N*	*P*	*K*	*Ca*	*Mg*	*S*	*Cu*	*Mn*	*Fe*	*Zn*
pH	1																
E.C	-0.338	1															
B.D	-0.034	-0.3127	1														
P.D	0.0156	0.2204	0.2143	1													
porosity	0.3957*	-0.1941	0.162	0.1897	1												
WHC	-0.103	-0.172	-0.004	-0.003	0.021	1											
OC	-0.098	-0.0416	0.0442	-0.187	0.147	0.034	1										
N	-0.202	0.1192	0.0978	-0.014	-0.401*	-0.206	0.1026	1									
P	-0.129	-0.1017	-0.059	-0.049	-0.266	0.334	0.1395	0.1639	1								
K	0.1985	-0.0112	0.1897	-0.123	0.202	0.252	0.5059*	-0.141	0.0335	1							
Ca	-0.246	0.3136	0.1346	0.059	-0.205	0.0032	-0.0167	-0.037	0.0779	-0.009	1						
Mg	0.1793	0.0056	-0.007	-0.217	0.2193	-0.1225	0.2143	0.2514	-0.273	0.2385	-0.2171	1					
S	0.3282	-0.2956	0.0274	0.123	0.2396	-0.1227	-0.0338	0.0624	0.0007	-0.091	0.03952	0.1447	1				
Cu	0.0187	-0.1472	-0.014	-0.444*	0.0696	-0.2532	0.3002	-0.069	0.0716	0.1657	-0.0796	0.0191	0.06715	1			
Mn	0.0988	-0.0654	-0.202	-0.166	0.3069	0.1051	0.2959	0.2198	0.3026	0.3279	-0.2897	0.2483	-0.0372	-0.0103	1		
Fe	-0.164	0.0575	0.1405	-0.172	-0.0152	-0.009	0.2039	0.1893	-0.139	0.1283	-0.1509	0.1228	-0.1646	0.2127	-0.0888	1	
Zn	-0.113	0.3238	0.0668	0.2296	0.0608	-0.009	-0.3453	-0.042	-0.112	0.1865	0.22063	0.0291	0.23846	-0.0827	-0.0865	-0.2947	1

4.2 Analysis of water parameters

4.2.1 Water quality parameters of Kovur block

The data on the water quality parameters of Kovur block is given in table-4.2 and Appendix-6.

4.2.1.1 pH and EC

The pH values of the water samples ranged from 6.4-8.4 with the mean value of 7.08 maximum value of pH was recorded in sample no:17 of Rajupalem village and minimum was observed in sample no:03 of Patur village. The values of SD-0.55± and CV of 0.07 % for pH were respectively. It was found that 96.6 % of water samples are suitable in nature.

Table 4.2.1.1a: Classification of water samples under different pH range.

Classes	Limit	No. of samples	% of samples
Suitable	0-6.4	1	3.3
Moderately suitable	6.5-8.4	29	96.6
Not suitable	>8.5	0	0

The EC values of the water samples ranged from 0.614-1.278 dSm with a mean value of 0.846 dSm^{-1}. The values of SD and CV for EC were ±0.180 and 21.3 % respectively. Maximum EC of water samples was recorded in sample no: 1 of Gummaldibba village and the minimum was observed in sample no:19 of Rajupalem village. 0 % of samples are not suitable for irrigation (table- 4.2.1b). The Variation in electrical conductivity of water samples reflects the variation of total soluble salt concentration present in groundwater of the region and ultimately the salinity of the groundwater samples.

Table 4.2.1.1b: Classification of water sample under different EC range

Classes	Limit (dS m^{-1})	No. of samples	% of samples
Suitable	<0.7	8	26.6
Moderately suitable	0.7-3.0	22	73.3
Not suitable	>3.0	0	0

4.2.2 Cation status in Ground water

The data on cation status of ground water such as calcium, magnesium, and sodium are given in the Table-4.2.

4.2.2.1 Calcium and magnesium

The calcium plus magnesium content of water samples ranged from 10.22-27.63 Meq L^{-1} with a mean value of 18.89 Meq L^{-1}. Maximum concentration of Ca^{2+} & Mg^{2+} was recorded in sample no: 4 of Patur road village while the minimum was observed in sample no: 2 of Gummaldibba village. The values of SD 3.52± and CV 18.6 % were respectively. The maximum permissible limit for total hardness is 27.63 Meq L^{-1} (ICMR, 1975). It was found that 35% of the samples are in suitable range and 65 % of the samples are not suitable for irrigation purpose in terms of hardness.

4.2.2.2 Potassium

The potassium content in water samples ranged from 1 to 38 Meq L^{-1} with an average value of 7.83 Meq L^{-1}. The SD and CV values for K were8.39 ± and 107 % respectively. Maximum potassium concentration was recorded in sample no:1 of Gummaldibba village while minimum was observed in sample no: 19 of Rajupalem village. The maximum permissible limit of Potassium in irrigation water is 0-2 ppm (FAO, 1994). On the basis of this only 6 % of the samples are suitable for irrigation and 85.2 % of the samples are unsuitable for irrigation, Such results were also recorded by Nagaraju *et.al*. (2014).

4.2.2.3 Sodium

The values of sodium content in water samples ranged from 2.28-11.52 Meg L^{-1} with a mean value of 5.94 Meq L^{-1}. The values of SD and CV for Na were 2.19± and 36 % respectively. Maximum sodium concentration was recorded in sample No-26 of Kothur village while minimum was observed in sample no: 29, Kothur village. The maximum permissible limit of sodium in irrigation water is 3-9 Meq L^{-1}. On the basis of this 73 % of the samples are unsuitable for irrigation and only 27 % of the samples are moderately suitable for irrigation (table 4.2.24). The high concentration of sodium in water samples may be due leaching of sodium salt like halite during the movement of water through sediments (Etteicb *et al.*, 2017). Such results were also reported by Prakash *et al.* (2020).

Table 4.2.2.3: Classification of water samples under different Sodium range

Classes	Limit (dSm^{-1})	No. of samples	% of samples
Suitable	<3	3	10
Moderately suitable	3-9	24	80
Not suitable	>9	3	10

4.2.3 Anions status in ground water

The data on anion status such as Chloride, Carbonates and bicarbonates of ground water is given in the Table-4.2 and Appendix-8. The values of carbonate concentration in ground water samples of Kovur block ranged from 0.2 to 2.43 Meq L^{-1} with a mean value of 0.92 Meq L^{-1} Maximum concentration of CO_3^{2-} ms recorded in sample no:2 of Gummaldibba village. The carbonate concentration with value more than 0.1 Meq L^{-1} are not recommended for irrigation purpose (Ayers and Westcot, 1985). It was found that 100 % of the samples are more than permissible limit. The values of SD and CV for carbonate were +0.58 and 63 % respectively. The values of bicarbonate concentration in water samples ranged from 2.4-9.6 Meg L^{-1} with a mean value of 6.28 Meq L^{-1}. The values of SD and CV for bicarbonate were 2.15 ± and 34 % respectively. Maximum concentration of HCO, was recorded in sample no:19 of Rajupalem and and the minimum was observed in sample no:1 of Gummaldibba village. According to Ayers and Westcot, 1985 bicarbonate concentration with value more than 10 Meq L^{-1} are not recommended for irrigation purpose.

Table 4.2.3a: Classification of water samples under different alkalinity range

Classes	Limit	No. of samples	% of samples
Suitable	1.25	3	10
Moderately suitable	1.25 – 8.50	27	90
Not suitable	>8.50	0	0

The values of chloride concentration in water samples ranged from 4.4-20.16 Meq L^{-1} with average value of 13.5 Meq L^{-1}. The SD and CV value for chloride were3.97 ± and 29 % respectively. Maximum value of chloride concentration was recorded in sample no:6 of Patur village whereas the minimum was observed in sample no: 15 of Yellayapalem village. It was found that 53.3 % of the samples are in suitable range and 46.7 % of samples are in moderately suitable for irrigation.

Table 4.2.3b: Classification of water samples under different chloride range

Classes	Limit	No. of samples	% of samples
Suitable	<4	0	0
Moderately suitable	4 – 10	5	16.6
Not suitable	>10	25	83.3

(Source FAQ.org)

4.2.4 Irrigation water quality index

The data on irrigation water quality index such as SAR, RSC, PI, SSP and KR are given in the Table-4.2. Values of irrigation water quality index of water samples ranged from 163.28 to 290.69 with a mean value of 210.91. The values of SD and CV for IWQI were 33.03± and 15.92 % respectively. Maximum value of IWQI was recorded in sample no:13 of yellayapalem village whereas the minimum was observed in sample no: 28, kothur village. Out of total number of water samples 40 % of the samples are in poor range for irrigation, 60 % of the samples are under very poor range for irrigation, 0 % of the samples are unsuitable for irrigation (table-4.2.4a).

Table 4.2.4a: Classification of water samples under different IWQI range

WQI	Water quality status	No. of classes	% of samples
<50	Excellent	0	0
51 -100	Good	0	0
101 -200	Poor	12	40
201 -300	Very poor	18	60
>301	Unsuitable	0	0

(Source: Aher and Gaikwad, 2017)

4.2.4.1 Sodium adsorption ratio

The values of sodium absorption ratio ranged from 0.73-3.5 Meq L^{-1} with mean value of 1.93 Meq L^{-1}. The SD and CV values of SAR were 0.746 and 39.2 % respectively. Maximum value of SAR was recorded in sample no:26 of Kothur village and the minimum was observed in sample no: 19 of rajupalem village. The study reveals that, 86.6 % of samples are in very low hazard and 13.4 % are in low hazard. (table-4.2.4b).

Table 4.2.4.1a: Classification of water samples under different sodium adsorption ratio range

Classes	Limit	No. of samples	% of samples
S1(very low sodium hazard	0-3	26	86.6
S2(low sodium hazard)	3-6	4	13.4
S3(medium sodium hazard)	6-12	0	0
S4(high sodium hazard)	12-20	0	0
S5(very sodium hazard)	20-40	0	0

(Source: FAQ.org)

4.2.4.2 Soluble sodium percentage

The SSP percentage of water samples ranged from 10.69-41.23 Meq L^{-1} with a mean value of 23.8 Meq L^{-1}. The SD and CV values of SSP were +7.62 and 32.5 % respectively. Maximum value of SAR was recorded in sample no:2 of gummalididdba village and the minimum was observed in sample no: 28 of Kothur village. It was observed that, 94.2 % of the water samples are than permissible limit and hence, quality of water is not suitable for irrigation purpose in terms of SSP (table-4.2.4c).

Table 4.2.4.2a: Classification of water samples under different soluble sodium percentage ratio range

SSP	Class	No. of samples	% of samples
Excellent	<20	11	36.6
Good	20- 40	17	56.6
Permissible	40 -60	2	6.6
Doubtfull	60 -80	0	0
unsuitable	>80	0	0

4.2.4.3 Kelly's ratio

The Kelly's ratio of the water samples ranged from 0.7-0.12 with an average value of 0.32. The SD and CV values of KI were + 0.139 and 44.09 % respectively. Maximum value of SAR was recorded in sample no: 28 of Kothur village and the minimum was observed in sample no: 28, site: 2of rajupalem village. It was observed that, 100 per cent of the water samples are not of good quality and not suitable for irrigation purposes due to alkali hazards in the water (table-4.2.4d).

Table 4.2.4.3a: Classification of water samples under different range of Kelly's

Classes	Limit	No. of samples	% of samples
Good	<1.0	30	100
Not suitable	>1.0	0	0

(Source: Adhikary and Dash, 2012)

4.2.4.4 Permeability index

The range of permeability index (PI) in water samples ranged from 21.21-66.9 with 34.60 as a mean value. The values of SD and CV of the samples were 10.15 and 29.8 % respectively. Maximum value of Pl was recorded in sample no: 5 of village and the minimum was observed in sample no:4 of Patur village. It was found that %of samples are in moderately permissible limit and % of the samples are not in permissible range and regarded as unfit for irrigation (table-4.2.4e)

Table 4.2.4.4a: Classification of water samples under different permeability index range

Classes	Limit	No. of samples	% of samples
Excellent	<25	5	16.7
Good	25-75	25	83.3
Not suitable	>75	0	0

(Source: Doneen's, 1964)

4.2.4.5 Residual Sodium Bicarbonate

The RSC values of water samples ranged from -22.45to -0.73 Meq L^{-1} with a mean value of -11.68 Meq L^{-1}. The SD and CV values for RSC were +4.96 and -43.1 % respectively. Maximum value of RSC was recorded in sample no: 2 of Gummaldibba village while the lowest was observed in sample no: 12 of yellayalapalem village. It was observed that 90 % of water samples are more than permissible limit i.e., more than 2.25 Meq L^{-1} which indicates unsafe water quality, suggesting that, the water quality of the study area is not under safe limit for irrigation use (table- 4.2.4f).

Table 4.2.4.5a: Classification of water samples under different RSC range

Classes	Limit	No. of samples	% of samples
Low hazard	<1.25	30	100
Medium hazard	1.25-2.25	0	0
High hazard	>2.25	0	0

(Source: Doneen's, 1964)

Table 4.2: Statistical data on water parameters

	Mean	Range	S. D	C.V %
pH	7.08	6.4-8.4	0.55	7
EC	0.846	0.614-1.278	0.180	21.3
Ca^{2+} + Mg^{2+}	18.89	10.22-27.63	3.52	18.6
Ca^{2+}	8.54	5.8-15.6	2.34	27
K^{+}	7.83	1-38	8.39	107
Na^{+}	5.94	2.28-11.52	2.19	36
Cl^{-}	13.5	4.4-20.16	3.97	29
HCO_3^{-}	6.28	2.4-9.6	2.15	34
CO_3^{2-}	0.92	0.2-2.43	0.58	63
SAR	1.93	0.73-3.5	0.74	39.2
PI	34.6	21.1-66.9	10.15	29.8
KR	0.32	0.7-0.12	0.13	44.09
SSP	23.8	10.69-41.23	7.62	32.5
RSC	-11.68	-22.45 to-0.73	4.96	-43.1
IWQI	210.91	163.28-290.69	33.03	15.92

4.3 Correlation Matrix between Physico-Chemical Properties of Water of Different Villages in Kovur block of Nellore district, Andhra Pradesh

Table 4.3 displays the data of the correlation matrix between physico-chemical parameters of water.

pH of water samples was found positively significant correlated with Carbonate (r = 0.505**), SSP (r = 0.389*), KR (r = 0.388*). It is negatively non- significant correlated with EC (r = -0.139), Mg (r = -0.162), Calcium and Magnesium (r = -0.156) of soil. EC of water samples showed positively significant relation with potassium (r= 0.488*) while it is negatively strong significant relation with Bicarbonate (r = 0.555**). With positive non-significant with Calcium (r = 0.024) and magnesium (r =0.140) of soil.

Sodium content of water samples were positively significant related with SSP(r = 0.560*), KR (r = 0.563*), PI (r = -0.612*) and SAR (r = 0.900*) of soil. whereas negatively non-significant related with Bicarbonate (r = -0.083) of water samples.

Potassium of water samples showed strongly positively significant relationship with Carbonate IWQI (r = 0.480**) of water samples while negatively non-significant related with Sodium (r = -0.061) Chlorine (r = 0.091).

Calcium in water samples of Kovur block was found positively non-significant correlated with Potassium (r = 0.197) and Calcium and magnesium (r = 0.306) of water samples while it is negatively non-significant related with PI (r = -0.257) and SSP (r = -0.181), Bicarbonate (r = 0.261) , KR (r = -0.178) and SAR (r = -0.140) of water samples.

Bicarbonate in water samples was positively non-significant correlated with SAR (r = 0.020), KR (r = 0.100), SSP (r = 0.073) and of water samples while negatively significant related to IWQI (r = -0.534**) of water samples while positive significant PI (r = 0.402) of soil. Chlorine of water was negatively non- significant related with Carbonate (r = -0.128), SAR (r = -0.026) and negatively significant related to PI (r = -0.281).

SAR was positively strong significant related to PI (r =0.729**), SSP(r= 0.702**), KR (r = 0.627**) of samples. SSP of positively strong Significant KR (r = 0.99**), PI (r =0.674**) and positively non-significant IWQI (r = 0.138). KR is positively strong significant with PI (r = 0.705**).

Table 4.3a: Correlation between water physico-chemical properties of Kovur Block, Nellore district of Andhra Pradesh

	pH	***EC***	***calcium***	***magnesium***	***cal&mag***	***potassium***	***sodium***	***chloride***	***carbonate***	***bicarbonate***	***SAR***	***SSP***	***KR***	***PI***	***IWQI***
pH	1														
EC	-0.1399	1													
calcium	0.0141	0.0242	1												
magnesium	-0.1628	0.1408	-0.352	1*											
cal&mag	-0.1562	0.1593	0.3063	0.7832*	1										
potassium	0.1761	0.4881*	0.1971	0.0633	0.1953	1									
sodium	0.2545	-0.053	-0.108	0.0105	-0.0611	-0.0614	1								
chloride	-0.2354	0.063	-0.13	0.4839*	0.4057*	-0.0912	0.011	1							
carbonate	0.5055**	-0.009	0.271	-0.4547	-0.2825	0.034	0.1271	-0.1289	1						
bicarbonate	0.2673	-0.555**	-0.262	-0.2362	-0.414*	-0.3024	-0.083	-0.2072	0.2694	1					
SAR	0.2584	-0.022	-0.141	-0.219	-0.3161	-0.0655	0.9001*	-0.027	0.2323	0.0202	1				
SSP	0.3895*	0.0555	-0.181	-0.3801	-0.5066*	-0.1583	0.5601*	-0.0291	0.3452	0.0733	0.7026**	1			
KR	0.3882*	0.0409	-0.179	-0.3989	-0.5243*	-0.1399	0.5634*	-0.0336	0.399*	0.1009	0.7151**	0.9924**	1		
PI	0.3538	-0.206	-0.257	-0.4594	-0.6379*	-0.2855	0.6124*	-0.2817	0.4909**	0.4023*	0.7297**	0.6748**	0.7057**	1	
IWQI	-0.0472	0.9808	-0.006	0.173	0.1722	0.4806**	0.0392	0.1696	0.0444	-0.5343**	0.0639	0.1383	0.123	-0.142	1

Chapter V

SUMMARY AND CONCLUSION

A study was conducted on the topic ―**SOIL AND WATER QUALITY STATUS OF DIFFERENT VILLAGES IN KOVUR BLOCK OF NELLORE DISTRICT, ANDHRA PRADESH.**‖ to evaluate soil and water quality. The study took place between September and November of 2021. Six different villages in the Kovur mandal provided surface soil samples (0-15 cm) and groundwater samples for irrigation. The water and soil samples were treated before being delivered to the lab for analysis. Physico-chemical parameters of these materials were examined using traditional methods. A relationship between specific soil and water factors was also discovered. The investigation's key findings are as follows:

5.1 Analysis of Soil Parameters of Kovur Block

- The pH of soil samples was found in alkaline condition and its values ranged from 6.1-8.4 with an average value of 7.3.
- The value of Electrical Conductivity varied from 0.112-0.965 dS m^{-1} with an average value of 0.45 dS m^{-1}.
- Organic carbon concentrations in soil samples ranged from 0.25 to 1.97 per cent, with an average of 0.87 per cent. According to the findings, the soils of block have a high organic carbon concentration, with 73.3 per cent of the soil samples having a medium-high organic carbon level.
- The Bulk density and Particle densities of the soil samples ranged from 1.14-1.6 gm cm^{-3} & 2.19-2.91 gm cm^{-3} with a mean value of 1.34 and 2.56 gm cm^{-3}, respectively.
- The percentage of porosity in the soil samples analyzed ranged from 0 to 53.8 per cent, with an average value of 37.5 per cent. Soil samples' water holding capacity ranges from 31.57 to 49.32 per cent, with a mean of 41.2 per cent.

- The amount of nitrogen available in soil samples ranged from 12.5-213.24 Kg ha^{-1}, with an average of 90.73 Kg ha^{-1}. The results of this investigation demonstrate that soil samples are insufficient in accessible nitrogen, with 100 % of soil samples having low nitrogen concentration.
- Phosphorus availability in soil samples ranged from 27.03 to 46.68 Kg ha-1, with an average value of 37.76 Kg ha-1. The results of this investigation demonstrate that blocks are high in phosphorus content, with 100 % of the samples having high phosphorus content.
- Available potassium levels in soil samples ranged from 145.6 to 548.8 Kg ha-1, with an average of 315.8 Kg ha-1. The current analysis reveals that blocks have high potassium content, with 66.6 per cent of soil samples falling into the medium potassium range and 33.3 per cent falling into the high potassium range.
- The exchangeable Calcium content of the soil samples ranged from 2.96 to 32 Meq $100g^{-1}$, with an average of 15.07 Meq $100g^{-1}$. The current study found that blocks are high in calcium content, with 100 per cent of soil samples falling into this category.
- The exchangeable magnesium content of the soil samples ranged from 1.9 to 93 Meq $100g^{-1}$, with an average of 39.7 Meq 100g-1. Because 100 per cent of the soil samples were in the range of high magnesium content, the current analysis showed that blocks are sufficient in magnesium.
- Available Sulphur levels in soil samples ranged from 0.26 to 15.35 mg kg^{-1}, with an average of 7.22 mg kg^{-1}. The results of this investigation demonstrate that blocks are low in sulphur content, with 80 per cent of samples falling into the low category and 20 per cent falling into the medium range.

5.2.1 Analysis of Water Parameters of Kovur Block

- The pH of the water samples was mildly acidic to alkaline, with values ranging from 6.4 to 8.4 and an average of 7.08. The results of this study suggest that the water samples from the Kovur block are good and acceptable for irrigation, with 3.3 per cent of samples being suitable for irrigation and the remaining 96.6 per cent being moderately suitable for irrigation.

- Water samples Electrical Conductivity ranged from 0.28 to 4.45 dSm^{-1}, with a mean of 1.54 dSm^{-1}. The current analysis revealed that water quality in terms of EC is moderate for irrigation use, with 7.50 per cent of samples in the irrigation range, 87.50 per cent in the moderate irrigation range, and only 5 % of samples not appropriate for irrigation.
- The chloride concentration in Kovur block water was higher, ranging from 4.4 to 20.16 Meq L^{-1} with a mean of 13.5 Meq L^{-1}. The current findings revealed that the majority of water samples are unsuitable for irrigation, with 16.6 % of samples falling into the somewhat appropriate range and 83.3 per cent falling into the unsuitable category.
- Carbonate concentrations ranged from 0.2-2.43 Meq L^{-1}in water samples, while bicarbonate concentrations ranged from 2.4-9.6 Meq $L^{-1}$with a mean of 6.28 Meq L^{-1}. According to the findings, 100 per cent of the samples are not appropriate for irrigation.
- Calcium concentrations in water samples ranged from 5.8-15.6 Meq L^{-1}, with an average of 8.54 Meq L^{-1}, whereas Calcium plus Magnesium concentrations ranged from 10.22 to 27.63 Meq L^{-1}, with an average of 18.89 Meq L^{-1}.
- The potassium levels in the water samples ranged from 1 to 38 Meq L^{-1}, with an average of 7.83 Meq L^{-1}. According to the findings, all of the water samples tested were moderately appropriate for irrigation.
- Sodium levels in water samples ranged from 2.28 to 11.52 Meq L^{-1}, with an average of 5.94 Meq L^{-1}. The current findings revealed that the water quality of the Kovur block is relatively appropriate for irrigation purposes in terms of sodium content, with 10 % of water samples falling into the suitable range, 80 % falling into the moderately suitable range, and 10 % falling into the not suitable area.

- The range of IWQI of samples ranged from 144.69 to 754.66 with a mean of 373.29. The present investigation showed that 77.5 % of the samples are unsuitable for irrigation, 17.50 % of samples are in very poor range for irrigation and 5 % samples are under poor range for irrigation purpose.
- In water samples, the SAR value ranged from 0.73 to 3.5 Meq L^{-1}, with a mean of 1.93 Meq L^{-1}. The investigation found that 100 % of the samples werewithin allowed limits and belonged to class S1 (0-10 Meq L^{-1}), indicating that there is no sodium concern and that ground water samples are within an irrigation-safe range. In the water samples, the SSP, RSC, KR, and PI values ranged from 3.38 to 13.68, -23.80 to 16.20, 0.03 to 0.14, and 15.76 to 99.25, with a mean of 5.63, -3.06, 0.06, and 26.20, respectively.

CONCLUSIONS

Soil and water testing is a low-cost way to learn about a soil's and water's ability to support crop growth. Growers who understand what each soil and water test value implies can make better crop input decisions, reducing risk and increasing profitability.

To aid farmers in analyzing and supplementing lacking nutrients, the soil test results were analyzed utilizing literature. According to the foregoing findings, the soils of Kovur Block are acidic in nature, and crop salinity is not a problem. Using thestudy region's soil nutrient index, it was discovered that the soils of the Kovur block were low in accessible nitrogen and sulphur, high in phosphorus, medium in potassium and organic carbon. Deficient nutrients can be supplemented to prevent deficiency in crops and to improve the efficiency of other nutrients. The key to long- term soil fertility control is integrated nutrient management.

The current study also indicated that the groundwater utilized for irrigation in several villages in the Kovur block is slightly acidic to slightly alkaline in nature, making it ideal for irrigation. The water quality was judged to be moderately suitable for its use in terms of EC. The majority of the water samples had minimal sodium hazard, and all of the water samples had high alkalinity, making them unsuitable for irrigation. According to the water quality index, 40 per cent of water samples in Block were poor for irrigation, 60 per cent were very poor for irrigation, indicating that the overall water quality of Kovur Block was judged to be very low.

This conclusion suggests that further work is needed to improve irrigation water quality, especially through better agricultural practices. The knowledge and experience obtained from the project could be used to help farmers enhance food quality, increase yields through soil and water conservation, and improve environmental protection in the future.

BIBLIOGRAPHY

Acharya, S., Sharma, S. K., & Khandegar, V. (2018). Assessment of groundwater quality by water quality indices for irrigation and drinking in South West Delhi, India. *Data in brief*, *18*, 2019.

Adeleye, E. O., Ayeni, L. S., & Ojeniyi, S. O. (2010). Effect of poultry manure on soil physico-chemical properties, leaf nutrient contents and yield of yam (Dioscorea rotundata) on alfisol in southwestern Nigeria. *Journal of American science*, *6*(10), 871-878.

Alagumuthu, G., & Rajan, M. (2008). Monitoring of fluoride concentration in ground water of kadayam block of Tirunelveli district, India: Correlation with physico-chemical parameters. *Chem*, *1*(4), 757-765.

Bataiya, A. G., Muhammad, H., Ahmad, S. I., & Muazu, J. (2017). Analysis of Water Quality Using Physicochemical Parameters of Boreholes Water Taken from Areas around Dala Hills, Northwestern Nigeria. *American Journal of Water Science and Engineering*, *3*(6), 80..

Bhat, A. N., Bhat, A. A., Nath, S., Singh, P. B., & Guha, B. D. (2016). Assessment of drinking and irrigation water quality of surface water resources of South-West Kashmir, India. *J. Civ. Environ. Eng*, *6*, 222.

Bhatt, M., Singh, A. P., Singh, V., Kala, D. C., & Kumar, V. (2019). Long-term effect of organic and inorganic fertilizers on soil physico-chemical properties of a silty clay loam soil under rice-wheat cropping system in Tarai region of Uttarakhand. *Journal of Pharmacognosy and Phytochemistry*, *8*(1), 2113-2118.

Black, C. A. (Charles Allen) | American Society for Testing and Materials | *American Society of Agronomy* No 9.

Boman, B. J., Wilson, P. C., & Ontermaa, E. A. (2002). Understanding water quality parameters for citrus irrigation and drainage systems. *Univ. of Florida IFAS Extension, Circ*, *1406*.

Chaudhari, P. R., Ahire, D. V., Ahire, V. D., Chkravarty, M., & Maity, S. (2013). Soil bulk density as related to soil texture, organic matter content and available total nutrients of Coimbatore soil. *International Journal of Scientific and Research Publications*, *3*(2), 1-8.

Devojee, B., Nagababu, G., Kumar, M., Nandini, Y., & Hemakumar, H. V. (2018). Assessment and mapping of irrigation water quality index of Bapatla Mandal, Guntur District, Andhra Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*, *7*(1), 1914-1920.

Dirican, S. (2015). Assessment of water quality using physico-chemical parameters of Çamlıgöze Dam Lake in Sivas, Turkey. *Ecologia*, *5*(1), 1-7.

Eaton, F. M. (1950). Significance of carbonates in irrigation waters. *Soil science*, *69*(2), 123-134.

El Bilali, A., Taleb, A., & Brouziyne, Y. (2021). Comparing four machine learning model performances in forecasting the alluvial aquifer level in a semi-arid region. *Journal of African Earth Sciences*, *181*, 104244.

Ganorkar, R. P., Chinchmalatpure, P. G., & Ganorkar, R. P. (2013). Physicochemical assessment of soil in Rajura Bazar in Amravati district of Maharastra (India). *International Journal of Chemical, Environmental and Pharmaceutical Research*, *4*(2&3), 46-49.

Gehlot, Y., Aakash, R. G., Bangar, K. S., & Kirar, S. K. (2019). Nature of soil reaction and status of EC, OC and macro nutrients in Ujjain Tehsil of Andhra Pradesh. *IJCS*, 7(6): 1323-1326.

Ghosh, C., Mukherjee, M., & Biswas, K. (2020). Physico-chemical Properties of Soil of Jaldapara National Park in West Bengal, India. *International Journal of Advanced Research in Biological Sciences*, *7*(6), 141-150.

Herrington, T. M., & Jackson, R. J. (1973). Osmotic coefficients of aqueous potassium chloride solutions at 50 and 70° C. *Journal of the Chemical Society, Faraday Transactions 1: Physical Chemistry in Condensed Phases*, *69*, 1635-1647.

Ismail, M., & Umamahesh, M. An Investigation of Physico-Chemical Properties of Soil Samples in Pathikonda Region, Kurnool District-Andhra Pradesh, India.

Jyothi, V. S., Rani, P. P., Ramana, K. V., Prasad, P. R., & Rekha, M. S. Physico-chemical Properties and Soil Fertility Status of Maize Growing Areas of Krishna delta, Andhra Pradesh.

Kadam. P. M. and Balasaheb. U. K. (2016). Physicochemical Properties and its Relationship with Water Holding Capacity of Soil in Deulgaon Raja region Maharashtra. Science and Technology, 2(6): 49-52.

Kankal, N. C., Indurkar, M. M., Gudadhe, S. K., & Wate, S. R. (2012). Water quality index of surface water bodies of Gujarat, India. *Asian J. Exp. Sci*, *26*(1), 39-48.

Kelley, W. P. (1963). Use of saline irrigation water. *Soil science*, *95*(6), 385-391.

Khadka, D., Lamichhane, S., Thapa, B., Baral, B. R., & Adhikari, P. (2016). An assessment of soil fertility status of national maize research program, Rampur, Chitwan, Nepal. *Imperial Journal of Interdisciplinary Research*, *2*(5), 1798-1807.

Khan, F., Hayat, Z., Ahmad, W., Ramzan, M., Shah, Z., Sharif, M., ... & Hanif, M. (2013). Effect of slope position on physico-chemical properties of eroded soil. *Soil Environ*, *32*(1), 22-28.

Krishna Kumar, S., Hari Babu, S., Eswar Rao, P., Selvakumar, S., Thivya, C., Muralidharan, S., & Jeyabal, G. (2017). Evaluation of water quality and hydrogeochemistry of surface and groundwater, Tiruvallur District, Tamil Nadu, India. *Applied Water Science*, *7*(5), 2533-2544.

Kumar, A., Mishra, V. N., Srivastav, L. K., & Banwasi, R. (2014). Evaluations of soil fertility status of available major nutrients (N, P & K) and micro nutrients (Fe, Mn, Cu & Zn) in Vertisol of Kabeerdham District of Chhattisgarh, India. *International Journal of Interdisciplinary and Multidisciplinary Studies*, *1*(10), 72-79.

Kumar, K., Giri, A., Bharti, V. K., Kumari, P., Kumar, S., Bhardwaj, A. K., & Chaurasia, O. P. (2021). Soil Physico-Chemical Properties and Macronutrients Evaluation during Sowing and after Harvesting of Crop at High Altitude, Leh-Ladakh, India.

Kumar, N., & Sinha, D. K. (2010). Drinking water quality management through correlation studies among various physico-chemical parameters: A case study. *International journal of environmental sciences*, *1*(2), 253.

Kumar, S., Ghosh, N. C., Singh, R. P., Sonkusare, M. M., Singh, S., & Mittal, S. (2015). Assessment of water quality of lakes for drinking and irrigation purposes in Raipur City, Chhattisgarh, India. *Int. J. Eng. Res. Appl*, *5*(2), 42-49.

Kumar, V., Kumar, S., I Navsare, R., Singh, A., Kumar Maurya, P., P Dhyani, B., & P Shahi, U. (2021). Availability of N, P, K and Their Relationship between Organic Carbon under Sugarcane-Ratoon-Wheat Cropping System in Western Uttar Pradesh Provinces, India.

Kumarasamy, P., Dahms, H. U., Jeon, H. J., Rajendran, A., & Arthur James, R. (2014). Irrigation water quality assessment—an example from the Tamiraparani river, Southern India. *Arabian Journal of Geosciences*, *7*(12), 5209-5220.

Lelago, A., Mamo, T., Haile, W. and Shiferaw, H., (2016). Assessment and mapping of status and spatial distribution of soil macronutrients in Kambata Tembaro zone, Southern Ethiopia. *Advances in Plants and Agriculture Research*, *4*(4), 305-317.

Lindsay, W. L., & Norvell, W. (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil science society of America journal*, *42*(3), 421-428.

Lingaswamy, M., & Saxena, P. R. (2015). Water quality of fox Sagar Lake, Hyderabad, Telangana State, India, its suitability for irrigation purpose. *Int. J. Adv. Res. Sci. Technol*, *4*(8), 490-494.

Lokhande, R. S., Singare, P. U., & Pimple, D. S. (2011). Study on physico-chemical parameters of waste water effluents from Taloja industrial area of Mumbai, India. *International Journal of Ecosystem*, *1*(1), 1-9.

Magadum, A., Patel, T., & Gavali, D. (2017). Assessment of physicochemical parameters and water quality index of Vishwamitri River, Gujarat, India. *International Journal of Environment, Agriculture and Biotechnology*, *2*(4), 238820.

Mandal, S. K., Dutta, S. K., Pramanik, S., & Kole, R. K. (2019). Assessment of river water quality for agricultural irrigation. *International Journal of Environmental Science and Technology*, *16*(1), 451-462.

Manjare, S. A., Vhanalakar, S. A., & Muley, D. V. (2010). Analysis of water quality using physicochemical parameters Tamdalge tank in Kolhapur district, Maharashtra. *International journal of advanced biotechnology and research*, *1*(2), 115-119.

Mauriya, A. K., Maurya, V. K., Tripathi, H. P., Verma, R. K., & Shyam, R. (2013). Effect of site-specific nutrient management on productivity and economics of rice (Oryza sativa)–wheat (Tritucum aestivum) system. *Indian Journal of Agronomy*, 58(3): 282-287.

Mishra, G., Giri, K., Jangir, A., Vasu, D., & Comino, J. R. (2021). Understanding the effect of shifting cultivation practice (slash-burn-cultivation-abandonment) on soil physicochemical properties in the North-eastern Himalayan region. *Investigaciones Geográficas (España)*, (76), 243-261.

Mohan, M. M., Krishna, T. G., Naidu, M. V. S., Reddy, G. P., & Ramana, K. V. Classification and Mapping of Rice Growing Soils in Tirupati Division of Chittoor District of Andhra Pradesh Using ArcGIS.

Mohan, U., Singh, R., & Singh, P. (2013). Water quality assessment and physicochemical parameters of groundwater in District Hapur, Uttar Pradesh, India. *Environment Conservation Journal*, *14*(3), 143-149.

Narsaiah, E., Ramprakash, T., Chandinipatnaik, M. and Reddy, V., (2018). Soil physical and physico-chemical properties of soils of Jangon district in Telangana state. *Journal of Pharmacognosy and Phytochemistry*, *7*(6), pp.2820-2827.

Nayak, S.B., Balaguravaiah, D., Ramana, K.V., Giridharakrishna, T., Munirathnam, P. and Reddy, B.R., (2019). Spatial variability of soil physical and Physico-chemical properties of Kurnool division of Andhra Pradesh. *Journal of Pharmacognosy and Phytochemistry*, *8*(4), pp.427-429.

Pandey, S. K., & Tiwari, S. (2009). Physico-chemical analysis of ground water of selected area of Ghazipur city-A case study. *Nature and Science*, *7*(1), 17-20.

Parker, F. W., Nelson, W. L., Winters, E., & Miles, I. E. (1951). The broad interpretation and application of soil test information. *Agronomy Journal*, *43*(3), 105-112.

Patidar, N. K., Patidar, R. K., Rajput, A., Sharma, S. K., & Thakur, R. (2017). Evaluation of basic properties of soil and major nutrient in soils of Jhabua district of Madhya Pradesh. *International Journal of Agriculture, Environment and Biotechnology*, *10*(1), 45.

Rajeshwar, M., & Khan, M. A. A. (2007). Physico-chemical and nutrient status of forests soils of Nizamabad, India. *Asian Journal of Soil Science*, *2*(2), 44-47.

Ramana, Y. V., Jat, L. K., Meena, S. K., Singh, L., Jatav, H. S., & Paul, A. (2015). Available Macro Nutrient Status and their Relationship with Soil Physico-Chemical Properties of Sri Ganganagar District of Rajasthan, India. *Journal of Pure and Applied Microbiology*, *9*(4), 2887-2894.

Ramanaiah, S. V., Mohan, S. V., Rajkumar, B., & Sarma, P. N. (2006). Monitoring of fluoride concentration in ground water of Prakasham district in India: correlation with physico-chemical parameters. *Journal of Environmental science and Engineering*, *48*(2), 129.

Rao, V. P. (2014). Physico-chemical analysis of mangrove soil in the Machilipatnam coastal region, Krishna District, Andhra Pradesh. *International Journal of Engineering Research*, *3*(6).

Raut Bhakti, V., Vaidya, K. P., Biradar, S. U., & More, S. S. (2021). Effect of integrated nutrient management on soil properties after harvest of lablab bean (Lablab purpureus) in Alfisols of Konkan region of Maharashtra.

Reddy, G. K., Sharma, S. H. K., Jayasree, G., Hussain, S. A., Triveni, S., & Neelima, T. L. (2021). Assessment of spatial variability of soil fertility status of Nagarjuna Sagar Left Bank command area in Nalgonda district, Telangana using GIS-GPS.

Richards, L. A. (1954). *Diagnosis and improvement of saline and alkali soils* (Vol. 78, No. 2, p. 154). LWW.

Sajil Kumar, P. J., & James, E. J. (2013). Physicochemical parameters and their sources in groundwater in the Thirupathur region, Tamil Nadu, South India. *Applied Water Science*, *3*(1), 219-228.

Sajitha, V., & Vijayamma, S. A. (2016). Study of physico-chemical parameters and pond water quality assessment by using water quality index at Athiyannoor Panchayath, Kerala, India. *Emer Life Sci Res*, *2*(1), 46-51.

Saravanakumar, K., & Kumar, R. R. (2011). Analysis of water quality parameters of groundwater near Ambattur industrial area, Tamil Nadu, India. *Indian Journal of Science and Technology*, *4*(5), 660-662.

Sashikala, G., Naidu, M. V. S., Ramana, K. V., Nagamadhuri, K. V., Reddy, A. P. K., Sudhakar, P., & Krishna, T. G. (2021). Mapping of nutrients status in tatrakallu village of anantapuramu district of andhra pradesh using geographic information system. *Journal of the Indian Society of Soil Science*, *69*(2), 133-141.

Schollenberger, C. J., & Simon, R. H. (1945). Determination of exchange capacity and exchangeable bases in soil—ammonium acetate method. *Soil science*, *59*(1), 13-24.

Schollenberger, C. J., & Simon, R. H. (1945). Determination of exchange capacity and exchangeable bases in soil—ammonium acetate method. *Soil science*, *59*(1), 13-24.

Seth, R., Mohan, M., Singh, P., Singh, R., Dobhal, R., Singh, K. P., & Gupta, S. (2016). Water quality evaluation of Himalayan rivers of Kumaun region, Uttarakhand, India. *Applied Water Science*, *6*(2), 137-147.

Shah, S. M., & Mistry, N. J. (2013). Groundwater quality assessment for irrigation use in Vadodara district, Gujarat, India. *International Journal of Agricultural and Biosystems Engineering*, *7*(7), 719-724.

SHArMA, V., & Walia, Y. K. (2015). Water quality assessment using physico-chemical parameters and heavy metals of Gobind Sagar lake, Himachal Pradesh (India). *Curr World Environ*, *10*(3), 161-166.

Shrivastava, S., & Kanungo, V. K. (2013). Physico-chemical analysis of pond water of Surguja district, Chhattishgarh, India. *International Journal of Herbal Medicine*, *1*(4), 35-43.

Simpi, B., Hiremath, S. M., Murthy, K. N. S., Chandrashekarappa, K. N., Patel, A. N., & Puttiah, E. T. (2011). Analysis of water quality using physico-chemical parameters Hosahalli Tank in Shimoga District, Karnataka, India. *Global Journal of Science Frontier Research*, *11*(3), 31-34.

Singh, G., Kaur, K., & Meetei, T. T. (2021). Effect of in stubble burning on physico chemical properties of soil, yield and environmental qualities.

Singh, K., Mishra, A. K., Singh, B., Singh, R. P., & Patra, D. D. (2016). Tillage effects on crop yield and physicochemical properties of sodic soils. *Land degradation & development*, *27*(2), 223-230.

Singh, M. K., Jha, D., & Jadoun, J. (2012). Assessment of physico-chemical status of groundwater samples of Dholpur District, Rajasthan, India. *International journal of Chemistry*, *4*(4), 96.

Singh, R. P., & Mishra, S. K. (2012). Available macro nutrients (N, P, K and S) in the soils of Chiraigaon block of district Varanasi (UP) in relation to soil characteristics. *Indian Journal of Scientific Research*, 97-101.

Singh, Y. V., Jat, L. K., Meena, S. K., Singh, L., Jatav, H. S., & Paul, A. (2015). Available macro nutrient status and their relationship with soil physico-chemical properties of Sri Ganganagar district of Rajasthan, India. *Journal of Pure and Applied Microbiology*, *9*(4), 2887-2895.

Srinidhi, P., Singh, Y.V., Sharma, P.K., Singh, R.K., Latare, A.M., Srinath, I. and Yogesh, Y.C., (2020). Physico-chemical analysis of soils in Madanapalle block, Chittor district of Andhra Pradesh. *IJCS*, *8*(3), pp.154-158.

Sudhakaran, S., Mahadevan, H., Arun, V., Krishnakumar, A. P., & Krishnan, K. A. (2020). A multivariate statistical approach in assessing the quality of potable and irrigation water environs of the Netravati River basin (India). *Groundwater for Sustainable Development*, *11*, 100462.

Sujitha, P. C., Dev, D. M., Sowmya, P. K., & Priya, R. (2011). Physico-chemical parameters of Karamana river water in Trivandrum district, Kerala, India. *International journal of environmental sciences*, *2*(2), 472-490.

Supriya, V. V., Swaroop, N., David, A. A., & Kumar, T. (2021). Assessment of physical properties of soil from different blocks of Guntur district, Andhra Pradesh, India.

Todd, D. K., & Mays, L. W. (1980). Groundwater Hydrology. John Willey & Sons. *Inc., New York, 535*.

Umeri, C., Onyemekonwu, R. C., & Moseri, H. (2017). Evaluation of physical and chemical properties of some selected soils in mangrove swamp zones of Delta State, Nigeria. *Archives of Agriculture and Environmental Science*, *2*(2), 92-97.

Vilakar, K., Sharma, S. H. K., Ravi, P., Rao, P. M., & Revathi, P. (2021). Soil fertility status of sesame growing soils of Northern Telangana zone.

Wagh, G. S., Chavhan, D. M., & Sayyed, M. R. G. (2013). Physicochemical Analysis of Soils from Eastern Part of Pune City. *Universal Journal of Environmental Research & Technology*, *3*(1).

Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil science*, *37*(1), 29-38.

Yadav, K. K., Gupta, N., Kumar, V., Arya, S., & Singh, D. (2013). Physico-chemical analysis of selected ground water samples of Agra city, India. *Recent Research in Science and Technology*, *4*(11).

Yavanika, P., Madhuri, K. V. N., Giridhara Krishna, T., & Maheshwara Reddy, P. (2021). Soil physical and physico-chemical properties under major cropping systems of Chittoor district, Andhra Pradesh.

APPENDICES

Appendix 1: Status of Bulk density, Particle density, Porosity and WHC in soil

Sample No.	**Bulk density (gm cm^{-3})**	**Particle density (gm cm^{-3})**	**Porosity (%)**	**Water Holding Capacity (%)**
S1	1.36	2.21	38.4	36.02
S2	1.25	2.5	50	34.1
S3	1.43	2.37	39.6	43.72
S4	1.43	2.36	39.4	42.52
S5	1.27	2.22	42.7	46.5
S6	1.35	2.7	50	40.66
S7	1.6	2.69	40.5	42.11
S8	1.24	2.46	49.5	42.55
S9	1.27	2.31	45	46.27
S10	1.34	2.71	50.5	45.37
S11	1.36	2.61	47.8	38.12
S12	1.32	2.48	0	40.96
S13	1.37	2.82	0	37.51
S14	1.25	2.71	53.8	45.24
S15	1.27	2.71	53.1	49.32
S16	1.36	2.64	48.4	36.29
S17	1.29	2.54	0	41.26
S18	1.5	2.67	43.8	43.44
S19	1.33	2.58	48.4	41.66
S20	1.37	2.65	0	39.42
S21	1.33	2.76	51.8	45.26
S22	1.31	2.19	0	46
S23	1.14	2.57	0	42.09
S24	1.42	2.63	46	45.47
S25	1.44	2.91	50.5	48.92
S26	1.38	2.58	46.5	34.37
S27	1.36	2.71	49.8	36.24
S28	1.27	2.64	51.8	31.57
S29	1.39	2.41	42.3	38.73
S30	1.41	2.61	45.9	36.75
Mean	**1.34**	**2.56**	**37.5**	**41.2**
Range	**1.14-1.6**	**2.19-2.91**	**0-53.8**	**31.57-49.32**
SD	**0.08**	**0.18**	**19.5**	**4.56**
CV	**6**	**7**	**51**	**11**

Appendix 2: Status of available pH, EC and organic carbon in soil

Sample No.	pH	Electrical Conductivity (ds/m)	Organic Carbon (%)
S1	7.5	0.1772	1.425
S2	7.7	0.674	1.35
S3	6.8	0.376	0.975
S4	6.7	0.1511	0.375
S5	8.1	0.3651	0.9
S6	6.2	0.863	1.42
S7	7.6	0.151	1.2
S8	7.5	0.719	0.675
S9	8.4	0.128	1.35
S10	6.9	0.112	1.97
S11	7.9	0.224	0.675
S12	6.1	0.586	0.45
S13	7.8	0.146	0.52
S14	7.6	0.376	0.6
S15	7.9	0.511	0.9
S16	6.8	0.651	0.975
S17	6.1	0.772	0.97
S18	8.2	0.673	1.275
S19	8.2	0.256	1.05
S20	7	0.917	0.75
S21	6.4	0.832	0.825
S22	6.1	0.212	1.35
S23	7.5	0.965	0.37
S24	7.8	0.201	0.225
S25	7.2	0.272	0.375
S26	7.6	0.665	1.425
S27	7.8	0.641	0.675
S28	8.2	0.257	0.45
S29	8.4	0.283	0.3
S30	6.7	0.595	0.375
Mean	**7.3**	**0.45**	**0.87**
Range	**6.1-8.4**	**0.112-0.965**	**0.25-1.97**
SD	**0.72**	**0.27**	**0.43**
CV	**9**	**59**	**5**

Appendix 3: Status of available primary macronutrient in soil

Sample No.	Nitrogen (kg/hac)	Phosphorus (kg/hac)	Potassium (kg/hac)
S1	50.176	39.61	358.4
S2	112.89	38.04	324.8
S3	200.7	43.07	302.4
S4	25.08	40.08	190.4
S5	12.54	31.12	425.6
S6	163.07	32.22	313.6
S7	100.35	34.11	515.2
S8	37.63	40.87	369.6
S9	112.89	44.01	548.8
S10	100.35	40.87	380.8
S11	87.8	40.87	302.4
S12	213.24	38.98	145.6
S13	137.98	37.09	212.8
S14	50.17	44.01	268.8
S15	12.54	38.04	246.4
S16	21.5	30.8	448
S17	150.52	39.92	403.2
S18	137.98	45.58	470.4
S19	137.98	33.79	280
S20	87.8	45.58	324.8
S21	12.54	31.21	369.6
S22	75.26	44.64	235.2
S23	125.44	38.04	268.8
S24	37.63	30.8	291.2
S25	50.17	46.68	291.2
S26	87.8	31.28	268.8
S27	62.72	33.79	201.6
S28	87.8	36.78	179.2
S29	100.35	27.03	324.8
S30	150.52	33.95	212.8
Mean	**90.73**	**37.76**	**315.8**
Range	**12.5-213.24**	**27.03-46.68**	**145.6-548.8**
SD	**56.06**	**5.35**	**99.2**
CV	**61**	**14**	**31**

Appendix-4: Status of available secondary macronutrients in soil

Sample No.	Calcium (me/100g)	Magnesium (me/100g)	Sulphur (mg/kg)
S1	9.7	38	8.41
S2	12.8	24.8	7.08
S3	21.3	42.1	9.56
S4	5.4	25.3	0.26
S5	2.96	87	5.07
S6	16.8	93	3.8
S7	17.34	11.8	8.39
S8	26.7	16.9	11.33
S9	3.6	72.8	5.62
S10	8.4	66.7	12.3
S11	5.7	29.1	5.54
S12	11.6	16	1.196
S13	7.7	2.9	7.59
S14	7	17.8	6.8
S15	14.6	5.9	2.196
S16	23.5	37	2.9
S17	22.9	41.2	1.21
S18	18.3	43.9	5.57
S19	7.8	68.4	14.7
S20	21	49.2	7.74
S21	9.4	1.9	5.98
S22	32	6.7	8.33
S23	16	37	7.52
S24	19.5	29	11.96
S25	24.8	37	9.28
S26	18.7	69	4.73
S27	26.1	8.9	7.58
S28	13.2	52	15.35
S29	21.7	89	7.05
S30	5.7	73.5	11.7
Mean	**15.07**	**39.7**	**7.22**
Range	**2.96-32**	**1.9-93**	**0.26-15.35**
SD	**7.84**	**27.1**	**3.8**
CV	**52**	**68**	**52**

Appendix-5: Status of available Micronutrients in soil

Sample No.	**Cu (Mg kg^{-1})**	Mn **(Mg kg^{-1})**	**Fe (Mg kg^{-1})**	**Zn (Mg kg^{-1})**
S1	3.67	0.24	3.5	0.25
S2	0.72	3.2	2.7	0.16
S3	0.91	2.8	1.8	0.34
S4	0.143	2.6	0.84	0.16
S5	0.15	0.72	5.5	0.17
S6	0.369	2.3	6.1	0.2
S7	0.186	0.35	5.4	0.39
S8	0.495	2.8	2.3	0.43
S9	0.575	4.7	0.34	0.48
S10	0.144	2.4	0.58	0.14
S11	0.163	1.2	1.08	0.09
S12	0.183	0.37	4.9	0.35
S13	0.139	1.1	1.3	0.04
S14	0.184	1.9	1.5	0.2
S15	0.135	0.95	0.74	0.12
S16	0.72	1.09	0.54	0.61
S17	0.15	1.7	0.21	0.58
S18	0.16	1.9	0.73	0.54
S19	0.27	1.5	1.2	0.35
S20	0.13	0.36	1.83	0.44
S21	0.19	0.87	0.64	0.89
S22	0.21	0.12	0.72	0.19
S23	0.27	0.69	0.34	0.53
S24	0.15	0.19	0.26	0.54
S25	0.14	0.72	1.21	0.62
S26	0.18	0.59	0.64	0.12
S27	0.16	0.39	0.95	0.38
S28	0.18	1.24	0.61	0.72
S29	0.24	0.96	0.38	0.43
S30	0.26	1.37	0.97	0.68
Mean	**0.38**	**1.37**	**1.6**	**0.37**
Range	**0.13-3.67**	**0.12-4.7**	**0.21-6.1**	**0.04-0.89**
SD	**0.65**	**1.07**	**1.7**	**0.21**
CV	**16.9**	**7.8**	**102**	**5.8**

Appendix 6: Status of available pH and EC in Water

Sample No.	Water pH	Water EC (dS/m^2)
S1	7.5	1.278
S2	7.3	0.760
S3	6.4	1.150
S4	7.6	0.830
S5	7.4	0.940
S6	6.5	0.695
S7	7.5	0.817
S8	8.2	0.660
S9	6.8	0.870
S10	6.5	0.690
S11	7.8	0.830
S12	6.9	1.065
S13	6.8	1.218
S14	8.1	0.762
S15	7.2	0.617
S16	6.7	0.727
S17	8.4	0.730
S18	7.1	0.877
S19	6.8	0.614
S20	7.8	0.763
S21	6.7	0.980
S22	6.9	0.671
S23	6.6	0.978
S24	6.9	0.912
S25	6.8	1.048
S26	6.5	0.793
S27	6.9	0.955
S28	6.7	0.615
S29	6.6	0.933
S30	6.5	0.627
Mean	**7.08**	**0.846**
Range	**6.4-8.4**	**0.614-1.278**
SD	**0.55**	**0.180**
CV	**7**	**21.3**

Appendix 7: Status of available Cations in water

Sample No.	Calcium (Meq L^{-1})	Magnesium (Meq L^{-1})	Calcium + Magnesium	Potassium (Meq L^{-1})	Sodium (Meq L^{-1})
S1	8.1	12.01	20.11	38	5.91
S2	8.85	1.37	10.22	5	7.17
S3	6.85	9.21	16.06	20	2.35
S4	13.15	14.48	27.63	20	3.86
S5	6.7	9.5	16.2	3	8.65
S6	7.95	16.8	24.75	3	5.5
S7	8.85	6.5	15.35	16	2.82
S8	6.65	10.7	17.35	2	8.08
S9	14.2	2.3	16.5	4	5.04
S10	7.85	11.35	19.2	4	4.17
S11	8.6	8.56	17.16	3	5.91
S12	15.6	10.95	26.55	13	5.86
S13	7.3	9.46	16.76	2	6.04
S14	7.85	9.54	17.39	21	9.82
S15	11.65	2.38	14.03	4	5.6
S16	6.75	12.83	19.58	3	3.86
S17	6.71	11.02	17.73	2	7.13
S18	7.86	12.92	20.78	7	4.17
S19	5.8	12.96	18.76	1	4.82
S20	9.75	10.94	20.69	9	6.91
S21	6.3	14.56	20.86	1	5.74
S22	7.3	7.57	14.87	2	5.6
S23	9.3	10.3	19.6	16	9.39
S24	8.95	11.19	20.14	3	4.56
S25	6.3	12.83	19.13	4	8.95
S26	7.8	13.83	21.63	7	11.52
S27	8.45	12.83	21.28	2	4.82
S28	8.4	11.11	19.51	6	6.02
S29	6.85	12.19	19.04	12	2.28
S30	9.8	8.14	17.94	2	5.73
Mean	**8.54**	**10.34**	**18.89**	**7.83**	**5.94**
Range	**5.8-15.6**	**1.37-16.8**	**10.22-27.63**	**1-38**	**2.28-11.52**
SD	**2.34**	**3.58**	**3.52**	**8.39**	**2.19**
CV	**27**	**34**	**18.6**	**107**	**36**

Appendix 8: Status of available anions in water

Sample No.	Chloride (Meq L^{-1})	Carbonate (Meq L^{-1})	Bicarbonate (Meq L^{-1})
S1	9.4	0.3	2.4
S2	13.64	2.43	7.06
S3	9.2	1	4.87
S4	15.96	1.43	7.8
S5	11.61	2.3	7.98
S6	20.16	0.62	3.73
S7	12.4	1.4	8.45
S8	6.18	1.13	9.14
S9	4.94	1.26	5.19
S10	14.37	0.4	6.88
S11	16.3	1.83	9.11
S12	14.82	1.4	2.7
S13	17.65	0.73	5.31
S14	14.89	1.45	7.7
S15	4.4	0.76	6.8
S16	11.61	0.2	8.62
S17	13.89	1	6.9
S18	10.11	1.42	7.8
S19	13.87	0.71	9.6
S20	14.01	1	2.91
S21	14.66	0.44	3.36
S22	12.11	0.36	8.34
S23	16.55	0.7	5.26
S24	20.08	0.73	3.75
S25	12.03	0.33	6.86
S26	15.93	0.43	3.62
S27	15.56	0.46	4.73
S28	12.8	0.36	7.11
S29	19.12	0.4	6.02
S30	17.2	0.63	8.54
Mean	**13.5**	**0.92**	**6.28**
Range	**4.4-20.16**	**0.2-2.43**	**2.4-9.6**
SD	**3.97**	**0.58**	**2.15**
CV	**29**	**63**	**34**

Appendix 9: Status of irrigation water quality parameters and index

Sample No.	SAR	SSP	RSC	KR	PI	IWQI
S1	1.86	22.71	-17.41	0.29	28.6	286.28
S2	3.17	41.23	-0.73	0.7	56.5	195.71
S3	0.82	12.76	-10.19	0.14	24.7	253.56
S4	1.03	12.25	-18.22	0.13	21.1	212.02
S5	3.03	34.8	-5.92	0.53	66.9	235.04
S6	1.56	18.18	-20.4	0.22	24.6	185.52
S7	1.01	15.5	-5.5	0.18	31.5	203.43
S8	2.71	31.7	-7.08	0.46	43.6	175.92
S9	1.75	23.3	-10.05	0.3	33.9	201.83
S10	1.34	17.84	-11.92	0.21	29.09	186.25
S11	2.07	25.61	-6.22	0.34	38.7	214.38
S12	1.6	18.08	-22.45	0.22	23.1	249.68
S13	2.08	26.49	-10.72	0.36	36.5	290.69
S14	3.3	36.08	-8.24	0.56	46.3	213.83
S15	2.11	28.52	-6.47	0.39	41.8	163.28
S16	1.23	16.46	-10.76	0.19	28.9	182.08
S17	2.43	28.68	-9.83	0.4	39.2	197.36
S18	1.29	16.71	-11.56	0.2	27.9	210.86
S19	0.73	20.4	-8.45	0.26	33.5	165.47
S20	1.51	25.03	-16.78	0.33	31.2	199.46
S21	1.77	21.57	-17.06	0.27	28.4	232.64
S22	2.05	27.37	-6.17	0.37	41.4	174.54
S23	2.99	32.39	-13.64	0.47	28.3	236.74
S24	1.43	31.87	-15.66	0.46	26.3	226.47
S25	2.89	34.75	-11.94	0.53	46.1	245.60
S26	3.5	18.46	-17.58	0.22	40.4	202.95
S27	1.47	23.58	-16.09	0.3	26.8	229.49
S28	1.92	10.69	-12.04	0.12	34.2	163.39
S29	1.57	24.2	-12.62	0.31	22.2	225.18
S30	1.91	18.46	-8.77	0.22	36.5	170.13
Mean	**1.93**	**23.8**	**-11.68**	**0.32**	**34.60**	**210.91**
Range	**0.73-3.5**	**10.69-41.23**	**-22.45 to-0.73**	**0.7-0.12**	**21.1-66.9**	**163.28-290.69**
SD	**0.746**	**7.62**	**4.96**	**0.139**	**10.15**	**33.03**
CV	**39.2**	**32.5**	**-43.1**	**44.09**	**29.8**	**15.92**

Note: SAR=Sodium adsorption ratio, RSC=Residual sodium carbonate, KR=Kelly's ratio, SSP=Soluble sodium percentage, PI=Permeability index, IWQI= Irrigation water quality index.