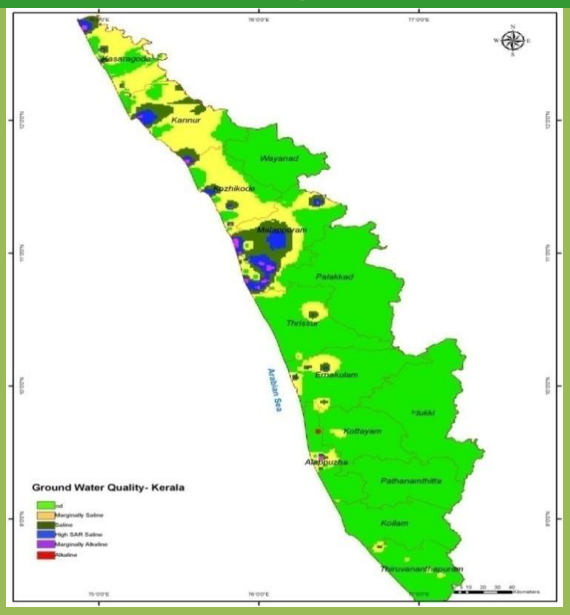
अखिल भारतीय समन्वित अनुसंधान परियोजना
लवणग्रस्त मृदाओं का प्रबंधन एवं खारे जल का कृषि में उपयोग

All India Coordinated Research Project
Management of Salt Affected Soils and Use of Saline Water in Agriculture



वार्षिक प्रतिवेदन
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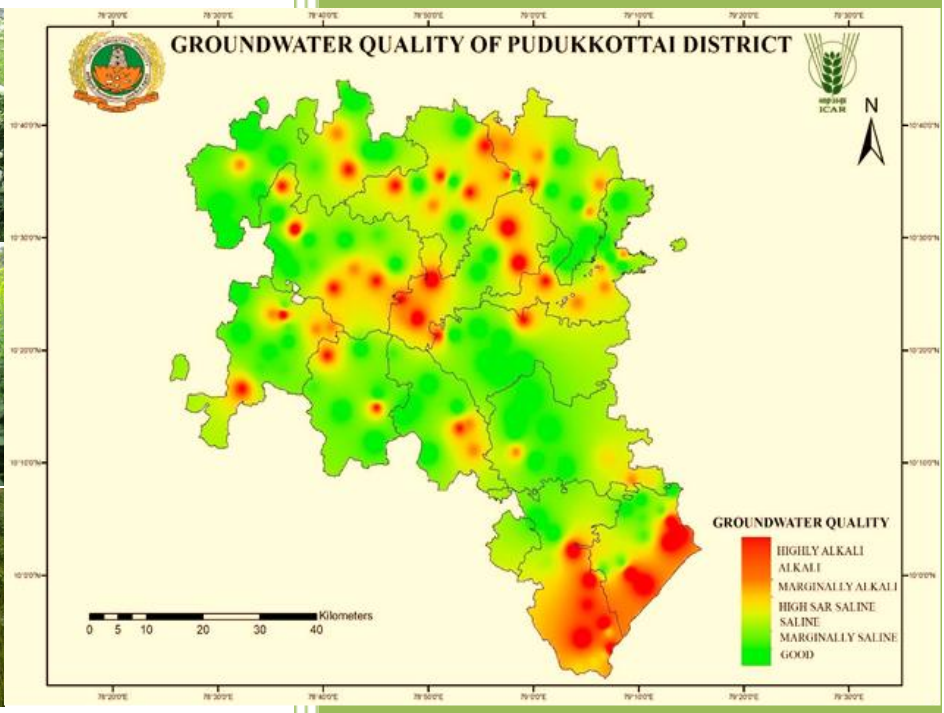
(2021)



परियोजना समन्वयन इकाई
भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान
करनाल – 132 001,हरियाणा (भारत)
Project Coordinating Unit

ICAR-Central Soil Salinity Research Institute
Karnal - 132 001, Haryana (India)

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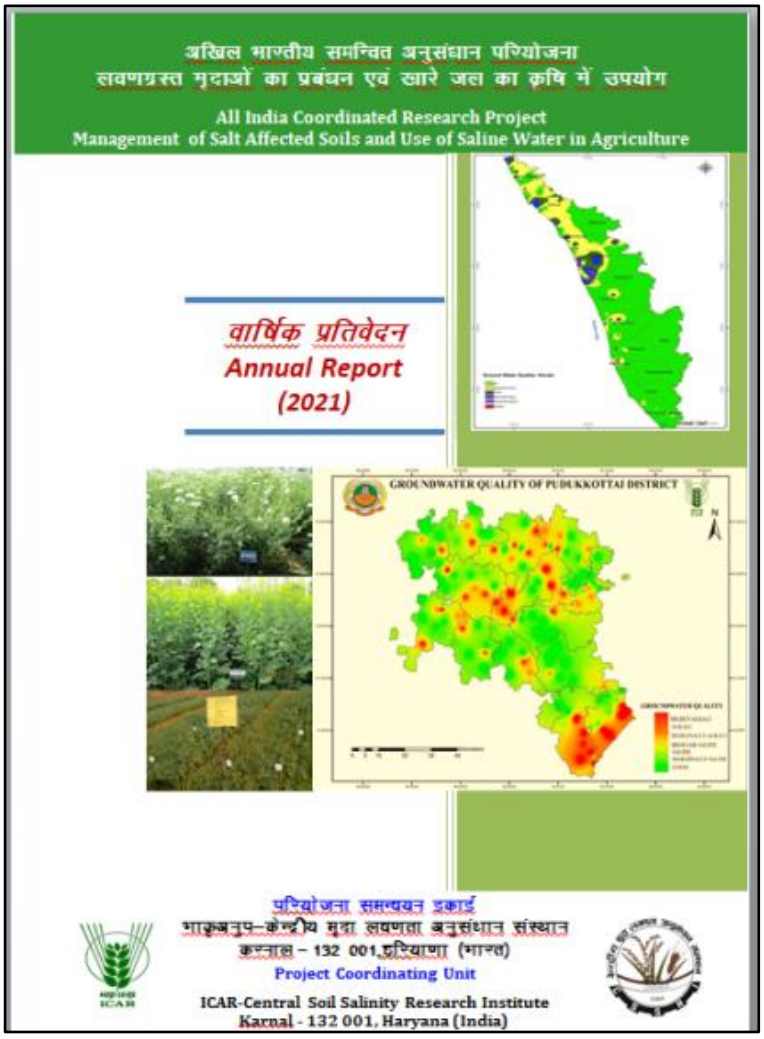

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अखिल भारतीय समन्वित अनुसंधान परियोजना

लवणग्रस्त मृदाओं का प्रबंध एवं खारे जल का कृषि में उपयोग

All India Coordinated Research Project

Management of Salt Affected Soils and Use of Saline Water in Agriculture

वार्षिक प्रतिवेदन

Annual Report

2021

Cooperating Centres

1. Raja Balwant Singh College, Bichpuri, Agra (Uttar Pradesh)
2. College of Agriculture, Acharya N.G. Ranga Agril. University, Bapatla (Andhra Pradesh)
3. ARS, Swami Keshwanad Rajasthan Agricultural University, Bikaner (Rajasthan)
4. ARS, University of Agricultural Sciences, Gangavathi (Karnataka)
5. Department of Soils, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana)
6. Anbil Dharmalingam Agricultural College and Research Institute, TNAU, Tiruchirappalli (Tamil Nadu)

Volunteer Centres

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2. Agriculture College, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Indore (Madhya Pradesh)
3. KLRS, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Panvel (Maharashtra)
4. Rice Research Station, Kerala Agricultural University, Vyttila, Kochi (Kerala)

परियोजना समन्वयन इकाई

भाकृअनुप–केन्द्रीय मृदा लवणता अनुसंधान संस्थान

करनाल – 132 001 (भारत)

Project Coordinating Unit

ICAR-Central Soil Salinity Research Institute

Karnal - 132 001 (India)

FOREWORD

India must raise its food grain production to 350 million tonnes by 2030 through intensive agriculture to feed its ever-growing population. Achieving such target is a formidable challenge as agricultural development with positive growth and long term sustainability cannot thrive on a dwindling natural resource base as evident from soil degradation, declining soil organic matter, accelerated soil erosion, deterioration of soil physical, chemical, and biological health, poor input (water and nutrient) use efficiency, groundwater pollution, declining water tables, waterlogging and soil salinization, loss of biodiversity including ecosystem services and decline in factor productivity. Agricultural intensification, supported by sustainable management of natural resources is need of hour for achieving food, nutritional, environmental and livelihood security in the country. Similarly, there is need to reclaim marginal lands and marginal irrigation waters so that those can be judiciously used in agricultural production system. If we particularly focus on chemical degraded soils, soil sodicity, soil salinity and soil acidity are major issues. Soil acidity is found in hilly regions with high rainfall while soil sodicity and soil salinity are problems of semi-arid and arid regions. Sometimes, coastal regions also face soil salinity problems due to sea water intrusion. Basically chemically degraded lands are good quality lands with improper water and salt balance due to poor irrigation water management practices or ingress of water from outside areas. Out of total degraded land of 120.70 Mha in India, salt affected land is 6.74 M ha. Around 175 districts of the country suffer from saline or alkali groundwater. Saline and alkali conditions certainly affect land and water productivity.

The Government of India established Central Soil Salinity Research Institute (CSSRI) during 1969 under aegis of Indian Council of Agricultural Research (ICAR) to address the issues of soil sodicity and soil salinity at national level. The AICRP on Salt Affected Soils and Use Saline Water in Agriculture (AICRP on SAS&USW) got associated with ICAR-CSSRI's vision and efforts in 1972. During initial period, ICAR-CSSRI focused on development of reclamation packages for alkali and saline soils, working out leaching requirement, crop and plant tolerances to salinity and sodicity, agro-forestry. The work of the institute was strengthened with addition of salt tolerant varieties of rice, wheat, mustard and gram as well as effective use of tolerant soil microbes for beneficial use under salt affected environments. The climate change and conservation agriculture studies have been included to ensure sustainability of the system. The ICAR-CSSRI has acted as centre of excellence at national level and playing important role of helping other developing countries for managing salt affected soils and poor quality saline and alkali waters. The centres of AICRP on SAS&USW are located under different agro-ecological regions of the country and are involved in developing location specific technologies. The centres give more emphasis on characterization and mapping of poor quality groundwater, irrigation induced soil salinity and sodicity problems and management strategies for judicious use of poor quality saline and sodic groundwater. The important technologies are as conjunctive use of saline/sodic water and good quality water, use of drip for saline/sodic waters, amelioration of alkali waters, testing and use of different types of gypsum, subsurface drainage and controlled drainage coupled with water management, skimming wells, growing of cumin with saline water, flowers with treated waste water, low cost recharge structure, reclamation of abandoned aqua ponds, screening and identification of crop genotypes/ varieties for salt tolerance, etc. The contributions made by the centres have been well appreciated by planners and farmers as these technologies are helping the farmers who are in distress.

At the end, efforts of Dr MJ Kaledhonkar, Principal Scientist and I/C, PC Unit and other staff members of the unit in smooth running of the scheme are appreciated. Also efforts in compilation and editing of Annual Report-2021 of the scheme deserve appreciation. It would be my pleasure to extend all support to the project for addressing future challenges and achieve desirable output.

(PC Sharma)
Director, ICAR-CSSRI

PREFACE

The groundwater has remained important source of water for irrigation and domestic purpose for more than two third portion of the country. Over the years, exploitation of groundwater has increased. Total irrigated area of the country is around 68.1 million ha. Out of it, 43.5 million ha is groundwater irrigated. It clearly indicates our over dependence on groundwater. An average stage of ground water development of the country was 58% in 2004 and at present, it is 63.33%. There is decline in overall availability of groundwater and deterioration in groundwater quality. Saline and alkali groundwater are found around 175 districts and irrigation by such waters adversely affect soil health and crop productivity. Farmers are compelled to use poor quality groundwater (saline or alkali) for irrigation as result of non-availability of good quality irrigation waters. The main mandate of the AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture is to use these marginal waters by combining synergetic effect of natural resource management (NRM) and biological strategies. Under of NRM technologies, favorable water and salt balance in root zone is achieved to have better crop growth and yield. Also issues of irrigation induced soil salinization and soil sodification are addressed. The scheme has made significant contributions towards characterization, mapping and judicious utilization of saline and alkali groundwater in different situations such as arid, semi-arid and coastal. Many cost effective and environment friendly technologies been developed by the centres. There are attempts to reduce crop production losses despite use of poor quality waters for irrigation. The AICRP is also working for development of national database on saline and alkali waters for irrigation purpose and spatial maps for better management of marginal quality groundwater.

I take this opportunity to express my sincere thanks and gratitude to Dr T Mohapatra, Secretary, DARE and Ex. DG, ICAR and Dr. H. Pathak, Secretary, DARE and DG, ICAR for providing financial support and taking keen interest in AICRP activities. I also express my deep sense of gratitude to Dr SK Chaudhari, DDG (NRM) ICAR for guiding the technical programme and providing unstinted support to the scheme. Heartfelt thanks are due to Dr PC Sharma, Director, ICAR-CSSRI for their excellent support to the scheme and cooperation in all spheres. Special thanks are due to Dr Adlul Islam, ADG (SWM)-Acting for kind support for smooth running of the AICRP.

I wish to extend my sincere thanks to Chief Scientists/ OICs at cooperating centers; Dr RB Singh, Dr Radha Krishna (Retd.), Dr A Mrudhula, Dr AK Singh (Retd.), Dr Ranjeet Singh, Dr Vishwanath Jowkin, Dr Satyvan (Retd.), Dr Ram Prakash, Dr UR Khandkar (Retd.), Dr KS Bangar, Dr P Balasubramaniam, Dr. Baskar and Nodal Officers at Volunteer Centres; Dr KS Bangar, Dr KV Vaidya Dr BK Yadav, Dr AK Sreelatha and all scientific, technical and supporting staff at respective centres for undertaking successful research programmes and reporting the achievements to Project Coordinating Unit timely. The contribution of centres in implementation of SCSP programme is also appreciated. I also thank staff at Project Coordinating Unit staff such as Dr BL Meena, Shri AK Sharma, Shri Shashi Pal, Shri Pradeep and Shri Ram Sevak as well as administration and finance sections of the institute for providing all necessary help.

Kaledhonkar 14/9/2022

(M J Kaledhonkar)
Principal Scientist & I/C, PC Unit

CONTENTS

AICRP ON MANAGEMENT SALT AFFECTED SOILS & USE OF SALINE WATER IN AGRICULTURE, ICAR-CSSRI, KARNAL

Executive Summary

Groundwater Survey, Characterization and Mapping of Quality for Irrigation Purpose

- **Mathura district, Uttar Pradesh:** The majority of samples in different blocks of Mathura district fall in saline water quality. The High SAR Saline water quality has been increased in Goverdhan, Mathura, Baldev, Chaumuha Raya, Chhata and Nandgaon blocks and Alkali water percentage found decreasing in Goverdhan, Mathura, Baldev, Chaumuha, Raya, Mant, Nandgaon and Chhata blocks respectively, whereas minute change was recorded in Farah block in respect of Alkali classes.

- **Kadapa district, Andhra Pradesh:** The good, saline and alkali groundwater samples were 53.19, 26.74 and 20.06, respectively. Marginally saline was major class in saline group with 21.88% samples followed by high SAR saline with 4.56% samples while marginally alkali, Alkali and Highly alkali samples were 6.69, 7.90 and 5.47%, respectively. Over the years, good quality samples have been reduced from 58.48% to 53.19%. At the same time marginal quality samples increased from 6.39 to 21.88%, reducing the samples under good and alkali classes.

- **Anantapur district, Andhra Pradesh:** The good, saline and alkali groundwater samples were 66.26, 19.71 and 14.02, respectively. Marginally saline was major class in saline group with 17.88% samples while marginally alkali, alkali and high alkali samples were 5.69, 6.91 and 1.42%, respectively. Over the years, good quality samples have been reduced from 88.3 to 66.26%. At the same time marginal quality samples increased from 9.5 to 17.68% while alkali group samples increased from 1.1% to 14.02%.

- **Pali district, Rajasthan:** The survey was conducted in the Bali, Desuri, Marwar Junction and Rani blocks by collecting 22, 31, 22 and 18 samples, respectively. Good quality samples ranged from 40 to 51.72%; marginally saline samples from 30 to 65.38%, saline from 0 (Marwar Junction) to 11.54% high SAR saline from 0 (Rani) to 16.67%. Marginal alkali was present only Bali block with 6.66% samples and high alkali was present in Marwar Junction with 6.90% samples.

- **Sonipat, district, Haryana:** The survey of groundwater quality in Sonipat district indicated that 31.37, 19.48, 4.44, 18.56, 6.54, 3.66 and 15.95 per cent samples were found in good, marginally saline, saline, high SAR saline, marginally alkali, alkali and highly alkali categories, respectively.

- **Villupuram District, Tamil Nadu:** The distribution of water samples in different blocks of Villupuram district revealed that the samples of Alkali category were found in all the blocks and recorded highest in Koliyanur and Kandamangalam blocks (100%), Vikkravandi (92.3%), Thiruvennainallur (87.5%), Olakkur and Melmalayanur blocks (80%), Mugaiyur (76.9%), Vanur (75%), Gingee (64.3%), Marakkanam (63.6%), Vallam (62.5%), Kanai(46.2%), Mailam (33.3%). The Marginal Alkali water was found highest in Kanai Block (46.2%), followed by Mailam (41.7%), Melmalayanur and Olakkur blocks (20%), Vallam (18.8%), Marakkanam (18.2%), Vanur (16.7%), Mugaiyur (15.4%), Thiruvennainallur (12.5%), Vikkravandi (7.7%). The samples of good quality groundwater were found in Mailam (25%), Vallam (18.8%), Kanai (7.7%), and Gingee (7.1%). The samples of Marginal saline quality groundwater were found in Marakkanam (9.1%), Vanur (8.3%), and

Mugaiyur (7.7%). The High-SAR saline water was only found in Marakkanam (9.1%). Groundwater samples of saline and high alkali quality were not observed in any of the Villupuram district blocks. The cationic order of groundwater in most of the blocks was Mg^{2+}> Ca^{2+}>Na^{+}>K^{+} while anionic order was Cl^{-}>HCO_3^{-} > CO_3^{2-}>$SO4^{2-}$.

- **Pudukottai district of Tamil Nadu:** Out of the total 149 samples collected in Pudukkottai district 45 per cent of groundwater were found as good quality and its remaining samples were found in different categories of water quality *viz.,* Marginally saline (12%), Saline (1%), High-SAR saline (4%), Marginally alkali (14%), Alkali (14%) and High alkali (10%). Among the different blocks investigated, the highest percentage of samples with good quality was found in Thiruvarankulam (75%), Viralimalai (62.5%), Gandarvakottai (55%), Arantangi (55%), Arimalam (55%), Annavasal (50%) and Thirumayam (50%). The cationic order of groundwater in most of the blocks was Na^{+}>Mg^{2+}> Ca^{2+}> K^{+} while anionic order was Cl^{-}>HCO_3^{-} > CO_3^{2-}>$SO4^{2-}$.

- **Bathinda, district, Punjab:** The groundwater survey based on 541 samples in the Faridkot district showed that good, Marginally Saline, Saline, High –SAR Saline, Marginally alkali, alkali and highly alkali samples were 17.9, 31.5, 14.5, 3.6, 17.6, 11.6 and 3.4 %, respectively. Analysis samples for fluoride (mg/L) in groundwater with reference to drinking water quality revealed that 26% samples were under safe category (<1.0 mg/L), 4% samples are marginal (1.0-1.5 mg/L) and 70% were unsafe (>1.5 mg/L) in Faridkot district. As far as Nitrate (mg/L) in groundwater of Faridkot district is concerned, on an average 10, 65 and 25% water samples were safe (<10 mg/L), marginal (10-150 mg/L) and unsafe (>150 mg/L) for drinking.

- **Groundwater Quality of Kerala:** The groundwater quality map of Kerala for irrigation purpose, based on groundwater quality data from 14 districts (namely Thiruvananthapuram, Ernakulam, Kasargod, Kannur, Kozhikode, Malappuram, Thrissur, Kottayam, Kollam, Alappuzha, Pathanamthitta, Palakkad, Wayanad and Idukki districts) was prepared as per CSSRI's groundwater quality guidelines. Out of 351 samples of ground water analyzed, 296 were in good category, four each in marginally saline and saline category, respectively. Twenty eight samples were marginally alkaline and two samples were highly alkaline in nature. As a whole in Kerala, 84.33, 1.14, 1.14, 2.28, 1.42 and 0.85% fall under good, marginally saline, saline, high SAR saline, marginally alkaline and high alkali category of ground water quality

Management of Alkali Irrigation Water

- **Conjunctive use of alkali and canal water for Til and Lentil cropping sequence (Agra)**

In case of Lentil- Til crop rotation, the lentil crop was grown under different conjunctive modes of canal and alkali (RSC 8 meq/l) water, to find out the most suitable cyclic and mixing mode. Statistically significant higher yields were recorded in cyclic and mixing modes over alkali water irrigation. The yield under alkali water treatment was 56.6% as compared to canal water treatment.

- **Rainwater Harvesting and Conjunctive Use of Groundwater, Canal and Harvested Rainwater in Sodic Water Areas of Tamil Nadu for Sustainability of Agriculture (Tiruchirappali)**

The new project has been initiated for conjunctive water use groundwater, canal and harvested rainwater in sodic groundwater areas of Tamil Nadu.

Management of Saline Irrigation Water

- **Performance of vegetable crops (chilli) with saline irrigation water through drip system (Bapatla)**

The field data indicated that the growth and yield of chilli crop were significantly influenced by irrigation water salinity. The use of best available water (0.6 dSm^{-1}) recorded the highest plant height (74.5cm), No. of branches per plant (5.8), no. green pods per plant (73.5) and yield of green pods (29.8 t ha^{-1}). These parameters were significantly reduced with increase in irrigation water salinity and the lowest plant height (52.5cm), no. of main branches per plant (4.4), no. of green pods per plant (43.2) and yield of green pods (17.5 tha^{-1}) were recorded at water salinity of 8.0 ECiw. The yield reduction varied from 4.0 to 41.3% with increasing water salinity from 0.6 dSm^{-1} to 8.0 dSm^{-1}.

- **Monitoring of quality of pumped groundwater from shallow tubewells in coastal sandy aquifers of Andhra Pradesh (Bapatla)**

Recently majority of the farmers adopted shallow bore wells (20 ft. depth) with pumps instead of *doruvu* wells. Pumped groundwater quality from shallow tubewells was monitored. The salinity of water was ranged from 1.0 to 3.6 dS/m except in one bore well where the salinity was 6.2. In general, the quality of irrigation water in shallow bore wells of sandy aquifers was within permissible limit.

- **Growing of cumin crop with saline water irrigation in arid region of Rajasthan (Bikaner)**

The cumin is important spice crop in arid region of Rajasthan. Field experiment on use of saline groundwater through drip for cumin crop was conducted at AICRP on SAS&USW, Bikaner for period of three years. Results showed that reduction in seed yield at irrigation water salinity of 2.4, 6 and 8 dS/m was 9, 12 and 34%, respectively. It clearly indicated irrigation water having salinity upto 6 dS/m can be effectively used through drip for cumin crop without too much yield reduction.

- **Integrated nutrient management in Pearl millet -wheat under saline water irrigation (Hisar)**

The highest grain and stover yield (28.74 and 83.21 q/ha) of pearl millet was obtained with RDF + FYM 10 t/ha + Biomix followed by RDF +2.5 t/ha vermicompost + Biomix (28.67 and 82.30 q/ha). The lowest grain and stover yield (23.09 and 64.96 q/ha) was recorded with 75% RDF alone. The highest grain and straw yield (51.70 and 84.12 q/ha) of wheat (WH 1105) was obtained with RDF + 10t/ha FYM + Biomix followed by RDF +2.5 t/ha vermicompost + Biomix (51.57 and 83.03 q /ha).The lowest grain and straw yield (43.86 and 66.23 q/ha) was recorded with 75% RDF alone.

- **Effect of nitrogen fertigation utilizing good and saline water under drip irrigation system in vegetable crops (Hisar)**

Under drip irrigation with 75% of RDN of nitrogen application, the reduction in yield of brinjal was 12.94 and 28.71% when irrigated with saline water of 2.5 and 5.0 dS/m, respectively, as compared to the yield reduction in yields recorded in canal water irrigation. Under drip irrigation in RDN application, the reduction in yield of brinjal were 10.51 and 24.39% when irrigated with 2.5 and 5.0 dS/m, respectively, as compared to the yield recorded in canal water irrigation. Under drip irrigation in 125% recommended dose of nitrogen application, the reduction in yield of brinjal obtained 8.98 and 20.25% when irrigated with saline water of 2.5 and 5.0 dS/m, respectively as compared to the yield recorded in canal water irrigation. Significant reduction in yield was recorded at ECiw 5.0 dS/m

as compared to the canal water irrigation. Significantly highest yield (269.60 q/ha) of brinjal was recorded with the application of 125% RDN and canal water irrigation.

- **Assessment of drain water quality from different RO water purifiers (Bathinda)**

The suitability of RO outlet drain water from different sites (A to E) for irrigation is mainly evaluated using electrical conductivity (EC) and residual sodium carbonate (RSC). The EC of supply water at site A and B were in marginal range (2.0-4.0 dSm^{-1}) and can be used for coarse textured soils/ salt tolerant crops with periodic monitoring of salt accumulation in soils. Whereas, other sites the supply water are good quality and can be use for vegetable production. The EC of drain water at different sites depends on quality of water supplied and efficacy of RO systems. Further, EC of drain water varied from 0.46 to 6.1 dSm^{-1} with an average value of 4.58 dSm^{-1} at site A, 2.93 dSm^{-1} at site B, 1.33 dSm^{-1} at site C, 1.7 dSm^{-1} at site D and 0.85 dSm^{-1} at site E. However, negligible amount of RSC was reported from all the sites. The higher salts of drain water at site A (EC > 4.0 dSm^{-1}) and site B (EC>2.9 dSm^{-1}) makes them unsafe for frequently use for irrigation, but they can be used with some management practices such as with periodic monitoring of salt accumulation in soils. While, drain water of other sites contain less salts (EC <2.0 dSm^{-1}) and can be used frequently for irrigation.

- **Effect of different levels of organic manures and mulching on vegetables (Brinjal, Chilli and Tomato) under drip irrigation (Panvel)**

Rabi season vegetable crops were irrigated by drip and provided mulch to manage salinity stress in coastal areas of Maharashtra where saline groundwater was within capillary zone. In general, drip irrigation and mulch was found effective removing salts from root zone. Plastic mulch significantly decreased EC value and increased pH value considerably as compared to paddy straw mulch and no mulch treatments. Similarly, significant highest moisture content was recorded due to plastic mulch and closely followed by paddy straw mulch. The lowest moisture content was observed in no mulch treatment. Yields of Brinjal, Chilli and Tomato were influenced significantly by paddy straw mulch followed by plastic mulch and no mulch treatment. Further significant interaction effect of paddy straw mulch and FYM @7.5 t ha^{-1} +Vermicompost @ 2.5 t ha^{-1} on yield of Brinjal, Chilli and Tomato of was evident.

- **Effect of planting windows and irrigation on dibbling of wal (Field bean) grown under zero tillage in coastal saline soils of Konkan (Panvel)**

Critical look of three years' data on planting windows further revealed that the planting immediate after harvest of rice (P_1) produced statistically higher yield (9.45 q ha^{-1}) of field bean over the treatments of P_2 (7.58 quintal ha^{-1}) and P_3 (7.04 q ha^{-1}). The treatment receiving irrigation water at the time of flowering (I_1) recorded statistically significant and higher yield of 9.03 quintal ha^{-1} which was statistically superior over two irrigation at flowering and at the time of pod formation I_2 (8.04 q ha^{-1}) and no irrigation I_0 (7.01 q ha^{-1}). Interaction effect of I_1P_1 (one irrigation at the time of flowering with planting immediate after harvest of rice) produced statistically significant and superior with higher yield of (10.75 q ha^{-1}) over remaining interactions.

Management of Treated Waste Water:

- **Effect of treated sewage water as a source of irrigation and nutrients supply for Marigold-Chrysanthemum rotation (Agra)**

A field experiment was conducted on marigold- chrysanthemum crop rotation in sandy loam soil with eight treatment combinations in RBD. The chrysanthemum crop sown as a first crop in rabi season. The results of experiment indicated that the crops irrigated with treated sewage along with recommended dose of fertilizer gave the highest flower yield compared with tube well water. The other treatments like TW+125%RDF, SW+75% RDF and 1SW:1TW + RDF gave the second highest flower yield compared with rest other treatments. It suggested that treated sewage water contained essential nutrients and can help reducing fertilizer requirements of crops.

Management of Irrigation Induced Sodic Soils

- **Management of Sodic Vertisols through resources conservation technologies (Indore)**

An experiment was conducted on sodic Vertisols for wheat (HI 1544) during 2019-20 with and without mulch and three tillage practices i.e. conventional, reduced and zero tillage. The sowing of wheat was done on dated 15.11.2019 and harvested on 19.3.2020. Wheat and straw yield were significantly influenced by various tillage systems and mulch. Among the tillage systems highest wheat (3490 kg/ha) and straw yield (4732 kg/ha) was recorded in conventional tillage which was significantly superior to reduced tillage and zero tillage. Application of rice crop residue as mulch @ 5 t/ha produced significantly higher straw yield (4658 kg/ha) in comparison to no mulch (4440 kg/ha). ESP was also influenced significantly by various tillage and mulch practices. The lowest mean value of ESP was recorded under conventional tillage (25.10) and with mulch (27.70) treatment. Similarly, paddy and straw yield were significantly influenced by various tillage systems and mulch during the experimentation. Among different tillage practices, highest paddy yield (3998 kg/ha) was recorded in conventional tillage which was significantly superior to reduced tillage and zero tillage. On the other hand, grain yield did not influence significantly by the application of mulch. Similarly, straw yield followed the same trend as found in paddy yield. Maximum ESP (31.7) was recorded in fallow treatment and was significantly higher over other treatments under study. All the tillage treatments are significantly differ in each other in respect of ESP. The lowest mean value of ESP (24.4) was recorded under conventional tillage. Similarly, the lowest ESP (26.9) was also noticed with mulch treatment as compared to no mulch (28.3) treatment. The result showed that the mulch has the capacity to reduce ESP to some extent in sodic Vertisols of Nimar Valley.

- **Evaluation of efficiencies of different gypsum sources for sodic soil reclamation (Tiruchirapalli)**

The experiment on efficiencies of different gypsum sources such as i) Marine gypsum, ii) Mineral gypsum and iii) Phospo- gypsum was initiated at Tiruchirapalli. The initial soil pH and ESP were 9.32 and 34.87. The soil application of different gypsum sources was done at 50% GR. The results of *Kharif* season indicated that i) Marine gypsum, iii) Mineral gypsum and iii) Phospo- gypsum are effective in reducing soil pH and soil ESP of sodic soil and improving the rice yields in the state of Tamil Nadu. As far as reclamation performance is concerned, the order is i) Marine gypsum, iii) Mineral gypsum and iii) Phospo- gypsum as rice yield was 4511, 4218 and 4020, respectively. The control yield was 2802 kg/ha.

Management of Irrigation Induced Waterlogged Saline Soils:

- **Enhancing water use efficiency in reclaimed waterlogged saline vertisols by adoption of water management practices in drainage area (Gangavathi)**

Paddy-paddy cropping system has become dominant in the TBP command area particularly at the up-reach and mid-reach of the command. In this system, intensive use of irrigation by continuously flooding throughout the growing season not only reduced water use efficiency but also resulted in water shortage to the growers downstream of the command. A field experiment was initiated at Agriculture Research Station, Gangavathi to address the impact of Alternative wetting and drying (AWD) method of irrigation under conventional and controlled subsurface drainage system (SSD) on the water table, quantity of irrigation water applied, evapotranspiration, deep percolation, water quality, crop yield and water, and nutrient use efficiencies saline in rice fields of TBP Command. The salt removed was 1.35 and 1.04 t ha^{-1} under Continuous flooding method of irrigation (CF) and Alternative wetting and drying method (AWD) of irrigation, respectively. Whereas, under controlled drainage approach during fertilizer application salt removal was 0.44 and 0.29 t ha^{-1} in continuous flooding method of irrigation and Alternative wetting and drying method (AWD) of irrigation, respectively. The grain yield was increased from 5.8 to 6.15 ton ha^{-1} under continuous flooding method of irrigation. Similarly under Alternative wetting and drying method (AWD) of irrigation system grain yield was increased from 5.04 to 5.46 ton ha^{-1}. Seasonal water balance of the study area was worked out by considering the quantity of irrigation water applied for paddy crop including rainfall under continuous flooding method of irrigation was 147.5 cm and similarly under Alternative wetting and drying method (AWD) of irrigation system was 129.5 cm. Thus, there was saving 18 cm of water in case AWD compared to CF. However, there was some yield penalty in case of AWD due to less leaching of salts through root zone.

- **Feasibility of drip irrigation in puddled transplanted rice (PTR) under saline Vertisols of TBP command area, Karnataka (Gangavathi)**

In TBP command, an experiment on use of drip for transplanted rice was initiated to address water shortage during later stages of crop. Transplanted rice is preferred over direct seeded rice (DSR) due to germination problem due to salinity in DSR. The first year's results are awaited.

Management of Saline-Acidic Soils

- **Integrated rice-vegetable-duck and fish cultivation system in P*okkali* fields of Kerala (Vytilla)**

Integration of aquaculture with rice farming is the safest strategy for sustaining rice production, increasing profit, and maintaining ecological balance of the region. This system is completely organic and environment friendly as no external elements were used for cultivation. In addition, integrated farming is found to enhance the nutrient status of the soil. It is a smart practice to enhance resilience of aquaculture communities to climate change and also improved the efficiency of land use. The experiment also showed that, mulching with polythene sheet was having a significant effect on crop growth and yield of vegetables. Hence for vegetable cultivation on *Pokkali* bunds with mulch and drip fertigation have a great scope. Thus it can be clearly pointed out that the integration of rice-vegetable-fish -duck in the *Pokkali* ecosystem can enhance the soil fertility, environmental sustainability, economic stability and overall, ensure the nutritional security of farmers of the coastal *Pokkali* ecosystem.

Alternate Land Use

- **Survey of existing plantations and characterization in coastal area (Bapatla)**

A study about existing major plantations in coastal areas is being conducted in coastal districts of Guntur and Prakasam district. The major plantations found in coastal area are cashew, casuarina, eucalyptus, subabul and mango. Some plantations of citrus, amla, guava and ber were also observed. Prosopis was observed in abandoned lands. The soil samples were collected from locations of plantations and were analyzed for $pH_{(1:2)}$ and $EC_{(1:2)}$. The pH varied from 5.3 to 8.4. The highest pH of 8.4 and 8.2 was noticed in mango, citrus and Eucalyptus plantation fields. The soil salinity ranged from 0.1 – 8.0 dSm^{-1}. However, the growth of Eucalyptus was severely affected at soil salinity of 4.1 dSm^{-1}. In barren land, the soil salinity is found to be 8.0 dSm^{-1}. In all other plantations surveyed, the soil salinity was recorded below 1.0 dSm^{-1}.

- **Development of horticulture based agri-horti system under saline water condition (Bikaner)**

This experiment was started during kharif 2018 to develop horticulture based agri-horti system under saline water. The treatments comprised of three levels of ECiw (BAW, 2. 4 and 6 dS/m) with cluster bean as intercrop between alleys of bael trees during kharif and four crops (mustard, taramira, oat and barley) as intercrop between alleys of bael trees during rabi. Data of Kharif 2020 indicated that seed and straw yields of cluster bean decreased significantly with increase of water salinity. It is observed that significant reduction in seed yield with the tune of 16.52 and 53.91 per cent, respectively with ECiw of 2.40 and 6 dS/m over BAW. In terms of straw yield similar trends was also observed. Further, data (Rabi 2020-21) indicated that seed and straw yields of mustard, taramira, oat and barley decreased with increase of ECiw. Except the oat, yield reduction due to irrigation water salinity was not significant. In case of oat, as compared yield at ECiw 0.25 (BAW), yields at ECiw of 2.4 dS/m and ECiw of 6.0 dS/m showed significant reduction of 9.51 and 14.46 per cent, respectively. The oat straw yield also showed similar trends.

Screening of different Crops for Salinity/ Sodicity Tolerance

The centres of AICRP on SAS&USW were involved in the screening of different crops/ crop varieties for salinity and sodicity tolerance. Details are provided below.

Sr. No.	Name of centre	Crops
1	Agra	Mustard (Salinity); Mungbean (Salinity); Mungbean (Alkalinity)
2	Hisar	Cotton, Wheat Pearl Millet and Mustard (all crops for salinity)
3	Bathinda	Brinjal (Salinity); Jattikhatti (*Citrus jambhiri*) (Salinity)

Operational Research Project at Agra and Bapatla

The Agra centre selected 25 farmers for demonstrations on saline water use (ECiw: 3.8 to 13.3 dS/m) in different villages such as Signa in district Agra and Jalal, and Kurkunda in district Mathura (UP). The technologies developed by the centre were demonstrated on farmers' fields. Main technologies were conjunctive use of saline and good quality waters, sowing with rain conserved moisture and groundwater recharge in saline water aquifers and suitable agronomic practices. It was observed that with the use of improved technologies helped in improving crop yields by 10 to 15% compared to traditional practices. The use of forate and zinc also gave fruitful results by

controlling the effect of termite and zinc deficiencies. The Bapatla centre also conducted demonstrations about use of gypsum for treating soil and use of gypsum bed for treating alkali water on the farmers' fields.

Activities under Scheduled Caste Sub Plan (SCSP):

All centres conducted different activities such as training, distribution of inputs, demonstrations of successful technologies under Grant in General component as well as provided small equipments to SC farmers' under Grant-in-Capital component. Allocations to different centres during 2021-22 for SCSP activities are provided below. As major part of FY 2021-22 was covered under year 2021, activities related to FY 2021-22 are covered in this report.

SCSP Allocations during 2021-22 (Rs. in Lakhs)

Sr. No.	Name of Centre	SCSP Capital	SCSP General
1	Agra	0.770	0.80
2	Bapatla	0.440	0.500
3	Bikaner	0.550	0.500
4	Gangavathi	0.000	0.700
5	Hisar	0.000	0.500
6	Tiruchirapalli	1.410	1.550
7	Bathinda	0.250	0.400
8	Indore	0.500	0.450
9	Panvel	0.250	0.540
10	Vytilla	0.200	0.600
	Total	**4.37**	**6.54**

The Tiruchirapalli centre adopted a nearby SC village under SCSP to support overall welfare of SC farmers. Around 450 SC farmers have been benefitted through the programme at different centres. Details of activities are provided in concerned section of the report.

INTRODUCTION

The All India Coordinated Project on Use of Saline Water in Agriculture was first sanctioned during the IVth Five Year Plan under the aegis of Indian Council of Agricultural Research, New Delhi at four research centres namely Agra, Bapatla, Dharwad and Nagpur to undertake researches on saline water use for semi–arid areas with light textured soils, arid areas of black soils region, coastal areas and on the utilization of sewage water respectively. During the Fifth Five Year plan, the work of the project continued at the above four centres. In the Sixth Five Year Plan, four centres namely Kanpur, Indore, Jobner and Pali earlier associated with AICRP on Water Management and Soil Salinity were transferred to this Project whereas the Nagpur Centre was dissociated. As the mandate of the Kanpur and Indore centres included reclamation and management of heavy textured alkali soils of alluvial and black soil regions, the Project was redesignated as All India Coordinated Research Project on Management of Salt Affected Soils and Use of Saline Water in Agriculture. Two of its Centres located at Dharwad and Jobner were shifted to Gangavathi (w.e.f. 01.04.1989) and Bikaner (w.e.f. 01.04.1990) respectively to work right at the locations having large chunks of land afflicted with salinity problems. During the Seventh Plan, Project continued at the above locations. During Eighth Five Year Plan, two new centres at Hisar and Tiruchirappalli were added. These Centres started functioning from 1 January 1995 and 1997 respectively. Further, during Twelfth Five Year Plan, four new Volunteer centres namely Bathinda, Port Blair, Panvel and Vyttila were added to this AICRP. These four centres started functioning from 2014.

As per recommendations of QRT (2011-2017) of ICAR-CSSRI, Karnal, Indore centre was converted from main cooperating centre to volunteer centre. The SFC document of the scheme has been submitted to NRM division. A new volunteer centre at Dr.PDKV, Akola (Maharashtra) has been proposed to address dry land salinity in Purna river basin.

Cooperating centres with addresses:

1. Raja Balwant Singh College, Bichpuri, Agra (Uttar Pradesh)
2. Regional Research Station, ANG Ranga Agricultural University Bapatla (Andhra Pradesh)
3. SK Rajasthan Agricultural University, Bikaner (Rajasthan)
4. Agricultural Research Station, University of Agricultural Sciences, Gangavati (Karnataka)
5. Department of Soils, CCS Haryana Agricultural University, Hisar (Haryana)
6. AD Agricultural College and Research Institute, TN Agri. Univ. Tiruchirappalli (Tamil Nadu)

However, with the establishment of Agricultural Universities at Gwalior (Madhya Pradesh) and Raichur (Karnataka), the administrative control of the centres at Indore and Gangavathi were transferred to these respective universities.

- As per recommendations of QRT (2011-2017) of ICAR-CSSRI, Karnal, Indore centre became Volunteer centre from 1st April 2020 and Kanpur was closed on 31st March 2020.

Volunteer Centres:

1. Regional Research Station, Punjab Agril University, Bathinda (Punjab)
2. Agriculture College, RVS Krishi Vishwa Vidyalaya, Indore (Madhya Pradesh)
3. Khar Land Research Station, Dr. BS Konkan Krishi Vidyapeeth, Panvel (Maharashtra)
4. Rice Research Station, Kerala Agril. University, Vyttila, Kochi (Kerala)

- As per recommendations of QRT (2011-2017) of ICAR-CSSRI, Karnal, Port Blair centre was closed on 31st March 2020.

Existing and proposed mandate for the AICRP

Name of the scheme (Present):

AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture,
ICAR-Central Soil Salinity Research Institute, Karnal, Haryana- 132001

Proposed:
In the NRM Division meeting dated 18 Nov. 2019, the issue of revision of the title of AICRP was discussed and the following title was finalized.

"AICRP on Management of Saline Water & Associated Salinization in Agriculture"

Objectives of the scheme (Present):

Survey and characterization of the salt affected soils and ground water quality in major irrigation commands.

- Evaluate the effects of poor quality waters on soils and crops and plants.
- Develop standards/guidelines for assessing the quality of irrigation waters.
- Develop management practices for utilization of waters having high salinity/alkalinity and toxic ions.
- Develop and test technologies for the conjunctive use of poor quality waters in different agro-ecological zones/major irrigation commands.
- Develop alternate land use strategies for salt-affected soils
- Screen crop cultivars and tree species appropriate to saline/alkali soil conditions.

Proposed:

- Survey, characterization and mapping of groundwater quality for irrigation purpose
- Evaluation of effects of poor quality groundwater irrigation on soils and crops under different agro-climate conditions
- Development of management practices for irrigation induced salinization / guidelines for saline water irrigation (including micro irrigation) under different agro-climatic regions
- Screen crop cultivars and tree species appropriate to soil salinity and alkalinity conditions

FINANCE:
The Three Year Plan (2017–2020) was sanctioned by the Council vide letter No. NRM-24--1/2017-IA-II dated 23-11-2017 with an outlay of Rs. 2522.18 lakh at these centres with the Coordinating Unit at Central Soil Salinity Research Institute, Karnal. The ICAR share was of Rs. 1980.60 Lakh while state share was of Rs. 541.58 Lakh. The year wise actual allocation in terms of ICAR share for financial year 2017-18, 2018-19, 2019-20, 2020-21 and 2021-22 were Rs. 615.00 Lakhs, Rs. 649.67 Lakhs and Rs. 527.03 Lakhs, Rs. 560.70 Lakhs and Rs. 479.17 Lakhs, respectively. The centre wise ad head wise budget details are provided in the section 7.6.

1. Groundwater Survey, Characterization and Mapping of Quality for Irrigation

- **Survey and characterization of ground water of Mathura district of Uttar Pradesh(Agra)**

The ground water survey of Mathura district in Uttar Pradesh was initiated again after 35 years and completed this year. Ten blocks viz. Farah, Goverdhan, Mathura, Baldev, Chaumuha, Raya, Nauhjheel, Mant, Nandgaon and Chhata are being surveyed and total 621 samples were collected from December to March, when the maximum number of tube wells were under use for irrigation. The water samples were analyzed for pH, EC, cations (Ca, Mg, Na and K) and anions (CO_3, HCO_3, Cl and SO_4). Quality parameters like SAR and RSC were calculated. Classification of water quality is done on the basis of EC, SAR and RSC values as suggested by CSSRI, Karnal (Table1.1).

Table 1.1. Grouping of quality irrigation waters for irrigation in India

Quality of water	**EC (dS/m)**	**SAR (mmol/l)$^{1/2}$**	**RSC (me/l)**
A.Good	<2	<10	<2.5
B. Saline			
i. Marginally saline	2-4	<10	<2.5
ii. Saline	>4	<10	<2.5
iii. High –SAR saline	>4	>10	<2.5
C. Alkali water			
i. Marginally alkali	<4	<10	2.5-4
ii. Alkali	>4	<10	>4
iii. High alkali	<4>	>10	>4

The range of EC, pH, SAR and RSC characters are presented in Table 1.2. The maximum EC of 20.4 dS/m was recorded in Nandgaon followed by Chaumuha 20.4 dS/m, Chhata (13.6 dS/m) Bladev (13.2 dS/m) and in Raya block (12.9 dS/m). The highest RSC value 16.0 me/l was recorded in Mathura block followed by 15.6, 15.0 and 11.6 me/l in Raya, Baldev and Chhata blocks, respectively whereas the highest SAR 45.7 (mmol/l)$^{1/2}$was recorded in Chaumuha followed by 36.2, 32.4 and 31.8 (mmol/l)$^{1/2}$ in Mant, Baldev and Mathura block , respectively.

Table 1.2. Range and mean of water quality parameters for blocks of Mathura district

Blocks Name	EC (dSm^{-1})		pH		RSC (meq/l)*		SAR (mmol/l)$^{1/2}$	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Farah	1.0-9.5	3.5	7.8-9.1	8.5	Nil-10.4	4.1	3.0-24.0	10.1
Goverdhan	1.2-12.4	5.6	7.7-9.0	8.3	Nil-3.4	0.9	Nil-27.1	9.6
Mathura	0.8-12.2	4.4	7.7-9.5	8.3	Nil-16.0	4.5	0.9-31.8	8.6
Baldev	1.0-13.2	4.1	8.2-9.5	8.8	Nil-15.0	4.1	0.4-32.4	12.0
Chaumuha	2.1-20.4	5.2	7.3-8.6	8.0	Nil- 9.6	3.3	7.6-45.7	15.7
Raya	2.0-12.9	5.0	7.6-8.7	8.1	Nil-15.6	4.8	5.1-25.5	13.6
Nauhjheel	1.1-12.5	4.5	8.0-8.9	8.4	Nil- 7.4	1.9	3.8-29.0	15.1
Mant	0.5-12.8	3.0	7.5-9.1	8.0	Nil-8.2	2.7	0.1-36.2	8.1
Nandgaon	1.5-29.0	7.1	7.1-8.3	7.5	Nil-2.0	2.0	1.8-27.5	11.7
Chhata	1.2-13.6	3.6	7.2-8.5	7.7	Nil-11.6	5.9	0.5-25.1	8.7

*Mean RSC of positive value.

The distribution of water samples in different EC, SAR and RSC classes are presented in Table 1.3. According to EC classes more than 30 per cent of analyzed samples came under category 1.5- 3.0 dS/m except the blocks Goverdhan, Baldev and Nandgaon blocks, while 20 to 45 per cent samples were found in class 5.0- 10.0 dS/m except Chaumuha, Mant and Chhata blocks respectively and rest of the samples were found in other category. More than 75 per cent samples in surveyed blocks were having RSC <2.5 me/l except Farah and Raya block. In category >10.0 me/l RSC only 1.5, 2.8, 1.2, 1.6 and 2.0 per cent samples in Farah, Mathura, Baldev, Raya and Chhata were recorded, respectively. In case of SAR classes, the major number of samples were found in 0-10 and 10-20 (mmol/l)1/2 classes. In class 20-30 (mmol/l)1/2 4.5, 3.2, 4.2 , 6.0, 7.9 & 4.8 per cent samples of Farah, Goverdhan, Mathura, Baldev, Chaumuha ,Raya and in class 30-40 (mmol/l)1/2 1.4, 1.2 and 1.7 per cent samples of Mathura, Baldev and Mant blocks were recorded.

Table 1.3. Frequency distribution of water samples in different EC, RSC and SAR classes of different blocks of Mathura district

Particulars/ blocks	Farah (67)	Gover-dhan (62)	Mathura (72)	Baldev (83)	Chau-muha (59)	Raya (63)	Nauhj-heel (57)	Mant (58)	Nand-gaon (50)	Chhata (50)
EC Classes										
0- 1.5	10.4	1.6	11.2	14.5	-	-	1.8	27.6	-	12.0
1.5- 3.0	40.3	14.5	34.7	21.7	45.8	31.8	29.8	41.4	22.0	46.0
3.0- 5.0	23.9	30.6	23.6	31.3	28.8	23.8	33.3	15.5	26.0	20.0
5.0-10.0	25.4	45.2	20.8	28.9	13.5	38.1	33.3	12.1	34.0	18.0
>10.0	-	8.1	9.7	3.6	11.9	6.3	1.8	3.4	18.0	4.0
RSC Classes										
Absent	65.7	93.5	84.7	73.5	61.0	69.8	66.7	63.8	98.0	84.0
0-2.5	6.0	6.5	5.6	10.8	16.9	3.2	24.5	29.3	2.0	6.0
2.5- 5.0	17.9	-	6.9	7.2	11.9	17.5	5.3	1.7	-	6.0
5.0-10.0	8.9	-	-	7.2	10.2	7.9	3.5	5.2	-	2.0
>10.0	1.5	-	2.8	1.2	-	1.6	-	-	-	2.0
SAR Classes										
0-10	62.7	56.5	65.2	36.1	27.0	27.0	15.8	67.2	46.0	64.0
10-20	32.8	40.3	29.2	56.6	65.1	68.2	66.7	29.3	40.0	30.0
20-30	4.5	3.2	4.2	6.0	7.9	4.8	17.5	1.7	14.0	6.0
30-40	-	-	1.4	1.2	-	-	-	1.7	-	-
>40	-	-	-	-	-	-	-	-	-	-

Fluoride:

It is clear from Table 1.4 that the most of the samples (>65%) in surveyed blocks came into class 0-1.5 ppm F category except Chaumuha and Chhata blocks, whereas in 1.5-3.0 (ppm) category the values varied from 8.0 to 72.0 per cent *viz.* 22.4, 8.1, 15.3, 10.8, 30.5, 12.7, 5.3, 10.3, 8.0 and 72.0 per cent, while 10.4, 3.2, 9.7, 7.3, 13.6, 12.7 per cent samples found in 3.0-5.0 ppm category in different blocks as per table, respectively. In all blocks of Mathura district, order of cations was found as Na>Mg>Ca>K while order of anions was found as $Cl>SO_4>HCO_3>CO_3$.

Distribution of water samples in different water quality categories

The distribution of water samples in different water quality classes (Table 1.5) revealed that 17.9, 6.5, 22.2, 18.1, 7.0, 32.8. 10.0 and 32.0 per cent sample of good quality underground irrigation water were found in Farah, Goverdhan, Mathura, Baldev, Nauhjheel, Mant, Nandgaon and Chhata block, respectively and none of the samples of good quality were found in Chaumuha and Raya blocks. Around 52.3, 88.7, 69.4, 68.7, 78.0, 73.0, 80.7, 42.5, 90.0 and 68.0 per cent samples of Farah, Goverdhan, Mathura, Baldev, Chaumuha, Raya, Nauhjheel, Mant, Nandgaon and Chhata blocks came under saline class (Marginally saline, saline and High SAR saline) while, rest 29.8, 4.8, 8.4, 13.2, 22.0, 27.0, 12.3, 1.7 per cent samples came in Alkali class (Marginally Alkali and High Alkali only), respectively.

Table 1.4. Fluoride in different blocks of Mathura district

Blocks Name	Fluoride classes (ppm)				
	0-1.5	1.5-3.0	3.0-5.0	5.0-10.0	>10.0
Farah	67.2	22.4	10.4	-	-
Goverdhan	88.7	8.1	3.2	-	-
Mathura	75.0	15.3	9.7	-	-
Baldev	81.9	10.8	7.3	-	-
Chaumuha	55.9	30.5	13.6	-	-
Raya	74.6	12.7	12.7	-	-
Nauhjheel	91.2	5.3	3.5	-	-
Mant	89.7	10.3	-	-	-
Nandgaon	92.0	8.0	-	-	-
Chhata	28.0	72.0	-	-	-

Table 1.5. Per cent distribution of water samples in different water quality ratings in blocks of Mathura district (2021)

S.No.	Blocks	No. of Samples	Good	Marginally Saline	Saline	High SAR Saline	Marginally Alkali	Alkali	High Alkali
	Farah	67	17.9	19.4	6.0	26.9	16.4	-	13.4
2	Goverdhan	62	6.5	25.8	29.0	33.9	-	-	4.8
3	Mathura	72	22.2	29.1	11.1	29.2	4.2	-	4.2
4	Baldev	83	18.1	19.3	2.4	47.0	3.6	-	9.6
5	Chaumuha	59	-	35.6	1.7	40.7	6.8	-	15.2
6	Raya	63	-	23.8	6.3	42.9	14.3	-	12.7
7	Nauhjheel	57	7.0	29.8	-	50.9	7.0	-	5.3
8	Mant	58	32.8	37.9	1.7	2.9	-	-	1.7
9	Nandgaon	50	10.0	22.0	18.0	50.0	-	-	-
10	Chhata	50	32.0	28.0	4.0	36.0	-	-	-

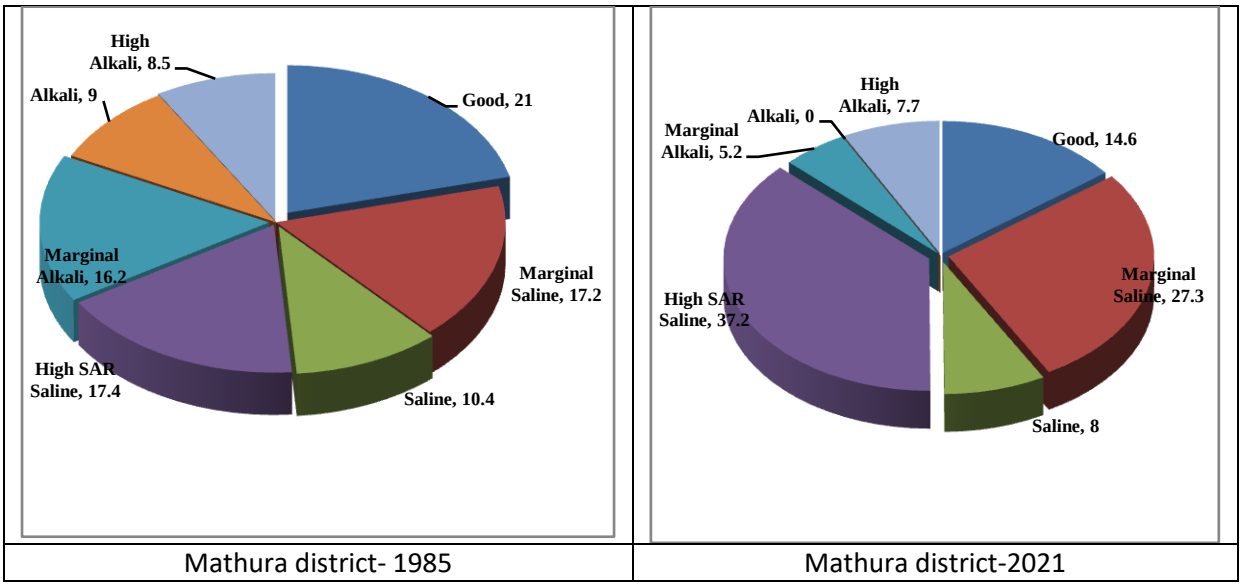
Comparing the water quality of latest collected samples with 35 years ago collected samples of Mathura district, it can be explained that the good quality water increased in Farah and Chhata block

while reduced in Goverdhan, Mathura, Chaumuha, Raya ,Nauhjheel, Mant and Nandgaon blocks while in Badev it was found at par. The major number of samples falls in Saline water quality in the surveyed periods, the High SAR Saline water quality has been increased in Goverdhan, Mathura, Baldev, Chaumuha Raya, Chhata and Nandgaon blocks (Table 1.6) and Alkali water trend found decreasing in Goverdhan, Mathura, Baldev, Chaumuha, Raya, Mant, Nandgaon and Chhata blocks respectively, whereas minute change was recorded in Farah block in respect of Alkali classes.

Table 1.6 Per cent distribution of water samples in different water quality ratings (1983-85)

S.No.	Blocks	No. of Samples	Good	Marginally Saline	Saline	High SAR Saline	Marginally Alkali	Alkali	High Alkali
1	Farah	97	9.3	10.3	15.5	35.0	11.3	5.1	13.5
2	Goverdhan	104	20.2	20.2	19.2	26.9	9.6	3.0	0.9
3	Mathura	94	28.7	20.2	17.0	14.9	6.4	5.4	7.4
4	Baldev	76	19.7	25.0	7.9	23.4	7.9	13.5	2.6
5	Chaumuha	85	15.3	15.3	11.8	16.3	29.4	-	11.9
6	Raya	97	17.5	13.4	11.3	24.7	16.5	7.3	9.3
7	Nauhjheel	125	14.8	19.5	16.4	20.6	7.8	8.0	12.5
8	Mant	84	39.3	22.6	3.6	15.5	9.5	5.9	3.6
9	Nandgaon	63	20.1	9.5	9.5	14.3	23.8	11.7	11.7
10	Chhata	95	24.2	13.7	5.3	5.3	33.7	6.2	11.6

The comparison of groundwater quality for Mathura district is given in the Fig. 1.1.



Mathura district- 1985 | Mathura district-2021

Fig. 1.1 Comparison of distribution of water quality classes in Mathura district during 1985 and 2021

Finally, a map (Fig. 1.2) has been prepared to show the area wise distribution of different water quality classes of Farah, Mathura, Goverdhan , Baldev, Chaumuha, Raya, Nauhjheel, Mant, Nandgaon and Chhata blocks of Mathura district.

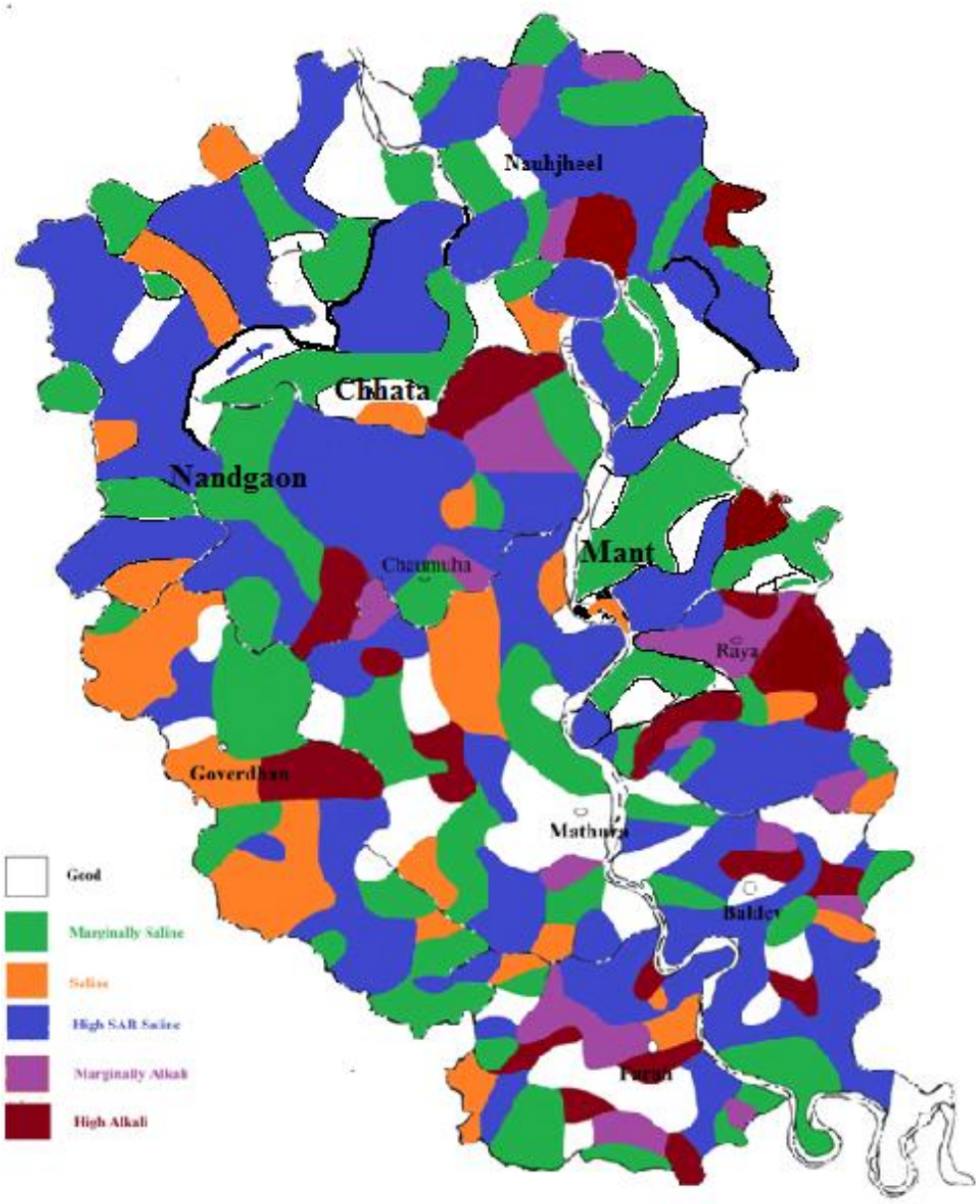


Fig. 1.2 Water quality map of different blocks of Mathura district

- **Survey and characterization of ground water for irrigation for Kadapa district (Bapatla)**

During 2020-21, revisiting was made to determine the ground water quality of Kadapa district. The survey was conducted and 329 ground water samples were collected from 51 mandals. The pH values of the groundwater samples in the study area varied from 6.5 to 8.1. In the study area, the values of electrical conductivity ranged between 0.4 and 11.1 dS m^{-1}. As per the classification given by Central Soil Salinity Research Institute, Karnal, the 53.19 per cent samples are good in irrigation quality and can be used for all types of soils and crops, 21.88 samples are marginally saline and can be used with slight salt tolerant crops and periodic monitoring, 0.3 per cent samples are saline, 4.56 per cent are with high SAR saline quality and are unsuitable for irrigation, 6.69 per cent samples with

marginally alkaline quality and can be used with periodic monitoring and gypsum application, 7.9 per cent samples with Alkali quality and 5.47 per cent samples with highly alkaline in quality and are unsuitable for irrigation (Table 1.7) .

Table 1.7 Physico-chemical and chemical properties of groundwater samples of Kadapa District

SN.	**Parameter**	**Range**
1	pH	6.5-8.1
2	EC(dSm^{-1})	0.4-11.1
3	CO_3^{2-} (me L^{-1})	0.0-2.0
4	HCO_3^- (me L^{-1})	1.0-17.6
5	Cl^-(me L^{-1})	0.4-76.0
6	SO_4^{2-}(me L^{-1})	0.3-14.8
7	Ca^{2+}(me L^{-1})	0.4-46.0
8	Mg^{2+}(me L^{-1})	1.2-16.4
9	Na^+(me L^{-1})	0.76-60.1
10	K^+(me L^{-1})	0.002-11.78
11	RSC(me L^{-1})	-52.4-16.2
12	SAR	0.4-41.2

The comparison of the ground water quality parameters of Kadapa district during 2007-08 and 2020-21 is given in Table 1.8. The good quality groundwater area has decreased by 5 percent while marginally saline water area has increased by 15 percent. There was slight increase in high SAR saline area. However, areas under alkali categories (marginally alkali, alkali and high alkali) have decreased. Overall there was decrease in groundwater quality.

Table 1.8 Comparison of ground water quality of Kadapa district (Revisiting) with previous work

S.No.	Quality	Per cent samples		Number of samples	
		2007-08	Present (2020-21)	2007-08	Present (2020-21)
1	Good water	58.48	53.19	293	175
2	Marginally saline	6.39	21.88	32	72
3	Saline	0.60	0.30	3	1
4	High SAR Saline	2.99	4.56	15	15
5	Marginally alkali	11.78	6.69	59	22
6	Alkali	13.57	7.90	68	26
7	Highly alkali	6.19	5.47	31	18
	Total	100	100	501	329

- **Survey and characterization of ground water for irrigation for Anantapur district (Bapatla)**

During 2020-21, bench mark sites were visited and 492 groundwater samples from 63 mandals were collected and analyzed to determine the ground water quality parameters for Anantapuram district. The pH values of the groundwater samples in the study area varied from 6.7 to 8.4. In the study area, the values of electrical conductivity ranged between 0.4 and 10.7 dS m^{-1} (Table 1.9)

As per the classification given by Central Soil Salinity Research Institute, Karnal 66.26 per cent samples are good in irrigation quality and can be used for all types of soils and crops, 17.68 samples are marginally saline and can be used with slight salt tolerant crops and periodic monitoring, 1.42 samples are Saline, 0.61 per cent samples are with high SAR saline quality and are unsuitable for irrigation, 5.69 per cent samples with marginally alkaline quality and can be used with periodic monitoring and gypsum application, 6.91 per cent samples with alkali quality and 1.42 per cent samples with highly alkaline in quality and are unsuitable for irrigation (Table 1.10).

Table 1.9 Physico-chemical and chemical properties of groundwater samples of Anantapur District

SN	Parameter	Range
1	pH	6.7-8.4
2	EC(dSm^{-1})	0.4-10.7
3	CO_3^{2-}(me L^{-1})	-5.4-1.8
4	HCO_3^-(me L^{-1})	0.88-15.4
5	Cl^-(me L^{-1})	0.4-59.6
6	SO_4^{2-}(me L^{-1})	0.21-17.08
7	Ca^{2+}(me L^{-1})	0.8-28.4
8	Mg^{2+}(me L^{-1})	0-43.2
9	Na^+(me L^{-1})	0.73-70.1
10	K^+(me L^{-1})	0.001-51.76
11	RSC(me L^{-1})	-66.8-15.4
12	SAR	0.43-36.34

The comparison of the ground water quality parameters of Anantpur district during 1975-76 and 2020-21 is given in Table 1.10. The good quality groundwater area has decreased by more than 20 percent while marginally saline water area has increased by 8.18 percent. The area under alkali ground water was non-significant. However, areas under alkali categories (marginally alkali, alkali and high alkali) have increased by 14.0 percent. Overall there was decrease in groundwater quality.

Table 1.10 Comparison of ground water quality of Anantapur district (Revisiting) with previous work

S.No.	Quality	Per cent samples		Number of samples	
		1975-76	Present (2020-21)	Previous	Present (2020-21)
1	Good water	88.3	66.26	704	326
2	Marginally saline	9.5	17.68	75	87
3	Saline	1	1.42	8	7
4	High SAR Saline	0.1	0.61	1	3
5	Marginally alkali	1.1	5.69	9	28
6	Alkali	0	6.91	0	34
7	Highly alkali	0	1.42	0	7
	Total	100	100	797	492

- **Survey and characterization of underground irrigation waters of Pali district (Bikaner)**

Survey and characterization of groundwater was undertaken to know suitability of groundwater for irrigation purpose. Water samples from 129 tube wells distributed in 93 villages in four tehsils (22

Bali, 31 Desuri, 22 Marwar Junction and 18 Rani) of Pali district were collected during December 2020 and analyzed for various chemical characteristics (Table 1.11). Total 129 surface soil samples were also collected from the fields irrigated with corresponding water and analyzed for their characterization. The data on range of EC and pH of water samples in Bali, Desuri, Marwar Junction and Rani tehsils of Pali district showed that EC ranged from 0.48 to 9.92, 0.47 to 10.30, 0.80 to 5.51, 0.61 to 4.65 dS/m, whereas, pH ranged from 7.69 to 8.89, 7.37 to 8.76, 7.87 to 8.33, 7.33 to 8.83, respectively. The concentration of calcium varied from 0.40 to16.20, 0.30 to18.20, 0.60 to 8.00, 0.80 to 9.00 and magnesium varied from 0.95 to 32.80, 1.32 to 24.00, 1.60 to 12.20, 1.60 to 13.60 me/L in Bali, Desuri, Marwar Junction and Rani tehsils, respectively. Sodium concentration ranged from 3.20 to 50.19,3.04 to 60.18,4.67 to 34.77, 4.31 to 24.57 me/L in Bali, Desuri, Marwar Junction and Rani tehsil whereas, concentration of potassium ion for Bali, Desuri, Marwar Junction and Rani tehsil varied from 0.01 to 1.08, 0.02 to 1.08, 0.01 to 0.70, 0.01 to 1.02 me/L, respectively.

Table 1.11 Characteristics of underground irrigation waters of different tehsils of Pali district

Characteristics	Tehsils			
	Bali (30)*	Desuri (44)*	Marwar Junction (26)*	Rani (29)*
pH	7.69-8.89 (8.27)**	7.37-8.76 (8.25)	7.87-8.33 (8.31)	7.33-8.83 (8.29)
EC (dS/m)	0.48-9.92 (2.82)	0.47-10.30 (2.64)	0.80-5.51 (2.10)	0.61-4.65 (2.55)
Ca(me/L)	0.40-16.20 (3.41)	0.30-18.20 (4.23)	0.60-8.00 (2.81)	0.80-9.00 (3.85)
Mg(me/L)	0.95-32.80 (6.78)	1.32-24.00 (6.80)	1.60-12.20 (4.78)	1.60-13.60 (6.27)
Na (me/L)	3.20-50.19 (17.86)	3.04-60.18 (15.15)	4.67-34.77 13.24)	4.31-24.57 (15.18)
K (me/L)	0.01-1.08 (0.24)	0.02-1.08 (0.19)	0.01-0.70 (0.100	0.01-1.02 (0.13)
CO_3 (me/L)	Trace - 7.90 (1.50)	Trace -10.50 (1.06)	0.10-4.00 (1.20)	Trace - 5.00 (1.31)
HCO_3 (me/L)	1.00-18.00 (6.77)	1.40-25.00 (7.37)	2.00-15.00 (6.43)	2.00-12.00 (7.47)
Cl (me/L)	3.00-62.00 (17.21)	3.20-64.00 (16.40)	4.00-30.00 (11.17)	3.00-29.00 (14.68)
SO_4 (me/L)	0.16-11.00 (2.62)	0.08-9.37 (1.51)	0.14-6.11 (2.23)	0.25-9.36 (2.07)
RSC (me/L)	Nil -3.11 (0.39)	Nil -0.95(0.07)	Nil -5.40 (0.71)	Nil -2.65 (0.37)
SAR	3.63-13.83 (7.91)	3.20-13.10 (6.28)	3.55-11.32 (6.80)	3.67-10.22 (6.89)
Potential salinity (me/L)	3.34-67.50 (18.52)	3.24-68.69 (17.15)	4.54-33.06 (12.29)	3.53-30.08 (15.71)
SSP	49.63-75.05 (64.57)	40.95-73.91 (58.10)	50.42-83.59 (63.58)	46.76-77.08 (60.44)
Adj. SAR	4.36-41.49(20.17)	4.80-47.16 (16.57)	6.86-35.10 (16.91)	7.48-27.42 (17.97)
Water table (ft)	60-500 (222)	50-375 (124)	60-575 (168)	80-600 (214)

* No. of samples tested () ** Figures in parenthesis are the average value

Concentration of carbonate varied from Trace to 7.90, Trace to 10.50, 0.10 to 4.00, Trace to 5.00 in Bali, Desuri, Marwar Junction and Rani tehsil, respectively while, bicarbonate varied from 1.00 to 18.00, 1.40 to 25.00, 2.00 to 15.00, 2.00 to 12.00 me/L in Bali, Desuri, Marwar Junction and Rani tehsil, respectively. The concentration of chloride varied from 3.00 to 60.00, 3.20 to 64.00, 4.00 to 30.00, 3.00 to 29.00 me/L while, sulphate varied from 0.16 to 11.00, 0.08 to 9.37, 0.14 to 6.11, 0.25 to 9.36 me/L in Bali, Desuri, Marwar Junction and Rani tehsils, respectively. Chloride and sodium was the dominant anion and cation, respectively. The SAR of water samples ranged from 3.63 to 13.83, 3.20 to 13.10, 3.55 to 11.32, 3.67 to 10.22 whereas, soluble sodium percentage (SSP) of water samples ranged from 49.63 to 75.05, 40.95 to 73.91, 50.42 to 83.59 and 46.76 to 77.08, respectively for Bali, Desuri, Marwar Junction and Rani tehsil. The Potential salinity varied from 3.34 to 67.50, 3.24 to 68.69, 4.54 to 33.06 and 3.53 to 30.08 me/L and Adj. SAR varied from 3.63 to 13.83, 3.20 to 13.10, 3.55 to 11.32 and 3.67 to 10.22 in Bali, Desuri, Marwar Junction and Rani Tehsil, respectively.

The RSC of these water samples ranged from Nil to 3.11, Nil to 0.95 Nil to 5.40 and Nil to 2.65 me/L in Bali, Desuri, Marwar Junction and Rani tehsils of Pali district, respectively (Table 1.11).

About 90, 100, 89.65 and 96.15 per cent water samples in Bali, Desuri, Marwar Junction and Rani tehsils of Pali district had RSC < 2.5 me/L, respectively. As regard to salinity, 33.33, 50.00, 55.17 and 23.08 per cent water samples in Bali, Desuri, Marwar Junction and Rani tehsil had EC < 2 dS/m, respectively. While 46.67, 34.09, 37.93 and 65.38 per cent water samples were in the range of EC 2 to 4 dS/m in these tehsils, respectively. Around 20.00, 15.91, 6.90 and 11.54 per cent water samples had EC >4 dS/m in Bali, Desuri, Marwar Junction and Rani Tehsil, respectively (Table 1.12).

Table 1.12 Distribution (per cent) of water samples in different ranges of EC and RSC in different tehsils of Pali district

EC (dS m^{-1})	Tehsils	RSC(me/L)			
		<2.5	2.5-5.0	5.0 – 7.5	> 7.5
< 1	Bali	10.00	-	-	-
	Desuri	13.64	-	-	-
	Marwar Junction	17.24	-	-	-
	Rani	3.85	-	-	-
1-2	Bali	23.33	-	-	-
	Desuri	36.36	-	-	-
	Marwar Junction	34.48	3.45	-	-
	Rani	19.23	-	-	-
2-3	Bali	26.67	6.67	-	-
	Desuri	20.45	-	-	-
	Marwar Junction	17.24	3.45	-	-
	Rani	46.15	3.45	-	-
3-4	Bali	10.00	3.33	-	-
	Desuri	13.64	-	-	-
	Marwar Junction	13.79	-	3.45	-
	Rani	15.38	-	-	-
>4	Bali	20.00	-	-	-
	Desuri	15.91	-	-	-
	Marwar Junction	6.90	-	-	-
	Rani	11.54	-	-	-

The per cent distribution of water samples in relation to pH, EC, SAR and SSP in different tehsils of Pali district is given in Table 1.13. Around 66 to 80 percent groundwater samples were in pH range of 7.5 to 8.5. Around 80 to 88 percent groundwater samples had EC less than 4 dS/m. Around 80 to 96 percent groundwater samples had SAR less than 10. Around 76 to 95 percent groundwater samples had SSP less than 70.

Categorization of water samples as per water quality is presented in Table 1.14. About 40, 30, 6.67, 16.67, 6.66 per cent water samples in Bali tehsil were found under good, marginally saline, saline, high SAR saline and marginally alkali category; 50.00, 36.36, 9.09, 4.55 per cent water samples in Desuri tehsil were found under good, marginally saline, saline and high SAR saline category; 51.72,

34.48, 6.90, 6.90 per cent water samples in Marwar Junction tehsil were found under good, marginally saline, high SAR saline and highly alkali category and 23.08, 65.38, 11.54 per cent water samples in Rani tehsil found under good, marginally saline and saline category, respectively.

Table 1.13 Per cent distribution of water samples in relation to pH, EC, SAR and SSP in different tehsils of Pali district

Characteristics	Tehsils			
	Bali	Desuri	Marwar Junction	Rani
pH				
7.0-7.5	0.00	4.55	0.00	3.85
7.5-8.0	23.33	13.64	13.69	11.54
8.0-8.5	43.33	61.36	65.52	53.85
> 8.5	33.33	20.45	20.69	30.77
EC(dS/m)				
<2	33.33	50.00	55.17	23.08
2-4	46.67	34.09	37.93	65.38
4-6	16.67	11.36	6.90	11.54
>6	3.33	4.55	0.00	0.00
SAR				
0-10	80.00	95.45	86.21	96.15
10-20	20.00	4.55	13.79	3.85
SSP				
< 50	3.33	9.09	0.00	7.69
50-60	20.00	52.27	31.03	38.46
60-70	53.33	34.09	48.28	42.31
70-80	23.33	4.55	17.24	11.54
> 80	0.00	0.00	3.45	0.00

Table 1.14 Per cent water samples under different categories of water quality in tehsils of Pali district

S.N	Water quality categories	Tehsils			
		Bali	Desuri	Marwar Junction	Rani
1.	Good (EC<2 dSm^{-1}, SAR <10 and RSC <2.5 meL^{-1})	40.00	50.00	51.72	23.08
2.	Marginally saline (EC 2-4dSm^{-1}, SAR<10 and RSC <2.5 meL^{-1})	30.00	36.36	34.48	65.38
3.	Saline (EC >4dSm^{-1}, SAR<10 and RSC < 2.5 meL^{-1})	6.67	9.09	-	11.54
4.	High- SAR saline (EC > 4dSm^{-1},SAR >10 and RSC <2.5 meL^{-1})	16.67	4.55	6.90	-
5.	Marginally alkali (EC < 4dSm^{-1},SAR< 10 and RSC 2.0-4.0meL^{-1})	6.66	-	-	-
6.	Alkali (EC < 4dSm^{-1},SAR< 10 and RSC >4.0 me L^{-1})	-	-	-	-
7.	Highly alkali (EC -Variable, SAR> 10 and RSC > 4.0 meL^{-1})	-	-	6.90	-

The ranges of soil parameters in these tehsils indicated that pH_2 of soil samples in Bali tehsil varied from 7.31 to 8.98, Desuri tehsil from 7.38 to 9.63, Marwar Junction tehsil from 7.19 to 9.78 and Rani tehsil from 7.50 to 9.82 whereas, the corresponding EC_2 ranged from 0.02 to 0.76, 0.03 to 2.53, 0.04

to 0.69 and 0.07 to 0.88 dS/m, respectively in Bali, Desuri, Marwar Junction andRani tehsils of Pali district (Table 1.15)

Table 1.15 Ranges of chemical parameters of soils irrigated with tube well waters of different tehsils of Pali district

Characteristics	Tehsils			
	Bali (30)*	Desuri (29)*	Marwar Junction (29)*	Rani (26)*
pH	7.31-8.98 8.00)**	7.38-9.63 (8.42)	7.19-9.78 (8.62)	7.50-9.82 (8.76)
EC (dS/m)	0.02-0.76 (0.16)	0.03-2.53 (0.25)	0.04-0.69 (0.18)	0.07-0.88 (0.20)
Ca(me/L)	0.02-1.000 (0.21)	0.05-3.50 (0.33)	0.05-0.92 (0.26)	0.09-1.10 (0.28)
Mg(me/L)	0.03-2.12 (0.41)	0.09-7.40 (0.67)	0.10-1.90 (0.48)	0.15-2.25 (0.52)
Na (me/L)	0.11-4.18 (0.85)	0.13-13.86 (1.40)	0.17-3.81 (0.96)	0.38-4.72 (1.09)
K (me/L)	0.01-0.28 (0.09)	0.02-0.81 (0.13)	0.02-0.31 (0.09)	0.02-0.70 (0.13)
CO_3 (me/L)	0.00-0.22 (0.05)	0.00-0.49 (0.06)	0.02-0.25 (0.06)	0.00-0.25 (0.07)
HCO_3 (me/L)	0.07-3.10 (0.61)	0.10-9.95 (0.98)	0.14-2.90 (0.68)	0.29-3.25 (0.77)
Cl (me/L)	0.09-3.61 (0.75)	0.12-13.17 (1.31)	0.18-3.40 (0.90)	0.30-4.30 (0.99)
SO_4 (me/L)	0.02-0.70 (0.13)	0.04-1.67 (0.19)	0.03-0.50 (0.15)	0.06-1.02 (0.19)
SAR	0.55-3.35 (1.42)	0.50-5.94 (1.79)	0.60-3.37 (1.47)	1.00-3.65 (1.64)
SSP	36.32-66.67 (54.16)	44.57-75.21 (56.76)	44.92-63.79 (53.46)	0.00-63.82 (52.32)

* No. of samples tested () **Figures in parenthesis are the average value

- **Survey and characterization of ground waters of Sonipat district for irrigation (Hisar)**

The project was undertaken to determine the quality of ground waters occurring in the Sonipat district of Haryana for irrigation purpose. The survey and characterization of underground irrigation water of Sonipat district was undertaken during 2020-2021. Sonipat district has a sub-tropical continental monsoon climate. The district lies in the central part of the state and having temperature regimes of hot semi-arid regions. The soil of this district are sandy to clay loam textured. It is predominantly an agricultural district. Sonipat district is divided into eight blocks, namely, Rai, Ganaur, Murthal, Kharkhoda, Sonipat, Gohana, Kathura and Mundlana Sonipat town is the headquarter of the district. . The total geographical area is 2, 13,000 hectares, out of which 1, 71,000 hectares area is cultivable. Net sown area is nearly 80.27 percent of the total area. The area sown more than once is 1, 47,000 hectares bringing the total cropped area (gross sown area) to 3, 16,000 hectares. The district has a high irrigation intensity of 187 percent. The net irrigated area by canals is 91,000 hectares and net irrigated area by tube wells is 78,000 hectares . Sonipat district is a part of the Indo-Gangetic plain. It has almost a plain topography with general slope from north to south. A natural depression exists in north and northwest of Gohana. The maximum elevation of the plain is 235 meters above mean sea level.

Water samples were collected at an interval of three to four kilometers on the kachcha, link and main roads. The elevation, longitude and latitude angles of the sampling points were recorded by GPS system at each location. All the 765ground water samples(67, from Rai,62 from Ganaur,45 from Murthal, 53 from Kharkhoda, 85 from Sonipat, 103 from Gohana, 135 from Kathura and 215 from Mundlana block) were colleced for various chemical parameters, viz. pH, EC, cations (Na^+, Ca^{+2}, Mg^{+2} and K^+) and anions (CO_3^{-2}, HCO_3^-,Cl^- and SO_4^{-2}). Subsequently, SAR and RSC were calculated for these samples. The range and mean

of different water quality parameters of these blocks are presented in various tables. Blockwise detailed studies of groundwater quality are given below.

Rai block

Total 62 groundwater samples were collected randomly. The samples were analyzed for EC, pH cations and anions. The range and mean of the different quality parameters for Rai block are given in Table 1.16. The average chemical compositions of groundwater samples in different EC classes are provided in Table 1.17.

Table 1.16: Range and mean of different water quality parameters for Rai block.

Sr. No.	Quality Parameter	Range	Mean
1	pH	6.83-8.97	7.62
2	EC (dSm^{-1})	0.24-14.86	3.00
3	RSC (me l^{-1})	0.00-5.26	0.96
4	SAR (mmol $l^{-1})^{1/2}$	1.38-25.90	9.20
5	Ca^{2+} (me l^{-1})	0.30-9.10	2.25
6	Mg^{2+} (me l^{-1})	0.90-27.10	6.63
7	Na^{+} (me l^{-1})	1.07-110.20	20.23
8	K^{+} (me l^{-1})	0.03-1.20	0.47
9	CO_3^{2-} (me l^{-1})	0.00-1.50	0.20
10	HCO_3^{-} (me l^{-1})	0.80-10.00	5.18
11	Cl^{-} (me l^{-1})	2.00-89.60	15.22
12	SO_4^{2-} (me l^{-1})	0.10-9.10	2.25

Table 1.17 Average **c**hemical composition of groundwater samples of Rai block in different EC classes

EC Classes (dSm^{-1})	Number of Samples	Percent of samples	Na^{+}	Ca^{2+}	Mg^{2+}	K^{+}	CO_3^{-2}	HCO_3^{-}	Cl^{-}	SO_4^{-2}	RSC	SAR (mmol $l^{-1})^{1/2}$
			(mel^{-1})									
0-2	27	40.30	9.39	0.99	2.94	0.47	0.15	4.32	6.42	2.29	1.64	6.70
2-4	26	38.81	18.69	2.54	7.58	0.40	0.32	5.99	13.66	7.70	0.77	8.51
4-6	9	13.43	33.99	3.72	10.39	0.49	0.14	5.63	25.56	16.16	0.00	12.83
6-8	4	5.97	50.04	3.93	11.81	0.76	0.00	4.25	42.89	17.45	0.00	18.24
>8	1	1.49	110.2	9.10	27.10	1.20	0.00	7.00	89.60	49.27	0.00	25.90

Ganaur block

Total 62 groundwater samples were collected randomly. The samples were analyzed for EC, pH cations and anions. The range and mean of the different quality parameters for Ganaur block are

given in Table 1.18. The average chemical compositions of groundwater samples in different EC classes are provided in Table 1.19.

Table 1.18. Range and mean of different water quality parameters of Ganaur block.

Sr. No.	Quality Parameter	Range	Mean	Sr. No.	Quality Parameter	Range	Mean
1	pH	7.00-8.95	7.85	7	Na^+ (me l^{-1})	3.27-46.36	11.95
2	EC (dSm^{-1})	0.50-6.01	1.76	8	K^+ (me l^{-1})	0.07-0.99	0.35
3	RSC (me l^{-1})	0.00-6.75	1.23	9	CO_3^{2-} (me l^{-1})	0.00-2.70	0.53
4	SAR (mmol $l^{-1})^{1/2}$	4.04-18.20	7.49	10	HCO_3^- (me l^{-1})	0.00-10.25	4.04
5	Ca^{2+} (me l^{-1})	0.31-3.81	1.27	11	Cl^- (me l^{-1})	1.50-39.87	7.44
6	Mg^{2+} (me l^{-1})	0.90-11.19	3.78	12	SO_4^{2-} (me l^{-1})	0.20-15.82	4.13

Table 1.19 Average Chemical composition of groundwater samples of Ganaur block in different EC classes

EC Classes (dSm^{-1})	Number of Samples	Na^+	Ca^{2+}	Mg^{2+}	K^+	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	RSC	SAR (mmol $l^{-1})^{1/2}$
		(mel^{-1})									
0-2	44	8.09	0.83	2.46	0.30	0.49	3.20	3.90	2.91	1.38	6.48
2-4	14	16.90	2.17	6.67	0.41	0.60	6.07	12.67	5.45	1.12	8.34
>4	4	37.11	2.89	8.29	0.58	0.69	6.25	28.03	12.87	0.00	15.61

Murthal block

Total 45 groundwater samples were collected randomly. The samples were analyzed for EC, pH cations and anions. The range and mean of the different quality parameters for Murthal block are given in Table 1.20. The average chemical compositions of groundwater samples in different EC classes are provided in Table 1.21.

Table 1.20 Range and mean of different water quality parameters for Murthal block

Sr. No.	Quality Parameter	Range	Mean	Sr. No.	Quality Parameter	Range	Mean
1	pH	7.00-8.49	7.70	7	Na^+ (me l^{-1})	2.20-23.48	10.02
2	EC (dSm^{-1})	0.45-3.30	1.46	8	K^+ (me l^{-1})	0.08-0.63	0.27
3	RSC (me l^{-1})	0.00-5.10	1.25	9	CO_3^{2-} (me l^{-1})	0.00-1.85	0.32
4	SAR (mmol $l^{-1})^{1/2}$	2.26-16.20	7.10	10	HCO_3^- (me l^{-1})	0.00-8.00	3.93
5	Ca^{2+} (me l^{-1})	0.40-4.00	1.11	11	Cl^- (me l^{-1})	0.50-14.64	5.75
6	Mg^{2+} (me l^{-1})	0.20-9.50	2.89	12	SO_4^{2-} (me l^{-1})	0.50-9.46	3.13

Table 1.21 Average **c**hemical composition of groundwater samples of Murthal block in different EC classes

EC Classes (dSm^{-1})	Number of Samples	Na^+	Ca^{2+}	Mg^{2+}	K^+	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	RSC	SAR $(mmol\ l^{-1})^{1/2}$
		(mel^{-1})									
0-2	40	9.12	0.99	2.65	0.27	0.33	3.83	5.12	2.58	1.28	6.76
2-4	5	17.24	2.14	4.82	0.29	0.26	4.73	10.78	7.49	1.06	9.80

Kharkhoda block

Total 53 groundwater samples were collected randomly. The samples were analyzed for EC, pH cations and anions. The range and mean of the different quality parameters for Kharkhoda block are given in Table 1.22. The average chemical compositions of groundwater samples in different EC classes are provided in Table 1.23.

Table 1.22 Range and mean of different water quality parameters for Kharkhod block

Sr. No.	Quality Parameter	Range	Mean	Sr. No.	Quality Parameter	Range	Mean
1	pH	6.50-10.36	8.03	7	Na^+ (me l^{-1})	1.90-192.87	16.86
2	EC (dSm^{-1})	0.28-23.20	2.39	8	K^+ (me l^{-1})	0.08-2.79	0.27
3	RSC (me l^{-1})	0.00-5.70	1.09	9	CO_3^{2-} (me l^{-1})	0.00-2.00	0.13
4	SAR $(mmol\ l^{-1})^{1/2}$	2.30-45.70	8.60	10	HCO_3^- (me l^{-1})	0.00-5.00	4.34
5	Ca^{2+} (me l^{-1})	0.10-11.20	1.67	11	Cl^- (me l^{-1})	0.50-98.64	10.33
6	Mg^{2+} (me l^{-1})	0.40-25.18	4.54	12	SO_4^{2-} (me l^{-1})	0.10-57.85	5.47

Table 1.23 Average **c**hemical composition of groundwater samples of Kharkhoda block in different EC classes

EC Classes (dSm^{-1})	Number of Samples	Na^+	Ca^{2+}	Mg^{2+}	K^+	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	RSC	SAR $(mmol\ l^{-1})^{1/2}$
		(mel^{-1})									
0-2	24	9.43	0.87	2.56	0.24	0.10	3.53	6.08	2.21	0.97	7.18
2-4	13	18.36	2.88	6.87	0.29	0.15	4.72	15.37	6.71	0.31	8.86
4-6	5	34.02	3.22	9.57	0.30	0.04	6.38	28.89	10.69	0.00	13.57
6-8	3	44.80	4.20	12.73	0.37	0.00	3.73	39.82	17.71	0.00	15.94
>8	8	83.32	5.71	17.87	0.71	0.00	4.25	78.27	23.53	0.00	24.26

Sonipat block

Total 85 groundwater samples were collected randomly. The samples were analyzed for EC, pH cations and anions. The range and mean of the different quality parameters for Sonipat block are given in Table 1.24. The average chemical compositions of groundwater samples in different EC classes are provided in Table 1.25.

Table 1.24 Range and mean of different water quality parameters for Sonipat block

Sr. No.	Quality Parameter	Range	Mean	Sr. No.	Quality Parameter	Range	Mean
1	pH	6.50-10.36	8.03	7	Na^+ (me l^{-1})	1.90-192.87	16.86
2	EC (dSm^{-1})	0.28-23.20	2.39	8	K^+ (me l^{-1})	0.08-2.79	0.27
3	RSC (me l^{-1})	0.00-5.70	1.09	9	CO_3^{2-} (me l^{-1})	0.00-2.00	0.13
4	SAR (mmol $l^{-1})^{1/2}$	2.30-45.70	8.60	10	HCO_3^- (me l^{-1})	0.00-5.00	4.34
5	Ca^{2+} (me l^{-1})	0.10-11.20	1.67	11	Cl^- (me l^{-1})	0.50-98.64	10.33
6	Mg^{2+} (me l^{-1})	0.40-25.18	4.54	12	SO_4^{2-} (me l^{-1})	0.10-57.85	5.47

Table 1.25 Average **c**hemical composition of groundwater samples of Sonipat block in different EC classes

EC Classes (dSm^{-1})	Number of Samples	Percent of samples	Na^+	Ca^{2+}	Mg^{2+}	K^+	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	RSC	SAR (mmol $l^{-1})^{1/2}$
			(mel^{-1})									
0-2	50	58.82	8.09	0.79	2.29	0.24	0.17	3.88	4.01	2.27	1.45	6.48
2-4	24	28.24	27.29	2.66	7.01	0.36	0.29	6.89	14.14	6.47	1.75	11.69
4-6	8	9.41	42.19	3.46	10.36	0.76	0.06	6.02	32.74	16.65	0.55	16.20
>6	3	3.53	83.34	8.27	19.26	0.39	0.00	4.33	67.63	37.90	0.00	22.15

Sonipat District

The Sonipat district forms the southern part of the Haryana state and lies between By using the latitude and longitude angles, a map is prepared for the sampling points for Sonipat district (Fig. 1.3). In the Sonipat district, electrical conductivity (EC) ranged from 0.24 to 22.32 dS/m with a mean of 2.90 dS/m (Table 1.26). It was observed that in Sonipat district, 381 samples had EC 0-2 dS/m, 215 samples had EC ranges from 2-4 dS/m, 90 samples had EC ranges from 4-6 dS/m 44 samples had EC ranges from 6-8 dS/m , 15 samples had EC ranges from 8-10 dS/m , 9 samples had EC ranges from 10-12 dS/m and 10 samples had EC ranges from >12 dS/m (Table 1.27). To study the spatial distribution of EC in the whole district, a spatial variable map was prepared by using ArcGIS through the interpolation of the available data at 765 sampling points (Fig. 1.4). The variation of EC in Sonipat district is grouped into7 classes with a class interval of 2dS/m. The most dominating range of EC is 0-2 dS/m which occupied maximum area in the district and covering all the blocks of the district. The next dominating range was 2-4 dS/m which is covering a large portion. EC ranging from 10-12 and >12 dS/m is observed in small sport in the district. The pH ranged from 6.50 to 11.50 with a mean of 8.04 (Table 1.26). The sodium adsorption ratio (SAR) were found to be ranged between from 0.22 to 45.68 (mmol $l^{-1})^{1/2}$ with a mean value of 9.14 (mmol $l^{-1})^{1/2}$. The residual sodium carbonate (RSC) was found to be ranged between from 0.00 to 14.40 mel^{-1} with a mean value of 1.32 mel^{-1}. Spatial variability of RSC of groundwater used for irrigation in Sonipat district presented in (Fig. 1.5). Spatial variability of SAR of groundwater used for irrigation in Sonipat district district presented in (Fig. 1.6). In case of anions, chloride was the dominant anion with maximum the concentration of chlorides in groundwater samples varied from 0.50 to 133.60 mel^{-1} with the mean value of 13.75 me l^{-1}.

The concentration of bicarbonates in groundwater samples varied from 0.00 to 120.00 mel^{-1} with a mean value of 4.71 me l^{-1}. The mean values for CO_3^{2-}, HCO_3^-, Cl^- and SO_4^{2-} were found to be 0.84, 4.71, 13.75 and 9.18mel^{-1}, respectively (Table 1.26). Table 1.27 and Fig. 1.7 illustrate the mean of anions according to the EC classes in district, the Cl^- was the highest and its value increased with the increase in EC.

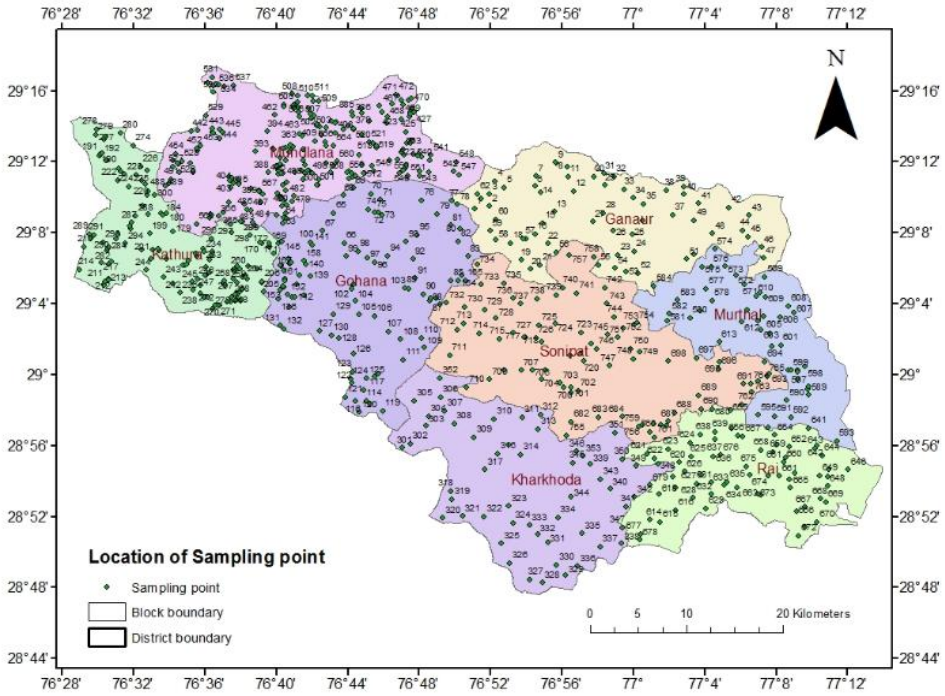


Fig. 1.3 Location map of the sampling points in Sonipat district

Table 1.26 Range and mean of different water quality parameters for Sonipat district

Sr. No.	Quality Parameter	Range	Mean
1	pH	6.50-11.50	8.04
2	EC (dSm^{-1})	0.24-22.32	2.90
3	RSC (me l^{-1})	0.00-14.40	1.32
4	SAR (mmol $l^{-1})^{1/2}$	0.22-45.68	9.14
5	Ca^{2+} (me l^{-1})	0.10-39.40	2.68
6	Mg^{2+} (me l^{-1})	0.20-44.75	6.58
7	Na^+ (me l^{-1})	0.37-192.87	19.45
8	K^+ (me l^{-1})	0.06-2.79	0.39
9	CO_3^{2-} (me l^{-1})	0.00-0.80	0.84
10	HCO_3^- (me l^{-1})	0.00-120.00	4.71
11	Cl^- (me l^{-1})	0.50-133.60	13.75
12	SO_4^{2-} (me l^{-1})	0.00-86.76	9.18

Table 1.27 Chemical composition of groundwater samples of Sonipat district in different EC classes

EC Classes (dSm^{-1})	No. of samples	Na^{+}	Ca^{2+}	Mg^{2+}	K^{+}	CO_3^{-2}	HCO_3^{-}	Cl^{-}	SO_4^{-2}	RSC	SAR
		----------(mel^{-1})----------									(mmol $l^{-1})^{1/2}$
0-2	381	8.23	0.92	2.38	0.21	0.10	2.44	3.83	2.61	0.00	5.56
2-4	215	18.54	2.33	6.68	0.39	0.89	5.27	11.65	9.60	0.68	9.81
4-6	90	32.52	4.02	11.32	0.60	1.76	7.19	24.46	18.26	4.17	13.44
6-8	44	45.46	6.53	16.78	0.85	2.51	8.42	42.38	22.06	5.19	16.71
8-10	15	61.34	11.02	20.80	1.02	3.24	9.88	56.47	30.03	6.36	20.20
10-12	9	76.07	14.95	26.89	1.32	3.84	11.38	67.22	35.48	7.33	22.40
>12	10	116.77	24.43	32.89	1.80	5.56	25.89	98.27	56.71	9.46	29.46

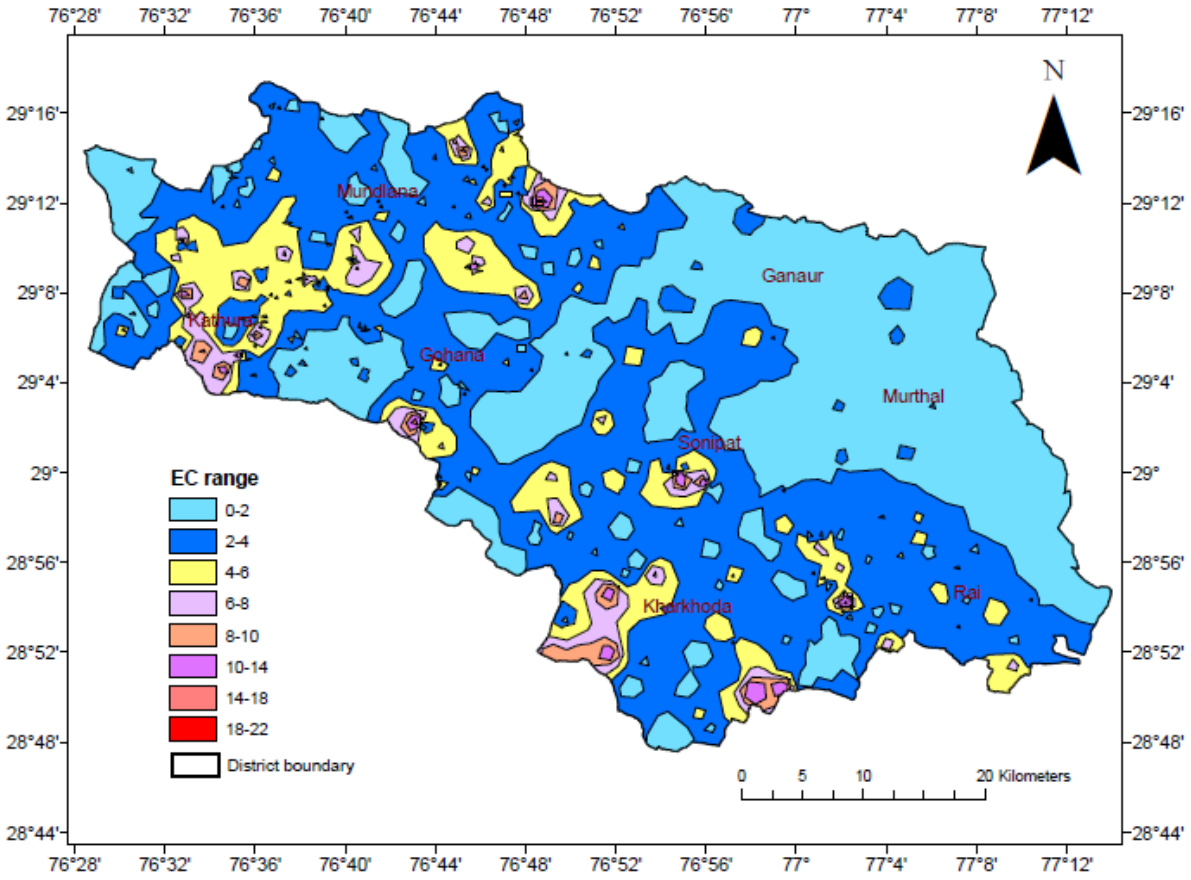


Fig. 1.4 Spatial variability of EC of groundwater used for irrigation in Sonipat district

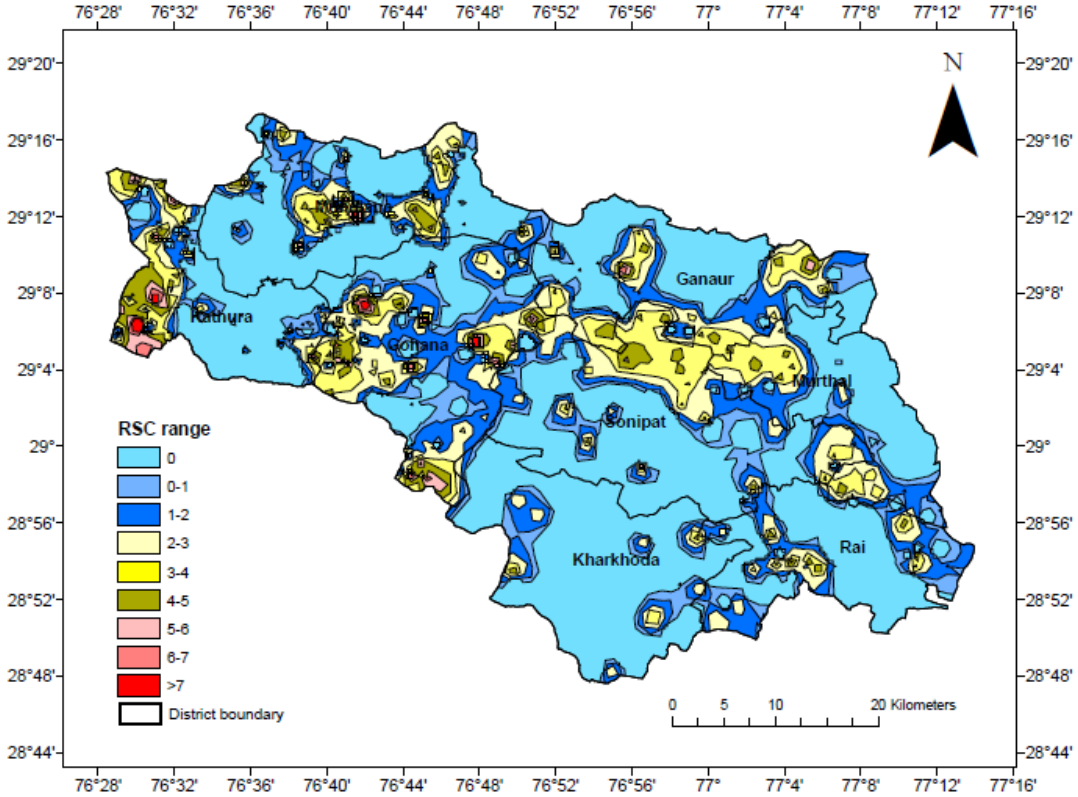


Fig.1.5 Spatial variability of RSC of groundwater used for irrigation in Sonipat district

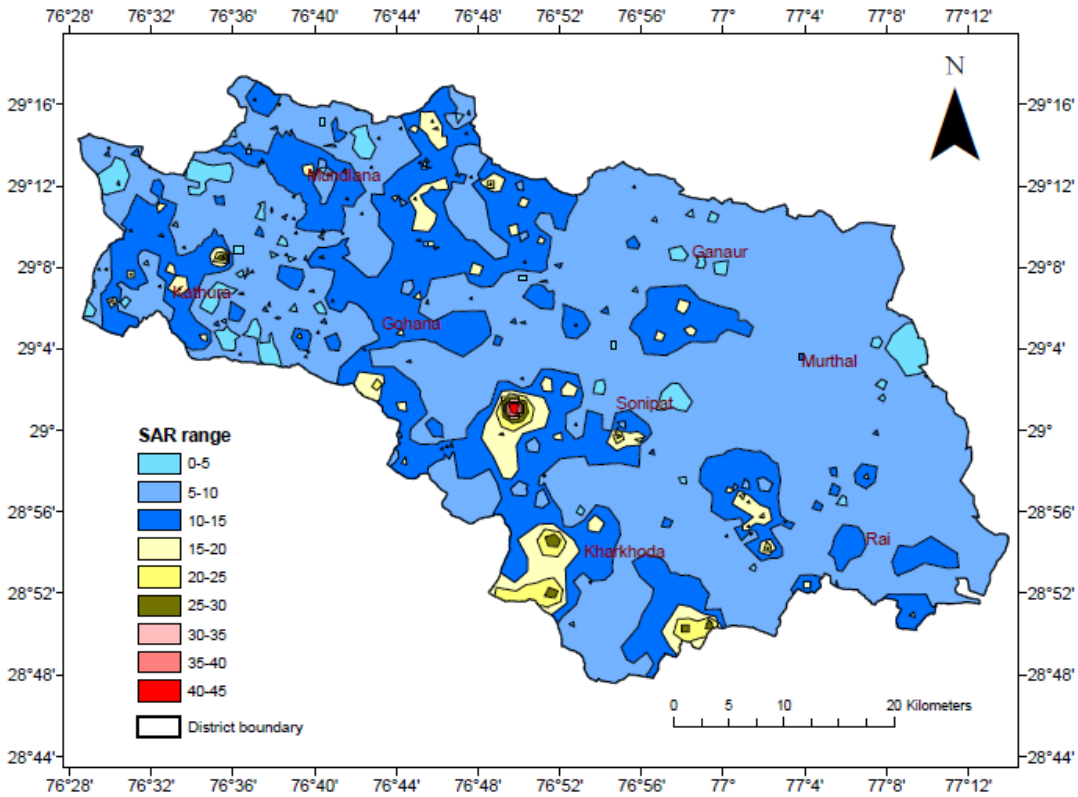


Fig. 1.6 Spatial variability of SAR of groundwater used for irrigation in Sonipat district

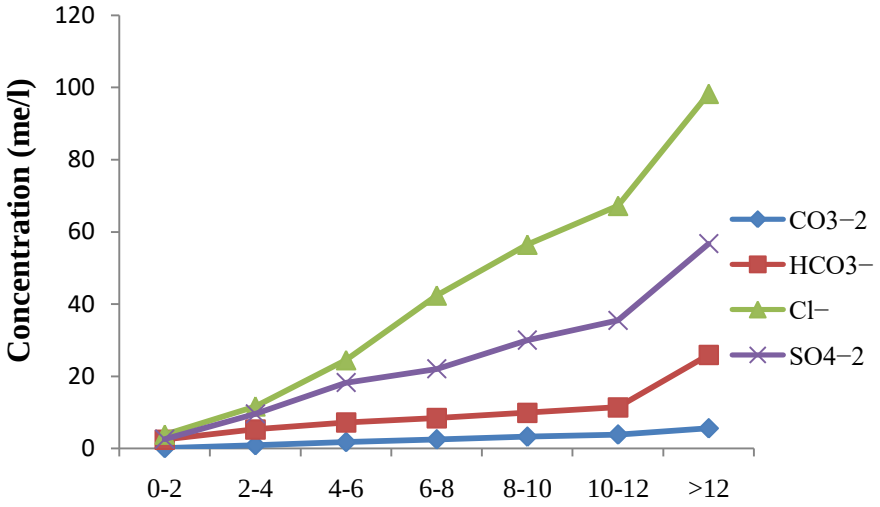


Fig. 1.7 Anions (CO_3^{-2}, HCO_3^{-}, Cl^{-} and SO_4^{-2}) concentration (me/l) in different EC classes of Sonipat district

The concentration of sodium in groundwater samples varied from 0.37 to 192.87 mel^{-1} with an average value of 19.45 mel^{-1} (Table 1.26), followed by magnesium (0.20 to 44.75 mel^{-1}) and calcium (0.10 to 39.40 me/l). Mean values for Na^{+}, Mg^{2+}, Ca^{2+} and K^{+} were 19.45, 6.58, 2.68 and 0.39 me/l, respectively. Table 1.27 and Fig. 1.8 illustrates the mean of cation according to the different EC classes in Sonipat district, Na^{+} was the highest and its value increased with the increase in EC. Its lowest mean value (8.23 me/l) was found in the class 0-2, the highest mean value (116.77 me/l) was laid in the EC class of >12 dS/m.

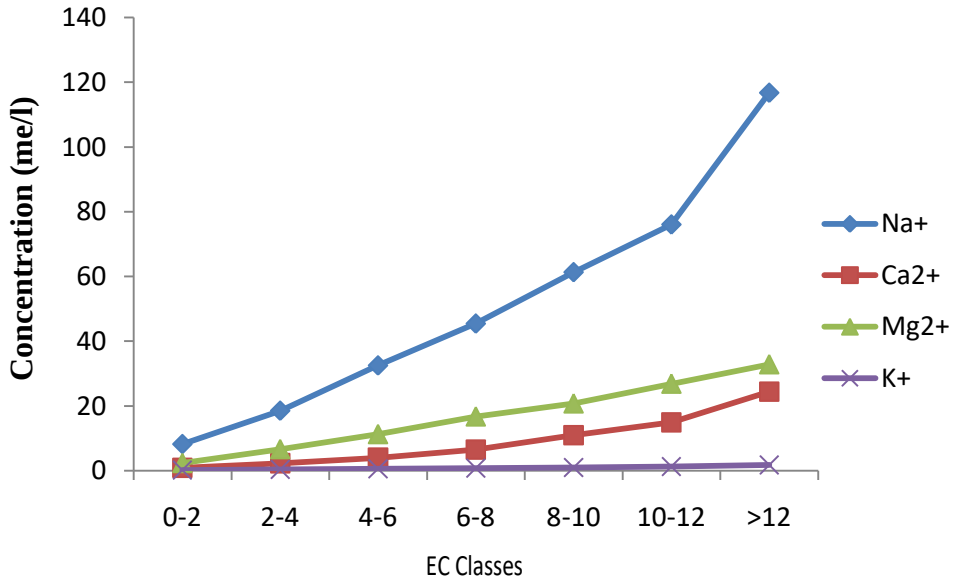


Fig. 1.8 Cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) concentration (me/l) in different EC classes of Sonipat district

According to AICRP classification, it was found that overall in Sonipat district, 31.37, 19.48, 4.44, 18.56, 6.54, 3.66 and 15.95 per cent samples were found in good, marginally saline, saline, high SAR saline, marginally alkali, alkali and highly alkali categories, respectively. Groundwater quality map for Sonipat district according to AICRP criteria was prepared to study its spatial variability in the district (Fig. 1.9). In the district, 31.37 percent samples are under good category but spatial variable map of block indicates less area under good quality. This is due to higher concentration of tubewells in that area and accordingly more samples were collected from that area. Good category groundwater is 22.39% in Rai, 48.39% in Ganaur block 62.22% in Murthal block, 27.18% in Gohana, 28.15% in Kathura, 32.08% in Mundlana block block and 35.29% in Sonipat block of the district and highly scattered in other blocks. Area of the district having EC < 2 can come under good quality category but among these area where SAR < 10 and RSC ≥ 2.5 will come under marginally alkali and alkali. Most of the area where EC is more than 4 dS/m went under high SAR saline in comparison to saline condition, whereas, in both condition EC is more than 4 dS/m. With this fact area under high SAR saline is increased and area under saline condition is reduced. There is a little problem of alkalinity in groundwater of the district because marginally alkali and alkali categories were observed very scattered with small polygons.

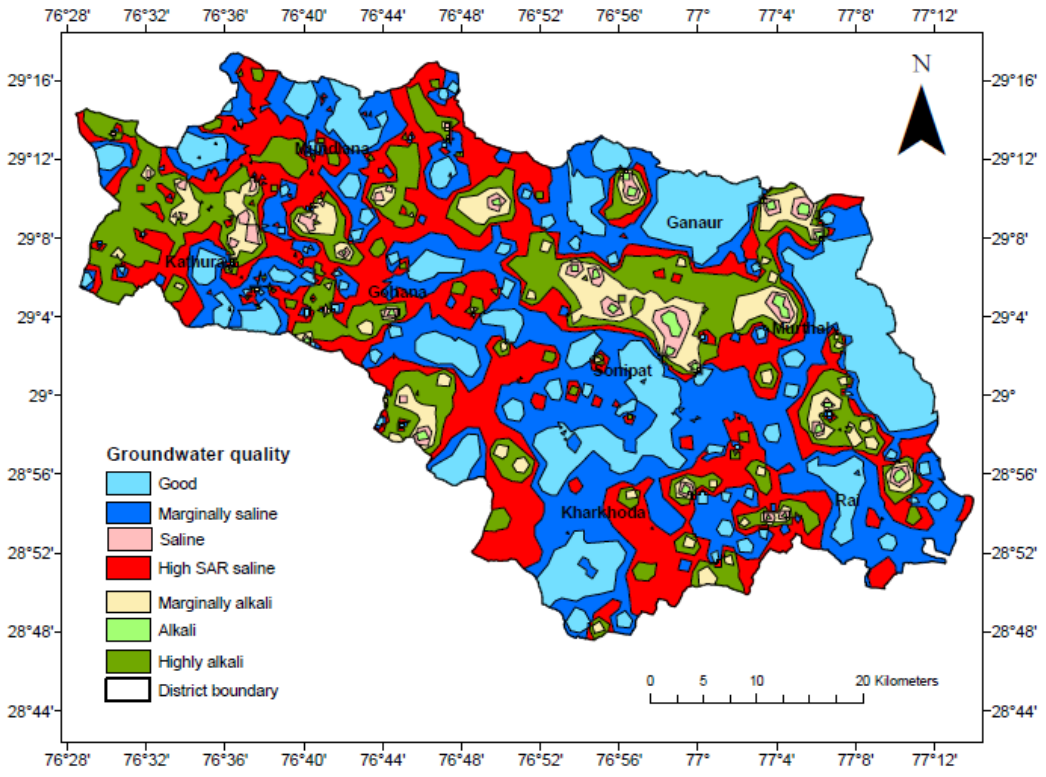


Fig. 1.9 Groundwater quality map for Sonipat district according to AICRP criteria

- **Survey and characterization of groundwater quality of Villupuram district of Tamil Nadu for irrigation purpose (Tiruchirappalli)**

The Villupuram District lies between 11 38' 25" N and 12 20' 44" S: 78 15' 00" W and 79 42' 55" E with an area of 7222.03 ha. It was carved out from the South Arcot District on 30.09.1993 and was rechristened as Viluppuram district. It is surrounded on East and South by Cuddalore district, in the West by Salem and Dharmapuri and on the North by Thiruvannamalai and Kanchipuram district. The

average rainfall of the district is 1060.3 mm. Villupuram district can be divided into 3 classes' *viz.,* Hilly terrains, Plain terrain and coastal plains. The hills are found in the western part of the district and they are Kalrayan and Ginjee hills falling under Kallakurichi and Ginjee taluks respectively. Plain terrain occurs in the middle part of this district, while the coastal plains lie in the eastern part of the district in and around Marakanam and Vanur taluks. The major rivers draining the district are Tondiar, Pennaiyar and Vellar. The groundwater resources have been estimated jointly by Central Ground Water Board, State Ground and Surface Water Resources and Development Centre (PWD, WRO, and Government of Tamil Nadu) as on 31st March 2004. The chemical characteristics of groundwater in the phreatic zone in Villupuram district has been studied using the analytical data of groundwater samples collected from Network Hydrograph Stations of Central Ground Water Board. The study of quality of groundwater in phreatic aquifers in the district has been attempted using the data collected from exploratory bore/tube wells constructed in the district. Groundwater in Villupuram District, in general, is colourless, odourless and slightly alkaline in nature. Villupuram comes under the North Eastern climatic zones. The number of samples collected from different blocks tends to marginally saline and saline due to seawater instruction is primary source for salinity. To characterize the ground water quality of Villupuram district, 130 water samples were collected from 13 blocks (*viz.,* Mailam, Vanur, Melmalayanur, Gingee, Vikkravandi, Kanai, Mugaiyur, Thiruvennainalur, Marakkanam, Vanur, Olakkur, Koliyanur, Kandamangalam.) of Villupuram district based on GPS location. The water samples were analyzed for pH, EC, cations (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) and anions (CO_3^{2-}, HCO_3^{-}, Cl^{-} and SO_4^{2-}). Quality parameters like SAR and RSC were calculated. Screening of ground water samples for their suitability to irrigation is done on the basis of EC, SAR, RSC values as suggested by AICRP (1989) and thematic map pertaining to ground water quality was prepared using RS – Arc GIS software. The ranges for groundwater pH, EC, Residual Sodium Carbonate (RSC) and SodiumAdsorption Ratio (SAR) for different blocks are given in Table 1.28.

Table 1.28. Quality of ground waters in different blocks of Villupuram district

Name of the block	pH			EC (dSm^{-1})			SAR			RSC ($meq.l^{-1}$)		
	minimum	maximum	mean	minimum	maximum	mean	minimum	maximum	mean	minimum	maximum	mean
Mailam	7.3	8.1	7.7	0.35	4.02	0.98	0.25	2.47	0.69	0.6	6.8	3.75
Vallam	7.2	8.0	7.7	0.71	2.83	1.53	0.36	1.46	0.75	0.0	10.7	5.0
Melmalayanur	7.4	7.9	7.7	0.61	3.44	1.21	0.31	2.04	0.82	3.6	7.6	6.4
Gingee	7.4	8.1	7.6	0.77	2.23	1.12	0.35	2.57	0.93	Nil	10.4	7.8
Vikkravandi	7.2	8.3	7.7	0.48	4.81	1.59	0.32	7.17	1.17	4.0	14.3	6.0
Kanai	7.2	7.9	7.5	0.96	3.6	2.03	0.29	3.20	1.19	0.1	7.6	4.0
Mugaiyur	7.1	8.4	7.8	0.44	3.34	1.63	0.26	2.38	1.02	1.1	8.6	6.0
Thiruvennainallur	7.5	8.0	7.7	0.9	2.04	1.04	0.62	2.24	0.92	4	8.9	5.5
Marakkanam	7.0	8.4	7.9	0.27	4.35	1.49	0.28	20.31	1.00	Nil	11.1	4.6
Vanur	7.1	8.4	7.5	0.4	3.91	1.05	0.26	1.80	0.66	Nil	8.2	6.2
Olakkur	7.4	8.5	7.8	0.44	2.46	1.29	2.8	13.10	6.05	0.23	2.27	1.0
Koliyannur	7.7	8.2	8.1	0.55	2.83	1.54	1.47	4.75	2.27	6.3	16.7	9.3
Kandamangalam	7.4	8.3	7.6	1.05	2.15	1.60	1.47	2.37	1.71	7.6	11.0	8.9

Water quality distribution (%) in Villupuram district

The concentrations of cations and anions in different blocks of Villupuram district are given in (Table 1.29). The distribution of water samples in different water quality classes reveals that the samples of Alkali category groundwater was found in all the blocks and recorded highest in Koliyanur and Kandamangalam blocks (100%), Vikkravandi (92.3%), Thiruvennainallur (87.5%), Olakkur and Melmalayanur blocks (80%), Mugaiyur (76.9%), Vanur (75%), Gingee (64.3%), Marakkanam (63.6%), Vallam (62.5%), Kanai(46.2%), Mailam (33.3%). The Marginal Alkali water was found highest in Kanai Block (46.2%), followed by Mailam (41.7%), Melmalayanur and Olakkur blocks (20%), Vallam (18.8%), Marakkanam (18.2%), Vanur (16.7%), Mugaiyur (15.4%), Thiruvennainallur (12.5%), Vikkravandi (7.7%). The samples of good quality groundwater were found in Mailam (25%), Vallam (18.8%), Kanai (7.7%), and Gingee (7.1%). The samples of Marginal saline quality groundwater were found in Marakkanam (9.1%), Vanur (8.3%), and Mugaiyur (7.7%). The High-SAR saline water was only found in Marakkanam (9.1%). Groundwater samples of saline and high alkali quality were not observed in any of the Villupuram district blocks (Tables 1.30). The spatial distribution of groundwater quality categories is provided in Fig. 1.10. The cationic order of groundwater in all blocks was Mg^{2+}> Ca^{2+}>Na^{+}>K^{+} while anionic order was Cl^{-} >HCO_3^{-} > CO_3^{2-}>$SO4^{2-}$.

Table 1.29.Cationic and anionic pattern in different blocks of Villupuram district

S.No	Block Name	Cations($meqL^{-1}$)				Anions($meqL^{-1}$)			
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
1	Mailam	1.55	1.8	0.80	0.02	2.0	6.0	6.5	0.29
2	Vallam	2.10	2.0	1.33	0.05	4.0	5.5	8.5	0.40
3	Melmalayanur	2.05	1.4	1.10	0.04	4.0	6.5	8.0	0.36
4	Gingee	1.75	1.5	1.54	0.03	4.0	7.0	9.0	0.69
5	Vikkravandi	2.30	1.9	1.60	0.04	4.0	6.0	12.0	0.33
4	Kanai	2.40	2.4	2.08	0.07	4.0	5.0	18.0	0.50
7	Mugaiyur	1.50	2.2	1.52	0.07	4.0	5.0	12.0	0.50
8	Thiruvennainallur	1.85	1.6	1.15	0.05	6.0	4.5	8.0	0.42
9	Marakkanam	1.60	4.0	1.16	0.02	4.0	5.0	8.0	0.44
10	Vanur	1.60	2.4	0.88	0.05	4.0	6.0	6.5	0.42
11	Olakkur	1.45	2.5	1.79	0.30	4.0	6.0	8.0	0.39
12	Koliyannur	0.90	1.2	2.48	1.03	6.0	2.0	10.0	0.48
13	Kandamangalam	1.65	1.85	2.27	1.03	7.0	5.5	12.0	0.64

Table 1.30. Water quality distribution (%) in Villupuram district

S. No	Block	No. of samples	Good	MS	Saline	HSS	MA	Alkali	HA
1.	Mailam	12	25.0	-	-	-	41.7	33.3	-
2.	Vallam	16	18.8	-	-	-	18.8	62.5	-
3.	Melmalayanur	10	-	-	-	-	20.0	80.0	-
4.	Gingee	14	7.1	-	-	-	-	64.3	-
5.	Vikkravandi	13	-	-	-	-	7.7	92.3	-
6.	Kanai	13	7.7	-	-	-	46.2	46.2	-
7.	Mugaiyur	13	-	7.7		-	15.4	76.9	-
8.	Thiruvennainallur	08	-	-	-	-	12.5	87.5	-
9	Marakkanam	11	-	9.1	-	9.1	18.2	63.6	-
10.	Vanur	12	-	8.3	-	-	16.7	75.0	-
11.	Olakkur	10	-	-	-	-	20.0	80.0	-
12.	Koliyanur	05	-	-	-	-	-	100.0	-
13.	Kandamangalam	06	-	-	-	-	-	100.0	-
	Average	143	6	2	-	1	18	73	-

Marginal Saline (MS), High-SAR Saline (HSS), Marginally Alkali (MA), High Alkali (HA)

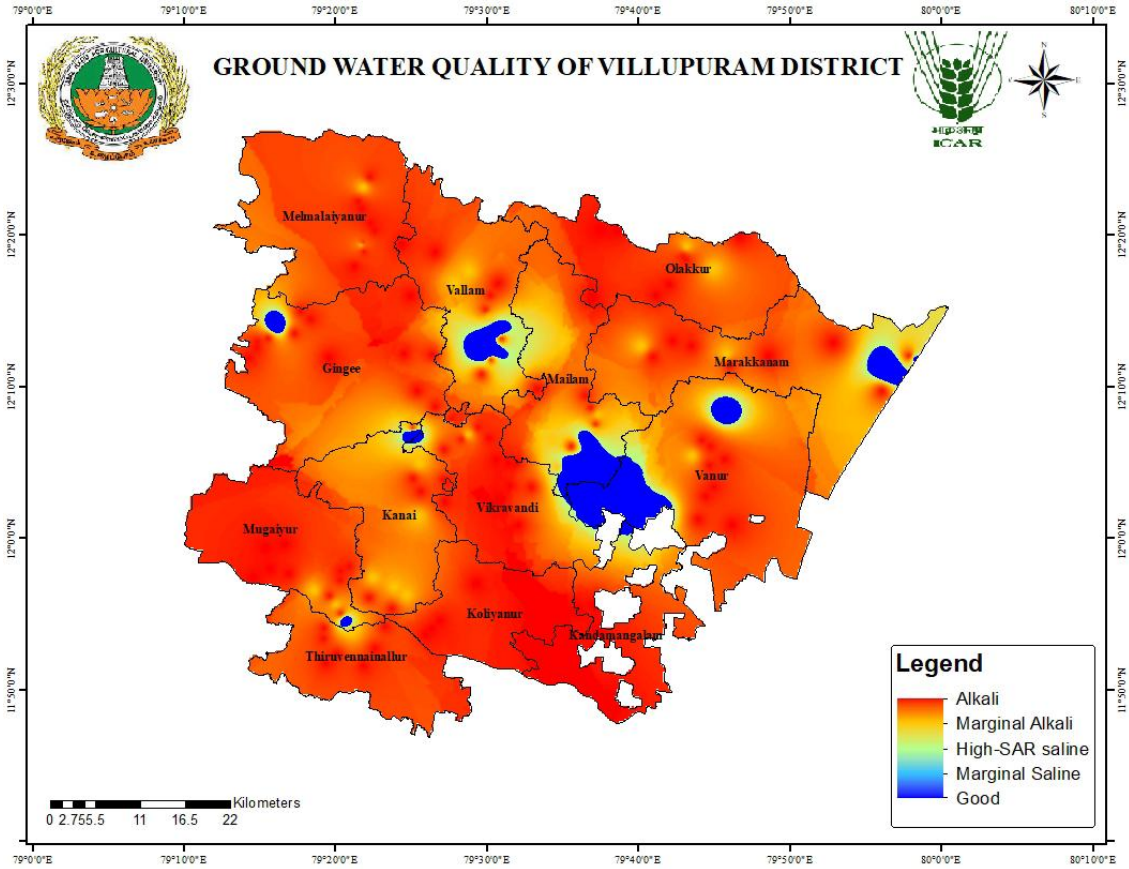


Fig 1.10. Spatial distribution of different categories of groundwater quality in Villupuram district

- **Survey and characterization of groundwater quality of Pudukottai district of Tamil Nadu for irrigation purpose (Tiruchirappalli)**

Pudukkottai district has an area of 4663 sq.km with a coast line of 42.8 km which includes 32 coastal villages and towns. The district lies between 78° 25' and 79° 15’ of the Eastern Longitude and between 9° 50' and 10° 40’ of the Northern Latitude. The total geographical areas of the district are accounting for 3.58% of the total geographical area of Tamilnadu State. The district is bounded by Thanjavur district in the Northeast and East, Tiruchirappalli district in the Northwest, Ramanathapuram and Sivaganga district in the Southwest, Palk Strait in the Southeast.The district is characterised by an undulating topography with residual hills in the northern, western and southern parts of the district, where as in the eastern part of the district is a flat terrain consisting of alluvial plains. Generally, there are 13 blocks in Pudukkottai district like Annavasal, Arimalam, Kunnandarkoil, Ponnamaravathi, Pudukkottai, Thirumayam, Viralimalai, Aranthangi, Avudaiyarkoil, Gandarvakottai, Karambakudi, Manalmelkudi, Thiruvarankulam. In which Manalmelkudi, Avudaiyarkoil blocks are comes under coastal line. High temperature throughout the year. The temperature ranges from 15.50 to 43.00. The hottest months are April to June, and the coldest months are November to January. Generally, a dry and hot climate prevails in this District. The normal annual rainfall of Pudukkottai district is 910 mm. During Northeast monsoons this district receives the highest rainfall of 427 mm followed by, South west monsoon with 340 mm of rainfall. The summer and winter rainfalls are 91 mm and 52 mm, respectively. Totally, 149 groundwater samples were gathered based on grid survey during the month of March 2020 in the Pudukkottai district. The coordinates of the sample location were recorded using a handheld GPS receiver (GPS,

Garmin). A pre-cleaned plastic polyethylene bottle was used to collect samples. Before sampling, all the sampling containers were carefully cleansed and rinsed with groundwater. The ranges for groundwater pH, EC, Residual Sodium Carbonate (RSC) and Sodium Adsorption Ratio (SAR) for different blocks are given in Table 1.31.

Table 1.31 Quality of ground waters in different blocks of Pudukkottai District

Name of the blocks	Range/ Mean	pH	EC (dsm^{-1})	SAR	RSC($meq\ L^{-1}$)
Viralimalai	Min	7.61	0.58	0.187	-15.49
	Max	8.43	4.33	11.65	6.82
	Mean	7.82	1.51	4.255	-0.443
Annavasal	Min	7.6	0.59	0.84	-6.82
	Max	8.37	2.47	11.54	8.64
	Mean	7.85	1.364	5.30	0.474
Ponnamaravathi	Min	7.54	0.61	1.627	-11.3
	Max	8.53	2.8	12.68	7.86
	Mean	8.02	1.91	5.43	-0.87
Avadaiyurkovil	Min	7.70	0.54	4.46	-12.9
	Max	8.59	78.25	44.61	7.08
	Mean	8.23	7.92	24.38	-6.73
Manamelkudi	Min	7.89	1.55	5.051	-14.9
	Max	8.62	5.18	28.51	13.67
	Mean	8.20	2.77	14.04	0.587
Arantangi	Min	7.40	0.44	2.58	-11.1
	Max	8.42	3.55	12.8	3.39
	Mean	7.80	1.56	8.27	-0.86
Thirumayam	Min	7.47	0.69	2.23	-5.32
	Max	8.29	3.29	10.30	6.72
	Mean	7.88	1.69	5.39	0.331
Arimalam	Min	7.52	0.46	1.85	0.72
	Max	8.18	2.99	7.23	9.03
	Mean	7.71	1.08	3.426	2082
Thiruvarankulam	Min	7.28	0.06	1.95	-2.1
	Max	7.92	1.94	4.97	6.2
	Mean	7.63	0.996	3.58	1.81
Pudukkottai	Min	7.53	0.65	4.08	1.66
	Max	8.26	2.53	27.39	12.9
	Mean	7.86	1.52	12.91	5.85
Kunnandarkovil	Min	7.45	0.21	1.89	-0.8
	Max	7.93	1.91	5.82	6.7
	Mean	7.68	0.99	3.50	3.39
Gandarvakottai	Min	7.45	0.25	0.49	-1.8
	Max	7.9	1.5	7.44	4.8
	Mean	7.61	0.733	2.56	1.62
Karambakudi	Min	7.49	0.37	1.99	-9.5
	Max	7.95	1.98	3.6	4.1
	Mean	7.645	0.84	2.72	1.06

The samples were analyzed for pH, Electrical Conductivity (EC), cations *viz.,* Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} and anions *viz.,* CO_3^{2-}, HCO_3^{-}, Cl^{-} and SO_4^{2-} by standard procedure (Table 1.32).

Table 1.32 Cationic and anionic pattern in different blocks of Pudukkottai district

S. NO	Block name	Cations ($meqL^{-1}$)				Anions ($meqL^{-1}$)			
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	$CO3^{2-}$	$HCO3^{-}$	Cl^{-}	$SO4^{2-}$
1.	Viralimalai	4.54	5.43	9.44	0.58	3.28	6.25	9.10	0.61
2.	Annavasal	4.20	4.99	10.79	0.41	3.32	6.35	8.71	0.33
3.	Ponnamaravathi	4.73	6.82	12.60	1.84	3.90	6.78	12.20	0.61
4.	Avadaiyurkovil	4.84	10.30	53.88	3.35	2.69	5.72	57.76	1.32
5.	Manamelkudi	4.61	5.83	28.04	1.11	3.89	7.13	22.80	1.19
6.	Arantangi	4.49	3.35	16.60	0.45	2.39	4.59	13.85	0.33
7.	Thirumayam	3.39	7.01	12.46	0.36	2.78	7.95	13.10	0.44
8.	Arimalam	2.54	4.07	6.37	0.25	3.14	6.28	5.56	0.51
9.	Thiruvarankulam	3.35	3.25	6.64	0.96	2.76	5.65	5.75	0.34
10.	Pudukkottai	1.83	4.06	20.04	0.27	3.79	7.95	9.70	0.76
11.	Kunnandarkovil	2.09	3.15	5.63	0.21	3.09	5.55	4.69	0.24
12.	Gandarvakottai	2.15	2.68	4.01	0.19	2.00	4.45	4.44	0.19
13.	Karambakudi	2.68	3.16	4.46	0.37	2.20	4.70	4.80	0.19

Out of the total samples collected in Pudukkottai district 45 per cent of groundwater were found as good quality and its remaining samples were found in different categories of water quality *viz.,* Marginally saline (12%), Saline (1%), High-SAR saline (4%), Marginally alkali (14%), Alkali (14%) and High alkali (10%). Among the different blocks investigated, the highest percentage of samples with good quality was found in Thiruvarankulam (75%), Viralimalai (62.5%), Gandarvakottai (55%), Arantangi (55%), Arimalam (55%), Annavasal (50%) and Thirumayam (50%)(Table 1.33).

Table 1.33Water quality distribution (%) in Pudukkottai district

S. No	Block	No. of samples	Good	MS	Saline	HSS	MA	Alkali	HA
1.	Viralimalai	16	62.50	19.00			12.50	6.25	
2.	Annavasal	14	50.00	14.00			7.00	22.00	7.00
3.	Ponnamaravathi	14	28.60	35.00			21.50	7.00	7.00
4.	Avadaiyurkovil	15	13.00		6.70	33.0	7.00	7.00	33.00
5.	Manamelkudi	14	21.50	36.00		7.0			35.00
6.	Arantangi	11	55.00	10.00		18.2	18.00		
7.	Thirumayam	8	50.00	25.00				25.00	
8.	Arimalam	9	55.00	11.00			22.00	11.11	
9.	Thiruvarankulam	8	75.00					25.00	
10.	Pudukkottai	8	25.00				12.50	12.50	50
11.	Kunnandarkovil	11	45.00				10.00	45.45	
12.	Gandarvakottai	11	55.00				36.40	10.00	
13.	Karambakudi	10	50.00				40.00	10.00	
	Average	**149**	**45**	**12**	**1**	**4**	**14**	**14**	**10**

Marginal Saline (MS), High-SAR Saline (HSS), Marginally Alkali (MA), High Alkali (HA)

Other quality parameters such as the Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) were estimated. Screening of groundwater samples for their suitability to irrigation is done on the basis of EC, SAR and RSC values as suggested by Central soil salinity Research Institute, Karnal and Thematic maps pertaining to groundwater quality were prepared using Arc GIS software 10.1. The spatial distribution of groundwater quality categories of Pudukkottai districtis provided in Fig. 1.11.

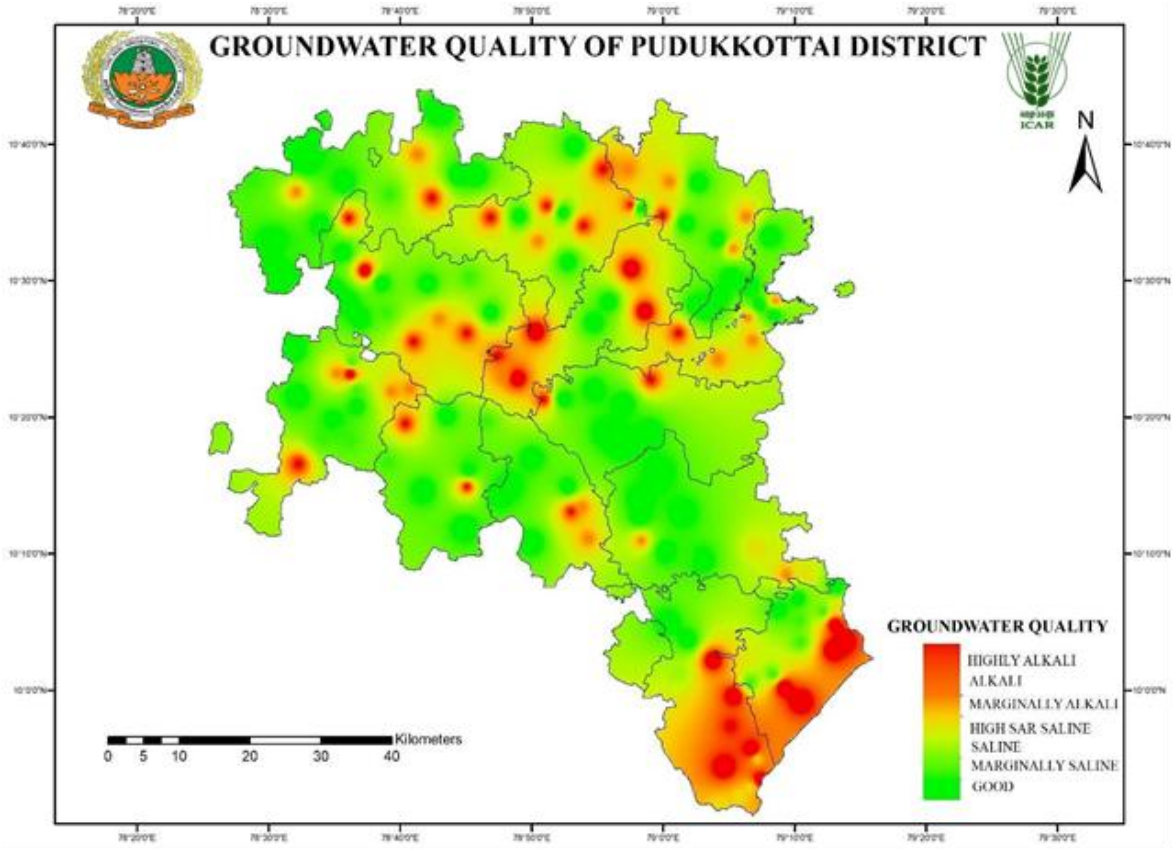


Fig 1.11 Spatial distribution of different categories of groundwater quality in Pudukkottai district

- **Survey and characterization of underground irrigation water of Faridkot, district, Punjab (Bathinda)**

The map of Faridkot district is shown in Fig. 1.12. The district is divided into three (3) tehsils *viz* Faridkot, Jaitu and Kotkapura. The ranges of chemical constituents of groundwater are presented in Table 1.34. The high pH of water was reported in Faridkot tehsil followed by Kotkapura and Jaitu.

The electrical conductivity (EC) ranged between 0.46-9.50 dSm^{-1} with mean of 3.51 dSm^{-1}, 0.24-10.50 dSm^{-1} with mean of 2.85 dSm^{-1} and 0.50-5.50 dSm^{-1} with mean of 2.43 dSm^{-1} in Faridkot, Jaitu and Kotkapura tehsils, respectively. Jaitutesil hadn higher RSC (2.85 meL^{-1}) followed by Kotkapura (2.8 meL^{-1}) and Faridkot tehsil (1.66 meL^{-1}). Whereas, maximum Ca^{+2} + Mg^{+2} was reported in Faridkot tehsil and minimum average value was recorded in Kotkapura tehsil. Among the anions, chloride was dominant ion with values ranging from 0.40 to 22.20 meL^{-1} followed by the bicarbonate (0.10-13.0 me L^{-1}) and carbonate (0.0 to 0.80 me L^{-1}).

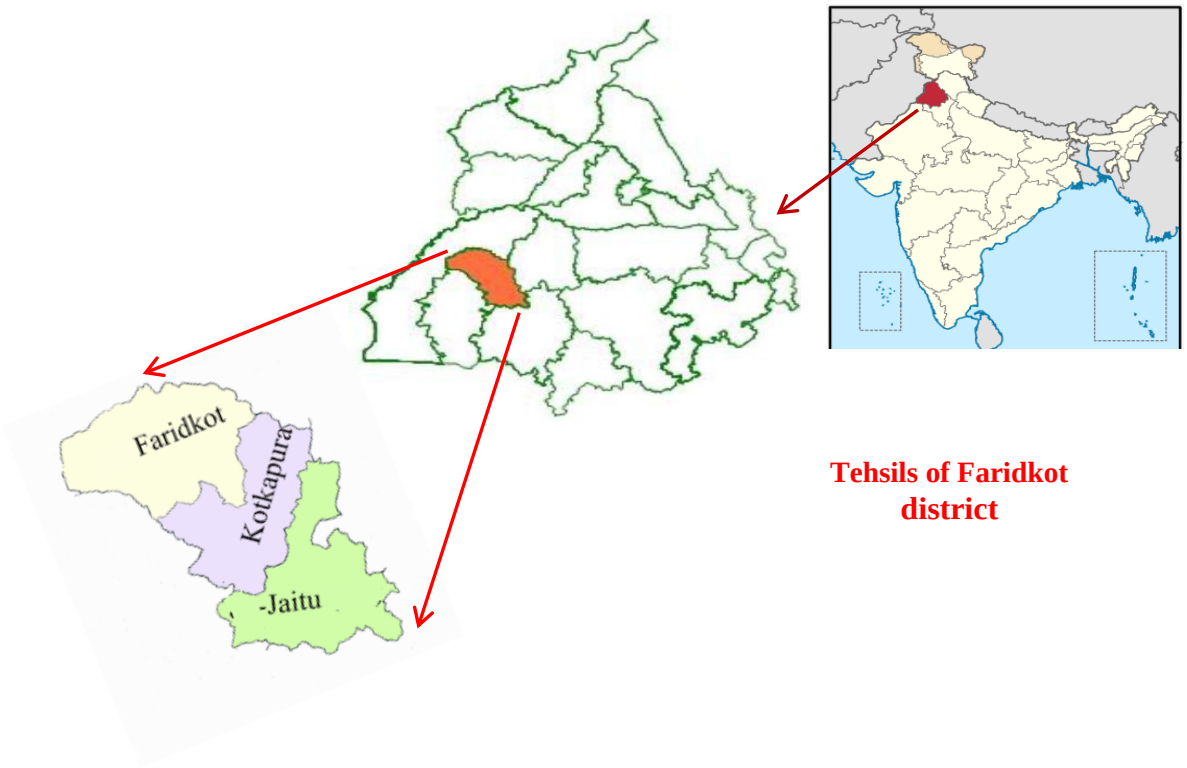


Fig. 1.12 Location of the surveyed area

Table 1.34.Range and average of different chemical constituents of ground water in Faridkot District

Name of Blocks	Faridkot		Jaitu		Kotkapura	
Parameters	Range	Average	Range	Average	Range	Average
pH	7.24-10.20	8.57	7.05-9.15	7.93	7.28-9.25	8.19
EC (dSm^{-1})	0.46-9.50	3.51	0.24-10.50	2.85	0.50-5.50	2.43
Ca^{+2} +Mg^{+2}($me\ L^{-1}$)	2.30-68.0	6.81	1.0-18.10	5.57	0.80-10.50	3.93
Cl^{-1} ($me\ L^{-1}$)	0.50-18.0	6.06	0.40-22.20	5.59	1.0-9.0	3.70
CO_3^{-2} ($me\ L^{-1}$)	0.0-0.60	0.31	0.0-0.80	0.25	0.0-0.60	0.27
HCO_3^{-} ($me\ L^{-1}$)	1.20-11.0	5.22	1.60-13.0	6.38	0.10-12.20	6.10
RSC ($me\ L^{-1}$)	0.0-4.90	1.66	0.0-8.0	2.85	0.0-8.20	2.80
SAR (m mol/l)	0.55-39.68	3.31	1.06-58.28	7.37	3.23-46.99	10.55
K (ppm)	4.50-256.0	53.40	7.90-526.0	47.51	1.23-352.0	40.35
Na ($me\ L^{-1}$)	1.27-46.74	5.58	1.41-131.6	12.26	6.30-70.48	13.99

The distribution of water samples in different ranges of electrical conductivity (EC) were given in Table 1.35. The EC of majority of the cases i.e. 29 % in Faridkot, 22 % in Jaitu and 29 % in Kotkapur was less than 2 dS m^{-1}. Whereas, 35 % in Faridkot, 65 % in Jaitu and 67 % in Kotkapur tehsil were observed between 2 to 4 dSm^{-1} and EC of remaining samples was more than 4 dSm^{-1}. It is reported that based on electrical conductivity only 26 % water could be used without any possible risk of soil salinization. Further, 57% water was rated as marginal (EC, 2 to 4 dSm^{-1}) for irrigation and 17% water was not suitable for irrigation due to their higher electrical conductivity.

Table 1.35: Percent (%) distribution of water samples of Faridlot district in different water quality

Tehsil/ Block	EC (dS/m)			RSC (meq/L)			SAR(m mol/L)	
	<2.0	2.0-4.0	>4.0	<2.5	2.5-5.0	>5.0	<10	>10
Faridkot	28.66	34.76	36.58	90.24	9.76	0.0	98.17	1.83
Jaitu	21.65	65.46	12.89	58.25	32.99	8.76	87.63	12.37
Kotkopura	28.96	66.67	4.37	54.10	34.43	11.48	62.30	37.70
Average	26.00	57.00	17.00	66.00	26.00	8.00	82.00	18.00

The distribution of water samples in different ranges of Residual Sodium Carbonate (RSC) are given in Table 1.35. It is observed that 90%, 58% and 54 % water samples have RSC < 2.5 me $L^{-1,}$ while 10%, 33% and 34 % of water samples showed RSC between 2.5-5.0 me L^{-1} in the Faridkot, Jaitu and Kotkapura tehsil, respectively. Further, it is reported that based on RSC 66% water is safe (RSC, <2.5 meL^{-1}), 26% water is marginal (RSC, 2.5 to 5.0 meL^{-1}) and 8% water is unsuitable for irrigation (RSC, > 5.0 meL^{-1}) in Faridkot district. The water quality was categorized for irrigation as per criteria given by ICAR-CSSRI, Karnal.

The results are presented in Table 1.36 showed that based on irrigation water electrical conductivity, sodium absorption ratio and residual sodium carbonate, 18% irrigation water was good, 49% water was saline and 33% water was alkaline in the Faridkot district. Maximum sample (25.6 %) with good quality irrigation water was reported in Faridkot tehsil followed by Kotkapura (10.9 %) and Jaitu (8.2%). Similarly, higher salinity in irrigation water was observed in Faridkot tehsil (62.9%) followed by Kotkapura (36.6 %) and Jaitu (22.7%), however, the alkalinity was higher in Jaitu (69.1%) tehsil followed by Kotkapura (52.5 %) and Faridkot (11.5%) tehsil.

Table 1.36 Classification of irrigation water quality of Faridkot district based on CSSRI, classification

Water quality	Name of Tehsil						Faridkot district	
	Faridkot		Jaitu		Kotkapura			
	Samples	%	Samples	%	Samples	%	Samples	%
A. Good	42	25.6	16	8.2	20	10.9	97	17.9
B. Saline								
I. Marginally Saline	46	28.0	27	13.9	58	31.7	170	31.5
II. Saline	56	34.1	6	3.1	8	4.4	78	14.5
III. High –SAR Saline	1	0.8	11	5.7	1	0.5	19	3.6
C. Alkaline Water								
I. Marginally alkaline	11	6.7	35	18.0	40	21.9	95	17.6
II. Alkaline	4	2.4	82	42.3	28	15.3	63	11.6
III. Highly alkaline	4	2.4	17	8.8	28	15.3	18	3.4
Total samples	164		194		183		541	

- **Estimation of fluoride (mg/L) in underground of Faridkot district of Punjab (Bathinda)**

The survey was conducted to identify high fluoride contaminated ground water area in Faridkot district. The distribution of fluoride in ground water of Faridkot district was presented in Table 1.37. Fluoride content ranged from 0.13 – 10.40 mg L^{-1} with mean 1.0 mg L^{-1}, from 0.12 – 12.90 mg L^{-1} with mean 3.69 mg L^{-1} and from 1.48 – 14.50 mg L^{-1} with mean 4.69 mg L^{-1} in Faridkot, Jaitu and Kotkapura tehsil, respectively. The maximum range of fluoride variation was reported in Kotkapura with

average value of 4.69 mg L^{-1} followed by Jaituwith average value of 3.69 mg L^{-1}. The ground water in Faridkot tehsil contain low amount of fluoride as compared to other blocks of the district.

Table 1.37 Range of fluoride (mg/L) in Faridkot district

Name of Blocks	Faridkot	Jaitu	Kotkapura
Minimum	0.13	0.12	1.48
Maximum	10.40	12.90	14.50
Average	1.00	3.69	4.69

The data in Table 1.38 indicated that about 74% water collected from Faridkot tehsil showed low content (<1.0 mg/L) of fluoride and were suitable for drinking purpose. Whereas, only 10.0% samples were found in Jaituthesil and none of the samples were found suitable in kothkapura tehsil for drinking. The most of water samples (99.5%) collected from the Kotkapura have higher amount (>1.5 mg/L) of fluoride, which makes it unsuitable for use. About 30 % samples were found within safe limit (<1.5 mgL^{-1}), in which 26 % samples having fluoride (<1.0 mgL^{-1}), whereas 4 % samples having fluoride between 1.0-1.5 mgL^{-1}.While, 70% samples were beyond permissible limits (>1.5 mgL^{-1}) (WHO, 1994) in the district. It was also reported that water in Kotkapura and Jaitu tehsil contain more fluoride as compared to Faridkot tehsil in Faridkot District.

Table 1.38 Percentage distribution of fluoride (mg/L) in Faridkot district

Name of Blocks	Faridkot	Jaitu	Kotkapura	Average
Safe (<1.0 mg/L)	73.78	10.31	0.0	26.00
Margin (1.0-1.5 mg/L)	9.15	2.58	0.55	4.00
Unsafe (>1.5 mg/L)	17.07	87.11	99.45	70.00

- **Estimation of Nitrate (mg/L) in underground of Faridkot district (Bathinda)**

The survey was conducted to identify high Nitrate contaminated ground water area in Faridkot district. The nitrate distribution in ground water of Faridkot district was presented in Table 1.39. The nitrate content ranged from 0.09-1110 mg L^{-1} with mean 502.16 mg L^{-1}, from 1.68-125.15 mg L^{-1} with mean 27.04 mg L^{-1} and from 6.60-176.0 mg L^{-1} with mean 52.78 mg L^{-1} in Faridkot, Jaitu and kotkapura tehsils, respectively. The maximum range of nitrate variation was reported in Faridkot tehsil with average value of 502.16 mg L^{-1} followed by Kotkapura tehsils with average value of 52.78 mg L^{-1}. The ground water in Jaitu tehsil contain low amount of nitrate (27.04 mg L^{-1}) as compared to other tehsils of Faridkot district.

Table 1.39 Range of Nitrate (mg/L) in Faridkot district

Name of Blocks	Faridkot	Jaitu	Kotkapura
Minimum	0.09	1.68	6.60
Maximum	1410	125.15	176.0
Average	502.16	27.04	52.78

The most of water samples (79%) collected from Faridkot tehsil have higher amount of fluoride, which makes it unsuitable for use. However, in Jaitu tehsil the ground water having safe to marginal nitrate concentration and only 4% sample were found unsafe limit (>150 mg/L) of nitrate in ground

water. On an average in Faridkot district 10%, 65% and 25% water samples having safe (<10 mg/L), margin (10-150 mg/L) and unsafe (>150 mg/L) limits of nitrate (Table 1.40)

Table 1.40 Percentage distribution of nitrate (mg/L) in Faridkot district

Name of Blocks	Faridkot	Jaitu	Kotkapura	Average
Safe (<10 mg/L)	8.54	17.53	2.73	10.00
Margin (10-150 mg/L)	12.20	82.47	94.0	65.00
Unsafe (>150 mg/L)	79.27	00	3.27	25.00

- **Survey, characterization and mapping of ground water quality in the coastal districts of Kerala (Vyttila)**

The survey, collection and analysis of ground water samples of all the districts were completed. The ground water quality of all the districts was classified according to CSSRI classification. GIS maps showing EC, SAR, RSC and groundwater suitability map for irrigation purpose for 14 districts were completed during the year 2021 and groundwater quality map for irrigation purpose was prepared for state of Kerala.

Thiruvananthapuram district: A total of thirty eight ground water samples were collected from Thiruvananthapuram district. Out of this 89.47, 2.63 and 7.89% belonged to good, marginally saline and saline categories of irrigation water quality.

Ernakulam district: A total of twenty-eight ground water samples were collected from Ernakulam district. Out of this, 75.86, 20.68 and 3.40% fall under good, high SAR saline and marginally alkali categories of irrigation water quality.

Kasargod district: A total of twenty six ground water samples were collected from Kasargod district. Out of the total ground water samples collected, 76.92% and 23.07% fall under good and marginally alkaline categories of irrigation water quality respectively.

Kannur district: A total of fifteen ground water samples were collected from Kannur district. Out of the total ground water samples collected, 60.00% falls under good category for irrigation. The rest 26.66% and 13.33% were marginally alkaline and high alkali categories of irrigation water quality respectively.

Kozhikode district: A total of nineteen ground water samples were collected from Kozhikode district. Out of the total ground water samples collected, 73.68% and 26.31% fall under good and marginally alkaline categories of irrigation water quality respectively.

Malappuram district: A total of twenty ground water samples were collected from Malappuram district. Out of the total ground water samples collected, 35% and 65% fall under good and marginally alkaline categories of irrigation water quality respectively.

Thrissur district: A total of thirty three ground water samples were collected from Thrissur district. Out of this, 93.93% falls under good and 4.76% falls under marginally saline categories of irrigation water quality.

Kottayam district: A total of seventeen ground water samples were collected from Kottayam district. Out of this, 82.35 %, 11.76 % and 5.88 % falls under good, marginally saline and saline categories of irrigation water quality respectively.

Kollam district: A total of twenty one ground water samples were collected from Kollam district. Out of this, 95.23% and 4.76% fall under good and marginally saline categories of irrigation water quality respectively.

Alappuzha district: A total of fifty six ground water samples were collected from Alappuzha district. Out of this, 87.50 % falls under good category of irrigation water. Remaining 7.14 % and 5.35 % falls under marginally alkaline and high alkaline categories of irrigation water quality respectively.

Pathanamthitta district: A total of five water samples were collected from Pathanamthitta district. All the samples fall under good category of irrigation water quality.

Palakkad district: In case of Palakkad, 97% falls under good quality and remaining 3% was marginally alkaline in nature.

Wayanad district: All samples from Wayanad district are good for irrigation.

Idukki district: All samples from Idukki districts are good for irrigation.

It is mentioned that the ground water quality data for Palakkad, Wayanad and Idukki were collected from Central ground water board (CGWB).

Groundwater quality of Kerala for irrigation

The EC, SAR and RSC were determined for groundwater samples. The ground water quality samples were classified according to ICAR-CSSRI classification for all districts (Table 1.41).

Table: 1.41. Classification of ground water samples in Kerala for irrigation

Sl No	District	Good (%)	Marginally saline (%)	Saline (%)	High SAR Saline (%)	Marginally alkali (%)	High alkali (%)
1	Thiruvanathapuram	89.47	2.63	7.89			
2.	Kollam	95.23	4.76				
3.	Pathanamthitta	100.00					
4.	Kottayam	82.35	11.76	5.88			
5.	Alappuzha	87.50				7.14	5.35
6.	Ernakulam	75.86			20.68	3.40	
7.	Idukki	100.00					
8.	Thrissur	93.93			6.06		
9.	Palakkad	97.00				3.00	
10.	Kozhikode	73.68				26.31	
11.	Kannur	60.00				26.66	13.33
12.	Wayanad	100.00					
13.	Malappuram	35.00				65.00	
14.	Kasargod	73.07	3.86%			23.07	

Out of 351 samples of ground water analyzed, 296 were in good category, four each in marginally saline and saline category, respectively. Twenty eight samples were marginally alkaline and two

samples were highly alkaline in nature. As a whole in Kerala, 84.33, 1.14, 1.14, 2.28, 1.42 and 0.85% fall under good, marginally saline, saline, high SAR saline, marginally alkaline and high alkali category of ground water quality (Fig 1.23).

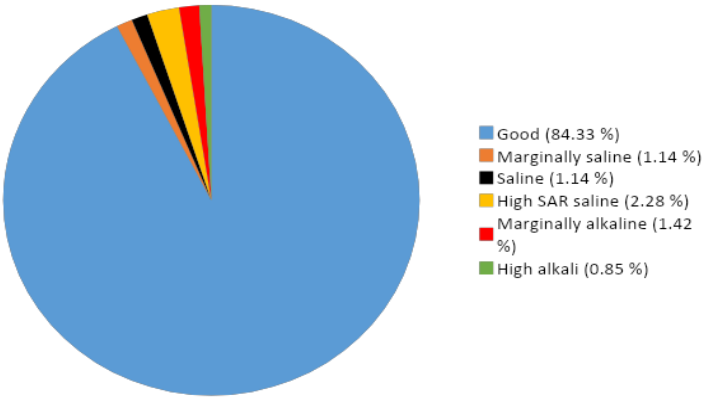
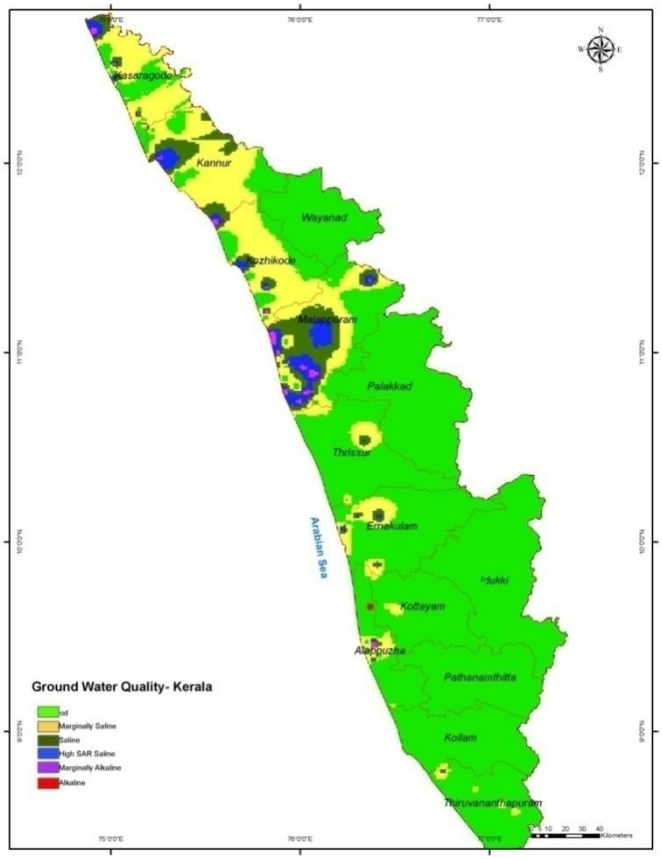


Fig. 1.13. Classification of ground water samples in Kerala for irrigation



The spatial map of groundwater quality for irrigation purpose for the state of Kerala is shown in Fig. 1.14.

Fig. 1.14 Spatial map of groundwater quality for irrigation purpose for the state of Kerala

2. Management of Alkali Irrigation Water

- **Conjunctive use of alkali and canal water for Til and lentil cropping sequence (Agra)**

An experiment was conducted under til and lentil cropping sequence to find suitable conjunctive water use of alkali and canal water and to study the effects on soil properties and crop yields. The details of experimentation were given in Table 2.1.

Table 2.1: Details of Experimentation

Treatments:	**Other Details**
T_1: All Canal water T_2: All Alkali water T_3: One canal: One alkali T_4: One alkali: One canal T_5: Mixing (1 Canal: 1 Alkali)	• RSC of irrigation water: 8 meq/l • Design: Randomized Block Design (RBD) • Replication: Three • Plot size: 4m x 4m • Crop rotation: Til (Sesamum indicum L.) – Lentil (Lens culinaris) **Note:** Sowing on Bed and furrow system for both crops Starting year: 2020-21
Other details	
Crop and Variety	Lentil & Variety PDL -1
Date of sowing	2.12.2020
Doses of N:P:K	20:40:40
No. & intervals of irrigation	3; 11.1.2021, 1.2.2021 & 26.2.2021
Depth of irrigation	4 cm
Total rainfall (mm)	1.9
Date of harvest	2.4.2021

Yield attributing characters: The yield contributing characters viz. length of siliqua , no. of seeds per siliqua and 1000 seed weight (g) were recorded and reported in Table 2.2. In respect of all these characters, the various treatments not differ significantly. The maximum siliqua was found in canal water and minimum in all alkali water treatment.

Growth characters and Crop yield: The yield attributing characters and grain and stover yield of lentil are presented in Table 2.2. All the growth characters i.e. plant height, No. of primary branches/plant, No. of secondary branches/plant, No. of pods/plant, Grain yield/plant and stover yield/plant are statistically significant. The grain and stover yield are also differ significantly amongst the different mode of canal and alkali irrigations water. The higher grain and stover yield were recorded in canal irrigated treatment (6.01 q/ha and 23.04 q/ha) and lowest in all alkali water irrigated treatment (2.61 q/ha and 9.90 q/ha).

Soil salinity: The initial status of soil in case of lentil crop is presented in Table 2.3. The initial soil ECe, pH and organic carbon is 2.3 (dS/m), 7.9 and 0.27%, respectively, in surface layer (0-15cm). In case of lower depth (60-90cm), ECe, pH and organic carbon were 1.5 (dS/m), 7.9 and 0.16 per cent, respectively. The ECe, pH, SAR and ESP were determined depth wise at harvest of lentil crop under different treatments and reported in Table 2.4. In general the ECe, pH, SAR and ESP at harvest of lentil crop are less in canal water as compared to alkali water alone and other modes of canal and alkali water.

Table 2.2 Effect of alkali water irrigation to supplemental canal water irrigation on Yield and yield attributing characters of Lentil (2020-21)

Treatments	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/ plant	No. of pods/ plant	Grain yield/ plant (gm)	Stover yield/ plant (gm)	Grain yield (q/ha)	Stover yield (q/ha)
All Canal Water	28.17	9.17	12.67	65.3	7.83	32.67	6.01	23.04
All alkali water	22.67	5.17	7.50	24.5	3.17	15.17	2.61	9.90
One Canal: One alkali	27.83	7.33	10.83	53.7	6.67	29.00	5.12	19.04
One Alkali: One Canal	27.17	6.00	9.50	48.3	5.50	23.83	4.1	15.58
Mixing (1:1)	28.33	7.50	10.67	54.8	6.67	25.00	5.2	20.50
CD at 5%	3.84	1.40	2.06	5.71	1.00	4.21	0.64	2.66

Table 2.3 Soil analysis at initial stage of lentil crop (2020-21)

Soil depth (cm) of initial soil sample	ECe (dS/m)	pH	Organic carbon (%)
0-15	2.3	7.9	0.27
15-30	2.2	7.8	0.26
30-45	1.9	7.8	0.19
45-90	1.5	7.9	0.16

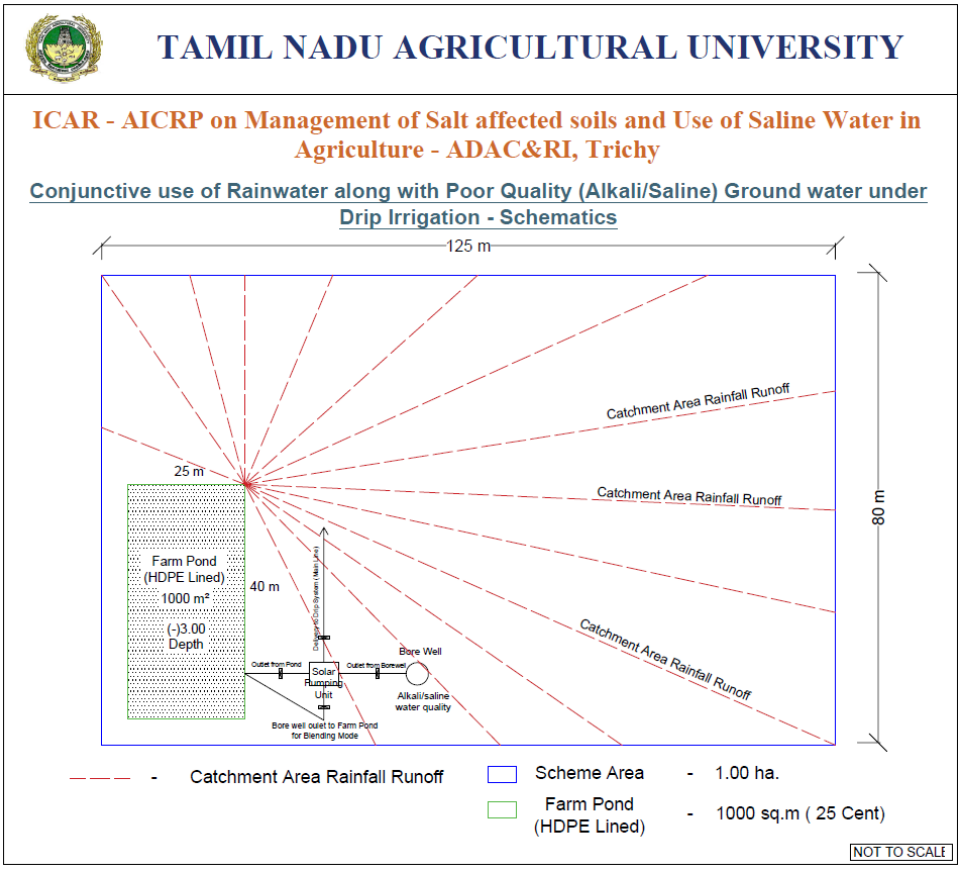
Table 2.4 Soil analysis of lentil crop at sowing and after harvest (2020-21)

Treatment	Soil depth (cm)	Lentil at harvest			
		ECe	pH	SAR	ESP
T_1	0-15	2.6	7.8	7.4	8.9
	15-30	2.3	7.7	7.3	9.2
	30-60	2.0	7.7	7.0	-
	60-90	1.8	7.7	6.5	-
T_2	0-15	3.4	8.1	11.6	11.4
	15-30	2.9	8.0	10.8	11.9
	30-60	2.5	8.0	9.8	-
	60-90	2.3	7.9	9.7	-
T_3	0-15	2.8	8.0	9.2	10.8
	15-30	2.4	7.9	9.0	11.4
	30-60	2.3	7.9	8.7	-
	60-90	2.2	7.7	8.7	-
T_4	0-15	3.2	8.0	10.0	11.1
	15-30	3.0	8.0	9.8	11.9
	30-60	2.7	8.0	9.7	-
	60-90	2.4	7.8	8.9	-
T_5	0-15	3.0	7.9	9.8	10.8
	15-30	2.8	7.9	9.7	11.6
	30-60	2.7	7.8	9.4	-
	60-90	2.4	7.8	8.8	-

Photographs of Lentil crop

- **Rainwater Harvesting and Conjunctive Use of Groundwater, Canal and Harvested Rainwater in Sodic Water Areas of Tamil Nadu for Sustainability of Agriculture (Tiruchirappali)**

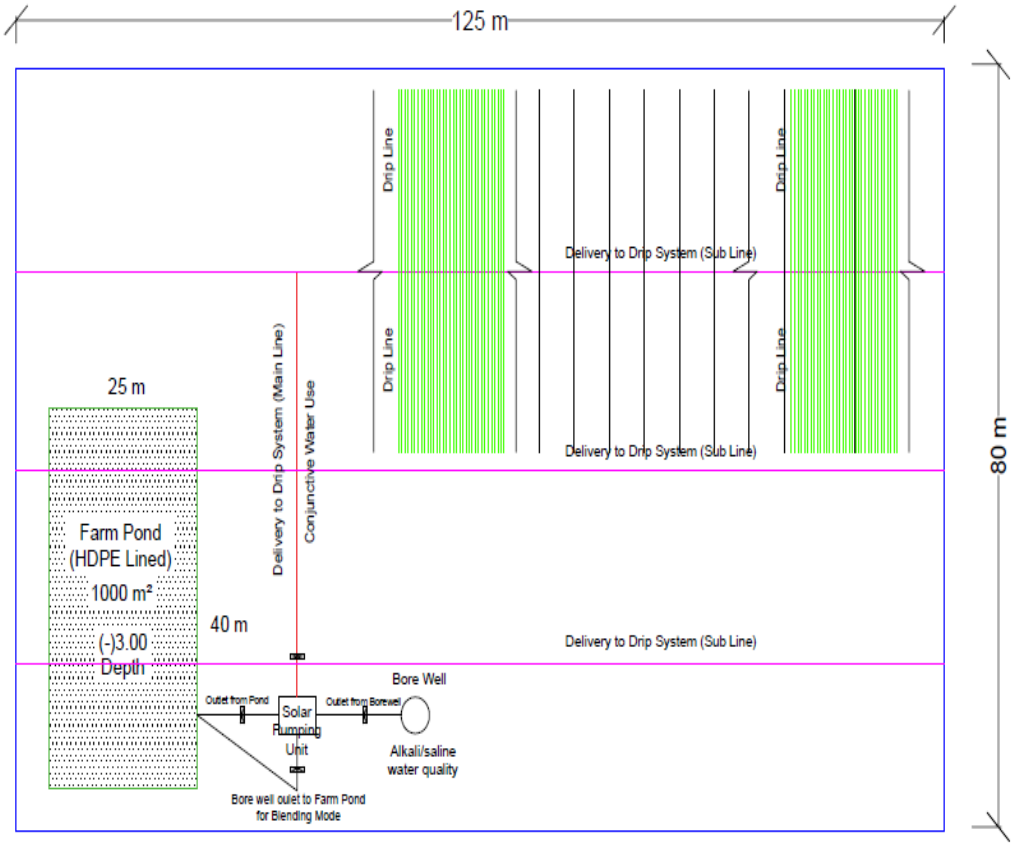
Necessary principal approval has been got from Tamil Nadu Agricultural University for the procurement / execution of capital items. Field location for executing different components was identified. Necessary tenders were called for the procurement/execution of works. It is planned to complete all the procurement and works before the end of financial year 2021-22. Schematics of the project execution:



TAMIL NADU AGRICULTURAL UNIVERSITY

ICAR - AICRP on Management of Salt affected soils and Use of Saline Water in Agriculture - ADAC&RI, Trichy

Conjunctive use of Rainwater along with Poor Quality (Alkali/Saline) Ground water under Drip Irrigation - Schematics



- Drip System (Main Line)
- Drip System (Sub Line)
- Drip Line

Scheme Area - 1.00 ha.

Farm Pond (HDPE Lined) - 1000 sq.m (25 Cent)

NOT TO SCALE

3. Management of Saline Irrigation Water

- **Performance of vegetable crops (chilli) with saline irrigation water through drip system (Bapatla)**

A response of green chilli to different irrigation water salinity levels such as 0.6, 2, 4, 6 and 8 dS/m was studied. Irrigation water was applied through drip. The experiment was laid out in Randomized Block Design with four replications. The seedlings of variety VNR 314 were planted on 03-12-2019 under drip irrigation. The pH of the soil was 7.4 and soil salinity was 0.3 dSm^{-1}. The tube well water salinity was 0.6 dSm^{-1}. The data presented in Table 3.1 indicated that the growth and yield of chilli crop were significantly influenced by water salinity level. The use of best available water (0.6 dSm-^{1}) recorded the highest plant height (74.5cm), No. of branches per plant (5.8), no. green pods per plant (73.5) and yield of green pods (29.8 t ha^{-1}). These parameters were significantly reduced with increase in water salinity and the lowest plant height (52.5cm), no. of main branches per plant (4.4), no. of green pods per plant (43.2) and yield of green pods (17.5 tha^{-1}) at water salinity of 8.0 ECiw. The yield reduction varied from 4.0 to 41.3% with increasing water salinity from 0.6 dSm^{-1} to 8.0 dSm^{-1}.

Table 3.1 Effect of water salinity on growth and yield of chilli crop

Treatment	Plant height (cm)	No. of branches per plant	No. of green pods per plant	Yield of green pods (t/ha)	Yield reduction (%)
BAW (0.6)	74.5	5.8	73.5	29.8	-
2ECiw	72.2	5.0	70.6	28.6	4.0
4ECiw	65.8	4.8	64.7	26.2	12.0
6ECiw	58.6	4.6	55.1	22.3	25.2
8ECiw	52.5	4.4	43.2	17.5	41.3
SEm±	1.6	0.3	1.8	0.7	
CD (5.0%)	4.8	0.9	5.7	2.0	
CV (%)	5.8	6.2	6.0	5.3	

The soil salinity after harvest of the crop varied from 1.4 to 2.4 dSm^{-1} and pH varied from 7.4 to 8.1 (Table 3.2). There was increase in soil salinity and pH values with increase in irrigation water salinity.

Table 3.2 Soil salinity and pH after harvest of the crop

Treatment	**pH**	**ECe (dSm^{-1})**
BAW (0.6) dSm^{-1}	7.4	1.4
2 dSm^{-1}	7.8	1.7
4 dSm^{-1}	8.1	1.9
6 dSm^{-1}	8.1	2.2
8 dSm^{-1}	8.1	2.4

- **A case study on the functioning of *doruvu* technology and shallow bore wells in farmers' fields and its impact on coastal saline agricultural production systems (Bapatla)**

Nowadays, shallow tubewells are installed by the farmers instead of traditional doruvu or improved doruvu technology. Therefore, changes in pumped water quality with time are monitored for 7 improved doruvu and 10 bore wells. The cropping pattern, crop yield and net returns were monitored with these groundwater structures. The changes in pH for pumped water from improved

doruvu wells are given Table 3.3 Table 3.4 and Table 3.5 for three consecutive years. Graphs of pH for all three years are shown in Fig. 3.1. Similarly, changes in EC for pumped water from improved doruvu wells are given Table 3.6, Table 3.7 and Table 3.8 for three consecutive years. Graphs of EC for all three years are shown in Fig. 3.2.

Table 3.3 Water pH in *doruvu* wells during 2019-20

S. No	pH of water in *doruvu* wells								
	June 2019	July 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2020	Jan 2020	Mean
1.	7.4	7.2	7.7	7.4	7.5	7.5	7.6	7.3	7.5
2.	6.9	6.9	7.3	7.2	7.3	7.3	7.9	7.6	7.3
3.	7.1	6.7	6.8	6.6	7.0	7.7	7.4	7.3	7.1
4.	6.8	6.9	7.0	7.0	7.2	7.2	7.3	7.5	7.1
5.	7.3	7.3	8.1	7.7	7.5	7.6	7.7	7.4	7.6
6.	7.3	7.4	8.0	7.6	7.5	7.5	7.8	7.6	7.6
7.	7.5	7.4	7.5	7.5	7.4	7.8	7.8	7.6	7.6
Mean	7.2	7.1	7.5	7.3	7.3	7.5	7.6	7.5	

Table 3.4 Water pH in *doruvu* wells during 2020-21

S. No.	pH of water in *doruvu* wells									
	June 2020	July 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mean
1.	7.4	7.5	7.6	7.4	7.5	7.4	7.5	7.8	7.4	7.5
2.	7.4	7.5	7.5	7.6	7.4	7.5	7.6	-	-	7.5
3.	7.5	7.4	7.3	7.2	7.3	7.4	7.4	7.9	6.2	7.3
4.	7.5	7.6	7.2	7.5	7.6	7.2	7.5	6.9	7.1	7.3
5.	7.8	7.5	7.7	7.8	7.6	7.4	7.5	7.3	7.1	7.5
6.	7.8	7.6	7.8	7.8	7.5	7.4	7.6	7.4	7.4	7.6
7.	7.5	7.4	7.6	7.5	7.4	7.5	7.6	8.3	8.0	7.6
Mean	7.6	7.5	7.5	7.5	7.5	7.4	7.5	7.6	7.2	7.5

Table 3.5 Water pH in *doruvu* wells during 2021-22

S. No.	pH of water in *doruvu* wells									
	June, 21	July, 21	Aug, 21	Sept, 21	Oct, 21	Nov, 21	Dec, 21	Jan, 22	Feb, 22	Mean
1.	7.4	7.1	7.2	7.4	7.3	7.2	7.0	8.8	7.2	7.4
2.	7.6	7.0	7.4	6.9	7.2	7.1	7.2	8.5	7.6	7.4
3.	8.4	6.8	6.1	6.7	7.2	7.1	7.4	8.4	7.9	7.3
4.	7.2	6.3	6.4	6.5	6.5	6.6	7.3	8.2	7.8	7.1
5.	7.0	7.4	7.0	7.2	7.0	7.1	6.9	8.6	8.1	7.4
6.	7.5	7.2	7.6	7.2	7.8	7.7	6.8	8.8	8.0	7.6
7.	7.9	7.0	7.1	7.8	7.7	7.6	6.7	8.6	8.0	7.6
Mean	7.6	7.0	7.0	7.1	7.2	7.2	7.0	8.6	7.8	

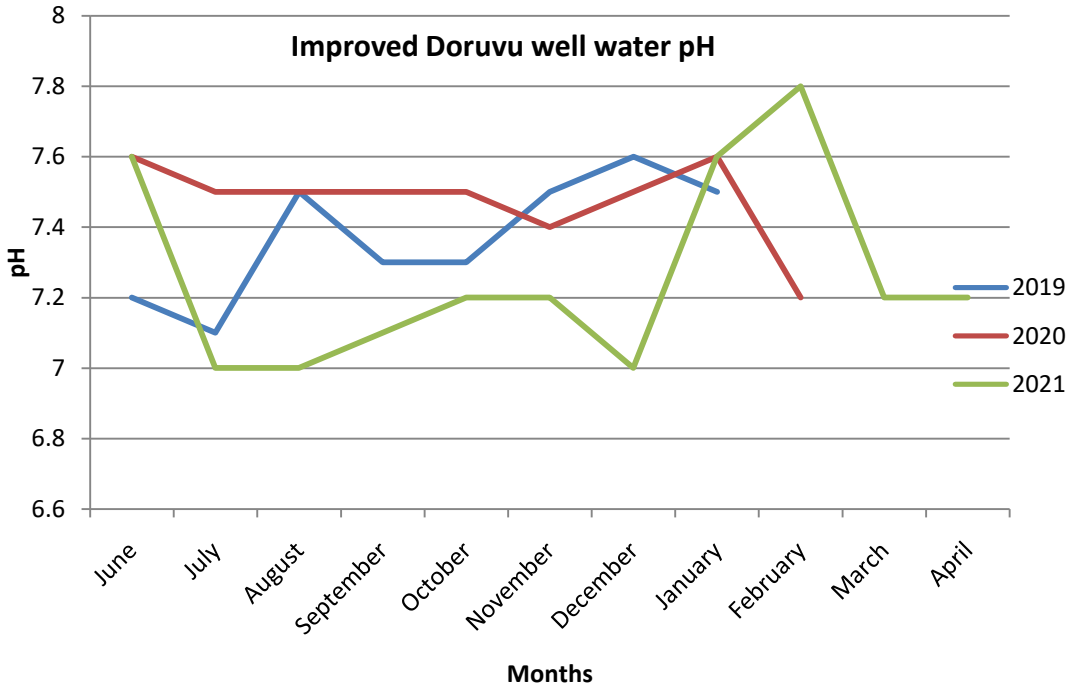


Fig. 3.1 Water pH in *doruvu* wells during 2019-22

Table 3.6. Water salinity of *doruvu* wells during 2019-20

S. No	Water salinity (ECiw) dS m^{-1} in *doruvu* wells								
	June 2019	July 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2020	Jan 2020	Mean
1.	2.2	2.3	2.2	2.3	2.1	2.1	2.1	1.4	2.1
2.	1.6	2.0	1.3	1.3	1.0	1.0	1.3	1.5	1.4
3.	2.3	2.5	3.1	2.7	1.8	1.3	1.8	2.3	2.2
4.	0.8	1.0	0.8	0.8	0.8	0.8	1.0	1.3	0.9
5.	4.4	3.7	2.6	2.5	2.3	3.1	3.3	4.0	3.2
6.	1.8	2.1	2.0	1.8	1.6	1.9	1.6	1.6	1.8
7.	2.7	2.0	2.5	2.2	1.6	1.5	1.3	1.5	1.9
Mean	2.3	2.2	2.1	1.9	1.6	1.7	1.8	2.3	

Table 3.7 Water salinity of *doruvu* wells during 2020-21

S. No.	Water salinity (ECiw) dS m^{-1} in *doruvu* wells									
	June 2020	July 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mean
1.	1.4	2.0	2.0	2.1	2.0	1.9	1.8	2.2	1.8	1.9
2.	1.3	1.7	1.4	1.3	1.5	1.4	1.5	-	-	1.4
3.	2.0	2.1	1.9	1.6	1.5	1.3	1.7	1.7	2.0	1.8
4.	1.4	1.6	1.0	1.4	1.0	0.8	0.7	1.0	1.2	1.1
5.	2.8	2.1	2.0	2.3	2.5	2.7	3.1	2.9	3.0	2.6
6.	1.2	1.0	1.0	1.0	1.1	1.1	1.2	1.1	1.1	1.1
7.	1.5	1.7	1.5	1.8	1.6	1.5	1.5	1.5	1.6	1.6
Mean	1.7	1.7	1.5	1.6	1.6	1.5	1.6	1.7	1.8	

Table 3.8 Water salinity of *doruvu* wells during 2021-22

S. No.	Water salinity (ECiw) dS m^{-1} in *doruvu* wells											
	June, 21	July 21	Aug, 21	Sept, 21	Oct, 21	Nov, 21	Dec, 21	Jan, 22	Feb, 22	Mar,22	Apr, 22	Mean
1.	1.6	1.6	1.4	1.6	1.5	1.4	1.0	0.6	1.3	1.3	1.3	1.3
2.	1.5	1.7	2.2	1.9	1.2	1.3	1.3	1.7	1.7	1.9	2.0	1.6
3.	1.7	1.9	1.7	1.0	1.1	1.0	1.2	1.5	1.6	1.5	1.6	1.4
4.	1.4	1.7	0.7	0.5	0.4	0.6	1.6	1.6	1.6	1.4	1.4	1.1
5.	1.0	1.0	2.1	2.1	2.0	1.7	1.8	2.1	2.2	2.2	2.3	1.8
6.	2.0	2.0	0.9	1.0	1.5	1.6	1.1	1.2	1.3	1.3	1.2	1.4
7.	1.1	0.9	2.0	1.4	1.4	1.5	1.4	1.2	1.2	1.3	1.3	1.3
Mean	1.5	1.5	1.6	1.4	1.3	1.3	1.3	1.4	1.6	1.6	1.6	

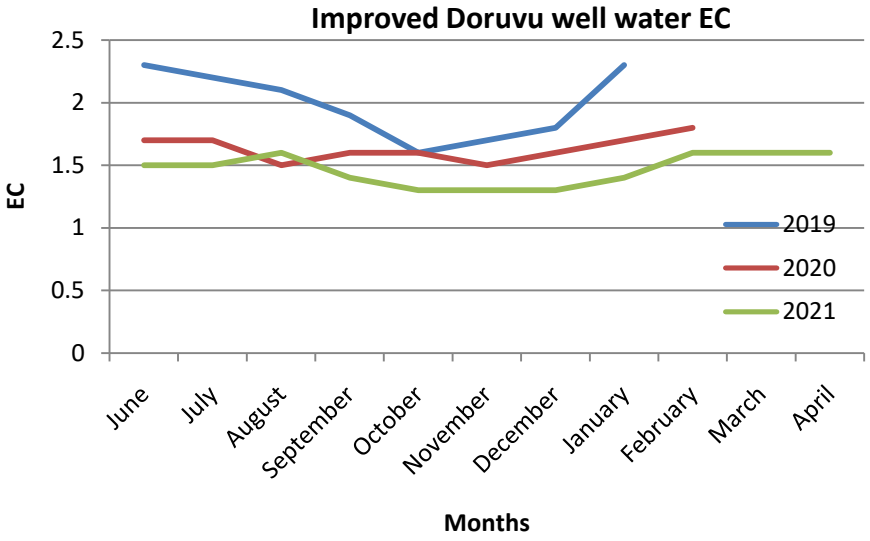


Fig 3.2 Water salinity in *doruvu* wells during 2019-22

The changes in pH for pumped water from shallow bore wells are given Table3.9, Table 3.10 and Table 3.11 for three consecutive years. Graphs of pH for all three years are shown in Fig. 3.3. Similarly, changes in EC for pumped water from improved doruvu wells are given Table 3.12 Table 3.13 and Table 3.14 for three consecutive years. Graphs of EC for all three years are shown in Fig. 3.4.

Table 3.9 Bore well water pH during 2019-20

S. No	pH of bore well water								
	June 2019	July 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2020	Jan 2020	Mean
1.	7.5	9.1	8.2	7.8	7.9	7.5	9.3	7.8	8.1
2.	8.1	9.0	7.5	7.5	7.3	7.9	8.3	7.6	7.9
3.	-	7.3	8.2	-	8.5	9.6	10.7	8.1	8.7
4.	-	8.9	8.7	-	-	7.9	-	8.6	8.5
5.	-	7.7	7.6	-	-	9.4	8.1	7.7	8.1
6.	-	7.1	7.8	-	-	-	7.1	7.0	7.3
7.	7.3	7.3	7.8	-	-	-	-	7.1	7.4
8.	-	7.3	8.3	-	-	7.8	8.3	7.9	7.9
9.	-	7.6	7.7	-	-	8.6	9.3	8.0	8.2
10	-	7.5	7.9		-	9.1	8.5	8.0	8.2
Mean	7.6	7.9	8.0	7.7	7.9	8.5	8.7	7.8	

Table 3.10. Bore well water pH during 2020-21

S.No.	pH of bore well waters									
	June 2020	July 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mean
1	-	7.6	7.4	7.6	7.7	7.6	7.2	7.9	7.8	7.6
2	-	7.5	7.3	7.5	7.5	7.4	7.9	7.5	7.0	7.5
3	-	7.8	-	-	7.8	7.6	7.5	8.0	9.8	8.1
4	8.0	8.2	8.6	7.3	7.4	7.5	7.5	7.6	9.3	7.9
5	8.2	7.8	7.7	7.0	7.3	7.5	7.6	8.3	8.6	7.8
6	-	7.5	7.8	7.4	7.5	7.6	7.5	-	7.4	7.5
7	-	-	-	-	7.2	7.2	7.4	7.1	7.2	7.2
8	-	7.8	7.9	7.6	7.5	7.6	7.7	9.0	7.3	7.8
9	-	7.7	7.8	7.7	7.7	7.8	7.7	8.1	8.0	7.8
10	8.2	7.5	7.5	7.6	7.9	7.7	7.5	8.0	9.9	8.0
Mean	8.1	7.7	7.8	7.5	7.6	7.6	7.6	7.9	8.7	

Table 3.11 Bore well water pH during 2021-22

S.No.	**pH of bore well waters**											
	June, 21	**July21**	**Aug,21**	**Sept, 21**	**Oct, 21**	**Nov, 21**	**Dec, 21**	**Jan, 22**	**Feb, 22**	**Mar22**	**Apr, 22**	**Mean**
1	7.8	6.8	7.6	7.5	7.3	7.1	7.2	7	8.0	7.9	7.8	7.5
2	8.0	7.1	7.5	7.0	7.0	7.0	7.0	6.8	7.6	7.7	7.7	7.3
3	9.5	9.3	6.6	6.7	7.9	6.5	6.6	7.7	8.1	7.9	7.7	7.8
4	9.2	9.1	7.1	9.1	8.0	7.0	7.1	7	7.8	7.5	7.5	8.0
5	8.5	8.3	7.9	8.3	8.3	6.7	6.9	7.7	8.2	7.8	7.8	8.1
6	7.3	7.2	7.1	8.4	8.2	6.8	7.0	8.1	8.1	7.1	7.0	7.7
7	7.1	7.0	7.0	8.6	8.5	6.9	7.0	8.1	8.2	7.5	7.5	7.7
8	7.6	7.4	7.0	8.4	8.3	7.4	7.5	8	8.0	8.0	8.1	7.8
9	7.7	7.5	7.0	8.0	7.8	7.6	7.6	7.7	8.2	7.5	7.5	7.8
10	9.5	9.2	7.0	7.7	7.9	7.6	7.6	7.7	8.2	7.5	7.5	8.2
Mean	8.2	7.9	7.2	8.0	7.9	7.1	7.2	7.6	8.0	7.6	7.6	

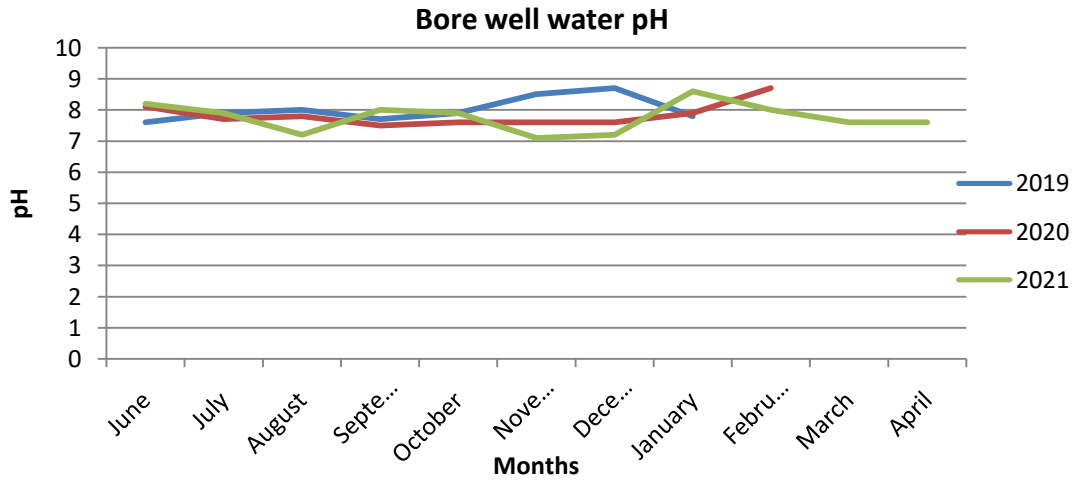


Fig 3.3 Shallow bore well water pH during 2019-22

Table 3.12 Water salinity of bore wells during 2019-20

S. No	Salinity of bore well waters								
	June 2019	July 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2020	Jan 2020	Mean
1	2.0	2.0	1.9	2.0	2.1	1.7	1.4	1.9	1.9
2	1.1	2.3	2.5	2.2	1.2	1.9	1.8	1.9	1.9
3	-	1.2	1.0	-	1.5	1.1	1.3	1.7	1.3
4	-	7.4	7.5	-	-	6.6	-	5.8	6.8
5	-	2.0	1.9	-	-	2.2	1.8	2.0	2.0
6	-	2.8	2.9	-	-	-	2.5	2.3	2.6
7	3.8	3.9	4.4	-	-	-	-	3.9	4.0
8	-	3.8	4.1	-	-	5.2	4.7	4.1	4.4
9	-	4.3	4.7	-	-	3.1	3.0	3.0	3.6
10	-	4.7	3.7		-	3.7	3.7	3.5	3.9
Mean	2.3	3.4	3.5	2.2	1.6	3.2	2.5	3.0	

Table 3.13 Water salinity of bore wells during 2020-21

S.No.	Salinity of bore well waters									
	June 2020	July 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mean
1	-	1.6	2.1	2.0	1.8	1.6	1.5	2.0	2.0	1.8
2	-	1.5	2.0	1.6	1.4	1.5	2.0	1.5	1.5	1.6
3	-	1.4	-	-	1.0	1.2	1.3	1.1	0.8	1.1
4	5.8	5.0	6.1	5.9	4.5	4.7	4.7	4.6	4.8	5.1
5	1.8	1.5	1.8	2.0	1.8	1.7	1.5	1.3	1.3	1.6
6	-	2.0	2.0	2.2	2.1	1.8	1.6	-	2.5	2.0
7	-	-	-	-	3.0	3.0	2.5	2.8	2.6	2.8
8	-	4.2	4.1	4.3	4.5	4.4	4.5	2.0	2.2	3.8
9	-	2.4	2.4	2.5	2.3	2.5	2.4	2.4	2.5	2.4
10	3.4	2.9	2.9	2.8	2.6	2.4	2.9	2.8	2.8	2.8
Mean	3.7	2.5	2.9	2.9	2.5	2.5	2.5	2.3	2.3	

Table 3.14 Water salinity of bore wells during 2021-22

S.No.	Salinity of bore well waters											
	June, 21	July, 21	Aug, 21	Sept, 21	Oct, 21	Nov, 21	Dec, 21	Jan, 22	Feb, 22	Mar 22	Apr 22	Mean
1	1.8	2.0	1.9	1.7	1.5	1.1	1.2	1.7	1.8	1.9	2.0	1.6
2	1.3	1.4	1.3	1.1	1.0	0.8	1.0	1.2	1.4	1.5	1.4	1.2
3	0.9	1.0	1.1	1.2	1.4	0.6	0.7	0.8	1.0	0.9	1.0	1.1
4	4.7	4.9	4.2	4.2	4.2	2.7	3.4	4.1	4.2	4.4	4.6	4.1
5	1.4	1.5	1.3	1.3	1.4	1.0	1.2	1.3	1.5	1.3	1.5	1.3
6	2.6	2.7	1.1	2.0	2.1	1.5	1.2	1.3	1.5	1.9	1.9	1.8
7	2.7	2.8	2.0	2.1	2.2	2.9	1.6	1.8	2.0	1.3	1.4	2.2
8	1.7	1.9	2.2	1.7	1.8	1.6	1.8	1.4	1.4	1.6	1.8	1.7
9	2.6	2.7	3.1	3.6	3.3	2.2	1.6	1.7	1.8	1.9	2.0	2.5
10	2.9	3.0	2.7	2.4	2.5	2.1	1.9	2.2	2.5	1.9	2.0	2.5
Mean	2.3	2.4	2.1	2.1	2.1	1.7	1.6	1.8	1.9	1.9	2.0	

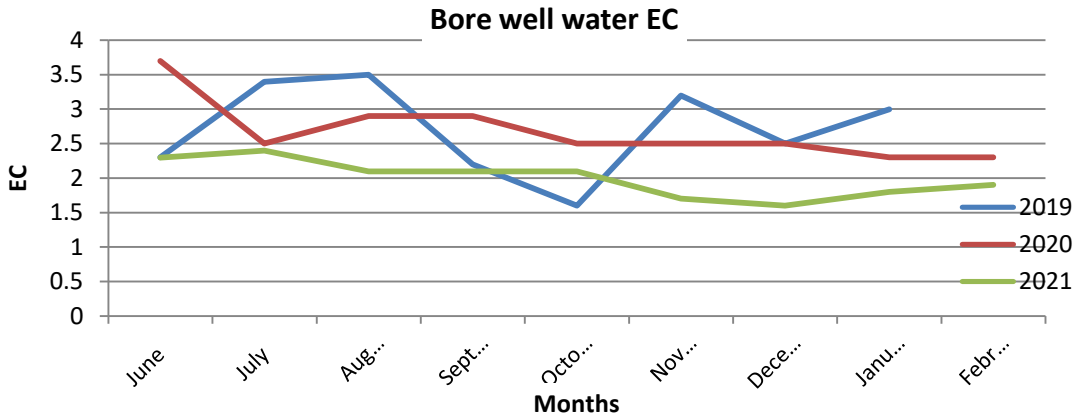


Fig 3.4 Water salinity of bore wells during 2019-22

The water quality parameters in case of *doruvu* wells and shallow bore wells are being monitored every month. It was leant from the data that EC of pumped water in case of doruvu wells was below 2.5 dS/m while it was 4.8 dS/m (Table 3.15). It proved that improved *doruvu* wells are more suitable for pumping fresh water from coastal aquifers compared to shallow tubewells. The upconing of saline water in fresh water aquifers can be avoided by adopting suitable pumping strategy. As shallow tube well takes water at single point, two hours pumping and two hours closing can be good strategy to avoid upconing of saline water.

Table 3.15 Output and water quality of bore wells before and after pumping

Bore well No.	Output (l/3sec)	Before pumping		After pumping	
		pH	ECiw (dSm^{-1})	pH	ECiw (dSm^{-1})
4	20.0	7.5	4.7	7.7	4.8
9	20.0	7.7	2.4	7.8	2.4
10	20.0	7.5	2.9	7.8	2.9

In coastal sands, farmers used to grow paddy nursery groundnut, green chillies, leafy vegetables, vegetables and flower plants. Each farmer used to cultivate less than one acre by installing a shallow bore well at a depth of 20 ft. Two bore wells are installed at 3m distance from each other and connected to each other for harvesting more water. The water is pumped out by using 2HP motor. It takes 3-4 hours for giving irrigation to one acre area. Many of the farmers give irrigation through flash watering and some farmers are using sprinklers. The water quality in *doruvu* wells and bore wells was regularly monitored every month. Farmers used to give irrigation daily and operate the motor for 2.0 hours for giving irrigation to half acre land. The pH of *doruvu* well waters varied from 7.0 to 7.8 and salinity varied from 1.3 dSm^{-1} to 2.3 dSm^{-1} in different months starting from June, 2019 to April, 2022. The pH and water salinity of 10 shallow bore wells during June, 2019 to April, 2022 varied from 7.1 to 8.7 and 1.6 dSm^{-1} to 3.7 dSm^{-1}, respectively. In bore wells, slightly salinity increases when compared to bore wells. In monsoon period during the three years of study, salinity decreases in both bore wells and improved doruvu wells when compared to other seasons. In study period in both bore wells and improved doruvu wells, salinity increased slightly during January to July months compared to monsoonal period. The groundwater availability for pumping was there in case of improved doruvu wells but it was exhausted in bore wells during summer period.

Cropping intensity was more in improved doruvu wells compared to bore wells. But one lacuna was there *i.e* installation cost was more in case of improved doruvu well when compared to bore well.

Improved doruvu well installation cost was nearly Rs.1,00,000 but bore well installation cost was Rs. 2,000-3,000. Good quality of water was available throughout year in improved doruvu wells but in bore wells salinity was high in summer months and availability of water was also low in bore wells. The output and water quality before and after pumping was also monitored in shallow bore wells. The output of bore well was 20 L/3sec with 2Hp motor. There is no much variation in water salinity before and after pumping. But after continuous pumping of irrigation water for 2-3 hours, the water will be exhausted in that bore well. After 4-5 hours of interval the water will recharged in the same bore well and it is ready for pumping. The net returns received with paddy nursery, chilli, groundnut and vegetable crops like ladys finger, brinjal, cucumber and leafy vegetables were Rs. 35,000/-, Rs.20,000, Rs. 30,000/- per acre and Rs.15,000 per each vegetable crop.

- **Effect of saline irrigation water on growth, yield attributes and yields of cumin through drip (Bikaner)**

An experiment on use saline water through drip to irrigate cumin crop was initiated during *Rabi* 2018-19 with intention to study the effect of saline irrigation water on growth, yield attributes and yield of cumin through drip. The treatments comprised of four levels of irrigation water salinity (EC_{iw}) 0.25, 2.4, 6 and 8 dS/m. Results (*rabi,* 2020-21) indicated that different treatments had significant effect on growth, yield attributes and yields of cumin. Increase in EC_{iw} beyond 6 dS/m caused significant reduction in seed yield of cumin. As compared to EC_{iw} of 0.25 (BAW), EC_{iw} 2.4, 6 and 8 dS/m caused reduction of 10.50, 14.29 and 32.35 per cent, respectively (Table 3.16). Similar trends were also noticed in almost all the parameters studied.

Table 3.16 Effect of water salinity on growth, yield attributes and yields of cumin

Treatments	Plant height (cm)				Number of branches per plant				Test weight (g)				Seed yield (q/ha)			
	2018-19	2019-20	2020-21	Pooled	2018-19	2019-20	2020-21	Pooled	2018-19	2019-20	2020-21	Pooled	2018-19	2019-20	2020-21	Pooled
EC_{iw} 0.25 dS/m	32.6	21.2	25.04	26.3	13.0	7.48	7.56	9.35	4.19	4.11	4.15	4.15	5.13	2.64	4.76	4.18
EC_{iw} 2.40 dS/m	31.4	20.2	24.60	25.4	12.5	7.24	7.48	9.07	4.02	3.89	4.09	4.00	4.88	2.31	4.26	3.82
EC_{iw} 6.00 dS/m)	31.2	20.00	24.36	25.2	12.1	6.56	7.20	8.60	3.79	3.82	3.95	3.85	4.79	2.20	4.08	3.69
EC_{iw} 8.00 dS/m)	24.5	16.1	21.28	20.6	9.28	4.88	5.72	6.63	2.93	2.78	3.21	2.97	3.40	1.68	3.22	2.77
SEm±	0.58	0.52	0.33	0.28	0.32	0.33	0.14	0.16	0.16	0.17	0.11	0.09	0.12	0.15	0.23	0.10
CD (P=0.05)	1.78	1.59	1.03	0.81	0.99	1.01	0.43	0.46	0.51	0.52	0.34	0.25	0.37	0.47	0.72	0.29

Field view of cumin trial

- **Integrated nutrient management in Pearl millet -wheat under saline water irrigation (Hisar)**

An experiment to evaluate the effect of various combinations of organic manures, biofertilizer on soil properties and yields of pearl millet and wheat under saline water irrigation (EC_{iw} as 8 dS/m) was conducted by the Hisar centre. The experiment was initiated during 2015-16. Treatments were 75% RDF; RDF; 75% RDF + *Azotobacter* ST-3; RDF + *Azotobacter* ST-3; 75% RDF + 2.5 t/ha biogas slurry + *Azotobacter* ST-3; RDF + 2.5 t/ha biogas slurry + *Azotobacter* ST-3; 75% RDF + 2.5 t/ha Vermicompost + *Azotobacter* ST-3; RDF + 2.5 t/ha Vermicompost + *Azotobacter* ST-3; 75% RDF + 10 t/ha FYM + Biomix ; RDF + 10 t/ha FYM + Biomix ; 75% RDF + 2.5 t/ha Vermicompost + Biomix and RDF + 2.5 t/ha Vermicompost + Biomix. The experimental design was RBD with three replications. Seed of both the crop were treated with the microbial cultures '*Azotobacter ST-3* and *Biomix* at the time of sowing. Recommended cultural practices and fertilizer doses were applied for raising the crops. The details of the experiment are given in Table 3.17. The crops were harvested at maturity and yield data were recorded for each plot.

Table 3.17 Experiments details for Pearl millet and wheat crop

Operation	Pearl millet	Wheat crop
Date of sowing	2.07.2020	8.11.2020
Variety	HHB 226	WH 1105
Fertilizers dose (Kg/ha)		
Nitrogen	156.2	150
Phosphorus	62.5	60
Zinc sulphate	25	25
No. of irrigations including pre-sowing	1	5
Date of harvesting	06.10.2020	10.04.2021

Pearl millet:

The highest grain and stover yield (28.74 and 83.21 q/ha) of pearl millet was obtained with RDF + FYM 10 t/ha + Biomix followed by RDF +2.5 t/ha vermicompost + Biomix (28.67 and 82.30 q/ha). The lowest grain and stover yield (23.09 and 64.96 q/ha) was recorded with 75% RDF alone. The maximum plant height (202.70 cm), yield attributes viz., effective tillers/plant (2.82), earhead length (20.73 cm) was observed in treatment RDF + FYM 10 t/ha + Biomix (Table 3.18 and 3.19).

Table 3.18 Effect of various treatments on grain and stover yield (q/ha) of pearl millet under saline water irrigation

Treatment	Grain	Stover
75% RDF	23.09	64.96
RDF	25.31	72.19
75% RDF +ST-3	23.39	65.83
RDF +ST-3	25.59	73.31
75% RDF +2.5t/ha biogas slurry + ST-3	27.17	78.87
RDF +2.5t/ha biogas slurry + ST-3	26.87	77.87
75% RDF + 2.5t/ha Vermicompost + ST-3	27.01	78.75
RDF + 2.5t/ha Vermicompost + ST-3	27.61	80.50
75% RDF + 10t/ha FYM + Biomix	28.54	81.94
RDF + 10t/ha FYM + Biomix	28.74	83.21
75% RDF + 2.5t/ha Vermicompost + Biomix	27.13	79.06
RDF + 2.5t/ha Vermicompost + Biomix	28.67	82.30
CD (p=0.05)	1.89	5.48

ST-3= *Azotobacter chrococuum,* Biomix = *Azotobacter chrococuum* (Mac27) + *Azospirillum* + PSB
Composition of biogas slurry: N=1.72%, P=1.16%, K=1.67%, FYM: N=0.75%, P=0.50%, K=1.08%, Vermicompost: N=1.66%, P=0.86%, K=1.10%

Table 3.19 Effect of various treatments on yield attributes of pearl millet under saline water irrigation

Treatments (Pearl millet)	Plant height at maturity (cm)	No. of effective tillers/plant	Earhead length (cm)
75% RDF	180.46	1.60	18.34
RDF	195.23	1.77	19.43
75% RDF +ST-3	186.50	1.72	18.32
RDF +ST-3	195.43	1.97	19.37
75% RDF +2.5t/ha biogas slurry + ST-3	191.03	2.03	19.20
RDF +2.5t/ha biogas slurry + ST-3	196.47	2.15	19.58
75% RDF + 2.5t/ha Vermicompost + ST-3	188.39	2.23	19.57
RDF + 2.5t/ha Vermicompost + ST-3	197.77	2.52	19.97
75% RDF + 10t/ha FYM + Biomix	189.15	2.72	19.68
RDF + 10t/ha FYM + Biomix	202.70	2.82	20.73
75% RDF + 2.5t/ha Vermicompost + Biomix	188.93	2.40	19.53
RDF + 2.5t/ha Vermicompost + Biomix	197.87	2.79	20.63
CD (p=0.05)	7.40	0.34	NS

Wheat :

The highest grain and straw yield (51.70 and 84.12 q/ha) of wheat (WH 1105) was obtained with RDF + 10t/ha FYM + Biomix followed by RDF +2.5 t/ha vermicompost + Biomix (51.57 and 83.03 q /ha).The lowest grain and straw yield (43.86 and 66.23 q/ha) was recorded with 75% RDF alone (Table 3.20).

Table 3.20 Effect of various treatments on grain and straw yield (q/ha) of wheat under saline water irrigation

Treatment	Grain	Straw
75% RDF	43.86	66.23
RDF	46.92	71.41
75% RDF +ST-3	44.61	67.36
RDF +ST-3	47.46	72.61
75% RDF +2.5t/ha biogas slurry + ST-3	48.28	74.35
RDF +2.5t/ha biogas slurry + ST-3	50.24	80.89
75% RDF + 2.5t/ha Vermicompost + ST-3	49.78	78.15
RDF + 2.5t/ha Vermicompost + ST-3	50.95	82.54
75% RDF + 10t/ha FYM + Biomix	49.94	79.41
RDF + 10t/ha FYM + Biomix	51.70	84.12
75% RDF + 2.5t/ha Vermicompost + Biomix	50.09	80.15
RDF + 2.5t/ha Vermicompost + Biomix	51.57	83.03
CD (p=0.05)	4.75	6.85

The lowest ECe (6.40 dS/m) was recorded in treatment RDF + 10t/ha FYM + Biomix and highest ECe (7.51 dS/m) was recorded with 75% RDF alone whereas, highest pH (8.22) was recorded in treatment where only RDF is applied and lowest pH (7.91) was recorded in treatment RDF + 10t/ha FYM + Biomix (Table 3.21).

Table 3.21 Effect of various treatments on EC_e (dS/m) and pH after harvest of wheat under saline water irrigation

Treatment	ECe	pH
75% RDF	7.51	8.15
RDF	7.32	8.22
75% RDF +ST-3	7.13	8.20
RDF +ST-3	7.01	8.14
75% RDF +2.5t/ha biogas slurry + ST-3	6.75	8.17
RDF +2.5t/ha biogas slurry + ST-3	6.64	8.12
75% RDF + 2.5t/ha Vermicompost + ST-3	6.69	8.08
RDF + 2.5t/ha Vermicompost + ST-3	6.50	8.04
75% RDF + 10t/ha FYM + Biomix	6.67	8.03
RDF + 10t/ha FYM + Biomix	6.40	7.91
75% RDF + 2.5t/ha Vermicompost + Biomix	6.56	8.13
RDF + 2.5t/ha Vermicompost + Biomix	6.45	8.05
CD (p=0.05)	NS	NS

- **Effect of nitrogen fertigation utilizing good and saline water under drip irrigation system in vegetable crops (Hisar)**

Experiment on nitrogen ferti-irrgation through in case of brinjal crop was undertaken at Hisar centre to understand the water and salt dynamics in root zone as well as its effect on crop yield. The main treatments were quality of the irrigation water such as Canal water EC_{iw} = 0.3 dS/m, Saline water EC_{iw} = 2.5 dS/m and Saline water EC_{iw} = 5.0 dS/m. Sub treatments were related to nitrogen fertigation and three levels of nitrogen doses such as 75% of RDN and RDN 125% of RDN were

adopted. The experiment was laid out in 2.0 x 2.0 m plot as per the following plan. The spacing between plant to plant and row to row was kept as 45 cm.

View of drip experimental site

Yield of brinjal fruit

The data on yield of brinjal under nitrogen and salinity levels with drip irrigation (Table 3.22) revealed that under drip irrigation with 75% of RDN of nitrogen application, the reduction in yield of brinjal were12.94 and 28.71 % when irrigated with saline water of 2.5 and 5.0 dS/m, respectively, as compared to the yield reduction in yields recorded in canal water irrigation. Under drip irrigation in RDN application, the reduction in yield of brinjal were 10.51 and 24.39% when irrigated with 2.5 and 5.0 dS/m, respectively, as compared to the yield recorded in canal water irrigation. Under drip irrigation in 125% recommended dose of nitrogen application, the reduction in yield of brinjal obtained 8.98 and 20.25% when irrigated with saline water of 2.5 and 5.0 dS/m, respectively as compared to the yield recorded in canal water irrigation. Significant reduction in yield was recorded at ECiw 5.0 dS/m as compared to the canal water irrigation. Significantly highest yield (269.60 q/ha) of brinjal was recorded with the application of 125% RDN and canal water irrigation.

Table 3.22 Effect of nitrogen fertigation under different saline water in drip irrigation system brinjal fruit yield (q/ha)

Nitrogen Level	Canal(0.3 dS/m)	2.5 dS/m	5.0 dS/m	Mean
75% RDN	237.90	207.10	169.60	204.90
RDN	257.90	230.80	195.00	227.90
125% RDN	269.60	245.40	215.00	243.30
Mean	255.10	227.80	193.20	
CD (p=0.05)	Nitrogen (N) = 2.56, Salinity level (S) =10.30, N x S = NS			

The data on soil ECe under nitrogen and salinity levels with drip irrigation revealed that highest mean values of ECe of 3.62 dS/m were observed in saline water irrigated plots of ECiw=5.0 dS/m followed by ECe of 2.20 in saline water irrigated plots of ECiw=2.5 dS/m at the soil depth (0-15 cm). No significant effect of nitrogen fertilizer application was observed on the soil ECe, however, the mean values of ECe slightly reduced at 100% RDN and 125% RDN as compared to the 75% RDN (Table 3.23).

The highest (131.40 kg/ha) available nitrogen after harvest of brinjal crop was observed at 125% RDN and canal water under drip irrigation whereas the minimum (98.87 kg/ha) was observed at 75% RDN under saline water irrigation of 5.0 dS/m. The mean available nitrogen was decreased with the

increasing of the salinity of irrigation water. The highest mean value (125.54 kg/ha) of available nitrogen after harvest of brinjal crop under drip irrigation was observed at canal water irrigation and it decreased 3.93 and 12.29% at ECiw 2.5 and 5.0 dS/m. However, the effect of 100% RDN and 125% RDN on available N did not differ significantly (Table 3.24).

Table 3.23 Effect of nitrogen fertigation and different saline water irrigation on soil ECe (0-15 cm) depth under brinjal crop

Nitrogen Level	Canal(0.3 dS/m)	2.5 dS/m	5.0 dS/m	Mean
75% RDN	0.38	2.26	3.68	2.11
RDN	0.35	2.21	3.61	2.06
125% RDN	0.31	2.13	3.57	2.00
Mean	0.35	2.20	3.62	
CD (p=0.05)	Nitrogen (N) = NS, Salinity level (S) = 0.60, N x S = NS			

Table 3.24 Effect of nitrogen fertigation and different saline water irrigation on soil available nitrogen (kg/ha) under brinjal crop

Nitrogen Level	Canal(0.3 dS/m)	2.5 dS/m	5.0 dS/m	Mean
75% RDN	112.80	108.67	98.87	**106.78**
RDN	129.40	124.80	114.21	**122.80**
125% RDN	131.40	128.33	117.24	**125.65**
Mean	125.54	120.60	110.11	
CD (p=0.05)	Nitrogen (N) = 5.50, Salinity level (S) = 6.85, N x S = NS			

The highest (32.30 kg/ha) available phosphorus after harvest of brinjal crop was observed at 125% RDN and canal water under drip irrigation whereas the minimum (26.76 kg/ha) was observed at 75% RDN under saline water irrigation of 5.0dS/m. The mean available phosphorus was decreased with the increasing of the salinity of irrigation water. The highest mean value (30.72 kg/ha) of available phosphorus after harvest of brinjal crop under drip irrigation was observed at canal water irrigation and it was decreased significantly 4.56 and 8.43% at ECiw 2.5 and 5.0 dS/m. However, the available phosphorus after harvest of brinjal crop under drip irrigation increased significantly at 125% RDN over 75% RDN. Available phosphorus increased 7.02 and 11.72% at RDN and 125% RDN over 75% RDN (Table 3.25).

Table 3.25 Effect of nitrogen fertigation and different saline water irrigation on soil available phosphorus (kg/ha) under brinjal crop

Nitrogen Level	Canal(0.3 dS/m)	2.5 dS/m	5.0 dS/m	Mean
75% RDN	28.91	27.81	26.76	**27.83**
RDN	30.94	29.67	28.48	**29.70**
125% RDN	32.30	30.49	29.16	**30.65**
Mean	30.72	29.32	28.13	
CD (p=0.05)	Nitrogen (N) = 2.19, Salinity level (S) = 1.20, N x S = NS			

The highest (264.12 kg/ha) available K after harvest of brinjal crop was observed at 125% RDN and saline water irrigation of 5.0 dS/m whereas the minimum (240.58 kg/ha) was observed at 75% RDN and canal water under drip irrigation. The mean available K increased with the increasing of the salinity of irrigation water. The highest mean value (259.42 kg/ha) of available K after harvest of brinjal crop under drip irrigation was observed at ECiw 5.0 dS/m. The available K increased significantly 3.57 and 6.72% at ECiw 2.5 and 5.0 dS/m over canal water irrigation. However, the effect of RDN and 125% RDN on available K did not differ significantly (Table 3.26).

Table 3.26 Effect of nitrogen fertigation and different saline water irrigation on soil available K(kg/ha) under brinjal crop

N Level	Canal(0.3 dS/m)	2.5 dS/m	5.0 dS/m	Mean
75% RDN	240.58	248.26	254.34	247.73
RDN	242.80	250.59	259.79	251.06
125% RDN	245.90	256.46	264.12	255.49
Mean	243.09	251.77	259.42	
CD (p=0.05)	Nitrogen (N) = 7.58, Salinity level (S) = 4.05, N x S = NS			

- **Assessment of drain water quality from different RO water purifiers (Bathinda)**

A survey was undertaken to assess the quality of waste water from RO water purifier in Bathinda district of Punjab. A total of 30 samples were collected from different sites (Table 3.27) and analyzed for various chemical properties *viz.,* pH, EC, $Ca^{+2} + Mg^{+2}$, Na^{+} and K^{+}, CO_3^{-2}, HCO_3^{-} and Cl^{-} .

Table 3.27 Description of water collection sites

Sites	Description
A	Public RO systems at village level with ground water
B	Urban households with ground water supply
C	Urban households with canal water and ground water supply
D	Urban households with Punjab Water Supply and Sewerage Board (PWSSB) supply and ground water
E	Urban households with PWSSB supply.

Water quality of different sites: The pH values of supply, stored and drain water ranged from 8.0 to 8.4, 7.0 to 7.7 and 7.3 to 8.1 with average value of 8.2, 7.2 and 7.8 respectively, having maximum average of 8.3 in ground water at site A. All the water showed pH values within drinking/irrigation water permissible limits of 6.5 to 8.5, irrespective of their sources. The supply water showed EC in the range of 0.35 to 2.8 dSm^{-1} with an average value of 2.24 dSm^{-1} at site A, 1.73 dSm^{-1} at site B, 0.52 dSm^{-1} at site C, 0.85 dSm^{-1} at site D and 0.51 dSm^{-1} at site E (Table 3.28). Similarly, the stored water (Table 3.29) showed EC in the range of 0.07 to 0.30 dSm^{-1} with an average value of 0.24 dSm^{-1} at site A, 0.10 dSm^{-1} at site B, 0.10 dSm^{-1} at site C, 0.10 dSm^{-1} at site D and 0.10 dSm^{-1} at site E. Whereas, a higher range of EC 0.46 to 6.1 dSm^{-1} with an average value of 4.58 dSm^{-1} at site A, 2.93 dSm^{-1} at site B, 1.33 dSm^{-1} at site C, 1.7 dSm^{-1} at site D and 0.85 dSm^{-1} at site E were reported in drain water (Table 3.30) as compared to supply and stored water.

Table 3.28 Chemical constituents of RO supply water at different sites

Site	A		B		C		D		E	
Parameter	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
pH	8.1-8.4	8.3	8.0-8.2	8.1	8.2-8.3	8.2	8.2-8.3	8.2	8.1-8.3	8.2
EC ($dS\ m^{-1}$)	1.6-2.8	2.24	1.3-2.6	1.73	0.43-0.66	0.52	0.8-0.9	0.85	0.35-0.80	0.51
CO_3^{-2}($meqL^{-1}$)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
HCO_3^{-} ($meqL^{-1}$)	1.9-3.2	2.7	1.5-2.1	1.8	1.2-1.6	1.3	3.1-3.8	3.5	1.2-1.6	1.4
Cl^{-} ($meqL^{-1}$)	2.5-4.8	3.3	8.6-10.2	9.4	0.4-0.5	0.5	0.6-0.8	0.7	0.4-0.8	0.5
Ca^{+}+ Mg^{+} ($meqL^{-1}$)	3.4-6.5	5.2	3.5-4.9	4.1	1.8-2.1	2	1.1-1.5	1.3	1.2-2.1	1.82
RSC ($meqL^{-1}$)	Nil	Nil	Nil	Nil	Nil	Nil	2.0-2.5	2.2	0.0-0.10	0.01
Na^{+} (mgL^{-1})	22-32	27	85-102	93.6	33-36	33.8	13.7-14.9	14.4	15.2-38.5	26.6
K^{+}(mgL^{-1})	9.8-16.0	12.1	15-22	17.6	8.8-9.0	8.9	15.9-16.7	16.4	5.9-8.5	7.1

Table 3.29 Chemical constituents of RO stored water at different sites

Site	A		B		C		D		E	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
pH	7.1-7.2	7.1	7.1-7.4	7.2	7.1-7.2	7.2	7.0-7.2	7.1	7.2-7.66	7.46
EC (dS m^{-1})	0.21-0.30	0.24	.09-.11	0.097	0.08-0.1	0.09	0.09-0.2	0.12	0.07-0.11	0.091
CO_3^{-2} ($meqL^{-1}$)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
HCO_3^- ($meqL^{-1}$)	0.2-1.1	0.7	0.3-0.6	0.4	0.8-1.2	0.9	0.8-1.4	1	0.2-0.6	0.4
Cl^- ($meqL^{-1}$)	0.9-1.6	1.3	0.5-0.8	0.7	0.2-0.2	0.2	0.4-0.6	0.5	0.1-0.2	0.16
$Ca^+ + Mg^+$ ($meqL^{-1}$)	0.2-1.9	0.7	0.5-1.2	0.9	1.1-1.2	1.2	0.1-0.3	0.2	0.4-0.7	0.53
RSC ($meqL^{-1}$)	0.0-0.6	0.3	Nil	Nil	0.0-0.1	0.02	Nil	Nil	0.0-0.1	0.02
Na^+ (mgL^{-1})	5.0-18.0	12.8	9.0-14.0	12.2	12.0-16.0	12.8	3.8-9.7	7.3	8.3-12.5	10.18
K^+(mgL^{-1})	1.2-2.1	1.6	0.8-1.7	1.2	0.8-1.1	0.9	0.1-1.0	0.5	0.5-1.2	0.95

Table 3.30 Chemical constituents of RO drain water at different sites

Site	A		B		C		D		E	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
pH	7.3-7.5	7.5	7.5-8.1	7.7	7.6-8.1	7.9	7.4-8.1	7.9	7.6-8.1	7.9
EC (dS m^{-1})	2.5-6.1	4.58	2.7-3.2	2.93	1.2-1.4	1.33	1.4-1.9	1.7	0.46-1.4	0.85
CO_3^{-2}($meqL^{-1}$)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
HCO_3^- ($meqL^{-1}$)	6.5-8.5	7.6	3.2-4.5	3.8	3.2-3.4	3.4	7.1-7.8	7.5	2.2-2.8	2.6
Cl^- ($meqL^{-1}$)	6.8-20.0	14.7	8.6-10.2	9.4	1.6-1.8	1.8	1.1-1.6	1.3	0.4-0.6	0.5
$Ca^+ + Mg^+$ ($meqL^{-1}$)	7.5-14.5	11.7	5.9-7.1	6.5	4.1-4.3	4.2	2.2-2.6	2.4	2.5-3.6	2.99
RSC ($meqL^{-1}$)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.0-0.1	0.02
Na^+ (mgL^{-1})	95-111	104.4	106-157	126.8	37-49	41.8	22.5-36.4	27.8	22-41	33.7
K^+(mgL^{-1})	109-135	121	32-44	38.2	7.6-8.1	7.9	25.2-28.2	26.8	7.8-12.3	9.77

The sodium (Na^+) concentration ranged from 13.7 to 102 mg L^{-1}, 3.8 to 18 mg L^{-1} and 22.4 to 157 mg L^{-1} with a mean of 39.1 mg $L^{-1,}$ 11.1 mg L^{-1} and 66.9 mg L^{-1} in supply, stored and waste water, respectively (Table 3.28-3.30). Higher Na^+ was reported in waste water followed by supply water, while stored water contains less amount of Na^+ (Table 3.29). Among other major cations, K^+ and Ca^{+2} + Mg^{+2} ions are important constituents, and varied from 5.9 to 16.7 mg L^{-1} with mean of 12.4 mg L^{-1} K^+ and varied from 1.1 to 6.5 meq L^{-1} with mean of 2.9 meq L^{-1} Ca^{+2} + Mg^{+2} ions in supply water (Table 13). Similarly, in stored water K^+ and Ca^{+2} + Mg^{+2} ions ranged from 0.1 to 2.1 mg L^{-1} with mean of 1.0 mg L^{-1} and from 0.1 to 1.9 meq L^{-1} with mean of 0.7 meq L^{-1} (Table 3.29). The drain water contains higher amount of K^+ and Ca^{+2} + Mg^{+2} ions, and ranged from 7.6 to 135 mg L^{-1} with mean of 40.7 mg L^{-1} K^+ and ranged from 2.2 to 14.5 meq L^{-1} with mean of 5.6 meq L^{-1} Ca^{+2} + Mg^{+2} ions (Table 15). Among the anions, chloride (Cl^-) was dominant ion, which ranged from 0.4 to 10.2 meq L^{-1}, from 0.1 to 1.6 meq L^{-1} and from 0.4 to 20.0 meq L^{-1} with mean value of 2.9 meq L^{-1}, 0.6 meq L^{-1} and 5.5 meq L^{-1} in supply, stored and drain respectively (Table 13-15), followed by bicarbonate (HCO_3^-) ranged from 1.2 to 3.2 meq L^{-1} with mean of 2.1 meq L^{-1} in supply water (Table 13), from 0.2 to 1.4 meq L^{-1} with mean of 0.7 meq L^{-1} in stored water (Table 3.29) and from 2.2 to 8.5 meq L^{-1} with mean of 5.0 meq L^{-1} in drain water (Table 3.30).

RO drains water suitability for crop irrigation

The suitability of RO outlet drain water from different sites (A to E) for irrigation is mainly evaluated using electrical conductivity (EC) and residual sodium carbonate (RSC), were presented in Table 15. The EC of supply water (Table 3.28) at site A and B were in marginal range (2.0-4.0 dSm^{-1}) and can be used for coarse textured soils/ salt tolerant crops with periodic monitoring of salt accumulation in soils. Whereas, other sites the supply water are good quality and can be use for vegetable production. The EC of drain water at different sites depends on quality of water supplied and efficacy of RO systems. In our study the EC of drain water varied from 0.46 to 6.1 dSm^{-1} with an average value of 4.58 dSm^{-1} at site A, 2.93 dSm^{-1} at site B, 1.33 dSm^{-1} at site C, 1.7 dSm^{-1} at site D and 0.85 dSm^{-1} at site E. However, negligible amount of RSC was reported from all the sites. The higher salts of drain water at site A (EC > 4.0 dSm^{-1}) and site B (EC>2.9 dSm^{-1}) makes them unsafe for frequently use for irrigation, but they can be used with some management practices such as with periodic monitoring of salt accumulation in soils. While, drain water of other sites contain less salts (EC <2.0 dSm^{-1}) and can be used frequently for irrigation.

- **Effect of different levels of organic manures and mulching on vegetables (Brinjal, Chilli and Tomato) under drip irrigation (Panvel)**

Mulch is a general term for a protective ground cover that can include manure, wood chips, seaweed, leaves, straw, grasses, sands, stones (boulders), synthetic plastics, and other natural products. It's main function is limited to controlling first stage of drying which helps in improved moisture content, reduction in soil temperature, besides this it also helps in checking seedling mortality and improving crop stand. Keeping in view the benefits of mulching and use of organic manure in vegetables (Brinjal, Chilli and Tomato) production during *rabi* season, the experiment was conducted. Details of treatments for different organic much in different crops are given in Table 3.31. Soil properties at initial and harvest stage are given in Table 3.32.

Table 3.31 Details of the experiment

	Treatments and other details:		
	A) Crops C_1- Brinjal C_2- Chilli C_3- Tomato **B) Mulching** M_1- Plastic mulch M_2- Paddy straw M_3- No mulch		**C) Organic manures** F_1- FYM @ 15 t ha^{-1} F_2- Vermicompost @ 5 t ha^{-1} F_3- FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} F_4- Control (No organic manure) **Design:** Factorial Randomised Block design Crop **and Variety:** Brinjal- Mahyco MEBH 10 Chilli- Semimis hybrid SHP 4884;Tomato- Sungro F1 hybrid 3618 Date of Sowing: 22/12/2020

Table 3.32 Soil properties of experimental plot

Sr. No	Particulars	At initial stage	After harvest of crop
1.	pH	6.83	6.90
2.	EC (dSm^{-1})	2.60	6.21
3.	OC (gm kg^{-1})	4.74	5.05
4.	P_2O_5 (kg ha^{-1})	45.36	55.92
5.	K_2O (kg ha^{-1})	925.32	1028.36



General View of Experimental Field

The experiment was conducted at Khar Land Research Station, Panvel farm by using various mulches *i.e.* Plastic mulch (M_1) and Paddy straw mulch (M_2) and control treatment having no mulch (M_3) by using organic manures FYM @ 15 t ha^{-1} (F_1), Vermicompost @ 5 t ha^{-1} (F_2), FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (F_3) and Control (No organic manure) (F_4). The data are presented in the following tables (1 to 21).

Brinjal crop

Data pertaining to soil EC at 30 days after planting (Table 3.33) revealed that the treatment of plastic mulch (M_1) was found to be statistically significant and the lowest EC value of 2.65 dS m^{-1} over rest of the mulching treatments containing paddy straw mulch M_2 (3.72 dS m^{-1}) and no mulch M_3 (4.95 dS m^{-1}).Similarly the data on different treatments of organic manures further recorded that the EC value of 3.32 dS m^{-1} was found to be statistically significant and recorded the lowest value as a result of application FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (F_3) over rest of the treatments FYM @ 15 t ha^{-1} (F_1), Vermicompost @ 5 t ha^{-1} (F_2) and No organic manure (F_4). A critical look on the data of interaction indicated that the M_1F_3 interaction was statistically significant and registered the lowest EC (2.13 dS m^{-1})value over rest of the treatments of interactions with exception of M_1F_1 (2.52 dS m^{-1}) interaction.

Table 3.33 Soil (EC) Electrical Conductivity (dS m^{-1}): (1:2.5; soil: water suspension) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	2.52	2.84	2.13	3.13	2.65
M_2	3.61	3.81	3.28	4.18	3.72
M_3	5.09	4.97	4.55	5.18	4.95
Mean	3.74	3.87	3.32	4.16	
SE± m for Mulching	0.09	SE± m for organic manure	0.11	SE± m for Interaction	0.19
CD @ 5%	0.27	CD @ 5%	0.31	CD @ 5%	0.54

It is evident from data presented in Table 3.34 that, the among various mulching treatments, plastic mulch (M_1) was found to be statistically significant and recorded the lowest EC value of 1.34 dS m^{-1} over (M_2) paddy straw mulch (2.02 dS m^{-1})and (M_3) no mulch (6.42 dS m^{-1}). Application of FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (F_3) exhibited significant and lowest EC value (2.87 dS m^{-1}) over rest of the treatments (F_1, F_2 and F_4). When data on interaction effect was studied it revealed that the interaction of M_1F_3 showed statistically significant and the lowest EC (1.09 dS m^{-1}) value over rest of the interactions except the treatment combinations M_1F_1 and M_1F_2.

Table 3.34 Soil (EC) Electrical Conductivity (dS m^{-1}): (1:2.5; soil: water suspension) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	1.26	1.33	1.09	1.68	1.34
M_2	1.92	2.14	1.83	2.20	2.02
M_3	6.08	6.15	5.67	7.80	6.42
Mean	3.08	3.21	2.87	3.89	
SE± m for Mulching	0.05	SE± m for organic manure	0.05	SE± m for Interaction	0.09
CD @ 5%	0.13	CD @ 5%	0.16	CD @ 5%	0.27

When data on pH at 30 days presented in Table 3.35 when studied revealed that the effect of mulching was observed on soil pH at 30 days after planting and plastic mulch (M_1)recorded significantly higher pH value of 6.73 over the treatments paddy straw mulch (M_2)(6.68)and no mulch (M_3) (6.64). While, treatment F_3 showed statistically significant higher pH value of 6.74 over the treatment F_1 (6.70) and F_2 (6.65)and F_4 (6.64).The data on interaction effect indicated that, application of plastic mulch with FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (M_1F_3) recorded statistically significant higher pH value of 6.78 over rest of the treatment combinations.

Table 3.35. Soil pH (1:2.5; soil: water suspension) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	6.73	6.71	6.78	6.68	6.73
M_2	6.71	6.66	6.72	6.64	6.68
M_3	6.67	6.60	6.70	6.61	6.64
Mean	6.70	6.65	6.74	6.64	
SE± m for Mulching	0.005	SE± m for organic manure	0.005	SE± m for Interaction	0.009
CD @ 5%	0.013	CD @ 5%	0.015	CD @ 5%	0.027

When data on pH at 90 days presented in Table 3.36 when studied revealed that, the effect of mulching was observed on soil pH at 90 days after planting and M_1 recorded significantly higher pH value of 6.71 over the treatments, paddy straw mulch (M_2)and plastic mulch (M_1).While the treatment F_3 showed statistically significant higher pH value of 6.68 over the treatment of F_2, andF_4 however it was statistically at par with the treatment F_1 (6.66).The data on interaction effect indicated that, interaction effect of plastic mulch with FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (M_1F_3) (M_1F_3) interaction recorded statistically higher pH value of 6.74 over rest of the treatment combinations however it was statistically at par with M_1F_1 (6.72).

Table 3.36 Soil pH (1:2.5; soil:water suspension) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	6.72	6.69	6.74	6.68	6.71
M_2	6.66	6.65	6.67	6.63	6.65
M_3	6.61	6.59	6.62	6.58	6.60
Mean	6.66	6.64	6.68	6.63	
SE± m for Mulching	0.004	SE± m for organic manure	0.004	SE± m for Interaction	0.007
CD @ 5%	0.010	CD @ 5%	0.012	CD @ 5%	0.021

Perusal of data on soil moisture presented in Table 3.37 indicated that the plastic mulch treatment M_1 recorded statistical significant and higher soil moisture value of 56.49 per cent over rest of the

treatments containing paddy straw mulch (M_2)and no mulch (M_3)at 30 days after sowing. The application of organic manures, of FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1}(F_3) exhibited significantly higher moisture content value of 55.12 per cent over the organic treatments F_1 (FYM @ 15 t ha^{-1}), F_2 (Vermicompost @ 5 t ha^{-1}) and F_4 (no organic manures). A critical look on data of interaction effect further indicated that, the interaction of M_1F_3 showed statistically higher soil moisture content (60.78 per cent) over all remaining interactions.

Table 3.37 Soil moisture (per cent) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	**Mean**
M_1	57.30	54.36	**60.78**	53.53	**56.49**
M_2	52.89	49.72	59.44	46.68	**52.18**
M_3	44.63	42.77	45.12	42.60	**43.78**
Mean	**51.60**	**48.95**	**55.12**	**47.60**	
SE± m for Mulching	0.21	SE± m for organic manure	0.24	SE± m for Interaction	0.42
CD @ 5%	0.61	CD @ 5%	0.71	CD @ 5%	1.23

From data presented in Table **3.3**8, on soil moisture content indicated that, the application of plastic mulch (M_1) recorded statistically significant and higher moisture content (55.78 per cent) at 90 days after planting over the treatment (M_2) paddy straw mulch (50.31 per cent) and (M_3) no mulching (40.78 per cent). Among various treatments of organic manures FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (F_3) noted significantly higher soil moisture content (51.96 per cent) over F_1 (50.06 per cent), F_2 (47.52 per cent) and F_4 (46.29 per cent).The interaction effect of M_1F_3 showed statistically significant and the highest soil moisture content (58.82 per cent) over rest of the treatment interactions.

Table 3.38 Soil moisture (per cent) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	56.88	54.29	58.82	53.14	55.78
M_2	51.68	48.49	54.95	46.13	50.31
M_3	41.63	39.77	42.12	39.60	40.78
Mean	50.06	47.52	51.96	46.29	
SE± m for Mulching	0.24	SE± m for organic manure	0.28	SE± m for Interaction	0.49
CD @ 5%	0.71	CD @ 5%	0.82	CD @ 5%	1.42

Brinjal yield (q ha^{-1})

The data on yield of brinjal are presented in Table 3.39 indicated that the application of paddy straw mulch (M_2) showed statistically significant and higher yield (300.28 q ha^{-1}) over plastic mulch M_1 (274.80 q ha^{-1}) and no mulch M_3 (250.70 qha^{-1}). Critical look on the data on application of organic manures further indicated that, the application of FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (F_3) produced significantly higher yield (323.40 q ha^{-1}) over rest of the treatments containing application of FYM @ 15 t ha^{-1}(288.66 q ha^{-1}), Vermicompost @ 5 t ha^{-1}(249.50 q ha^{-1}) and no organic manures (239.49 q ha^{-1}). Interaction of Paddy straw mulching with FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} (M_2F_3) produced statistically significant yield (388.41 q ha^{-1}) over plastic mulch and no mulch treatments.

Table 3.39. Yield of Brinjal (q ha^{-1})

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	302.56	246.35	320.20	230.08	274.80
M_2	307.93	255.06	388.41	249.73	300.28
M_3	255.48	247.08	261.58	238.67	250.70
Mean	288.66	249.50	323.40	239.49	
SE± m for Mulching	1.51	SE± m for organic manure	1.74	SE± m for Interaction	3.01
CD @ 5%	4.42	CD @ 5%	5.10	CD @ 5%	8.84

Chilli crop:

When data on soil EC (Table 3.40) studied, it is observed that among various mulching treatments, M_1 exhibited statistically significant and the lowest EC value of 2.24 dS m^{-1} over paddy straw mulch M_2 (3.48 dS m^{-1}) and no mulch M_3 (4.60 dS m^{-1}). Similarly data pertaining to the treatments of organic manures further revealed that the treatment F_3 showed significant and the lowest EC value of 3.18 dS m^{-1} over the treatments F_1, F_2 and F_4 with EC values of 3.34 dS m^{-1}, 3.52 dS m^{-1} and 3.72 dS m^{-1}, respectively. When interaction effect was studied it is evident from the data that the M_1F_3 interaction recorded statistically significant and lowest EC value (2.13 dS m^{-1})over F_4 interaction with exception of M_1F_1 (2.18 dS m^{-1}) and M_1F_2 interactions (2.22 dS m^{-1}).

Table 3.40 Soil (EC) Electrical Conductivity (dS m^{-1}) : (1:2.5; soil: water suspension) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	2.18	2.22	2.13	2.44	2.24
M_2	3.38	3.62	3.21	3.70	3.48
M_3	4.46	4.72	4.19	5.04	4.60
Mean	3.34	3.52	3.18	3.72	
SE± m for Mulching	0.04	SE± m for organic manure	0.05	SE± m for Interaction	0.09
CD @ 5%	0.13	CD @ 5%	0.15	CD @ 5%	0.26

It is evident from the data presented in Table 3.41 that the highest EC value of 6.44 dS m^{-1} was recorded in the no mulch treatment *i.e.* control (M_3). However the lowest and statistically significant EC value of 1.08 dS m^{-1} was observed as a result of plastic mulch (M_1) over rest of the mulching treatments M_2 (1.43 dS m^{-1}) at 90 days after sowing. A critical look on the data further revealed that the organic manure treatment (F_3) recorded the significant and the lowest EC value of 2.79 dS m^{-1} over rest of the organic treatments (F_1, $F_2$and F_4).When interaction effect was studied it is evident from the data that the application of plastic mulch and FYM @7.5 t h^{-1}+Vermicompost @ 2.5 t h^{-1} (M_1F_3)produced the lowest EC value of 1.01dS m^{-1} which was found to be numerically lowest over remaining interactions.

Table 3.41 Soil (EC) Electrical Conductivity (dS m^{-1}): (1:2.5; soil:water suspension) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	**Mean**
M_1	1.06	1.09	**1.01**	1.15	**1.08**
M_2	1.47	1.50	1.18	1.58	**1.43**
M_3	6.20	6.27	6.18	7.12	**6.44**
Mean	**2.91**	**2.95**	**2.79**	**3.28**	
SE± m for Mulching	0.03	SE± m for organic manure	0.03	SE± m for Interaction	0.05
CD @ 5%	0.08	CD @ 5%	0.09	CD @ 5%	0.16

Data on soil pH at 30 days after planting are presented in Table 3.42 when studied indicated that the treatment of no mulch (M_1) recorded statistically significant and higher pH value of 6.76 over other treatments containing paddy straw mulch (soil pH 6.72) and no mulch (soil pH 6.67). Application of no organic manures (F_4) was found to be statistical significant and recorded the lowest pH value of 6.69 over rest of the organic treatments. When interaction effect was studied it was found that the interaction of M_1F_3 treatment was recorded higher pH value of 6.81 over remaining treatments of interactions.

Table 3.42 Soil pH (1:2.5; soil:water suspension) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	**Mean**
M_1	6.77	6.74	6.81	6.72	**6.76**
M2	6.73	6.71	6.74	6.70	**6.72**
M3	6.68	6.67	6.69	6.65	**6.67**
Mean	**6.72**	**6.71**	**6.75**	**6.69**	
SE± m for Mulching	0.03	SE± m for organic manure	0.003	SE± m for Interaction	0.006
CD @ 5%	0.009	CD @ 5%	0.010	CD @ 5%	0.017

When data on soil pH at 90 days after planting (Table 3.43) studied revealed that, the treatment M_3 *i.e.* control produced statistically lowest pH value of 6.61 over other mulching treatments *viz.,* plastic mulch (M_1) 6.70 and paddy straw mulch (M_2) 6.64. Similarly, the application of treatment F_4 (no organic manures) recorded the lowest pH value of 6.63 which found to be statistically at par with F_2 (6.64). Interaction effect of the treatments M_1F_3 was statistically significant and recorded higher pH value of 6.72 over M_1F_3 (7.24) with exception of the treatments M_1F_1 and M_1F_2 which were found to be statistically at par.

Table 3.43 Soil pH (1:2.5; soil: water suspension) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	**Mean**
M_1	6.70	6.69	6.72	6.67	**6.70**
M_2	6.65	6.63	6.66	6.62	**6.64**
M_3	6.60	6.61	6.61	6.60	**6.61**
Mean	**6.65**	**6.64**	**6.66**	**6.63**	
SE± m for Mulching	0.004	SE± m for organic manure	0.004	SE± m for Interaction	0.008
CD @ 5%	0.011	CD @ 5%	0.013	CD @ 5%	0.022

Perusal of data on soil moisture at 30 days after planting presented in Table 3.44 indicated that, treatment containing plastic mulch (M_1) recorded significantly higher moisture content (60.78 per cent) over rest of the mulching treatments *viz.,* paddy straw mulch (M_2) (52.46 per cent) and no mulch (M_3) (48.58 per cent). While application of organic manures treatment, receiving application of FYM @ 7.5 t ha^{-1} + Vermicompost@ 2.5 t ha^{-1} (F_3) recorded significantly higher moisture content (56.29 per cent) over rest of organic treatments. Data on interaction effect when studied revealed that the interaction of M_1F_3 treatment recorded statistically significant and the highest soil moisture content of 62.71 per cent over remaining treatment interactions.

Table 3.44 Soil moisture (per cent) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	60.67	60.87	**62.71**	58.87	**60.78**
M_2	52.28	51.73	56.11	49.72	**52.46**
M_3	49.12	48.10	50.04	47.05	**48.58**
Mean	**54.02**	**53.57**	**56.29**	**51.88**	
SE± m for Mulching	0.13	SE± m for organic manure	0.15	SE± m for Interaction	0.25
CD @ 5%	0.37	CD @ 5%	0.43	CD @ 5%	0.75

The data on per cent moisture content at 90 days are given in Table 3.45. A critical look on the data on soil moisture at 90 days after planting indicated that treatment of plastic mulch (M_1) recorded statistically significant and higher soil moisture content value of 56.12 per cent which was statistically significant over the treatments containing paddy straw mulch (M_2) 50.21 per cent and no mulch (M_3) 43.41 per cent. Similarly, application of FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1}(F_3) showed statistically significant and higher soil moisture content (52.45 per cent) over the treatment F_1 (50.38 per cent), F_2 (48.36 per cent) and F_4 (48.45 per cent). The data on interaction effect indicated that the treatment (M_1F_3) with the application of plastic mulch and FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1} recorded significantly higher soil moisture content (59.19 per cent) over rest of the treatments of interactions.

Table 3.45 Soil moisture (per cent) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	56.61	52.93	**59.19**	55.74	**56.12**
M_2	51.10	49.05	53.13	47.57	**50.21**
M_3	43.44	43.10	45.04	42.05	**43.41**
Mean	**50.38**	**48.36**	**52.45**	**48.45**	
SE± m for Mulching	0.18	SE± m for organic manure	0.21	SE± m for Interaction	0.37
CD @ 5%	0.54	CD @ 5%	0.62	CD @ 5%	1.07

Chilli yield (q ha^{-1})

Data on yield of chilli (Table 3.46) indicated that the among various treatments of mulching, the treatment of paddy straw mulch (M_2) recorded statistically significant and higher yield of 115.72 q ha^{-1} over the treatments of plastic mulch M_1 (99.68 q ha^{-1}) and no mulch M_3 (90.32 q ha^{-1}). The data on various organic manures when studied further revealed that the application of FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1}(F_3)produced statistically significant and higher yield (107.61 q ha^{-1}) over F_1 (103.90 q ha^{-1}), F_2 (99.86 q ha^{-1}) and F_4 (96.24 q ha^{-1}) the treatments. Interaction effect of M_2F_3 (Paddy straw mulching with FYM @ 7.5 t ha^{-1}+ Vermicompost @ 2.5 t ha^{-1}) produced statistically significant and higher yield of (122.38 q ha^{-1}) over remaining treatments of interactions.

Table 3.46 Yield of Chilli (q ha^{-1})

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	101.29	96.23	105.65	95.53	**99.68**
M_2	118.61	113.58	**122.38**	108.30	**115.72**
M_3	91.80	89.77	94.80	84.90	**90.32**
Mean	**103.90**	**99.86**	**107.61**	**96.24**	
SE± m for Mulching	0.20	SE± m for organic manure	0.23	SE± m for Interaction	0.40
CD @ 5%	0.58	CD @ 5%	0.67	CD @ 5%	1.17

Tomato crop:

Data on EC 30 days after planting revealed that the effect of mulching was observed on EC of soil. Plastic mulching recorded the lowest EC value (2.90 dS m^{-1}) which was statistically significant over rest of the treatments (Table 3.47). Application of organic manures, the application of FYM @7.5 t h^{-1}+Vermicompost @ 2.5 t h^{-1} (F_3) recorded statistically significant and lowest EC (3.50dS m^{-1}) over F_1 (3.74 dS m^{-1}), F_2 (3.82 dS m^{-1}) and F_4 (4.25 dS m^{-1}). Further interaction effect of mulching and organic manure was also observed in M_1F_3 interaction which was showed significant and lowest EC value of 2.77 dS m^{-1} over all remaining interactions with the exception of interaction of M_1F_1(2.86 dS m^{-1}) and M_1F_2 (2.89 dS m^{-1}) which was found to be statistically at par at 30 days after planting.

Table 3.47 Soil (EC) Electrical Conductivity (dS m^{-1}) : (1:2.5; soil:water suspension) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	2.86	2.89	**2.77**	3.08	**2.90**
M_2	3.94	4.06	3.49	4.15	**3.91**
M_3	4.42	4.51	4.24	5.52	**4.67**
Mean	**3.74**	**3.82**	**3.50**	**4.25**	
SE± m for Mulching	0.03	SE± m for organic manure	0.03	SE± m for Interaction	0.05
CD @ 5%	0.08	CD @ 5%	0.09	CD @ 5%	0.16

It is evident from the data on EC presented in Table 3.48 that the highest EC value of 7.05 dS m^{-1} was recorded in the no mulch treatment *i.e.* control (M_3). However, the lowest and statistically significant EC value of 1.30 dS m^{-1} was observed as a result of plastic mulch (M_1) which was found statistically significant over rest of the mulching treatments M_2 (2.29 dS m^{-1}) and M_3 treatment without mulch (7.05 dS m^{-1}) at 90 days after planting. A critical look on the data further revealed that (F_3) recorded the statistically significant and lowest EC value of 3.11 dS m^{-1} over rest of the treatments (F_1, F_2andF_4). When interaction effect was studied it is evident from the data that the application of plastic mulch withFYM @7.5 t h^{-1}+Vermicompost @ 2.5 t h^{-1} (M_1F_3) produced the lowest EC value of 1.05 dS m^{-1} which was found to be statistically significant over remaining interactions however it was at par with the interaction of plastic mulch with FYM @ 15 tha^{-1} (M_1F_1).

Table 3.48 Soil (EC) Electrical Conductivity (dS m^{-1}): (1:2.5; soil:water suspension) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	1.32	1.38	**1.05**	1.44	**1.30**
M_2	2.17	2.43	1.95	2.62	**2.29**
M_3	7.06	7.15	6.34	7.65	**7.05**
Mean	**3.52**	**3.65**	**3.11**	**3.90**	
SE± m for Mulching	0.05	SE± m for organic manure	0.06	SE± m for Interaction	0.10
CD @ 5%	0.15	CD @ 5%	0.17	CD @ 5%	0.29

The treatment (M_1) with plastic mulch was observed to be statistically significant in case of soil reaction (pH 6.74) over rest of the treatments (Table 3.49). Similarly, treatment with application of organic manure (F_3) also recorded statistically the highest mean pH value of 6.73 over rest of the treatments. When interaction effect was studied it was found that the treatmentM_1F_3 was found to be statistically significant (6.79) over remaining treatments of interactions at 30 days after planting.

Table 3.49 Soil pH (1:2.5; soil:water suspension) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	6.75	6.72	6.79	6.70	**6.74**
M_2	6.71	6.69	6.72	6.68	**6.70**
M_3	6.66	6.64	6.67	6.63	**6.65**
Mean	**6.70**	**6.68**	**6.73**	**6.67**	
SE± m for Mulching	0.002	SE± m for organic manure	0.002	SE± m for Interaction	0.003
CD @ 5%	0.005	CD @ 5%	0.006	CD @ 5%	0.010

Data on soil pH at 90 days after planting are presented in Table 3.50 when studied revealed that the without mulch produces statistically the lowest pH value of 6.61 over remaining mulches. Similarly, the organic treatment receiving no application of organic manure (F_4) recorded the lower pH value of 6.63 which was found to be statistically significant over rest of the treatments. Interaction effect of the treatments M_3F_4 (6.59) was statistically significant and lowest pH over rest of the treatments with exception of the treatment M_3F_2 (6.60) which found to be statistically at par.

Table 3.50 Soil pH (1:2.5; soil: water suspension) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	6.71	6.70	6.73	6.68	**6.71**
M_2	6.66	6.65	6.67	6.61	**6.65**
M_3	6.62	6.60	6.63	6.59	**6.61**
Mean	**6.67**	**6.65**	**6.68**	**6.63**	
SE± m for Mulching	0.003	SE± m for organic manure	0.003	SE± m for Interaction	0.005
CD @ 5%	0.008	CD @ 5%	0.009	CD @ 5%	0.015

It is seen from data presented in Table 3.51 that the plastic mulch treatment (M_1) showed significantly higher soil moisture 58.52 per cent over rest of the treatments containing paddy straw mulch and no mulch. Application of FYM @7.5 t h^{-1}+Vermicompost @ 2.5 t h^{-1} (F_3)produced significantly higher soil moisture content (55.63 per cent) over F_1 (FYM @15 t ha^{-1}), F_2 (Vermicompost @ 5 t ha^{-1}) and F_4 (no organic manures). The interaction effect of M_1F_3 (60.90 per cent) showed statistically significant and higher soil moisture content over rest of the interactions at 30 days after planting of crop.

Table 3.51 Soil moisture (per cent) at 30 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	58.37	57.87	**60.90**	56.94	**58.52**
M_2	55.64	50.97	59.56	48.93	**53.77**
M_3	44.74	42.99	46.42	41.49	**43.91**
Mean	**52.92**	**50.61**	**55.63**	**49.12**	
SE± m for Mulching	0.20	SE± m for organic manure	0.24	SE± m for Interaction	0.41
CD @ 5%	0.60	CD @ 5%	0.69	CD @ 5%	1.20

It is seen from data of moisture content at 90 days (Table 3.52) revealed that the plastic mulch treatment (M_1) showed significantly higher soil moisture 56.30 per cent over rest of the treatments containing paddy straw mulch and no mulch. Application of FYM @7.5 t h^{-1}+Vermicompost @ 2.5 t h^{-1} (F_3)produced significantly higher soil moisture content (53.02 per cent) over F_1 (FYM @15 t ha^{-1}), F_2 (Vermicompost @ 5 t ha^{-1}) and F_4 (no organic manures). The interaction effect of M_1F_3 (59.22 per

cent) showed statistically significant and higher soil moisture content over rest of the interactions at 90 days after planting of crop.

Table 3.52 Soil moisture (per cent) at 90 days after planting

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	57.22	55.19	**59.22**	53.57	**56.30**
M_2	53.18	50.20	56.12	49.79	**52.32**
M_3	41.87	40.65	43.70	37.18	**40.85**
Mean	**50.76**	**48.68**	**53.02**	**46.85**	
SE± m for Mulching	0.14	SE± m for organic manure	0.16	SE± m for Interaction	0.27
CD @ 5%	0.40	CD @ 5%	0.46	CD @ 5%	0.79

Tomato yield (quintal ha^{-1})

Data on yield of tomato crop (Table 3.53) indicated that the among various treatments of mulching, the treatment of paddy straw mulch (M_2) recorded statistically significant and higher yield (320.85 q ha^{-1}) over rest of all treatments containing plastic mulch (M_1)300.26 q ha^{-1} and no mulch (M_3) 250.38 q ha^{-1}. Critical look on the data further revealed that the F_3 produced statistically higher yield (325.89 q ha^{-1}) over the organic treatments of manure FYM @ 15 t ha^{-1} (F_1)(297.12 q ha^{-1}), Vermicompost @ 5 t ha^{-1} (F_2)(273.73 q ha^{-1}) and without application of organic manure (F_4)(265.24 q ha^{-1}). Interaction effect of M_2F_3 (Paddy straw mulching with FYM @ 7.5 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1}) produced statistically significant and higher yield of tomato (359.92 q ha^{-1}) over remaining treatment combinations.

Table 3.53 Yield of Tomato (q ha^{-1})

Treatments	F_1	F_2	F_3	F_4	Mean
M_1	296.92	276.22	353.11	274.79	**300.26**
M_2	342.62	301.29	**359.92**	279.56	**320.85**
M_3	251.83	243.69	264.64	241.37	**250.38**
Mean	**297.12**	**273.73**	**325.89**	**265.24**	
SE± m for Mulching	1.17	SE± m for organic manure	1.35	SE± m for Interaction	2.35
CD @ 5%	3.44	CD @ 5%	3.97	CD @ 5%	6.68

In general plastic mulch was found to be responsible for significant decrease in EC value and considerable increase in pH value as compared to paddy straw mulch and no mulch treatments. Similarly, significant highest moisture content was recorded due to plastic mulch and closely followed by paddy straw mulch. The lowest moisture content was observed in no mulch treatment. Yield of Brinjal, Chilli and Tomato was found to be affected significantly by paddy straw mulch followed by plastic mulch and no mulch treatment. Further significant interaction effect of paddy straw mulch and FYM @7.5 t ha^{-1} +Vermicompost @ 2.5 t ha^{-1} on yield of Brinjal, Chilli and Tomato of was evident.

- **Effect of planting windows and irrigation on dibbling of wal (Field bean) grown under zero tillage in coastal saline soils of Konkan (Panvel)**

An experiment was undertaken to study effect of planting windows and irrigation on yield of field bean under zero tillage. The experimental details are given in Table 3.54. Details of soil properties are provided in Table 3.55.

Table 3.54 reatments and other details

Treatments **A) Irrigation levels** I_0- No Irrigation I_1- One irrigation (At flowering) I_2- Two irrigation (At flowering and pod formation) **B) Planting window** P_1-After harvest of Rice P_2- 10 days After harvest of Rice P_3- 20 days After harvest of Rice	Design :Factorial Randomized Block design Replications : Four Plot size : 20.40m X 1.5m Date of Sowing : 26/11/2020, 06/12/2020 and 16/12/2020 Crop and Variety: Wal (Field bean)- Konkan wal-1

Table 3.55 Soil properties of experimental plot

Sr. No	Particulars	At initial stage	After harvest of crop
1.	pH	7.13	7.43
2.	EC (dSm^{-1})	1.74	4.69
3.	OC ($gmkg^{-1}$)	5.26	6.63
4.	P_2O5 (kg ha^{-1})	62.82	63.41
5.	K_2O (kg ha^{-1})	1026.81	1223.71

The experiment was laid out during *rabi* 2020-21 with three levels of irrigations *viz.,* no irrigation (I_0), one irrigation (I_1-At flowering) and two irrigation (I_2-At flowering and pod formation) and three levels of planting windows *i.e*. immediately planted after harvest of rice (P_1), 10 days After harvest of rice (P_2) and 20 days After harvest of rice (P_3) with four replications using wal crop. The results are given in Table 3.56. The data indicated that the treatment without irrigation (I_0) was observed to be statistically significant (3.37 dS m^{-1}) over rest of the treatments. When date on planting effect was studied it was found that, the treatmentP_3 (20 days AHR) was found to be statistically significant (3.06 dS m^{-1}) over the treatmentsP_1 andP_2 (10 days AHR) which recorded EC value of 2.47 and 2.77 dS m^{-1}, respectively. However, interaction effect of irrigation water and planting windows was observed, in I_0P_3 interaction which showed significantly higher EC 3.74dS m^{-1} over all remaining interactions.

Table 3.56 Soil (EC) Electrical Conductivity (dS m^{-1}): (1:2.5; soil: water suspension) at 30 days after sowing of wal

Treatments	P1 (AHR)	P_2(10 days AHR)	P_3(20 days AHR)	Mean	
I0	3.04	3.32	3.74	**3.37**	
I1	2.60	2.77	2.93	**2.77**	
I2	**1.77**	2.23	2.51	**2.17**	
Mean	**2.47**	**2.77**	**3.06**		
SE± m for Irrigation	0.04	SE± m for Planting window	0.04	SE± m for Interaction	0.07
CD @ 5%	0.12	CD @ 5%	0.12	CD @ 5%	0.21

* AHR- After Harvest of Rice

It is evident from the data presented in Table 3.57 that, the higher EC value of 5.75 dS m^{-1} was recorded in the no irrigation treatment *i.e.* I_0. However, the lowest and statistically significant EC value of 4.36 dS m^{-1} was observed as a result of two irrigations at flowering and at pod formation (I_2) at 90 days after sowing. A critical look on data of planting windows further revealed that the treatment (P_3) recorded significantly highest EC value of 5.29 dS m^{-1} over rest of the treatment except P_2 (10 days AHR) which was at par with the treatment P_2. When interaction effect was studied it is evident from the data that with no irrigation and sowing 20 days after harvest of rice produced

statistically significant the highest value 6.11 dS m^{-1} of EC over rest of the treatments with exception of the treatment I_0P_2 (5.79).

Table 3.57 Soil (EC) Electrical Conductivity (dS m^{-1}) : (1:2.5; soil:water suspension) at 90 days after sowing of wal

Treatments	P_1 (AHR)	P_2(10 days AHR)	P_3(20 days AHR)	Mean	
I_0	5.36	5.79	6.11	5.75	
I_1	4.81	5.21	5.30	5.10	
I_2	4.24	4.39	4.46	4.36	
Mean	4.80	5.13	5.29		
SE± m for Irrigation	0.12	SE± m for Planting window	0.12	SE± m for Interaction	0.21
CD @ 5%	0.36	CD @ 5%	0.36	CD @ 5%	0.62

* AHR- After Harvest of Rice

The data on soil pH at 30 days after sowing are presented in Table 3.58 when studied revealed that the treatment I_2 produced statistically significant and highest pH value of 6.84 over other irrigation treatments containing one irrigation at flowering (I_1) and two irrigations at flowering and at pod formation (I_2).The treatment of planting immediately after harvest of rice P_1 was statistically significant and recorded the highest pH 6.77 value which was found to be statistically at par with P_2 (6.70). The data on interaction effect of the treatments, I_2P_1 recorded numerically highest pH value of 6.90 over the rest of interactions.

Table 3.58 Soil pH (1:2.5; soil:water suspension) at 30 days after sowing of wal

Treatments	**P_1 (AHR)**	**P_2(10 days AHR)**	**P_3(20 days AHR)**	**Mean**	
I_0	6.77	6.70	6.64	**6.70**	
I_1	6.79	6.78	6.75	**6.77**	
I_2	6.90	6.83	6.80	**6.84**	
Mean	**6.77**	**6.70**	**6.64**		
SE± m for Irrigation	0.04	SE± m for Planting window	0.04	SE± m for Interaction	0.07
CD @ 5%	0.11	CD @ 5%	0.11	CD @ 5%	0.19

* AHR- After Harvest of Rice

Data on Soil pH at 90 days (Table 3.59) showed that without application of irrigation waterI_0 treatment showed significantly lowest value of pH 6.67 over rest of the treatments containing one irrigation at flowering (6.73) and two irrigations at flowering and at pod formation (6.77). Application of different time of planting, the treatment of immediate planting after harvest of rice (P_1) noted statistically significant and higher pH value of 6.74 over rest of the interactions except P_2 treatment which was found to be statistically at par with (6.72). Interaction effect ofI_0P_3 (6.64) showed significantly lowest value of soil pH over the interaction I_0P_2 (6.68).

Table 3.59 Soil pH (1:2.5; soil: water suspension) at 90 days after sowing of wal

Treatments	**P_1 (AHR)**	**P_2(10 days AHR)**	**P_3(20 days AHR)**	**Mean**	
I_0	6.70	6.68	6.64	**6.67**	
I_1	6.74	6.73	6.71	**6.73**	
I_2	6.79	6.76	6.75	**6.77**	
Mean	**6.74**	**6.72**	**6.70**		
SE± m for Irrigation	0.01	SE± m for Planting window	0.01	SE± m for Interaction	0.02
CD @ 5%	0.03	CD @ 5%	0.03	CD @ 5%	0.05

* AHR- After Harvest of Rice

Data pertaining to soil moisture content at 30 days after sowing (Table 3.60) revealed that the treatment with two irrigations (I_2) recorded statistically higher soil moisture value (56.96 %) over one irrigation at flowering (I_1) and with no irrigation (I_0).Similarly, planting immediately after harvest of rice (P_1) recorded the highest soil moisture content value of 53.03 per cent which was found to be statistically significant over rest of the treatments containing P_2 (50.48) and P_3 (47.67). Interaction of the treatment I_2P_1 exhibited statistically significant soil moisture content (60.48 per cent) over rest of the interactions.

Table 3.60 Soil moisture (per cent) at 30 days after sowing of wal

Treatments	**P_1 (AHR)**	**P_2(10 days AHR)**	**P_3(20 days AHR)**	**Mean**	
I_0	45.63	42.49	40.43	**42.85**	
I_1	52.99	51.46	49.69	**51.38**	
I_2	**60.48**	57.50	52.90	**56.96**	
Mean	**53.03**	**50.48**	**47.67**		
SE± m for Irrigation	0.55	SE± m for Planting window	0.55	SE± m for Interaction	0.95
CD @ 5%	1.60	CD @ 5%	1.60	CD @ 5%	2.77

* AHR- After Harvest of Rice

A critically look on the data on soil moisture at 90 days after sowing (Table 3.61) indicated that treatment with the application of two irrigations (I_2- at time of flowering and at pod formation) recorded statistically significant and higher soil moisture content value of 54.49 per cent followed by the treatments receiving no irrigation (I_0) and one irrigation at flowering (I_1) soil moisture content value of 42.26 per cent and 50.03 per cent, respectively. However, planting immediately after harvest of rice (P_1) showed significant superior and higher soil moisture (51.77 per cent) over other treatments. The data on interaction effect indicated that the treatment with planting window of wal crop immediately after harvest of rice with two irrigations (I_2P_1)produced significantly higher soil moisture content (57.63 per cent) over rest of the interactions *viz.,* I_0P_1, I_0P_2, I_0P_3, I_1P_1, I_1P_2, I_1P_3, I_2P_2, and I_2P_3.

Table 3.61 Soil moisture (per cent) at 90 days after sowing

Treatments	**P_1 (AHR)**	**P_2(10 days AHR)**	**P_3(20 days AHR)**	**Mean**	
I_0	45.01	42.62	39.14	**42.26**	
I_1	52.67	50.60	46.80	**50.03**	
I_2	57.63	53.68	52.18	**54.49**	
Mean	**51.77**	**48.97**	**46.04**		
SE± m for Irrigation	0.43	SE± m for Planting window	0.43	SE± m for Interaction	0.74
CD @ 5%	1.24	CD @ 5%	1.24	CD @ 5%	2.15

* AHR- After Harvest of Rice

Seed yield:

The data on seed yield of wal is presented in Table 3.62 indicated that, yield of wal was found to be affected due to no irrigation water and late planting of crop. In general, the higher yield was produced with one irrigation (I_1- at flowering) and planting immediately harvest of rice (P_1- after harvest of rice). It was observed that the among various treatments of irrigations, the treatment receiving irrigation water at the time of flowering (I_1) recorded statistically significant and higher yield of 9.03 quintal ha^{-1} which was statistically superior over two irrigation at flowering and at the time of pod formation I_2 (8.04 quintal ha^{-1}) and no irrigation I_0 (7.01 quintal ha^{-1}). Critical look on the data for planting windows further revealed that the planting immediate after harvest of rice (P_1)

produced statistically higher yield (9.45 quintal ha^{-1}) over the treatments of P_2 (7.58 quintal ha^{-1}) and P_3 (7.04 quintal ha^{-1}). Interaction effect of I_1P_1 (one irrigation at the time of flowering with planting immediate after harvest of rice) produced statistically significant and superior with higher yield of (10.75 quintal ha^{-1}) over remaining interactions.

Table 3.62 Seed yield of wal (q ha^{-1})

Treatments	**P_1 (AHR)**	**P_2(10 days AHR)**	**P_3(20 days AHR)**	**Mean**	
I_0	8.22	6.61	6.21	**7.01**	
I_1	10.75	8.26	8.09	**9.03**	
I_2	9.39	7.88	6.84	**8.04**	
Mean	**9.45**	**7.58**	**7.04**		
SE± m for Irrigation	0.26	SE± m for Planting window	0.26	SE± m for Interaction	0.46
CD @ 5%	0.77	CD @ 5%	0.77	CD @ 5%	1.33

* AHR- After Harvest of Rice

4. Management of Waste Water for Irrigation

- **Effect of treated sewage water as a source of irrigation and nutrients supply for Marigold-Chrysanthemum rotation (Agra)**

An experiment conducted to evaluate the effect of different irrigation water quality treatments (sewage and tube well) on yield and economics of marigold and chrysanthemum cultivation. Details of experiment are given below (Table 4.1). Analysis of sewage

Table 4.1 Details of Experimentation:

Treatments	**Other information about experiment**
T_1: SW	Design: R.B.D
T_2:SW+RDF	Plot size: 4m x 4m
T_3:SW+50% RDF	Replication: Three
T_4:SW+75% RDF	Crop rotation: Marigold- Chrysanthemum
T_5:TW+RDF	Starting year:2020-21
T_6:TW+75%RDF	
T_7:TW+125%RDF	
T_8:1SW: 1TW+RDF	
SW-Sewage water, TW-Tube well water	
Observations	
Date of sowing	4-12-2020
Variety	Garden chrysanthemum-bold
Doses of N:P:K	120:60:60
No. & intervals of irrigation	4, (19.01-2021,08.02.2021,11.03.2021 & 31.03.2021)
Depth of irrigation	6 cm
Total rainfall (mm)	5.0
Date of harvesting	17-04-2021

Irrigation water analysis:

Sewage water (Inlet): The sewage water samples were collected from inlet of sewage treatment plant Bichpuri, Agra at the time of pre irrigation of chrysanthemum crop. The water showed high EC in all collected samples. The pH values were normal in all collected samples for in let in three crop period (Table 4.2). BOD found in collected sample 178.0 mgL^{-1}. The bio-carbonate increased in the winter season sample. The calcium was the dominant cation. The nitrate was also higher in chrysanthemum crop period sample. The sodium values were higher in collected samples. RSC was not found but SAR was recorded 17.8 $mmolL^{-1}$.

Sewage water (out let): The treated sewage water samples were collected from out let of sewage treatment plant Bichpuri; Agra at chrysanthemum crop period. In collected water, EC showed its highest during chrysanthemum crop sowing time. The pH values were normal in collected samples (Table 4.2). BOD value found 71.0 mgL^{-1}. The bio-carbonate increased in the summer season sample. Calcium was the dominant cation in crop period sample. The nitrate was higher in crop period sample and the sodium values were also higher in collected samples. RSC was not found in all collected samples but SAR was recorded 17.1 $mmolL^{-1}$. The sewage water at outlet was used for experimental purpose.

Tube well water:

The tube well water samples of the submersible water were taken from R.B.S.College, Research farm, Bichpuri, Agra. The EC of this water was very high 3.8 dS/m with pH value 7.7. Among different anions chloride was the dominant one (14.6 $mgL^{-1)}$. Sulphate content 11.5 mgL^{-1}. The nitrate was absent in collected samples. The water contained some higher amount of calcium, magnesium and sodium. In this water RSC did not found but SAR was recorded (10.6 $mmolL^{-1}$ (Table 4.2). The tube well water was also used for experimental purpose along with sewage water.

Table 4.2 Irrigation water analysis (sewage water and tube well water (2020-21) during Chrysanthemum crop period

Particulars	Sewage water in let	Sewage water out let	Tube well water
pH	7.8	7.7	7.7
EC_e dS/m	2.6	2.5	3.8
BOD mgL^{-1}	178.0	71.0	-
COD mgL^{-1}	222.0	112.0	-
CO3mgL^{-1}	23.8	21.6	-
HCO3mgL^{-1}	558.2	520.8	12.1
Chloride mgL^{-1}	508.3	438.7	14.6
Sulphate mgL^{-1}	610.2	521.3	11.5
Nitrate mgL^{-1}	21.8	21.3	-
Calcium mgL^{-1}	118.6	116.8	5.8
Magnesium mgL^{-1}	211.5	208.5	6.7
Sodium mgL^{-1}	228.5	218.6	26.2
Potassium mgL^{-1}	21.8	20.2	-
SAR $(mmol/l)^{1/2}$	17.8	17.1	10.6
RSC meq/l	NIL	NIL	NIL

Yield attributing characteristics: The plant height of chrysanthemum crop was found significantly higher in SW+RDF (132.3 cm) and lowest in TW+75% RDF (111.3 cm), the number of primary branches per plant found statistically significant and maximum in SW+RDF (50.3) and minimum in TW+75% RDF (39.3) and The number of secondary branches per plant were also significant and maximum in AW+RDF (190.0) and minimum in SW+75%RDF (164.3). The number of flower per plant found significantly maximum in SW+RDF (190.0) and minimum in TW+75%RDF (164.3). The flower weight of per plant was also found significant with maximum in SW+RDF (789.6 gm), minimum in TW+75%RDF (691.3 gm), respectively (Table 4.3).

Table 4.3. Effect of different treatments on yield attributing characteristics of chrysanthemum

Treatments	Survivability (%)	Plant height (cm)	No .of primary branches	No. of secondary branches	No. of flowers per plant	Flower weight per plant(gm)
T_1: SW	100	120.0	42.3	179.0	178.0	748.3
T_2:SW+RDF	100	132.3	50.3	190.0	190.0	789.6
T_3:SW+50% RDF	100	126.3	46.0	183.7	180.0	750.3
T_4:SW+75% RDF	100	128.0	48.0	188.7	182.7	774.0
T_5:TW+RDF	100	119.0	42.7	170.7	175.0	712.3
T_6:TW+75%RDF	100	111.3	39.3	162.0	164.3	691.3
T_7:TW+125%RDF	100	125.3	45.3	181.7	182.0	742.0
T_8: 1SW: 1TW+RDF	100	124.7	43.3	177.3	174.7	738.0
CD at 5%	NS	4.4	3.3	3.7	5.5	20.9

Flower yield of chrysanthemum: The data on flower yield as affected by different treatments have been presented in Table 4.4. The respective data analyzed statistically and found that flower yield significantly influenced with various treatments of SW, TW and RDF. Application of SW+RDF (T2) resulted in conspicuously more flower yield by 9.25 to 28.15 per cent with other treatments tested in the experiment. Treatment SW+75%RDF (T_4) did not differ appreciably as compared with TW+125%RDF (T7) but produced significantly higher flower yield when compared with rest of treatments and the magnitude of increase was to the tune of 2.22 to 13.48 per cent . Application of TW+125% RDF (T7) was statistically at par with SW+50% RDF (T3) and 1SW:1TW+RDF (T8) gave 7.17 and 6.03 per cent higher flower yield than that of SW (T1) and TW+RDF (T5), respectively. Treatments T3, T7, T8 and T1, T5 were nominal among them in this respect and could not reach the level of significance. Minimum flower yield (175.1 q/ha) was obtained with the application of TW+75% RDF (T6) which proved its significant inferiority over all other treatments (Table 4.4).

Net profit and Benefit cost ratio: The Table 4.4 clearly indicated that the net profit of chrysanthemum crop was maximum in SW+RDF (Rs. 1, 54,817) and minimum in TW+ 75% RDF (Rs. 1, 08,938). The benefit cost ratio of chrysanthemum were also calculated and presented below. The B:C ratio of the crop was maximum in SW+RDF (3.22) and minimum in TW+75% RDF (2.65).

Table 4.4 Effect of different treatments on flower yield of chrysanthemum, cost of cultivation, gross income, net profit and B: C ratio

Treatments	Flower yield (q/ha)	Cost of cultivation(Rs/ha)	Gross income(Rs/ha)	Net profit (Rs/ha)	B:C ratio
T_1: SW	185.4	56,740	1,85,400	1,28,660	3.26
T_2:SW+RDF	224.4	69,583	2,24,400	1,54,817	3.22
T_3:SW+50% RDF	194.4	63,162	1,94,400	1,31,238	3.08
T_4:SW+75% RDF	205.4	66,372	2,05,400	1,39,028	3.09
T_5:TW+RDF	187.4	69,583	1,87,400	1,17,817	2.69
T_6:TW+75%RDF	175.1	66,162	1,75,100	1,08,938	2.65
T_7:TW+125%RDF	198.7	72,793	1,98,700	1,25,907	2.72
T_8: 1SW: 1TW+RDF	192.1	56,740	1,92,100	1,35,360	3.38
CD at 5%	8.4	-	-	-	-

Soil analysis at sowing and harvest of chrysanthemum: The pH recorded at sowing time was in normal range in all the treatments. The sodium was in range of 13.6 to 18.7 me/l in all the treatments of the experiment. The Ca+Mg, chloride and sulphate were present. The CO_3 was absent (Table 4.5). The SAR was also present in all the collected soil samples but RSC was not noticed.

Table 4.5. Soil analysis at sowing of chrysanthemum crop (2020-21)

Treatment	Depth (cm)	ECe (dS/m)	pH	Na (me/l)	Ca+Mg (me/l)	CO_3 (me/l)	HCO_3 (me/l)	Cl (me/l)	SO_4 (me/l)	SAR $(mmol/l)^{1/2}$	RSC (me/l)
SW	0-15	3.0	7.7	13.6	17.0	-	9.0	11.0	10.0	4.5	-
	15-30	2.8	7.8	18.1	10.0	-	9.0	11.0	8.0	8.0	-
	30-60	2.4	7.7	16.0	8.0	-	8.0	11.0	6.0	8.0	-
	60-90	2.4	7.6	14.0	10.0	-	7.0	10.0	7.0	6.3	-
SW+RDF	0-15	3.0	7.8	16.0	15.0	-	8.0	12.0	11.0	5.8	-
	15-30	2.7	7.6	16.0	12.0	-	8.0	11.0	8.0	6.5	-
	30-60	2.7	7.7	10.2	18.0	-	8.0	10.0	10.0	3.4	-
	60-90	2.5	7.7	13.5	12.0	-	8.0	11.0	7.0	5.5	-
SW +50%RDF	0-15	3.1	7.8	15.2	16.0	-	11.0	11.0	9.0	5.4	-
	15-30	2.9	7.8	12.0	17.0	-	9.0	12.0	9.0	4.1	-
	30-60	2.8	7.7	11.4	17.0	-	9.0	11.0	8.0	3.9	-

	60-90	2.5	7.8	16.1	9.0	-	9.0	11.0	6.0	7.6	-
TW+75% RDF	0-15	3.0	7.8	15.2	15.0	-	11.0	10.0	9.0	5.4	-
	15-30	2.8	7.8	13.0	16.0	-	8.0	13.0	7.0	4.6	-
	30-60	2.6	7.7	14.0	12.0	-	8.0	11.0	7.0	5.7	-
	60-90	2.6	7.7	13.8	12.0	-	8.0	12.0	7.0	5.6	-
TW+RDF	0-15	3.1	7.8	17.0	15.0	-	11.0	12.0	8.0	6.2	-
	15-30	2.9	7.7	14.0	15.0	-	12.0	9.0	9.0	5.1	-
	30-60	2.7	7.6	15.0	12.0	-	10.0	7.0	10.0	6.1	-
	60-90	2.6	7.7	18.7	8.0	-	7.0	11.0	8.0	9.4	-
TW+ 75%RDF	0-15	3.0	7.8	17.0	13.0	-	12.0	8.0	10.0	6.7	-
	15-30	2.8	7.7	16.0	12.0	-	10.0	9.0	9.0	6.6	-
	30-60	2.7	7.8	14.0	13.0	-	7.0	10.10	10.0	5.5	-
	60-90	2.5	7.6	13.0	12.0	-	11.0	8.0	7.0	5.3	-
TW+125%RDF	0-15	3.1	7.7	17.0	15.0	-	11.0	12.0	8.0	6.2	-
	15-30	2.9	7.8	17.0	12.0	-	12.0	9.0	9.0	6.9	-
	30-60	2.6	7.8	13.0	13.5	-	9.0	9.0	8.0	5.0	-
	60-90	2.5	7.7	12.0	13.0	-	8.0	11.0	7.0	4.7	-
1SW:1TW +RDF	0.-15	3.0	7.7	15.0	16.0	-	12.0	8.0	11.0	5.3	-
	15-30	2.8	7.7	17.0	11.4	-	11.0	8.0	9.0	7.1	-
	30-60	2.7	7.8	15.0	12.0	-	11.0	8.0	8.0	6.1	-
	60-90	2.5	7.7	15.0	10.0	-	11.0	6.0	8.0	6.7	-

After harvest of chrysanthemum crop, the soil samples were taken and analyzed, pH was found in normal range. There was increase in soil salinity in all treatments. The increase in soil salinity was higher in tube well water treatments compared to sewage water treatments (Table 4.6).

Table 4.6. Soil analysis at harvest of chrysanthemum crop (2020-21)

Treatment	Depth (cm)	ECe (dS/m)	pH	Na (me/l)	Ca+Mg (me/l)	CO_3 (me/l)	HCO_3 (me/l)	Cl (me/l)	SO_4 (me/l)	SAR $(mmol/l)^{1/2}$	RSC (me/l)
SW	0-15	3.6	7.8	20.8	15.0	-	9.0	4.0	22.7	7.6	-
	15-30	3.6	7.7	23.0	14.0	-	4.0	16.0	16.0	8.7	-
	30-60	3.4	7.8	18.0	16.2	-	6.0	16.0	13.0	6.3	-
	60-90	3.3	7.7	16.0	18.0	-	5.0	15.0	13.8	5.3	-
SW+RDF	0-15	3.6	7.8	25.0	11.0	-	8.0	13.0	15.0	10.7	-
	15-30	3.4	7.8	19.0	15.0	-	7.0	12.0	15.0	6.9	-
	30-60	3.4	7.7	23.0	12.0	-	7.0	16.0	12.0	9.4	-
	60-90	3.2	7.7	18.0	14.0	-	8.0	17.0	7.0	6.8	-
SW +50%RDF	0-15	3.6	7.8	25.1	10.0	-	10.0	12.0	15.0	11.3	-
	15-30	3.5	7.8	25.4	10.0	-	8.0	18.0	10.0	11.4	-
	30-60	3.5	7.7	25.0	10.0	-	6.0	20.0	9.0	11.3	-
	60-90	3.2	7.7	19.0	14.0	-	8.0	14.0	11.0	7.2	-
SW+75% RDF	0-15	3.8	7.8	22.7	15.0	-	6.0	14.0	16.0	8.3	-
	15-30	3.7	7.8	23.8	13.0	-	5.0	12.0	21.2	9.3	-
	30-60	3.6	7.7	22.8	13.0	-	6.0	13.0	16.8	8.9	-
	60-90	3.6	7.7	20.5	16.0	-	6.0	14.0	16.0	7.3	-
TW+RDF	0-15	5.1	7.8	32.7	18.3	-	10.8	13.8	26.4	10.8	-
	15-30	4.8	7.7	30.9	17.1	-	9.7	14.1	24.2	10.6	-
	30-60	4.5	7.8	29.8	15.2	--	10.3	12.8	21.9	10.8	-
	60-90	4.0	7.7	29.2	10.8	-	11.2	13.2	15.6	12.6	-
TW+ 75%RDF	0-15	5.2	7.7	35.1	16.9	-	10.8	12.6	28.6	12.1	-
	15-30	4.7	7.8	32.2	14.9	-	10.2	14.1	22.7	11.8	-
	30-60	4.5	7.8	30.7	14.3	-	9.8	13.8	21.4	11.5	-

	60-90	4.4	7.8	29.9	14.1	-	9.5	15.1	19.4	11.2	-
TW+125%RDF	0-15	5.0	7.7	33.9	16.1	--	11..2	14.2	24.6	11.9	-
	15-30	4.8	7.7	32.2	15.8	-	10.8	13.8	23.4	11.5	-
	30-60	4.6	7.8	30.6	15.4	-	11.6	13.2	21.2	11.0	-
	60-90	4.3	7.7	29.7	13.3	-	11.8	13.8	17.4	11.5	-
1SW:1TW +RDF	0.-15	4.4	7.8	29.9	14.1	-	10.7	12.8	20.5	11.2	-
	15-30	4.3	7.6	28.7	14.3	-	10.3	13.5	19.2	10.7	-
	30-60	4.1	7.7	29.2	11.8	-	10.1	13.2	17.7	12.1	-
	60-90	4.1	7.8	30.1	10.9	-	11.2	14.1	15.7	12.9-	-

TW+125%RDF

Experimental View of Chrysanthemum

5. Management of Irrigation Induced Sodic Soils

- **Management of Sodic Vertisols through resources conservation technologies (Indore)**

An experiment was conducted to find out effect of different tillage (T_1: Conventional Tillage-Conventional Tillage; T_2: Reduced tillage-Zero tillage; T_3: Zero tillage (Self tilled)-zero tillage (ZT-ZT) and T_4: Fallow (M0) and organic mulch (M_1) on crop performance in sodic Vertisols. The initial ESP of the experiment plot before the experimentation was 45. The gypsum was applied and its ESP was reduced up to 36. The paddy – wheat cropping sequence was taken. Only wheat crop was taken during 2018-19. The experiment was laid out by taking paddy as test crop paddy (CSR-10) and wheat (HI-1544) during 2020-21 with and without mulch and three tillage practices i.e. conventional, reduced and zero tillage. Growth and yield parameters of paddy and wheat were recorded and soil samples were also taken to know the soil properties before and after paddy and wheat. The sowing of wheat was done on dated 15.11.2019 and harvested on 19.03.2020. The paddy was transplanted on dated 08.07.2020 and harvested on 19.10.2020.

Effect of tillage and mulch on wheat crop

Data presented in Table 5.1 revealed that plant height, number of tillers /plant, length of earhead, grain and straw yield of wheat were significantly affected by various tillage practices during the experimentation. Data presented in Table 5.1 revealed that plant height (cm) of wheat did not influenced by various tillage practices during the experimentation. However, the maximum value (76.65 cm) of plant height was recorded in conventional tillage followed by in reduced tillage and lowest was in zero tillage.

Table 5.1. Effect of resources conservation technologies on growth and yield attributes of wheat

Mulches	**Tillage practices**			
	Conventional tillage	Reduced tillage	Zero tillage	Mean
Plant height (cm)				
Without mulch	75.87	71.77	70.72	72.78
With mulch	77.43	72.73	71.53	74.90
Mean	76.65	72.25	71.12	
	Tillage	Mulch	Tillage x mulch	
CD 5%	NS	NS	NS	
Number of tillers/m row length				
Without mulch	80.68	68.62	64.30	71.20
With mulch	84.35	76.00	72.80	77.71
Mean	82.50	72.31	68.55	
	Tillage	Mulch	Tillage x mulch	
CD 5%	7.3	NS	NS	
Length of Ear head (cm)				
Without mulch	7.60	7.32	7.27	7.39
With mulch	7.90	7.87	7.60	7.79
Mean	7.75	7.59	7.43	
CD 5%	Tillage	Mulch	Tillage x mulch	
	0.31	NS	NS	
Grain yield (kg/ha)				
Without mulch	3445	3255	3178	3293
With mulch	3535	3305	3211	3350

Mean	3490	3280	3195	
	Tillage	Mulch	Tillage x mulch	
CD 5%	124	NS	NS	
Straw yield (kg/ha)				
Without mulch	4658	4428	4235	4440
With mulch	4805	4782	4388	4658
Mean	4732	4605	4312	
	Tillage	Mulch	Tillage x mulch	
CD 5%	370	110	NS	

Note: Rice straw @ 5 t/ha was used as mulch in *rabi* season (wheat crop) and Wheat straw @ 5 t/ha was used as mulch in *kharif* season (rice crop)

The number of tillers /m row length, length of ear head and grain and straw yield of wheat were significantly affected by various tillage practices during the experimentation (Table 5.1). The highest values of number of tillers/m row length (82.5), length of earhead (7.75 cm), grain yield (3490 kgha^{-1}) and straw yield (4732 kg ha^{-1}) were recorded in conventional tillage followed by reduced tillage and lowest was in zero tillage (Table 5.1). Mulch were failed to cause any significant effect on plant height, number of tillers /plant, length of ear head and grain yield of wheat. However, application of rice crop residue as mulch @ 5 t/ha produced significantly higher straw yield (4658 kg/ha) in comparison to no mulch (4440 kg/ha).

Effect of tillage and mulch on soil properties after harvest of wheat

The pH values of soil paste were affected significantly by tillage practices (Table 5.2). Fallow field showed maximum soil pH (8.60) followed by zero tillage (8.52). Mulch did not affect soil pH. Significantly lowest value of ECe (1.37 dS/m) was recorded under conventional tillage followed by reduced tillage (1.45 dS/m) and zero tillage (1.70 dS/m). However, ECe did not influenced significantly by mulch.

Table 5.2. Effect of resources conservation technologies on soil pHs, ECe, ESP and organic carbon after wheat harvest

pHs					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	8.38	8.50	8.58	8.62	8.52
With mulch	8.38	8.44	8.46	8.57	8.46
Mean	8.38	8.47	8.52	8.60	
	Tillage	Mulch	Tillage x		
CD 5%	0.14	NS	NS		
ECe (dS/m)					
Mulch	Conventional	Reduced	Zero	Fallow	Mean
Without mulch	1.40	1.49	1.74	2.00	1.66
With mulch	1.34	1.40	1.67	1.92	1.58
Mean	1.37	1.45	1.70	1.96	
	Tillage	Mulch	Tillage x		
CD 5%	0.10	NS	NS		
ESP					
Mulch	Conventional	Reduced	Zero	Fallow	Mean
Without mulch	26.2	28.1	29.4	33.0	29.2

With mulch	24.1	26.3	28.0	32.3	27.7
Mean	25.1	27.2	28.7	32.6	
	Tillage	Mulch	Tillage x		
CD 5%	1.20	0.41	NS		
Organic carbon (%)					
Mulch	Conventional	Reduced	Zero	Fallow	Mean
Without mulch	0.42	0.35	0.38	0.36	0.38
With mulch	0.44	0.43	0.40	0.39	0.42
Mean	0.43	0.39	0.39	0.37	
	Tillage	Mulch	Tillage x		
CD 5%	0.03	0.03	NS		

The ESP was influenced significantly by various tillages and mulch practices (Table 5.2). The lowest mean value of ESP (25.1) was recorded under conventional tillage followed by reduced tillage (27.2). The lowest ESP (27.7) was noticed with mulch as compared to no mulch (29.2). Similarly, significantly higher organic carbon content was recorded with conventional tillage (0.43%). Application of mulch recorded significantly higher organic carbon content (0.42%) as compared to without mulch treatment. The data presented in Table 5.3 indicated that tillage practices and mulch had no significant effect on available N, P and K.

Table 5.3. Effect of resources conservation technologies on available N, P and K after wheat harvest

Available N (kg/ha)					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	168.62	164.00	157.60	148.16	159.59
With mulch	179.30	176.24	168.61	170.00	173.53
Mean	173.96	170.12	163.10	159.08	
	Tillage	Mulch	Tillage x mulch		
CD 5%	NS	NS	NS		
Available P (kg/ha)					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	9.20	8.37	8.20	9.67	8.86
With mulch	9.45	8.77	8.90	10.50	9.40
Mean	9.33	8.57	8.55	10.08	
	Tillage	Mulch	Tillage x mulch		
CD 5%	NS	NS	NS		
Available K (kg/ha)					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	461.35	460.70	461.54	470.60	463.54
With mulch	467.00	466.22	463.71	501.35	474.57
Mean	462.17	463.46	462.62	485.97	
CD 5%	Tillage	Mulch	Tillage x mulch		
	NS	NS	NS		

Effect of tillage and mulch on paddy crop

Data presented in Table 5.4 revealed that plant height; number of tillers /plant, panicle length, grain and straw yield of paddy were significantly affected by various tillage practices during the

experimentation. The highest values of plant height (71.27 cm), number of tillers/plant (9.73), panicle length (17.27 cm), paddy yield (3998 kg ha^{-1}) and straw yield (5238 kg ha^{-1}) were recorded in conventional tillage followed by in reduced tillage and lowest was in zero tillage. However, the lowest values of all the parameters under study were noticed under zero tillage. Mulch had failed to cause any significant effect on plant height, number of tillers /plant, panicle length and paddy yield.

Table 5.4: Effect of resources conservation technologies on paddy growth, yield attributes and yield of paddy

Mulches	**Tillage practices**			
	Conventional tillage	Reduced tillage	Zero tillage	Mean
Plant height (cm)				
Without mulch	69.10	67.47	66.00	67.53
With mulch	73.43	69.60	67.40	70.29
Mean	71.27	68.54	66.70	
	Tillage	Mulch	Tillage x mulch	
CD 5%	6.5	NS	NS	
Number of tillers/plant				
Without mulch	9.67	8.65	8.33	8.88
With mulch	9.80	9.35	8.41	9.19
Mean	9.73	9.00	8.37	
	Tillage	Mulch	Tillage x mulch	
CD 5%	0.4	NS	NS	
Panicle length (cm)				
Without mulch	17.00	16.80	16.03	16.61
With mulch	17.50	17.10	16.40	17.00
Mean	17.25	16.95	16.22	
CD 5%	Tillage	Mulch	Tillage x mulch	
	0.7	NS	NS	
Paddy yield (kg/ha)				
Without mulch	3840	3473	3223	3512
With mulch	4157	3597	3343	3699
Mean	3998	3535	3283	
	Tillage	Mulch	Tillage x mulch	
CD 5%	166	NS	NS	
Straw yield (kg/ha)				
Without mulch	5030	4515	4222	4589
With mulch	5446	4676	4379	4834
Mean	5238	4596	4301	
	Tillage	Mulch	Tillage x mulch	
CD 5%	176	136	NS	

Effect of tillage and mulch on soil properties after paddy harvest

The data presented in Table 5.5 and Table 5.6 indicated that tillage and mulch had no significant effect on pHs, available N, P and K. The pH values of soil paste were not affected significantly by tillage practices and mulch application.

Table 5.5. Effect of resources conservation technologies on soil pHs, ECe, ESP and organic carbon

pHs					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	8.41	8.45	8.55	8.6	8.50
With mulch	8.38	8.44	8.46	8.55	8.46
Mean	8.40	8.45	8.51	8.58	
	Tillage	Mulch	Tillage x mulch		
CD 5%	NS	NS	NS		
ECe (dS/m)					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	1.39	1.45	1.72	1.98	1.63
With mulch	1.33	1.40	1.68	1.88	1.57
Mean	1.36	1.42	1.70	1.93	
	Tillage	Mulch	Tillage x mulch		
CD 5%	0.12	NS	NS		
ESP					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	25.1	27.4	28.6	32.1	28.3
With mulch	23.6	25.8	27.1	31.2	26.9
Mean	24.4	26.6	27.9	31.7	
	Tillage	Mulch	Tillage x mulch		
CD 5%	0.81	0.74	NS		
Organic carbon (%)					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	0.42	0.36	0.37	0.36	0.38
With mulch	0.44	0.43	0.39	0.38	0.41
Mean	0.43	0.40	0.38	0.37	
CD 5%	Tillage	Mulch	Tillage x mulch		
	0.02	0.02	NS		

Fallow field showed maximum soil pH (8.58) followed by zero tillage (8.51). However, significantly lowest value of ECe (1.36 dS/m) was recorded under conventional tillage. Non- significant difference in ECe was obtained between conventional and reduced tillage values. Fallow field had maximum ECe (1.93 dS/m) followed by zero tillage and reduced tillage and they significantly differed with each other. While, soil ECe was not affected by mulch application. Similarly, significantly higher organic carbon content was recorded with conventional tillage (0.43%) which was significantly higher to reduced tillage, zero tillage and fallow. Application of mulch recorded significantly higher organic carbon content (0.41%) as compared to without mulch treatment. ESP is an important soil property as influenced significantly by various tillage and mulch practices. Maximum ESP (31.7) was recorded in fallow treatment and was significantly higher over other treatments under study. All the tillage treatments significantly differ in each other in respect of ESP. The lowest mean value of ESP (24.4) was recorded under conventional tillage. Similarly, the lowest ESP (26.9) was also noticed with mulch treatment as compared to no mulch (28.3) treatment. The result showed that the mulch had the capacity to reduce ESP to some extent in sodic Vertisols of Nimar Valley.

Table 5.6. Effect of resources conservation technologies on available N, P and K after paddy harvest

Available N (kg/ha)					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	170	166	159	151	162
With mulch	181	180	170	173	176
Mean	176	173	165	162	
	Tillage	Mulch	Tillage x mulch		
CD 5%	NS	NS	NS		
Available P (kg/ha)					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	9.43	8.41	8.22	9.70	8.94
With mulch	9.51	8.80	8.90	10.60	9.45
Mean	9.47	8.61	8.56	10.15	
	Tillage	Mulch	Tillage x mulch		
CD 5%	NS	NS	NS		
Available K (kg/ha)					
Mulch	Conventional tillage	Reduced tillage	Zero tillage	Fallow	Mean
Without mulch	465	462	463	472	466
With mulch	471	467	465	495	475
Mean	468	465	464	484	
	Tillage	Mulch	Tillage x mulch		
CD 5%	NS	NS	NS		

- **Evaluating the reclamation efficiency of different sources of gypsum for sodic soil management (Tiruchirappalli)**

Approximately 25% of world's irrigated area (955 M ha) is salt-affected (Szabolcs, 1991). These are in parts of the world which now face rapid population increases and do not have additional land and water that can be used to expand agriculture. Vast areas of salt-affected soils have developed as a result of implemention of irrigation projects without provisions of adequate drainage, inefficient irrigation practices, and use of poor quality irrigation water. Though organized and continuous efforts are being made to control soil salinity and sodicity problems, these problems are still increasing. In India, about 6.73 M ha has salt-affected soils. Tamil Nadu has 0.35 M ha area under sodic soil. These soils are not easily reclaimable by leaching without use of ameliorates. The affected lands are either lying barren or give poor crop yields. Considering soils, climate and socio-economic conditions, there is a need to reclaim saline- sodic soils with effective but low-cost environment friendly reclamation techniques.

Soil degradation resulting from salinity and/or sodicity is a major environmental impediment with severe adverse impacts on agricultural productivity and sustainability in arid and semiarid climates (Qadir *et al.,* 2006, 2007; Suarez, 2001). Theoretically, reclamation of sodic soils requires removal of Na^+ from the colloid's cation exchange sites and leaching of the replaced Na out of the root zone in percolating water. Chemical amendments provide a source of Ca to replace exchangeable Na from the cation exchange complex and play an important role in the reclamation of sodic soils. The chemical amendments commonly used as a direct Ca source include mined gypsum ($CaSO_4 \cdot 2H_2O$),

which is the most common chemical amendment for saline-sodic and sodic soil reclamation because it is comparatively cheap, generally available, and easy to apply.

Phospho-gypsum, a by-product of chemical industry is currently being used as an alternative source. At present there is two chemical companies supplies Phospho-gypsum as an industrial by products which is used for Agricultural purpose. The purity of the above gypsum is around 70 percent which is an agricultural grade. Though industrial by product phospho gypsum is also a cheap source as that of mined gypsum, its usage is limited in the farmers field due to socio-economic reasons *viz.,* i) The supply will be effected to the farmers provided, a minimum purchase of 16 tons (one truck load) has to be done by a farmer, ii) Since only two industries (one at Chennai and one at Tuticorin) supplying phospho-gypsum, the transport cost is very high, which is not affordable by the farmers and iii) The industrial phospho - gypsum poses environmental problem as detailed below.

The quality and quantum of phospho-gypsum generation depends upon the quality of the phosphate rock, process route used to produce phosphoric acid, calcium sulphate generated either in dihydrate ($CaSO_4$ $2H_2O$) or the hemihydrate ($CaSO_4$.1/2 H_2O) form. Generally, about 4 to 6 tonnes of phospho-gypsum are generated to recover one tonne of phosphoric acid. The purity of phospho-gypsum ranges from 77 to 98% $CaSO_4$ $2H_2O$. It contains about 0.2 to 0.7% total P_2O_5. Phospho-gypsum is mostly used in Cement and Fertilizer industries. Presently, most phosphoric acid plants dispose the phospho-gypsum generated, by way of stacking it within the plant premises. These stacks are subsequently sold off when demand arises for them. Phospho-gypsum generated from phosphoric acid plants contains three types of impurities such as residual acid, fluorine compounds and trace elements including those that are radioactive that are considered to be potentially harmful. The environmental concerns mainly are associated with phospho-gypsum stacks are fluoride uptake and ground & surface water pollution. For useful application of phospho-gypsum, the presence of fluorine and phosphate contents considered deleterious. The phosphate content affects setting properties of cement and fluorine content causes ring formation in kiln. Besides, phospho-gypsum also poses radiological hazard due to the presence of naturally occurring uranium and radium in the phosphate ore. Phospho-gypsum is known to contain about 1% P_2O_5, 1% F and 10 to 30 times more radon, none of which is desirable. These entities along with radon that were a scare in the 1980s resulted in a 1989 EPA (Environment Protection Agency, USA) ruling that phospho-gypsum is unsuitable for sale as common gypsum. In addition to mineral gypsum and phos-gypsum, seawater is source of by-product marine gypsum. Marine gypsum is recovered from salt pans during production of common salt in coastal region, particularly in Gujarat and Tamil Nadu. The recovery of marine gypsum is substantial and is comparable with the production of mineral gypsum. Various grades of gypsum (as per $CaSO_4.2H_2O$ content) are produced and consumed by industries like cement, fertilizer plants, plaster of Paris *etc*. Gypsum is also a neutralizing agent and helps in improving soil permeability. At the present time, there is no / very limited availability of commercial mined mineral gypsum in India and Tamil Nadu in particular Therefore, a substitute for mined gypsum needs to be found that can be readily used as an external source of Ca for this region. Marine gypsum may be a viable alternate for mined mineral gypsum. This study was undertaken using mined mineral gypsum, industrial by-product phosphor gypsum and salt pan industry byproduct marine gypsum with the following objectives such as i) to assess the reclamation efficiency of different sources of Gypsum as an alternate to mineral gypsum and ii) to assess the performance of rice in sodic soil reclaimed through different sources of Gypsum.

Experimental field location: The field experiment was conducted for rice crop during *Rabi* season 2021-22 at the Research farm, Field No. A7a, Anbil Dharmalingam Agricultural College and research Institute, Tamil Nadu Agricultural University, Tiruchirappalli- 620027, Tamil Nadu State. Main

treatments were related gypsum sources such as T_1, T_2, T_3 and T_4 such as Control (Sodic Soil without reclamation), Mineral Gypsum (50 % GR), Phospho Gypsum (50 % GR) and Marine Gypsum (50 % GR). Method of application of gypsum included soil application, puddling and leaching. There were 5 replications. Field experimental design was Randomized Complete Block Design. Rice variety was TRY-3 (135 Days duration - Medium duration). Season was Rabi 2021-22. The rice was transplanted with plant spacing 20x15. Date of nursery sowing was 26-08-2021 and date of transplanting was 13-09-2021.

Initial Soil properties: The representative soil samples were collected from the experimental field before the start of the reclamation process and analyzed for their fertility status and presented in the Table 5.7 .

Table 5.7. Initial experimental field soil properties

S.No	Particulars	Value	S.No	Particulars	Value
1	pH	9.42	5	Available P (kg ha^{-1})	11.4
2	EC (dS/m)	0.42	6	Available K (kg $ha^{-1)}$	226
3	Organic (Carbon %)	0.43	7	ESP %	38.21
4	Available N (kg ha^{-1})	213			

Gypsum reclamation of sodic soil: The 100 percent gypsum requirement (GR) for the reclamation of sodic soil was 8.2 t ha^{-1}. Only 50 % GR was used for the reclamation of sodic soil as a standard procedure. The particulars of gypsum applied are presented in Table. 5.8. The gypsum were applied on the surface of the soil, ploughed and puddled using good quality canal water allowed for three weeks and leached with good quality canal water. The purity of Marine Gypsum, Mineral gypsum and phospo gypsum was 90.59, 84.30 and 79.30%, respectively. The 100% Gypsum requirement was worked out as 8.2 t ha^{-1} and 50% Gypsum requirement was worked out as 4.1 t ha^{-1}.

Table 5.8. Quantum of gypsum amendment applied per ha basis

S.No	Source	For 100 % GR Equivalent amendment required based on purity (tha^{-1})	Actual Quantity of Gypsum source applied in the field as 50 % GR Equivalent amendments used based on purity (t ha^{-1})
1	Mineral Gypsum	9.73	4.87
2	Phospho Gypsum	10.34	5.17
3	Marine Gypsum	9.05	4.52

The observation on plant height was observed at active tillering, panicle initiation and flowering stages. Leaf Area Index (LAI) and above ground plant dry matter production (DMP) was recorded five times at 20 days interval from 10 Days after transplanting (DAT) up to 90 DAT. Straw yield was recorded at the time of harvest. The plant height (cm) was observed at different crop growth stages of rice *viz.,* Active tillering (AT), panicle initiation (PI) and flowering stages (FL) and presented in Table. 5.9. The observed plant height at AT stage revealed that T_4 recorded with a highest plant height followed by T_2 which is on a par with T_4, followed by T_3 which is significantly lower than T_4 and T_2. T_1 recorded with significantly lowest plant height. The plant height observed at PI stage has a statistically similar trend as that of the results observed during AT stage. However, the plant height observed at flowering stage shows that T_4 recorded with significantly the highest plant height followed by T_2 and T_3 which are statistically on a par. The statistically least plant height was observed with the T_1 Treatment.

Table 5.9. Effect of sodic soil reclamation using different sources of Gypsum on Plant Height (cm)

Treatment	Active Tillering stage	Panicle initiation stage	Flowering Stage
T_1: Control (Sodic Soil without reclamation)	45.0	59.1	88.6
T_2: Mineral Gypsum (50 % GR)	49.8	67.5	94.8
T_3: Phospho Gypsum (50 % GR)	47.4	64.5	93.2
T_4: Marine Gypsum (50 % GR)	50.7	69.0	100.1
SEd	0.9	1.2	0.9
CD(0.05)	2.0	2.7	2.0

Leaf Area Index at different crop growth periods: The leaf area index was observed at different crop growth periods after transplantation in the main field and presented in Table 5.10. The LAI observed at 10 DAT reveals that T_4 recorded with significantly highest LAI than T_2 and T_3 which are statistically on a par with each other. The significantly lowest LAI was recorded with T_1 treatment. However, the statistically analyzed results with respect to the LAI observed at 30, 50, 70 and 90 DAT reveals that T_4 recorded with significantly the highest LAI during the above crop growth periods followed by T_2 and T_3. The significantly lowest LAI was recorded with the T_1 Treatment. Dry matter production at different crop growth periods is provided in Table 5.11.

Table 5.10. Effect of sodic soil reclamation using different sources of Gypsum on Leaf Area Index

Treatment	10 DAT	30 DAT	50 DAT	70 DAT	90 DAT
T1: Control (Sodic Soil without reclamation)	0.82	1.67	4.66	5.21	3.08
T2: Mineral Gypsum (50 % GR)	0.88	2.16	5.21	5.55	3.69
T3: Phospho Gypsum (50 % GR)	0.86	1.96	5.16	5.45	3.52
T4: Marine Gypsum (50 % GR)	0.91	2.24	5.28	5.62	3.86
SEd	0.01	0.01	0.01	0.02	0.02
CD(0.05)	0.02	0.02	0.03	0.03	0.05

Table 5.11. Effect of sodic soil reclamation using different sources of Gypsum on Dry matter production (kg ha^{-1})

Treatment	**10 DAT**	**30 DAT**	**50 DAT**	**70 DAT**	**90 DAT**
T_1: Control (Sodic Soil without reclamation)	740	2616	3858	5291	6031
T_2: Mineral Gypsum (50 % GR)	767	3520	5347	6012	7047
T_3: Phospho Gypsum (50 % GR)	750	3394	5152	5803	6868
T_4: Marine Gypsum (50 % GR)	780	3709	5429	6241	7326
SEd	3.0	35	37	29	40
CD(0.05)	6.2	76	81	64	87

The above ground dry matter (kg) production was recorded during five crop growth periods from 10 DAT with 20 days interval up to 90 DAT and presented in Table 5.11. The statistically analyzed result reveals that during all the dry matter estimation crop growth periods after transplantation, all the

treatments were significantly different. Thus, T_4 recorded with a highest dry matter production followed by T_2, T_3 and T_1.

Tiller production at different crop growth periods: The total number of tillers (Nos) per hill was recorded at 50, 70 and 90 DAT were recorded and presented in Table 5.12. The analyzed data results reveal that throughout the observation period, T_4 recorded with significantly highest number of tillers per hill followed by T_2, T_3 and T_1.

Table 5.12. Effect of sodic soil reclamation using different sources of Gypsum on Total tiller per hill

Treatment	Total tiller (Nos)			
	50 DAT	50 DAT	70 DAT	90 DAT
T_1: Control (Sodic Soil without reclamation)	11.3	11.3	15.8	18.3
T_2: Mineral Gypsum (50 % GR)	17.2	17.2	22.0	23.6
T_3: Phospho Gypsum (50 % GR)	16.0	16.0	20.1	22.1
T_4: Marine Gypsum (50 % GR)	17.7	17.7	23.2	25.7
SEd	0.2	0.2	0.3	0.3
CD(0.05)	0.5	0.5	0.7	0.6

6. Management of Irrigation Induced Waterlogged Saline Soils

- **Enhancing Water Use Efficiency in Reclaimed Waterlogged Saline Vertisols by Implementation of Improved Water Management (Gangavathi)**

Subsurface drainage system has been quite useful in addressing waterlogging and soil salinity problems in the TBP command. However, irrigation water and nutrients are lost due to over-draining. As a result of low irrigation water use efficiency, water shortage is experienced by farmers of downstream areas of the command. Based on previous years data, controlled SSD could save 20 percent (240 mm/ha) irrigation water and reduce nitrogen loss up to 50 percent compared to conventional SSD. Therefore, it is advised to practice conventional SSD in the beginning and switch over to Controlled SSD later on. However, continuous Controlled drainage could lead to a re-build of soil salinity over a period of time. Hence provision for leaching of salts is essential/mandatory.

In order to further increase irrigation water savings, Alternate Wetting and Drying (AWD) method of irrigation appears to be a viable option to further improve water use efficiency in reclaimed drainage areas, so as to address the problem of water shortage, as it has shown to reduce irrigation water use to the extent of 7-70%. AWD also helped to improve rice yield by 10% as compared to the traditional practice of continuous submergence.

Keeping in view of the above, this project proposal is prepared to address the impact of AWD method of irrigation under conventional and controlled subsurface drainage system (SSD) on water table, quantity of irrigation water applied, evapo-transpiration, deep percolation, water quality, crop yield, and water, and nutrient use efficiencies in rice fields under waterlogged saline soils of TBP Command.

The objectives of the experiment are i) to estimate the water balance components and water table depth for AWD and non-AWD conditions under conventional and controlled drainage; ii) to study the effect for AWD and non-AWD conditions on drain discharge, drainage water salinity, salt removal and nutrient loss; iii) to assess the effect of for AWD and non-AWD conditions on water use efficiency and water productivity and iv) to work out the economics of AWD and non-AWD conditions. The experiment is having separate treatments for *Kharif* season and separate treatment for *Rabi* season. The treatments are explained below:

Kharif Season Treatments:

T_1: Conventional drainage (CNV) during Kharif season with continuous flooding method of irrigation
T_2: Conventional drainage (CNV) during Kharif season with Alternative wetting and drying (AWD) method of irrigation
T_3: T_1 + Apply Controlled SSD during fertilizer application (for 12-15 days) only
T_4: T_2 + Apply Controlled SSD during fertilizer application (for 12-15 days) only

Rabi Season Treatments:

T_1: Controlled drainage during Rabi/Summer season with continuous flooding method of irrigation
T_2: Controlled drainage during Rabi/Summer season with Alternative wetting and drying (AWD) method of irrigation

A field experiment was initiated during *Kharif* -2020 at ARS, Gangavathi on an area of 2.8 ha (Fig. 6.1) by taking paddy crop with continuous flooding and AWD method of irrigation with the existing

conventional and controlled subsurface drainage plot (50 m spacing). As per the suggestions of QRT team adopted conventional drainage approach by comparing both continuous flooding and Alternative wetting and drying methods of irrigation and except during fertilizer application (12-15 days) to go for controlled drainage mode in order to reduce the movement of nutrients (No_3-N). During rabi/summer season adopted controlled drainage approach for all days with continuous flooding and Alternative wetting and drying methods of irrigation.

The quantity of irrigation water applied in both continuous flooding and Alternative wetting and drying methods treatment at each irrigation event was measured by using the Parshall flume. The drain flows were measured manually at all lateral drains by using a bucket and stopwatch at two days interval during drainage events (mm/d) and collected drain water (leachate) samples were analyzed for soluble salt concentration (EC, dSm^{-1}), pH and Nitrate–N concentration (mg/L) in both the treatments. The salt and nitrate concentrations in the leachate were multiplied by their corresponding drainage discharge of each lateral to estimate salt load and loss of Nitrate-N on a kg/ha basis. The water balance components like Evapo-transpiration, Percolation and Evaporation were measured through set of closed and open bottom lysimeters. The evaporation (E) was measured through closed bottom lysimeters without rice plants. Percolation together with Evaporation (E+DP) was measured at open bottom lysimeters without rice plants. Rice evapo-transpiration together with percolation (ETc+DP) was measured at open bottom lysimeters with rice plants.

Alternate wetting and drying method (AWD) of irrigation was measured through Bouman tube or field water tube having 20 cm diameter with 35cm length. The lower end of the pipe up to 15cm depth was made with small holes at 3-4 cm interval and the remaining portion of the pipe about 20cm length left as it is on the soil surface. The lower end of the pipe was inserted in the puddled soil and soil inside the tube was removed. Irrigation was done when the water level recedes below 15 cm depth inside the tube so as to maintain 5cm standing water in the plot. The observation wells installed to a depth of 1.0 m and depth to the water table was measured manually by tape once in two days interval.

As per the literature, Alternative wetting and drying method (AWD) of irrigation should be adopted 1-2 weeks after the transplantation to suppress the growth of weeds and be continued till crop reaches flowering stage. Later, continuous flooding (CF) method of irrigation needs to be followed so as to avoid any adverse effect on crop yield.

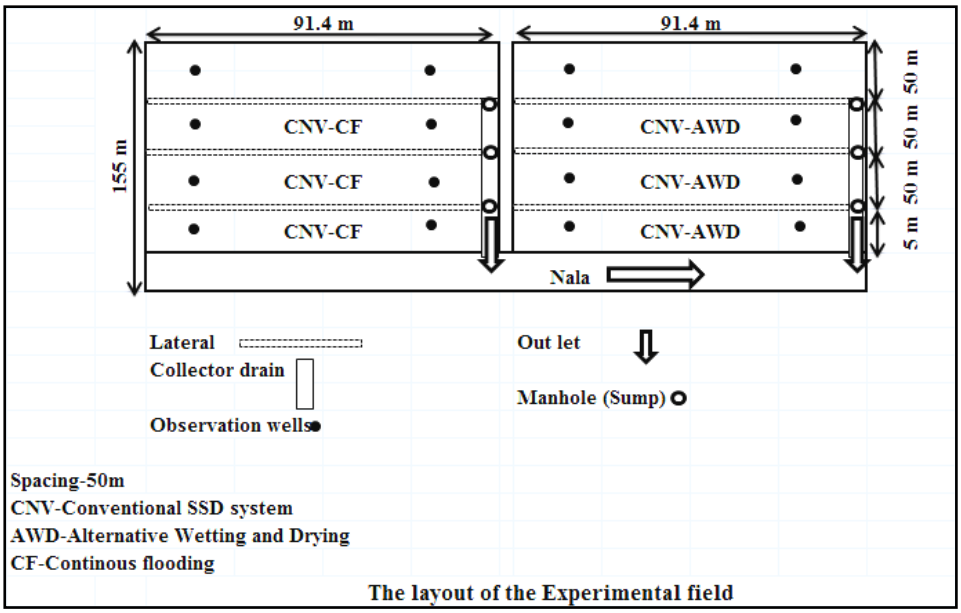


Fig. 6.1 Layout of the experimental plot

Temporal changes in soil salinity

The soil salinity up to 90cm depth at the end of season under both continuous flooding (CF) and alternative wetting and drying method (AWD) of plots was measured. The mean soil salinity reduced from initial to Kharif-20 was 2.78 to 1.36 dS/m (0-15 cm), 2.32 to 1.91dS/m (15-30cm), 4.41 to 2.58dS/m (30-60cm) and 3.26 to 2.45 dS/m (60-90cm) under continuous flooding (CF) method of irrigation. However, under Alternative wetting and drying method (AWD) of irrigation, the mean soil salinity reduced slightly from 1.65 to 1.53 dS/m at 0-15 cm whereas generally at lower depths soil salinity increased slightly (Table 6.1).

Table 6.1. Soil salinity (ECe, dS/m) at different soil depth (cm) as influenced by different irrigation regime under conventional drainage system

Season	Continuous flooding (CF)				Alternative wetting and drying method (AWD)			
	Depth (cm)				Depth (cm)			
	0-15	15-30	30-60	60-90	0-15	15-30	30-60	60-90
Initial	2.78	2.32	4.41	3.26	1.65	2.20	5.11	8.25
Kharif-20	1.36	1.91	2.58	2.45	1.53	2.56	5.63	7.73

Temporal changes in drainage discharge

The drain discharge was measured and collected from the outlet of the each treatment during *Kharif*-2020. The drain discharge or drainage water outflow was higher in case of conventional drainage with continuous flooding method of irrigation compared to Alternative wetting and drying method (AWD) of irrigation system. The monthly drain discharge varied from 0.92 to1.12 mm d^{-1} with a mean value of 1.03 mm d^{-1} under conventional drainage with continuous flooding irrigation (Fig. 6.2). Similarly under conventional drainage with Alternative wetting and drying method (AWD) of irrigation system drain discharge varied from 0.63 to 0.78 mm d^{-1} with a mean value of 0.68 mm d^{-1} respectively. Drain discharge under Controlled drainage during fertilizer application with continuous flooding method of irrigation was 0.64 mm d^{-1}. Similarly under Alternative wetting and drying method (AWD) of irrigation system drain discharge was 0.46 mm d^{-1} (Table 6.2)

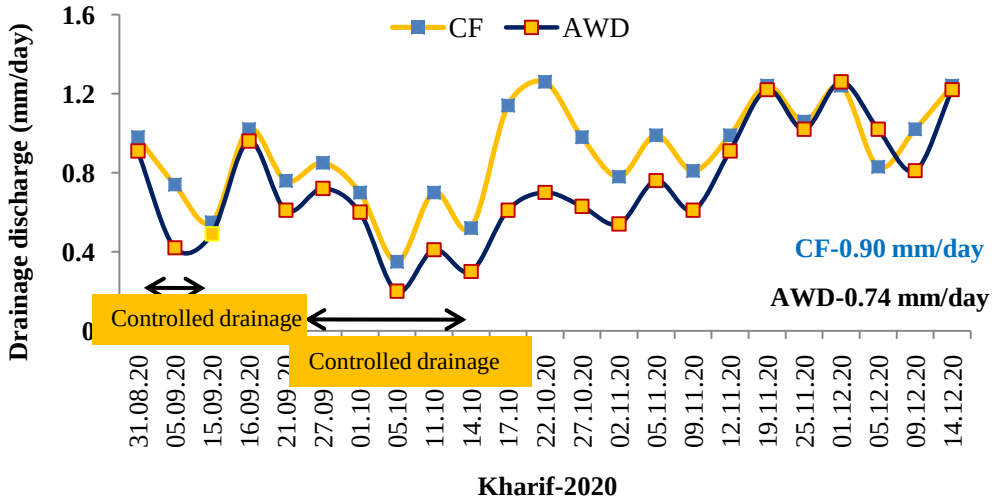


Fig. 6.2 Temporal variation in drain discharge under continuous flooding and alternate wetting and drying method

Table 6.2. Drainage discharge (mm d^{-1}) as influenced by different irrigation regime under conventional drainage system

Sl. No	Kharif-2020					
	Treatments	Sep	Oct	Nov	Dec	Avg
1.	CF	0.92	1.12	0.98	1.08	1.03
	CF-CDF	0.72	0.56			0.64
2.	AWD	0.78	0.64	0.63	1.06	0.68
	AWD-CDF	0.54	0.37			0.46

Note: CF: Continuous flooding method of irrigation (CF); AWD**:** Alternative wetting and drying method of irrigation (AWD); **CF-CDF:** Controlled drainage during fertilizer application under CF and AWD-**CDF:** Controlled drainage during fertilizer application under AWD.

Temporal changes in drainage water salinity

The monthly drainage water salinity varied from 1.82 to 1.99 dS m^{-1} with a mean value of 1.89 dSm^{-1} under conventional drainage with continuous flooding irrigation (Fig. 6.3). Similarly, under conventional drainage with Alternative wetting and drying method (AWD) of irrigation system drain discharge varied from 1.72 to 1.80 dS m^{-1} with a mean value of 1.74 dSm^{-1}. The mean drain water salinity in Controlled drainage during fertilizer application under continuous flooding method of irrigation was 1.77 dS m^{-1}. Similarly, under Alternative wetting and drying method (AWD) of irrigation system the mean drain water salinity was 1.73 dS m^{-1}, respectively (Table 6.3).

Table 6.3 Drainage water salinity (dS m^{-1}) as influenced by different irrigation regime under conventional drainage system

S.No.	Kharif-2020					
	Treatments	Sep	Oct	Nov	Dec	Avg
1.	CF	1.91	1.82	1.85	1.99	1.89
	CF-CDF	1.81	1.73			1.77
2.	AWD	1.72	1.77	1.74	1.80	1.74
	AWD-CDF	1.74	1.71			1.73

Fig. 6.3 Temporal variation in drainage water salinity under continuous flooding and alternate wetting and drying method

Salt removal

The monthly Salt removed varied from 0.26 to 0.41 ton ha^{-1} with a total value of 1.35 ton ha^{-1} under conventional drainage with continuous flooding irrigation (Fig. 6.4). Similarly under conventional drainage with Alternative wetting and drying method (AWD) of irrigation system drain discharge varied from 0.22 to 0.30 ton ha^{-1} with a total value of 1.04 ton ha^{-1} Controlled drainage during fertilizer application under continuous flooding method of irrigation Salt removed was 0.44 ton ha^{-1} (Table 6.4).

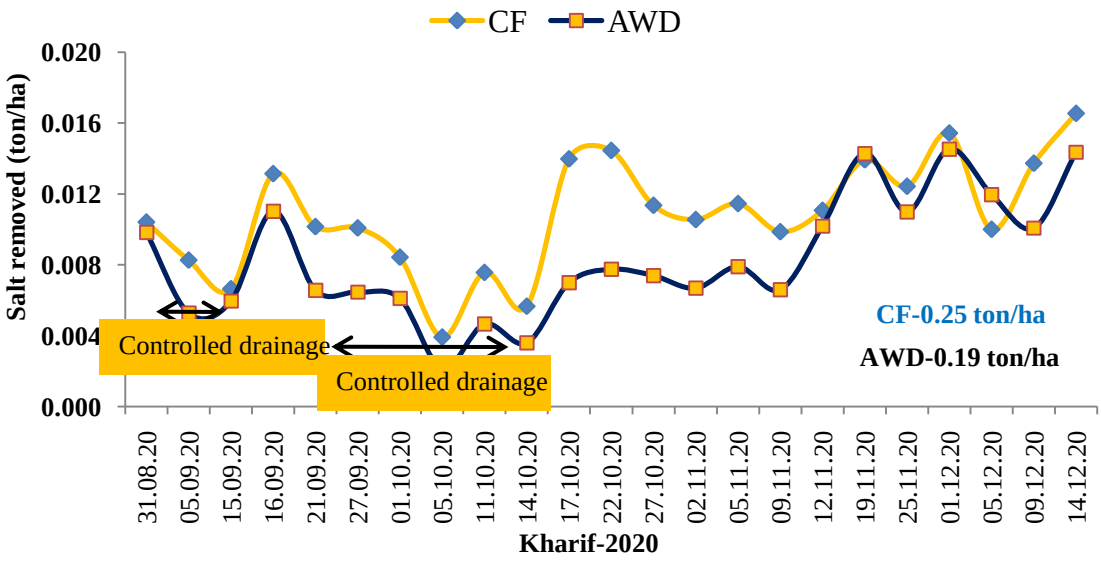


Fig. 6.4. Temporal variation in salt removal under continuous flooding and alternate wetting and drying method

Table 6.4 Salt removed (ton ha^{-1}) as influenced by different irrigation regime under conventional drainage system

S.No.	Kharif-2020					
	Treatments	Sep	Oct	Nov	Dec	Total
1.	CF	0.34	0.41	0.34	0.26	1.35
	CF-CDF	0.25	0.19			0.44
2.	AWD	0.27	0.22	0.30	0.25	1.04
	AWD-CDF	0.17	0.12			0.29

Similarly, under Alternative wetting and drying method (AWD) of irrigation system the mean Salt removed was 0.29 t ha^{-1}, respectively.

Water table

The monthly water table varied from 6.0 to 18.0 cm with a mean value of 12.4 cm under conventional drainage with continuous flooding irrigation. Similarly under conventional drainage with Alternative wetting and drying method (AWD) of irrigation system water table varied from 5.0 to 19.0 cm [with] a mean value of 13.4 cm (Fig. 6.5). The mean water table in Controlled drainage during fertilizer application under continuous flooding method of irrigation was 6.7 cm. Similarly, under Alternative wetting and drying method (AWD) of irrigation system the mean depth to water table was 8.0 cm (Table 6.5).

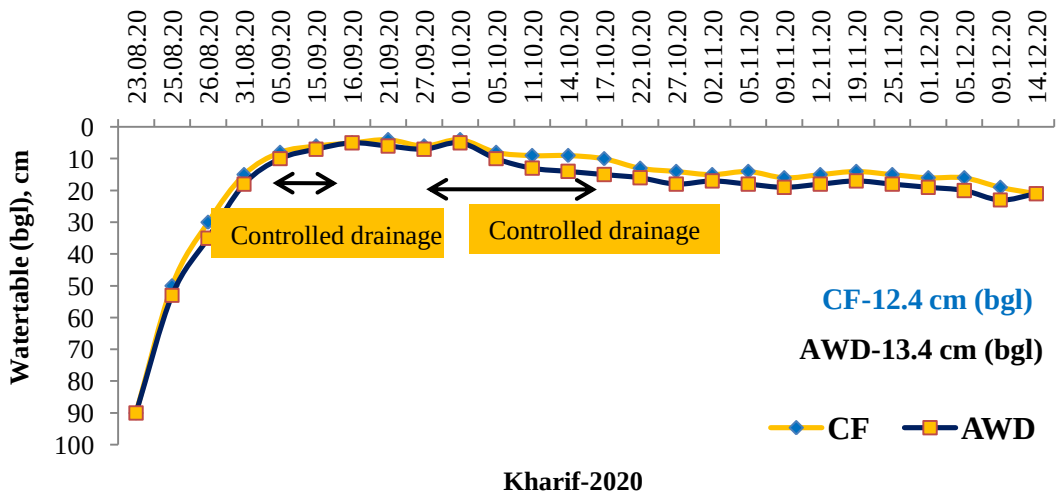


Fig. 6.5 Temporal variation in depth to water table under continuous flooding and alternate wetting and drying method

Table 6.5 Water table (cm) as influenced by different irrigation regime under conventional drainage system

S.No.	*Kharif*-2020					
	Treatments	Sep	Oct	Nov	Dec	Avg
1.	CF	6.0	11.0	14.8	18.0	12.4
	CF-CDF	5.4	8.0			6.7
2.	AWD	5.0	12.0	17.7	19.0	13.4
	AWD-CDF	6.0	11.0			8.0

Crop Yield

The grain yield was increased from 58.0 to 61.5 q/ha under continuous flooding method of irrigation. Similarly, under Alternative wetting and drying method (AWD) of irrigation system grain yield increased from 50.4 to 54.6 q/ha. The per cent increase was slightly higher under AWD (7.70%) compared to CF (6.0%) (Table 6.6).

Table 6.6. Crop yield (q/ha) as influenced by different irrigation regime under conventional drainage system

Season	CF	AWD
Initial (Kharif-19)	58.0	50.4
Kharif-2020	61.5	54.6

Irrigation water applied:

Seasonal water balance of the study area worked out by considering the quantity of irrigation water applied for paddy crop including rainfall under continuous flooding method of irrigation was 147.5 cm and under Alternative wetting and drying method (AWD) of irrigation system it was 129.5 cm (Table 6.7).The result indicated that, Alternative wetting and drying method (AWD) of irrigation system could save 18.0 cm (12%) of irrigation than continuous flooding method of irrigation.

Table 6.7 Depth of irrigation and water saving as influenced by different irrigation regime under conventional drainage system

Depth of irrigation, cm		Saving of water, cm	Rain fall, cm
CF	AWD		
147.5	129.5	18.0	22.27

- **Evaluation of different depth (head) of controlled drainage system in saline vertisols of TBP Command (Evaluation of variable lateral outlet head of controlled drainage system in saline vertisols of TBP command)- (Gangavathi)**

A field experiment was laid out at Thimmapur village (Farmers field) in an area of 2 ha block by taking three treatments i.e., Controlled SSD with 50 m spacing each with a raise of lateral head up to root zone, 0.3 m and 0.6 m including conventional, fixed and variable outlet heads. The topography of the area is about 0.165% sloping towards east direction. Considering the topography, the main collector line of the sub surface drainage was planned west to east direction with provision of outlet in east end. The experimental site was divided into eight blocks based on soil salinity so as to accommodate the treatments. A total of 17 soil samples to a depth of 90 cm from 2.0 ha area were collected for characterization. Based on the analysis the ECe of experimental area varied from 4.04 to 23.41 dS/m with an average value of 13.48 dS/m, 4.76 to 26.07 dS/m with mean of 14.40 dS/m, 4.39 to 22.88 dS/m with a mean of 12.29 dS/m and 3.06 to 23.41 dS/m with a mean of 11.67 dS/m at 0-15, 15-30, 30-60 and 60-90 cm, respectively. As per the suggestions of QRT, only the conventional SSD system was practiced till *Kharif* 2018, so as to attain faster reclamation and impose

the actual variable outlet head concept during *Kharif* 2019, depending on the availability of water and soil salinity status.

Temporal changes in drainage discharge

The drain discharge was collected from the outlet of the each treatment during *Kharif*-2020 (Table 6.8). The drain discharge or drainage water outflow was higher in case of conventional SSD compared to variable controlled drainage system. The monthly drain discharge varied from 1.36 to 1.80,0.91 to 1.61,0.87 to 1.30 and 0.76 to 1.08 mm d^{-1} with a mean value of 1.54,1.25,1.06 and 0.93 mm d^{-1} under conventional drainage system, Controlled with 0.3 m height, Controlled with 0.6 m height and Controlled with root zone (0.7m height) respectively.

Table 6.8 Drainage discharge (mm d^{-1}) as influenced by variable depth of drainage systems

Sl.No.	Treatments	Sep	Oct	Nov	Dec	**Avg**
1	Conventional drainage	1.40	1.80	1.58	1.36	**1.54**
2	Controlled with 0.3m height	1.23	1.61	1.25	0.91	**1.25**
3	Controlled with 0.6m height	0.95	1.30	1.10	0.87	**1.06**
4	Controlled with root zone (0.7m height)	0.87	1.08	1.02	0.76	**0.93**

Temporal changes in drainage water salinity

The monthly drainage water salinity varied from 5.0 to 7.95,6.93 to 8.32,7.21 to 10.88,6.30 to 8.42 dS m^{-1} with a mean value of 6.58,7.53,8.24 and 7.61 dS m^{-1} under conventional drainage system, Controlled with 0.3 m height, Controlled with 0.6 m height and Controlled with root zone (0.7m height) respectively. The salinity of the effluent was higher with high flow rate under conventional compared to other drainage systems (Table 6.9).

Table 6.9 Drainage water salinity (dS m^{-1}) as influenced by variable depth of drainage systems

Sl. No.	**Treatments**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**
1	Conventional drainage	7.06	7.95	5.0	6.30	**6.58**
2	Controlled with 0.3m height	7.57	8.32	6.93	7.30	**7.53**
3	Controlled with 0.6m height	7.26	10.88	7.21	7.60	**8.24**
4	Controlled with root zone (0.7m height)	7.60	8.42	6.30	8.10	**7.61**

Salt removal

On the basis of drainage water outflow and drainage water salinity, salt removal patterns for conventional and other variable controlled drainage system were worked out by considering the quantity of irrigation water applied and with their salinity level (EC) multiplied by standard factor of 640 to get salt load in mg l^{-1}. The monthly salt removal varied from 1.52 to 2.75, 1.28 to 2.57, 1.27 to 2.72 and 1.18 to 1.75 t ha^{-1} under conventional drainage system, Controlled with 0.30 m height, Controlled with 0.60 m height and Controlled with root zone (0.70 m height) respectively, with a total value of 7.81, 7.30, 6.83 and 5.43t ha^{-1}. The data indicating that higher drainage discharge coupled with higher salt removal in conventional system over the other controlled system resulted in higher salt removed (Table 6.10).

Table 6.10 Salt removed (t ha^{-1}) as influenced by variable depth of drainage Systems.

Sl.	Treatments	Sep	Oct	Nov	Dec	Avg
1	Conventional drainage	1.90	2.75	1.52	1.65	**7.81**
2	Controlled with 0.3m height	1.79	2.57	1.66	1.28	**7.30**
3	Controlled with 0.6m height	1.32	2.72	1.52	1.27	**6.83**
4	Controlled with root zone (0.7m height)	1.27	1.75	1.23	1.18	**5.43**

Nitrogen loss (NO_3-N) through drainage system (mg L^{-1})

The monthly Nitrogen concentration in drain discharge varied from 2.24 to 3.92, 1.40 to 3.42, 1.12 to 3.64 and 0.84 to 3.36 mg L^{-1} with a mean value of 3.30, 2.07, 1.82 and 1.89 mg L^{-1} under conventional drainage system, Controlled with 0.30 m height, Controlled with 0.60 m height and Controlled with root zone (0.70 m height) respectively.The data indicated that higher concentration of nitrogen flow occurred under conventional system than other variable controlled drainage system (Table 6.11).

Table 6.11 Nitrogen loss (NO_3-N) (mg L^{-1}) as influenced by variable depth of drainage systems.

S.No.	Treatments	Sep	Oct	Nov	Dec	Avg
1	Conventional drainage	3.70	2.24	3.92	3.36	**3.30**
2	Controlled with 0.3m height	3.42	1.40	1.79	1.68	**2.07**
3	Controlled with 0.6m height	3.64	1.12	1.12	1.40	**1.82**
4	Controlled with root zone (0.7m	3.36	2.24	0.84	1.12	**1.89**

Nitrogen loss (NO_3-N) through drainage system (kg ha^{-1})

The monthly Nitrogen loss varied from 1.25 to 1.86, 0.47 to 1.26, 0.37 to 1.04 and 0.26 to 0.88 kg ha^{-1} with a total value of 6.08, 3.11, 2.24 and 2.15 kg ha^{-1} under conventional drainage system, Controlled with 0.30 m height, Controlled with 0.60 m height and Controlled with root zone (0.70 m height) respectively. The data indicated that higher loss of nitrogen occurred under conventional system than controlled drainage system due to higher concentration of nitrogen flow the effluent so also higher drain discharge (Table 6.12).

Table 6.12 Nitrogen loss (NO_3-N) (kg ha^{-1}) as influenced by variable depth of drainage systems

Sl. No.	Treatments	Sep	Oct	Nov	Dec	Avg
1	Conventional drainage	1.55	1.25	1.86	1.42	**6.08**
2	Controlled with 0.3m height	1.26	0.70	0.67	0.47	**3.11**
3	Controlled with 0.6m height	1.04	0.45	0.37	0.38	**2.24**
4	Controlled with root zone (0.7m height)	0.88	0.75	0.26	0.26	**2.15**

Under conventional drainage, soil salinity at surface and subsurface soils remained nearly same whereas it increased at lower depths i.e., 30-60 and 60+ cm respectively from April 2019 to till the end of crop harvest in *kharif* 2021. On the contrary, soil salinity increased at all the depths in the remaining subsurface treatments viz., controlled with 0.3 m height, controlled with 0.6 m height and

controlled with root zone (0.7 m height). Use of poor quality borewell water during shortage of canal water has resulted in increase in soil salinity (Table 6.13).

Table 6.13 Average soil salinity (ECe,dS/m) as influenced by variable lateral head drainage system.

Treatments	Dates of Sampling											
	29.04.2019				23.01.2020				18.01.2021			
	0-15 cm	15-30 cm	30-60 cm	60+ cm	0-15 cm	15-30 cm	30-60 cm	60+ cm	0-15 cm	15-30 cm	30-60 cm	60+ cm
Conventional drainage	16.1	11.0	8.70	7.40	14.1	13.3	15.8	17.0	14.1	11.7	14.3	14.5
Controlled with 0.3m height	8.80	8.20	10.1	8.40	10.5	9.70	14.2	8.40	9.20	9.70	12.1	10.3
Controlled with 0.6m height	6.70	9.80	10.5	3.30	12.0	9.70	12.6	12.20	9.20	11.30	15.2	14.50
Controlled with root zone (0.7m height)	13.2	8.80	9.70	10.8	13.2	12.5	15.5	16.6	9.90	11.9	14.8	14.7

Grain yield:

There was improvement in rice grain yield from 31.5 to 45.3, 30.4 to 43.5, 31.8 to 41.5 and 33.1 to 38.7 qha^{-1} under conventional drainage system, Controlled with 0.30 m height, Controlled with 0.60 m height and Controlled with root zone (0.70 m height) respectively compared to the initial yield levels over the years. The slightly higher grain yields were observed under conventional SSD compared to other drainage systems. However, reduced paddy grain yields during kharif 2020 could be attributed to slightly increase in soil salinity due to use of tubewell water and severe incidence of gall midge pest across the TBP command area (Table 6.14).

Table 6.14 Grain yield (q ha^{-1}) as influenced by variable depth of drainage systems

Season	Conventional drainage	Controlled with 0.3m height	Controlled with 0.6m height	Controlled with root zone (0.7m height)
Initial	31.5	30.4	31.8	33.1
RS-17-18	43.2	41.4	40.4	37.6
Kharif-2018	51.8	48.4	47.1	45.3
Kharif-2019	60.1	58.3	56.1	54.3
Kharif-2020	45.3	43.5	41.5	38.7

- **Feasibility of drip irrigation in puddled transplanted rice (PTR) under saline Vertisols of TBP command area, Karnataka (Gangavathi)**

At present, actual area under paddy is often exceeding 40 percent of the command as against proposed 2% area. It is also observed that paddy is being cultivated by farmers in upstream area of the command rather than the downstream as suggested in the guidelines. Due to violation of the cropping pattern, farmers in mid and downstream areas are not only facing shortage of canal water supply for paddy crop but also experiencing problem of secondary salinization as a result of seepage from the upstream areas. Problems of waterlogging and soil salinity were felt in about 20,200 ha during 1979-80 and it increased to 96,215 ha in 2013-14 (CADA-TBP report, 2013) indicating an estimated annual loss of about 3000 ha due to waterlogging and soil salinity in TBP command. To overcome shortage of irrigation water supply, farmers are now opting for light irrigated/rainfed

crops or direct seeded rice (DSR) particularly at mid reach/downstream areas. Generally there are two scenarios in case of DSR.

Scenario I: Farmers sow the crop with the onset of monsoon in the upstream area of the command and irrigate the crop once the canal water is available (often during last week of July or first week of August) till the physiological maturity of the crop.

Scenario II: Farmers sow the crop with the onset of monsoon in the mid reach/downstream and irrigate with drip using tube well water or canal water stored in storage tank. In case of non-availability of tube well or storage tank water, they depend totally on the rainfall.

In both the scenarios, DSR is followed at slightly elevated fields which do not have the problem of soil salinity. Thus germination and establishment of paddy are not affected by salinity. It is observed that puddle transplanted rice (PTR), irrespective of field situations/ conditions does not face soil salinity effects so much as flooding by good quality canal water helps in dilution. However, acute water shortage particularly at later stages of crop is experienced in mid and downstream areas and saving of paddy crop is very important. The mid reach and downstream areas with waterlogging and soil salinity problems do not go for DSR due to low germination problem. Under such situations, drip can be effective in keeping soil saturated with limited available irrigation water. The additional requirement for adoption of drip is secondary storage structure and farmers are willing to invest on it, if they are getting assurance of the crop. Further, it is expected that drip can reduce irrigation application losses drastically and help in controlling waterlogging and soil salinity, particularly in mid and downstream portions of command in long term, if adopted on large scale.

Research gaps:

The available irrigation water is not sufficient to grow rice crop to the extent it is being cultivated in the command. In spite of water shortage, farmers at mid and downstream have no other option and are compelled to grow only paddy using seepage water from upstream paddy fields. Sometime, these farmers either use poor quality tube well water or drain water.

- Present water allocation to mid and downstream areas is highly insufficient and they have to devise better water management practices to continue with paddy cultivation.
- As the irrigation water is the most critical input for paddy, drip can save irrigation water application losses and farmers will be able to grow transplanted paddy crop with available irrigation water.
- Farmers are using drip irrigation for DSR whereas no such attempts/information is available for puddle transplanted rice under waterlogged saline Vertisol in TBP command area.
- It will be motivating to know the feasibility of drip in controlling waterlogging and soil salinity under PTR.
- It will be important to know suitable paddy variety for such type of water management.

In view of the above situation, this project was initiated with the following Objectives:

i. To assess soil moisture content at different crop growth stages as influenced by different ET levels and paddy varieties.
ii. To study changes in waterlogging and soil salinity at start and harvest of paddy crop as influenced by different ET levels and paddy varieties.
iii. To study performance of different paddy varieties in terms of yield and yield attributes as influenced by different ET levels.
iv. To workout the economics.

Treatment details:

Place	:	ARS Gangavathi
Main plot	:	Varieties (2) – **M_1 & M_2** (M_1 = GVT-05-01, M_2 =GNV 1801)
Sub plot	:	ET levels (4) – **I_1, I_2, I_3 and I_4** (1.20, 1.40, 1.60 and 1.8 ET).
Design	:	Split-plot
Replication	:	Four
Plot size	:	5 x 4 m
NPK	:	RDF (NPK @ 150:75:75 kg ha^{-1})

Experimental Field Layout

R-I	R-II	R-III	R-IV
M_1I_1	M_2I_1	M_1I_4	M_2I_4
M_1I_2	M_2I_2	M_1I_3	M_2I_3
M_1I_3	M_2I_3	M_1I_2	M_2I_2
M_1I_4	M_2I_4	M_1I_1	M_2I_1
Buffer			
M_1I_1	M_2I_1	M_1I_4	M_2I_4
M_1I_2	M_2I_2	M_1I_3	M_2I_3
M_1I_3	M_2I_3	M_1I_2	M_2I_2
M_1I_4	M_2I_4	M_1I_1	M_2I_1

The experiment was initiated during Rabi/summer 2020-21 in waterlogged saline soils at Agricultural Research Station, Gangavathi as per the layout shown above. Since, the layout of the experiment was delayed with regard to lay of main, lateral and checking for flow rate, there was not much time to irrigate the crop through drip. Moreover, seepage from the adjacent area appeared to be influencing soil moisture content and depth to water table measured in the observation wells. Hence, it was planned to cover the entire plot (treated as well as control plots) with drip in the ensuing *kharif* season (2021) and continue the experiment. The initial soil pH varied from 7.88 to 8.37 with a mean of 8.12 and soil salinity from 2.91 to 10.0 with a mean of 5.41 dS/m at 0-30 cm.

View of layout of drip irrigation in puddle transplanted paddy in waterlogged saline Vertisols at ARS, Gangavathi

7. Management of Saline-Acidic Soils

- **Integrated farming system for sustainable land use in *Pokkali* lands (Vytilla)**

Integrated farming system (IFS) models are being planned for pokkali lands for improving land and water productivity. The evaluation of two IFS models namely Rice – Vegetable – Duck – Fish Integration and Rice- prawn-horticulture integration was undertaken to study effects on soil properties, economic benefits and long-term sustainability.

A) Rice – Vegetable – Duck – Fish Integration

a] Rice Cultivation

The field was prepared for rice cultivation. By April 2021, the bunds were strengthened and sluices were repaired for regulating water level. Fields are then drained during low tide and the sluices were closed. When the soil in the field became dry, mounds of 1 m base and 0.5 m height were formed. This facilitates the washing down of the dissolved salts from the surface of the mounds with the onset of monsoon, which are ultimately removed from the field by tidal action.

The mounds in the field were raked and top leveled by last week of July. The sprouted seeds (VTL-10) were sown on the top of mounds, and the mounds were cut into pieces with a few seedlings, which were uniformly spread in the field. Being inherently fertile, chemical fertilizers or pesticides were not used in *Pokkali* lands making it unique from other farming systems. No other cultural operation except weeding was conducted in the field. The harvest was on October, 2021. Only panicles were harvested at a height of 30 to 35 cm from the top and the remaining plant part is left in the field. The rice yield was 2.81 tons.

Soil sampling was done in June (before the rice cultivation) from a depth of 0- 15 cm and the next sampling was carried out in October, after rice harvest and the data were given in Table 7.1. The data showed a slight decrease in soil pH after harvest of crop compared to initial value. The electrical conductivity of soil also got reduced after rice harvest. Organic carbon content of the soil increased as compared to initial content. The data also showed decrease in content of available P, Ca and Mg compared to initial values before sowing whereas available K, Na and S the content got increased. The micronutrients content *viz*., Fe, Mn, Zn and Cu in soil was high compared to initial value.

Table 7.1. Changes in soil properties before and after harvest of rice at RRS, Vyttila

Soil properties	Unit	Values	
		Initial	Final
pH		6.05	5.65
EC	dS/m	1.42	1.25
OC	%	1.28	1.41
P	kg /ha	158.67	102.13
K		314.21	539.14
Na		414.12	579.54
Ca		1458.02	925.35
Mg		41.34	34.68

S	mg/kg	11.74	17.31
B		0.19	0.23
Fe		187.80	206.97
Zn		1.48	2.20
Cu		0.21	1.23
Mn		4.68	5.25

b) Vegetable Cultivation

The bunds in between the rice fields were selected for planting vegetables in January 2021. After field leveling, ridges and furrows were prepared. Polythene mulches were spread over the fields for required treatments. The planting was done on ridges with specified spacing for each crop according to Package of Practices recommendation of Kerala Agricultural University. Fertilizers were applied through drip fertigation according to adhoc fertilizer recommendation by Kerala Agricultural University. Need based application of bio-pesticides were done for controlling insect pest attack. The experiment was conducted with an objective to compare the effect of mulching on yield of vegetables. High yielding varieties of vegetables released from Kerala Agricultural University *viz.,* chilli, brinjal, cowpea and tomato were selected to check the adaptability of these vegetables in *Pokkali*lands and to find the most suitable vegetable for *Pokkali* fields. Treatment details are given in Table 7.2.

Table 7.2. Details of treatments

Sl. No.	Treatments	Crops	Use of mulch
1	T_1C_1	Chilli	With mulch (WM)
2	T_2C_2	Brinjal	
3	T_3C_3	Cowpea	
4	T_4C_4	Bhindi	
5	T_5C_1	Chilli	Without mulch (WOM)
6	T_6C_2	Brinjal	
7	T_7C_3	Cowpea	
8	T_8C_4	Bhindi	

- Number of treatments: 8
- Design: RBD
- No. of replications: 3
- Plot Size: 3m X 2m
- Planting: 2021 January 20 and 21
- Varieties planted: Chilli (Anugraha), Brinjal (Haritha), Cowpea (Kanakamony) and Tomato (Anagha)



Plate 1: Vegetable cultivation on bunds of rice field at RRS, Vytilla

The initial soil samples were collected for analyzing pH, EC, OC, available P, K, Na, Ca, Mg, S, B, Fe, Zn, Cu and Mn. The soil data before vegetable cultivation are given in the Table 7.3. Harvesting of crops was started during March. After harvest of vegetables, soil samples were collected again to analyze the nutrient content and to evaluate the changes in soil properties. Soil data after vegetable cultivation are given in Table 7.4.

Table 7.3. Soil properties before vegetable cultivation

Treatments			p H	EC	OC	P	K	Na	Ca	Mg	S	Fe	Mn	Zn	Cu	B
				dS/m	%	kg/ha			mg/kg			mg/kg				
T_1	Chilli	WM	4.24	0.33	1.66	102	413	347	1210	389	30.0	513	10.50	5.49	1.52	0.41
T_5		WOM	3.06	2.13	1.65	121	197	586	2155	608	1208	888	7.31	12.31	2.10	1.06
T_2	Brinjal	WM	4.26	0.16	1.60	64.1	351	368	956	282	19.5	533	3.95	3.35	1.26	0.93
T_6		WOM	3.10	1.77	1.26	77.9	142	412	1189	471	1003	708	2.05	6.13	1.31	1.08
T_3	Cowpea	WM	3.79	0.31	1.35	105	387	396	1095	267	80.6	546	7.31	8.43	0.93	0.70
T_7		WOM	3.16	1.80	1.62	77.3	262	574	1867	514	470	843	3.54	5.55	1.50	1.67
T_4	Tomato	WM	4.26	0.27	1.84	82.9	313	485	1285	398	26.1	594	4.72	4.84	1.41	0.37
T_8		WOM	3.07	2.39	1.39	194	241	683	2463	629	1288	930	6.95	10.74	1.50	1.10

Table 7.4. Soil properties after vegetable cultivation

Soil properties		pH	EC	OC	P	K	Na	Ca	Mg	S	Fe	Mn	Zn	Cu	B
			dS/m	%	kg/ha			mg/kg			mg/kg				
Initial	WM	4.29	0.25	1.59	75.9	346	223	444	370	122	324	6.48	4.3	0.26	0.73
	WOM	3.05	1.94	0.70	105.8	74.8	406	884	167	1220	442	28.7	3.3	0.30	1.77

The soil pH was higher in treatments with mulch as compared to without mulch in case of all the vegetables. This was in accordance with initial soil condition. On observing the electrical conductivity of soil samples in all treatments, it was clear that treatments without mulch were having higher EC values in most of the treatments. The organic carbon per cent of the soil samples were found to be varied among treatments. The available phosphorus content in soil was found to increase in all the treatments with respect to initial soil phosphorus status. The available K content of the soil samples was found to increase in most of the treatments with respect to initial soil nutrient status. The

sodium content increased in all treatments compared to initial value and treatment with mulch reported lower sodium content. Among the secondary nutrients, available calcium and magnesium content increased in all the treatments with respect to the initial value. An increment was recorded in available sulphur content in most of the treatments from the initial soil status.

The highest yield of crop was obtained in the treatments brinjal and cowpea with mulch in the year 2021. The other treatments did not vary significantly and was on par with respect to yield. The yield data was given in Table 7.5. The yield data from each treatment plots revealed that higher yield was obtained from treatments with mulch rather than without mulch. It was seen that, mulching with polythene sheet was having a significant effect on crop growth and yield of vegetables.

Table 7.5. Yield of vegetables

Treatments			Yield(t/ha)
T_1	Chilli	WM	3.25^b
T_5		WOM	0.51^b
T_2	Brinjal	WM	**28.68^a**
T_6		WOM	7.45^b
T_3	Cowpea	WM	**21.63^a**
T_7		WOM	5.23^b
T_4	Tomato	WM	9.07^b
T_8		WOM	3.86^b
	CD (0.05)		1.752

c] Duck- fish integration

The study involved integration of ducks (120 no.) and fish along with *Pokkali* rice and vegetable cultivation. The ducks were reared in duck cages in ponds. Normally ducks were released after the harvest of paddy cultivation in *Pokkali* fields. Remaining paddy waste contributed the feed for them. They were also fed with broken rice and pellet feed. Ducks were also released in the standing crop fields, so that the pest population could be controlled.

Fishes were reared in those ponds, where the duck cages were kept. Various kinds of fishes *viz., Thilapia, Karimeen, etc* were grown in the ponds. Duck droppings acts as feed for fishes. No additional feed is required for fishes. The soil and water analysis from pond was done to check whether the condition was suitable for duck-fish integration. The data were presented in Table 7.6.

Table 7.6. Soil and water analysis of the pond for duck-fish integration

Soil Parameters	**Initial value**	**Water Parameters**	**Initial value**
pH	5.66	pH	6.64
EC (dS/m)	1.94	EC(dS/m)	2.51
OC(%)	2.11	Nitrite (mg/L)	0
P (kg /ha)	255.32	Nitrate (mg/L)	2.50
K (kg /ha)	341.02	Ammonia (mg/L)	0.52
Ca (mg/kg)	625.32	TDS (mg/L)	892.00
Mg (mg/kg)	489.52	Total hardness (mg/L)	175.60
		Total alkalinity (mg/L)	184.00
		Total salinity (mg/L)	1.25

It was revealed that, the conditions in the pond ecosystem were favourable for the growth and development of both fish and duck. It was also noticed that nutrient uptake by the duck as feed got returned back to soil without loss. Returns from duck farming were sale of eggs and ducks for meat purpose and from fish rearing it is the sale of fish. For one year period of study, approximately about 13,000 eggs, 65 ducks and 3500 kg fish were sold, which showed the profitability of integrated farming system.

Benefit-Cost Ratio of integrated farming system

The results of the present study suggest that growing rice, vegetable and duck-fish together is a potentially better alternative which can yield significantly higher production compared to the traditional *Pokkali*farming alone. Analysis of benefit-cost ratio approved the same. Cost and returns for rice cultivation, vegetable cultivation, duck and fish farming were given individually in Table 7.7, 7.8 and 7.9 respectively. The BC ratio obtained for this multilevel integrated farming system was 2.55 (Table 7.10).

Table 7.7 Costs and returns of rice cultivation per hectare

Sl. No.	Cultural operations	Quantity/ No. of labourers	Rate (Rs.)	Total cost (Rs.)
1	Seed cost	100 Kg	65	6500.00
2	Strengthening of bunds	10 Labourers	750	7500.00
3	Land and mound preparation	20 Labourers	750	15000.00
4	Preparing top of mound for sowing and sowing seeds	18 Labourers	750	13500.00
5	Dismantling	20 Labourers	750	15000.00
6	Harvesting and handling	45 Labourers	750	33750.00
7	Threshing and drying	13 Labourers	750	9750.00
8	Weeding	18 Labourers	750	13500.00
9	Electricity	100 Units	2.5	250.00
10	Diesel	2.5 Litres	92	230.00
	Total cost incurred			**1,14,980.00**
	Returns	2.81 tonnes	65/kg	**1,82,650.00**
	BC Ratio			**1.58**

Table 7.8 Costs and returns of vegetable cultivation

Sl. No.	**Cultural operations**	**No. of labourers/quantity**	**Rate (Rs.)**	**Total cost (Rs.)**
1.	Land preparation and bed preparation	10	750	7500.00
2.	Seeds	800	2	1600.00
3.	Sowing of seeds and drip irrigation work	12	750	9000.00
4.	Drip irrigation accessories			4,000.00
5.	Weeding	14	750	10500.00
6.	Harvesting	16	750	12000.00
	Total cost			**44,600.00**
	Returns			**1,05,242.00**
	BC Ratio			**2.35**

Table 7.9 Costs and returns of duck and fish farming

Sl	Components	Cost (Rs)
1	Pellet feed	284550.00
	Total	**2,84,550.00/-**
Returns		
1	Eggs (13000 eggs @ Rs. 10/egg)	130000.00
2	Duck (65ducks @ Rs.250/duck)	16250.00
3	Fish (3500 kg @ Rs.200/kg)	700000.00
	Total	**8,46,250.00/-**
	BC Ratio	**2.97**

Table 7.10 BC ratio of integrated farming system

Gross expenditure (Rs)	4,44,130.00
Gross Returns (Rs)	11,34,142.00
BC ratio	2.55

Conclusion:

The overall result in this study indicated that integrated rice-vegetable-duck and fish cultivation system in P*okkali* fields is a good example for a sustainable model of development, which has the potential to regain the glory of P*okkali* fields. Integration of aquaculture with rice farming is the safest strategy for sustaining rice production, increasing profit, and maintaining ecological balance of the region. This system is completely organic and environment friendly as no external elements were used for cultivation. In addition, integrated farming is found to enhance the nutrient status of the soil. It is a smart practice to enhance resilience of aquaculture communities to climate change and also improved the efficiency of land use. The experiment also showed that, mulching with polythene sheet was having a significant effect on crop growth and yield of vegetables. Hence for vegetable cultivation on *Pokkali* bunds mulch and drip fertigation attained a great scope. Thus it can be clearly pointed out that the integration of rice-vegetable-fish -duck in the *Pokkali* ecosystem can enhance the soil fertility, environmental sustainability, economic stability and overall, ensure the nutritional security of farmers of the coastal *Pokkali* ecosystem.

B) Rice- prawn-horticulture integration at Kumbalangi, Ernakulam

The experiment was conducted in *Pokkali* land at farmer's field, Kumbalangi, Ernakulam.

a) Prawn cultivation

Rice field was prepared for prawn cultivation in January 2021. Tiger prawn seedlings was released during February 2021.The prawns were harvested during first week of May. The prawn yield was 325 kg ha^{-1}. Soil samples were collected in the month of December (before cultivation of prawn) and in the month of May (after the harvest of the prawn). The samples were analyzed for chemical parameters *viz.,* pH, EC, organic carbon, available P, K, Ca, Mg, S, Fe, Mn, Zn and Cu and B to evaluate continuous changes in soil properties which needs to be thoroughly studied (Table 7.11). Soil pH was neutral before and after the prawn release. Electrical conductivity of the soil was below 4 dS m^{-1} before release of prawn and after prawn harvest. This specifies the importance of low and high saline phases in *Pokkali*cultivation. The organic carbon content remained unchanged before and after the prawn cultivation. The electrical conductivity increased during prawn cultivation due to salt water intrusion after the cessation of monsoon.

The analysis data revealed that the nutrients like available P and K were high in the soils. The level of available potassium was found to increase by the time of harvest. Amount of available Ca increased after the harvest of prawn. Available Fe content was very high throughout the study period compared with other micro nutrients. Available Cu recorded low levels in the soil during the study.

Table 7.11. Chemical properties of soil samples from Kumbalangi field before after prawn release

Particulars	pH	EC	OC	P	K	Ca	Mg	S	Fe	Mn	Cu	Zn	B
		$dS\ m^{-1}$	%	$kg\ ha^{-1}$		$mg\ kg^{-1}$							
Before release	6.75	1.80	2.0	87.6	780	847	45.6	427	636	1.65	Bdl	2.73	0.96
After prawn harvest	6.71	2.40	2.1	67.9	826	3401	1422	524	465	2.33	0.98	1.77	0.40

b) **Rice cultivation**

The field was prepared for rice cultivation by draining out water from the field and was tilled and levelled. Due to the severe labour shortage and increase in the wages in this pandemic period, preparation of mat nursery and transplanting using transplanter was reported for the first time in *pokkali* fields in order to overcome the labour shortage.

Mat type nursery for rice

The mat type nursery system of raising rice seedlings and transplanting those seedlings into field by a transplanter (mechanical) was advised for *Pokkali* areas where the major constraints of production are non-availability of labourers and high labour cost. The mat nursery uses less land, can be installed closer to the house than traditional field nurseries, and uses less labour for both transporting seedling mats and replanting. As a result, root damage is minimal while separating seedlings. The mat nursery for rice seedlings was prepared and seeds were sown in the first week of June, 2021. For that, a mixture of 70–80% soil + 15–20% well-decomposed organic manure was spread on seed tray almost to the top of the frame. The seeds were soaked for 24 hrs for pre-germination and those seeds were sown uniformly (approx. 1 seed/cm^2) in the trays. Proper care was taken so that the seedling mats are always wet. After 15 days of sowing, the seedlings were ready for the transplantation. A few hours before the water was drained for mat nursery uprooting.

Land preparation for rice cultivation

Rice transplanting using mechanical transplanter

The seedlings raised in mat nursery were ready for transplanting into field by last week of June, 2021. Transplanting using trans-planter was done with the assistance of agricultural engineering wing of State Agrl. Department. Walking type rice trans-planter (manually driven), which can transplant four lines in one pass was used for transplanting operation. Before transplanting; the fields are well-puddled and well-leveled. The subsurface soil layers need to be hard enough to support the trans-planter. Soil should not be so dry that it sticks and interferes with planting parts or wheels of the trans-planter. Seedling mats from nursery were loaded into the machine and transplanted at the selected machine setting.

Seedlings transplanted using trans-planter

Harvesting was started after 110 days of sowing, on 26.10.2021 and was done manually. Only the panicles were harvested and were brought to the bund using a small boat by farmer. The straw was left in the field itself for decomposition. This adds nutrients to soil for upcoming farming practices. The harvested yield was 2.10 tons per hectare for the year 2021. The soil samples were analyzed before and after the rice cultivation to evaluate the changes in soil properties. The data was given in Table 7.12. The pH of the soil before rice cultivation was neutral and remained unchanged after the rice harvest. This might be due to neutralization of potential acidity by liming. Liming is the most common practice used to overcome the impacts of soil acidification. Similarly EC values were very high during the initial phase and later got reduced. While observing the organic carbon content of the soil, it is evident that OC per cent remained high throughout the period of rice cultivation but got slightly reduced after the cultivation of rice. Higher level of organic carbon may be due to the dead remains of prawn. Tidal action significantly increased nutrient content in the soil. Availability of P and K content in the soil was normally high during the experimentation. Among the secondary nutrients, available Ca recorded adequate content before and after rice cultivation. The available Mg content was higher during study period and found slightly reduced after the harvest of the crop. On contrast, S content was high during first season and found to be adequate during the second cropping season. Thereafter available S content in the soil was extremely high. On analyzing the micronutrient content of the soil, available Fe content was found to be high. The copper content was deficient before and after rice cultivation which showed inadequate copper availability.

Table 7.12. Changes in soil properties of Kumbalangi before and after rice cultivation

Soil Properties	Unit	Initial	Final
pH		6.71	6.93
EC	dS m^{-1}	2.40	1.91
OC	%	2.06	1.69
Available P	kg ha^{-1}	67.89	59.32
Available Na		1577.23	2015.33
Available K		825.84	935.14
Available Ca	mg kg^{-1}	3401.00	2963.025
Available Mg		1422.50	854.74
Available S		524.00	658.21
Available B		3.40	2.57
Available Fe		465.20	397.65
Available Zn		1.77	1.05
Available Cu		0.98	0.44
Available Mn		2.33	1.54

c) Integration with other crops-Coconut plantations and sesame cultivation on bunds

Rice based farming system involving rice, other field and horticultural crops, generates more income to the farmer and will be more relevant in the risk prone *Pokkali* areas. The field bunds were planted with T x D coconut plantation. A total of 65 coconut trees were planted along the field bunds in an area of 0.5 acres of land. Approximately about 1050 number of coconuts was collected as part of this IFS system. This creates an additional income to the farmer. Sesame cultivation was also done in the field bunds during August- December to maximize the land utilization and to earn extra income. For this, the soil was ploughed for breaking the clods and to make the soil fine tilth. Seed rate was 4-5 kg per ha. The seeds were broadcasted uniformly (mixed with sand 2-3 times its volume) and covered with soil. After 100-110 days harvest was done, when the capsules turned yellowish by pulling out the plants. The seeds were cleaned and dried in the sun for about 7 days before storing. About 15 kg sesame seed was harvested.

Benefit-Cost Ratio of Integrated Farming System

The main objective of the study was to estimate the total cost and return realizable from the integrated cultivation system. The details of information are depicted in Table 7.13, 7.14 and 7.15. Economic analysis confirms the increase in net returns and benefit: cost ratio of *Pokkali* fields by integrated farming system.

Table 7.13 Costs and returns of prawn cultivation per hectare

Sl no	Components	Cost (Rs)
1	Field preparation and sluice maintenance	13000.00
2	Prawn seedlings	15000.00
3	Transportation charge	8000.00
4	Feed	20000.00
5	Harvest (labour charge, pumpset)	19000.00
	Total cost	75,000.00/-
	Returns (325 kg @ Rs. 525 per kg)	1,70,625.00/-
	BC Ratio	2.27

Table 7.14 Costs and returns of coconut- sesame cultivation

Sl no	**Components**	**Cost (Rs)**
1	Land preparation	5000.00
2.	Seeds	1000.00
	Total	**6000.00/-**
Returns		
1	Coconut (1050 nos. @ Rs. 20 per coconut)	21,000.00
2	Sesame (15 kg @ Rs. 180 per kg)	2700.00
	Total	**23,700.00/-**
	BC Ratio	**3.95**

Table 7.15 Costs and returns of rice cultivation per hectare

Sl no	Components	Quantity/ No. of labourers	Rate (Rs.)	Cost (Rs)
1	Seed	100 kg	65	6500.00
2	Land preparation, ploughing and tillering	15 labourers Tiller rent (2days)	1000 1000	15,000.00 2000.00
3	Weeding	5 labourers	1000	5000.00
4	Transplanting using transplanter	10 labourers Trans-planter rent (2 days)	1000 4000	10,000.00 8000.00
5	Harvesting	6 labourers	1000	6000.00
6	Threshing and drying	4 labourers	500	2000.00
7	Transportation charges			5000.00
	Total cost incurred			59,500.00/-
	Returns	2.10 tonnes	65/kg	1,36,500.00/-
	BC Ratio			2.29

Table 7.16. BC ratio of integrated farming system

Gross expenditure (Rs)	1,40,500.00/-
Gross Returns (Rs)	3,30,825.00/-
BC ratio	2.35

Conclusion

Research conducted in *Pokkali* lands is presented here in order to understand the role of IFS in enhancing production, income and livelihood; minimizing risk associated with farming utilizing and conserving the resources; and in enhancing mitigation and adaptation to climate change. It has been concluded that IFS involving integration of different enterprises (crop, livestock, horticulture, poultry and fish) enhanced productivity, profitability, resource use efficiency, generated more employment and minimized resources degradation and risks. IFS, therefore, could be a key form of farming intensification needed for achieving future food security and environmental sustainability in *Pokkali* regions.

8. Alternate Land Use

- **Survey of existing plantations and characterization in coastal area (Bapatla)**

A study about existing major plantations in coastal areas is being conducted in coastal districts of Guntur and Prakasam district. The major plantations found in coastal area are cashew, casuarina, eucalyptus, subabul and mango. Some plantations of citrus, amla, guava and ber were also observed. Prosopis was observed in abandoned lands. The soil samples were collected from locations of plantations and were analyzed for $pH_{(1:2)}$ and $EC_{(1:2)}$. The pH varied from 5.3 to 8.4. The soil salinity ranged from 0.1 – 8.0 dSm^{-1}. The highest pH of 8.4 and 8.2 was noticed in mango, citrus and Eucalyptus plantation fields. However, the growth of Eucalyptus was severely affected at soil salinity of 4.1 dSm^{-1}. In barren land the soil salinity is found to be 8.0 dSm^{-1}. In all other plantations surveyed, the soil salinity is recorded below 1.0 dSm^{-1} (Table 8.1).

Table 8.1: Analysis of soil samples collected from Plantation crops

S.No.	Name of the plantation	pH	EC (dSm^{-1})(1:2)
1.	Eucalyptus	5.3	0.10
2.	Casuarina	7.1	0.10
3.	Pogada	6.2	0.10
4.	Cashew	6.3	0.10
5.	Mango, Citrus and ber	8.4	0.20
6.	Mango	5.9	0.10
7.	Eucalyptus	8.2	0.30
8.	Eucalyptus	7.6	4.10
9.	Barraned land	7.7	8.00
10.	Citrus	7.8	0.10
11.	Papaya	7.4	0.10
12.	Eucalyptus	5.3	0.10

- **Development of horticulture based agri-horti system under saline water condition (Bikaner)**

This experiment was started during *Kharif* 2018 to develop horticulture based agri-horti system under saline water condition. The treatments comprised of three levels of irrigation water salinity (EC_{iw}) such as 0.25 and 2. 4 and 6 dS/m with cluster bean intercrop between alleys of bael trees during *Kharif* and four intercrops namely mustard, taramira, oat and barley, between alleys of bael trees during *rabi*. Data of Kharif, 2020 season indicated that seed and straw yields of cluster bean decreased significantly with increase of water salinity (Table 8.2). It was also observed that significant reduction in seed yield with the tune of 16.52 and 53.91 per cent, respectively, was observed with EC_{iw} of 2.40 and 6 dS/m over Best Available Water (BAW) of 0.25 dS/m. In terms of straw yield similar trends were observed.

Table 8.2 Effect of irrigation water salinity on yield of cluster bean crop

Treatments	Seed yield (q/ha)		Straw yield (q/ha)	
	2019	2020	2019	2020
BAW (EC_{iw} as 0.25 dS/m)	5.71	5.75	22.37	24.10
Tube-well water (EC_{iw} as 2.40 dS/m)	4.48	4.80	16.13	18.50
Saline irrigation water (EC_{iw} as 6.00 dS/m)	2.55	2.65	8.15	8.70
SEm±	0.28	0.21	0.90	0.40
CD(P= 0.05)	0.88	0.64	2.80	1.40

Further, data of *rabi*, 2020-21 indicated that seed and straw yields of mustard, taramira, oat and barley decreased with increase of EC_{iw} but the difference in yield was statistically at par with BAW except in case of oat. As compared to BAW (0.25 dS/m), EC_{iw} of 2.4 dS/m and 6.0 dS/m showed significant yield reduction of 14.46 and 9.51 per cent, respectively. In terms of straw yield similar trends was also observed (Table 8.3).

Table 8.3 Effect of irrigation water salinity on yields of crops under agri-horti system

Treatments	Seed yield q/ha)			Straw yield (q/ha)		
	2018-19	2019-20	2020-21	2018-19	2019-20	2020-21
Mustard						
BAW (EC_{iw} 0.25 dS/m)	17.58	25.38	15.31	52.49	58.70	46.24
Tube-well water (EC_{iw} 2.4 dS/m)	17.25	24.26	14.51	51.43	57.99	44.26
Saline irrigation water (EC_{iw} 6.0 dS/m)	16.58	23.58	12.25	51.19	55.40	37.48
SEm±	0.34	0.59	0.70	0.40	1.48	2.15
CD(P= 0.05)	NS	NS	NS	NS	NS	NS
Taramira						
BAW (EC_{iw} 0.25 dS/m)	12.68	16.35	12.34	75.15	54.03	49.59
Tube-well water (EC_{iw} 2.4 dS/m)	12.43	15.76	11.19	74.98	53.17	49.22
Saline irrigation water (EC_{iw} 6.0 dS/m)	11.95	14.80	10.74	73.25	49.16	46.74
SEm±	0.32	0.77	0.51	0.55	1.46	2.16
CD(P= 0.05)	NS	NS	NS	NS	NS	NS
Oat						
BAW (EC_{iw} 0.25 dS/m)	21.06	21.98	21.92	47.85	52.08	50.86
Tube-well water(EC_{iw} 2.4 dS/m)	20.68	21.56	20.72	47.07	50.70	50.14
Saline irrigation water (EC_{iw} 6.0 dS/m)	19.44	20.55	18.75	46.34	49.20	46.12
SEm±	0.37	0.31	0.42	0.28	0.58	1.00
CD(P= 0.05)	1.27	1.06	1.44	0.97	2.01	3.42
Barley						
BAW (EC_{iw} 0.25 dS/m)	37.46	48.76	52.12	51.20	66.75	78.70
Tube-well water (EC_{iw} 2.4 dS/m)	36.80	47.70	49.22	51.02	66.50	76.78
Saline irrigation water (EC_{iw} 6.0 dS/m)	36.01	45.84	48.85	50.11	64.50	75.72
SEm±	0.81	0.92	0.95	0.37	1.15	1.46
CD(P= 0.05)	NS	NS	NS	NS	NS	NS

Field view of horticulture based agri-horti system

9. Screening for Sodicity and Salinity Tolerance

- **Screening of mustard cultivars under saline irrigation (Agra)**

The experiment was conducted in micro-plots of 4.5 m x 5.0 m size for AVT each plot. The irrigation water was prepared synthetically for water salinity.

Details of experimentation
Treatments:

Water salinity	:EC_{iw} 10 dS/m for all cultivars
Cultivars	: AVT CSCN 20-01 to CSCN 20-06
Design	: Randomized Block Design (RBD)
Replication	: Four
Plot size	: 4.5 x 5.0 m
Crop	: Rape seed mustard
Date of sowing	: 29.10.2020
Doses of fertilizer (kg/ha)	: N: P: K (120:60:60)
Number of irrigations	: 3 (Pre-sowing, flowering stage and siliqua stage)
Depth of irrigation	: 7 cm
Total rainfall during crop period	: 0.9 mm
Date of harvesting	: 05.03.2021

Yield attributing characteristics and seed yield: The yield attributing characteristics of mustard genotype (AVT) i.e. germination, days of 50% flowering, plant height, No. of primary branches and No. of secondary branches were recorded at harvest of crop (Table 9.1). The all yield attributing characters were found significant effect in genotypes. The yield data of different mustard genotype is presented in (Table 9.2). The yield of genotype (AVT) was significantly affected in saline water irrigation.

Table 9.1 Effect of saline water irrigation on yield and yield attributing characters of mustard (AVT) genotype 2020-21

Genotype	Germination (%)	Days to 50% Flowering	Plant height (cm)	No. of primary Branches	No. of Secondary Branches	Grain yield (kg/ha)
CSCN 20-1	79.75	63.50	196.90	6.63	12.63	1723.76
CSCN 20-2	79.25	63.00	195.75	7.75	13.25	1792.87
CSCN 20-3	84.25	61.75	210.50	7.75	16.38	2439.53
CSCN 20-4	80.75	63.25	191.00	6.50	11.38	1760.42
CSCN 20-5	80.25	65.50	186.38	6.88	12.38	1912.54
CSCN 20-6	83.50	63.50	205.38	7.50	15.75	2143.43
CD (P=0.05)	3.37	1.53	14.90	1.48	2.66	347.29
C.V. (%)	2.84	1.65	5.16	14.10	13.36	11.74

Plot size: 3.0m x 1.35m

The statistically significantly higher yield was produced in genotype CSCN 20-03 (2439.53 kg/ha) and lowest was recorded in genotype CSCN 20-01 (1723.76 kg/ha). The soil salinity build up at sowing and at harvest of crop is presented in Table 9.2. The salinity was higher in upper layers at sowing as well as at harvest time.

Table 9.2 Soil salinity buildup at sowing and at harvest of mustard (2020-21)

Treatments	Soil depth(cm)	At sowing		At harvest	
		pH	ECe (dS/m)	pH	ECe (dS/m)
ECiw-12dS/m	0-15	7.8	4.6	7.7	10.42
	15-30	7.8	4.1	7.8	9.23
	30-60	7.9	3.7	8.2	5.34
	60-90	8.0	3.1	8.3	5.29

Photo graphs of Mustard screening trial

- **Screening of Mungbean entries under alkali irrigation water (Agra)**

The experiment was conducted in micro-plots of 1.5 m x 4.0 m size for each plot. The irrigation water was prepared synthetically for water alkalinity and salinity.

Details of experimentation

Parameter	**Details**	**Parameter**	**Details**
Water alkalinity	RSCiw 4 meq/l (alkali water) for all Genotypes	Date of sowing	27.03.2021
Entries	CSRM-21-01 to CSRM-21-16	Doses of fertilizer (kg/ha)	N:P:K (20:40:20)
Net plot size	6 rows of 4 m length	Number of irrigations	3
Design	Randomized Block Design (RBD)	Depth of irrigation	6 cm
Replication	3	Total rainfall	118.2 mm
Crop	Mungbean	Date of harvesting	17.06.2021

Yield attributing characteristics and grain yield: In case of alkali water, details of yield attributing characteristics of Mungbean entries such as plant height, No. of branches/plant, No. of pods/plant, Pod length, No. of grain pod, grain yield/plant and grain yield/plot were recorded at harvest of crop (Table 9.3). All the yield attributing characters were found statistically significant. In Alkali water, the grain yield of Mungbean was found significant in different genotypes. The maximum grain yield was recorded in Entry CSRM-21-05 with yield of 659.5 kg/ha and lowest yield (321.4 kg/ha) recorded with CSRM-21-02 entry.

Table 9.3: Yield and yield attributing characters of Mungbean Screening trial in alkali water (2021)

Name of Entry	Plant height (cm)	No. of branches	No. of pods/ plant	Pod length (cm)	No. of grains/ pod	Grain yield/plant (gm)	Grain yield plot (gm)	Grain yield (kg/ha)
CSRM-21-01	32.0	4.3	14.7	5.9	5.8	3.74	197.7	329.6
CSRM-21-02	30.0	4.0	15.7	6.1	6.8	3.50	192.8	321.4
CSRM-21-03	33.0	5.7	13.7	5.5	6.3	7.96	263.0	438.3
CSRM-21-04	35.0	6.3	27.7	7.1	10.0	7.97	346.3	577.2
CSRM-21-05	39.0	6.7	27.3	7.1	7.9	7.05	395.7	659.5
CSRM-21-06	40.0	6.7	21.7	6.7	8.3	7.42	348.7	581.3
CSRM-21-07	32.3	5.0	17.7	6.9	7.4	6.31	239.6	399.4
CSRM-21-08	33.7	4.3	21.0	7.1	6.3	4.60	333.3	555.4
CSRM-21-09	37.0	5.7	21.0	6.2	7.5	5.71	312.4	520.6
CSRM-21-10	39.0	5.7	23.7	7.2	7.3	5.20	325.9	543.2
CSRM-21-11	37.3	5.7	18.0	7.0	7.1	4.45	294.6	491.0
CSRM-21-12	37.7	4.0	22.7	6.8	5.8	4.24	293.6	489.3
CSRM-21-13	36.7	4.3	21.7	5.9	6.1	5.26	298.1	496.8
CSRM-21-14	36.7	4.3	17.0	6.3	6.3	5.20	281.2	468.6
CSRM-21-15	36.0	4.7	15.7	5.7	6.2	4.23	273.5	455.8
CSRM-21-16	31.0	4.0	17.0	5.9	7.6	4.67	298.9	498.1
SEm+	2.72	0.89	3.85	0.54	1.05	0.94	48.72	81.21
CD at 5%	5.48	1.79	7.78	1.09	2.12	1.90	98.33	163.89
CV (%)	4.70	10.69	11.94	5.11	9.13	10.80	6.77	10.17

Soil studies: At the Mungbean sowing time the ECe and ESP recorded 3.3 (dS/m) and 13.2 in surface layer (0-15 cm), respectively. At the time of harvest both ECe and ESP increased to 4.4 (dS/m) and 15.7 (Table 9.4).

Table 9.4 Soil status at sowing and at harvest of Mungbean in case of alkali water(2021)

Treatments	Soil depth (cm)	At sowing			At harvest		
		pH	ECe (dS/m)	ESP	pH	ECe (dS/m)	ESP
RSCiw 4 (meq/l)	0-15	7.9	3.3	13.2	8.0	4.4	15.7
	15-30	7.8	3.0	13.7	7.8	4.2	15.9
	30-60	7.9	2.8	10.9	8.2	3.8	13.5
	60-90	8.0	2.6	10.9	8.3	3.0	13.7

Photograph of Mungbean in Alkali water

- **Screening of Mungbean Entries under saline irrigation water (Agra)**

Details of experimentation

Parameter	Details	Parameter	Details
Water salinity	EC_{iw} 5 dS/m for all Genotypes	Date of sowing	17.4.2021
Entries	CSRM-21-01 to CSRM-21-16	Doses of fertilizer (kg/ha)	N:P:K (20:40:20)
Net plot size	6 rows of 4 m length	Number of irrigations	3
Design	Randomized Block Design (RBD)	Depth of irrigation	6 cm
Replication	Three	Total rainfall	118.2 mm
Crop	Mungbean	Date of harvesting	01.07.2021

Yield attributing characteristics and grain yield: In case of saline water irrigation, the yield attributing characteristics of Mungbean entries such as Plant height, No. of branches/plant No. of pods/plant, Pod length, No. of grain pod, grain yield/plant and grain yield/plot were recorded at harvest of crop (Table 9.5). All the yield attributing characters were found statistically significant. In Saline water, the grain yield of Mungbean was found significant in different genotypes. The maximum grain yield was recorded in entry CSRM-21-05 with yield of 611.28 kg/ha and lowest yield (256.67 kg/ha) recorded with CSRM-21-13 entry.

Table 9.5 Yield and yield attributing characters of Mungbean Screening trial in Saline water

Name of Entry	Plant height (cm)	No. of branches	No. of pods/ plant	Pod length (cm)	No. of grains/ pod	Grain yield/plant (gm)	Grain yield plot (gm)	Grain yield (kg/ha)
CSRM-21-01	31.3	4.0	10.3	4.87	5.47	3.56	184.89	308.16
CSRM-21-02	34.0	4.7	10.3	6.93	6.80	5.83	189.16	315.27
CSRM-21-03	31.3	4.7	16.3	5.13	4.93	3.53	200.86	334.77
CSRM-21-04	29.3	5.7	18.3	6.93	8.27	6.04	326.04	543.42
CSRM-21-05	42.3	5.3	17.7	8.13	8.60	8.10	366.76	611.28
CSRM-21-06	41.3	6.7	20.7	7.33	6.33	6.44	321.77	536.29
CSRM-21-07	32.0	4.3	15.3	6.67	6.13	4.86	210.86	351.43
CSRM-21-08	38.3	4.7	10.7	7.53	6.80	5.75	321.08	535.15
CSRM-21-09	39.0	5.7	18.0	7.00	6.33	6.52	203.19	338.65
CSRM-21-10	39.7	4.3	15.7	7.01	6.33	6.95	287.61	479.36
CSRM-21-11	39.7	5.0	12.0	7.33	6.20	5.21	257.21	428.69
CSRM-21-12	34.7	5.3	11.7	6.33	5.93	5.92	313.92	523.22
CSRM-21-13	32.3	5.0	14.7	6.53	6.20	6.00	154.00	256.67
CSRM-21-14	32.0	5.0	14.7	6.40	6.40	3.65	316.98	528.31
CSRM-21-15	25.7	3.0	11.7	5.93	6.13	4.65	268.65	447.76
CSRM-21-16	28.3	4.0	11.7	5.00	5.60	5.08	296.42	494.04
SEm+	4.79	0.77	3.28	0.80	0.85	1.20	44.87	74.78
CD at 5%	9.66	1.55	6.62	1.61	1.72	2.42	90.54	150.91
CV (%)	8.51	9.72	13.89	7.46	8.15	13.34	6.94	10.42

Soil studies: At the time of sowing ECe and SARe were recorded 3.6 (dS/m) and 10.4 $(mmol/l)^{1/2}$ in surface layer (0-15 cm), respectively. And at the time of harvest of Mungbean crop the ECe and SARe it increased to 5.8 (dS/m) and 12.4 $(mmol/l)^{1/2}$ in surface layer (Table 9.6).

Table 9.6 Soil salinity buildup at sowing and at harvest of Mungbean (2021)

Treatments	Soil depth (cm)	At sowing			At harvest		
		pH	ECe (dS/m)	SARe (mmol/l)$^{1/2}$	pH	ECe (dS/m)	SARe (mmol/l)$^{1/2}$
ECiw-5dS/m	0-15	7.8	3.6	10.4	7.9	5.8	12.4
	15-30	7.8	3.4	10.1	7.8	4.7	11.7
	30-60	7.8	3.0	10.0	8.1	4.2	10.5
	60-90	8.0	2.9	9.9	8.1	3.1	10.0

Photograph of Mungbean in saline water

- **Screening of summer mung bean genotypes under saline conditions (Bikaner)**

Mung bean genotypes (sixteen entries) were evaluated in randomized block design with three replications under saline water condition (EC_{iw} 5.0 dS/m). The difference among the genotypes for biological yield was found significant. Entry CSRM-21-14 was observed top yielder for biological yield (4.0 q/ha) closely followed by CSRM-21-15 and CSRM-21-04. It was significantly superior over rest of the entries (Table 9.7).

Table 9.7 Screening of summer mung bean genotypes under saline water condition

Treatments	**Plant height (cm)**	**Number of branches/ plant**	**Number of pods/ plant**	**Biological yield (q/ha)**
CSRM-21-01	20.13	4.33	2.73	1.89
CSRM-21-02	16.07	3.20	0.67	1.14
CSRM-21-03	19.73	4.60	2.47	2.33
CSRM-21-04	21.47	5.00	2.80	3.03
CSRM-21-05	21.60	3.93	3.80	1.89
CSRM-21-06	23.33	4.73	3.33	2.78
CSRM-21-07	21.00	4.13	2.20	2.11
CSRM-21-08	20.00	4.20	2.40	1.83
CSRM-21-09	18.27	4.40	3.13	1.42
CSRM-21-10	22.20	4.80	3.67	2.97
CSRM-21-11	22.27	4.60	2.67	2.78
CSRM-21-12	22.40	4.80	2.67	2.81
CSRM-21-13	23.67	4.07	3.67	2.33
CSRM-21-14	25.07	4.87	4.93	4.00
CSRM-21-15	23.67	4.80	4.00	3.72
CSRM-21-16	20.53	4.40	3.33	2.17
SEm±	0.88	0.28	0.20	0.17
CD (P=0.05)	2.53	0.81	0.58	0.50

Note: Delayed sowing due to late availability of seed material and very harsh climatic conditions prevailed during the months of April and May at Bikaner resulted in almost nil pod formation and seed setting. Hence seed and straw yield were not separated.

Field view of summer mungbean trial

- **Screening of elite varieties of crops irrigated with poor quality waters (Hisar)**

The screening of different crop varieties under saline water irrigation was undertaken by Hisar Centre. The main crops were cotton, wheat, pearl millet and mustard. Treatments such as T_1: Canal water; T_2: Saline water of EC_{iw} 2.5 dS/m; T_3: Saline water of EC_{iw} 5.0 dS/m and T_4: Saline water of EC_{iw} 7.5 dS/m were adopted for screening purpose. The following crop genotypes were tested.

(a) Cotton Genotypes: 7
H 1480, H 1520, H 1527, H 1530, H 1566, H 1569 and H 1601
(b) Wheat Genotypes: 14
WH 1292, WH 1293, WH 1294, WH 1295, WH 1296, WH 1297, WH 1298, WH 1299, WH 1402, WH 1403, WH 1404, WH 1405, WH 1406 and WH 1407
(c) Pearl millet Genotypes: 7
94555A X ISK51, 0499A X EBL-12-237, 48A XEMRI-15-109, 47A X HPT-2-12-32, 47A X H78/711, 53A X SGP-10-107 and 41A X HB15/085
(d) Mustard Genotypes: 8
AVT-I: CSCN-01, CSCN-02, CSCN-03, CSCN-04, CSCN-05 and CSCN-06

Technique for screening

The tolerance of cotton, wheat, pearl millet and mustard genotypes under saline water irrigation treatments was evaluated in lined micro-plots of 2 m x 2 m in size. The plots were constructed above ground and filled with the sandy loam surface soil (0-15 cm). The soil was allowed to stabilize before sowing the crop. The tolerance of seven genotypes of cotton (H 1480, H 1520, H 127, H 1530, H 1566, H 1569 and H 1601), fourteen genotypes of wheat (WH 1292, WH 1293, WH 1294, WH 1295, WH 1296, WH 1297, WH 1298, WH 1299, WH 1402, WH 1403, WH 1404, WH 1405, WH 1406 and WH 1407), seven genotype of pearl millet (94555A X ISK51, 0499A X EBL-12-237, 48A XEMRI-15-109, 47A X HPT-2-12-32, 47A X H78/711, 53A X SGP-10-107 and 41A X HB15/085) and six genotypes of mustard (CSCN-01, CSCN-02, CSCN-03, CSCN-04, CSCN-05 and CSCN-06) were tested under different saline water irrigation treatments i.e. canal water, EC_{iw} 2.5, 5.0 and 7.5 dS/m.

Recommended cultural practices and fertilizer doses were applied in raising the crops. Uniform fertilizer applications were made in all the treatments using urea, DAP and $ZnSO_4$. Irrigation schedule was based on the recommendations for the non-saline irrigated soils. The soil samples were collected before sowing and after the harvesting of the crops. The soil samples were air dried, ground to pass through a 2 mm sieve and analyzed for electrical conductivity.

Results achieved:

Cotton: Increasing salinity led to a gradual decrease in seed cotton yield (Table 9.8). Among the seven genotypes, H 1520 gave the highest (199.44 g/m^2) seed cotton yield and H 1601 resulted in the lowest seed cotton yield (160.30 g/m^2) at EC_{iw} 7.5 dS/m. The mean seed cotton yield reduced by 23.88 % at EC_{iw} 7.5 dS/m as compared to canal irrigation. Overall mean yield (226.57 g/m^2) of H 1520 was higher than other genotypes followed by H 1566 (222.38 g/m^2) and H 1601 was the lowest yielder (186.03 g/m^2).

Table 9.8 Effect of saline waters on seed cotton yield (g/m^2) of cotton genotypes

Genotype	ECiw (dS/m)				Mean
	Canal	2.5	5.0	7.5	
H 1480	240.65	232.19	206.28	182.36	215.37
H 1520	251.84	241.41	218.60	199.44	226.57
H 1527	225.80	217.61	192.46	171.33	201.80
H 1530	236.55	226.31	200.21	176.47	209.89
H 1566	248.55	238.88	213.42	188.67	222.38
H 1569	219.92	210.54	186.52	167.87	196.21
H 1601	207.55	199.60	176.68	160.30	186.03
Mean	232.98	223.79	199.17	177.35	
CD (p=0.05)	Variety (V) =13.71, Salinity (S) = 10.41 V x S = NS				

Wheat: The data showed that the grain yield of different genotypes of wheat decreased with an increase in EC_{iw} (Table 9.9).Wheat genotype WH 1407 (430.25 g/$m^{2)}$ performed the best at EC_{iw} 7.5 dS/m. It was followed by WH 1404 (421.26 g/m^2) whereas the performance of WH 1403 (284.66 g/m^2) was the least. On the basis of overall mean, WH 1407 gave maximum grain yield (509.33 g/m^2) followed by WH 1404 (498.40 g/m^2). The overall mean yield reduction at 2.5, 5.0 and 7.5 dS/m was 1.9, 14.1 and 26.4%, respectively, as compared to canal.

Pearl millet: Among the pearl millet genotype, 53A X SGP-10-107(189.67 g/m^2) performed best at ECiw (7.5 dS/m) followed by 48A X EMR-15-109(179.83 g/m^2) whereas the performance of 41A X HB15/085 (155.37g/m^2) was the poorest. The mean grain yield (220.28 g/m^2) of 53A X SGP-10-107 was higher than other genotypes followed by 48A X EMR-15-109 (214.04 g/m^2). The overall mean reduction in pearl millet yield at 2.5, 5.0 and 7.5 dS/m was 3.78, 13.14 and 23.81%, respectively as compared to canal (Table 9.10).

Mustard: Six genotypes under AVT-1 mustard were tested. The data showed that the seed yield of different genotypes of mustard decreased with an increase in EC of the irrigation water (Table 9.11). In AVT-1, the mustard genotype CSCN-03 gave the highest seed yield (244.73g/m^2) followed by CSCN-06 (207.65g/m^2) at ECiw 7.5 dS/m and the lowest seed yield (154.73 g/m^2) was obtained in CSCN-01. The overall mean reduction in AVT-1 yield at 2.5, 5.0 and 7.5 dS/m was 3.68, 12.42 and

24.89%, respectively as compared to canal. All the genotypes under AVT-1 showed decreasing trend with the increasing levels of salinity (canal to 7.5 dS /m).

Mean chlorophyll content (SPAD units) of mustard genotypes under initial variety trial AVT-1 decreased from 45.36 to 36.07 with increasing salinity levels *i.e.* control to 7.5 dS m^{-1}. Maximum chlorophyll content was observed in CSCN-05 (40.63) which is at par with CSCN-03 (38.03) and minimum in CSCN-01 (33.33) at 7.5 dS m^{-1} of salinity (Table 9.12). Salinity susceptibility index (SSI) is used to test the sensitivity of genotypes to salinity stress. The value less <1 was recorded at 7.5 dSm^{-1} of salinity in CSCN-03 (0.84) in the tested mustard genotypes (Fig 9.1). The mean salinity in the soil profile at the time of mustard harvest varied from 1.89 dS/m in canal water irrigated plot to 10.14 dS/m in plots receiving saline water irrigation of ECiw 7.5 dS/m (Table 9.13).

Table 9.9: Grain yield (g/m^2) of wheat genotypes as affected by different saline waters

Genotype	EC_{iw} (dS/m)				Mean
	Canal	2.5	5.0	7.5	
WH1292	430.44	420.96	364.52	302.98	379.72
WH 1293	528.50	519.44	456.43	391.13	473.88
WH 1294	449.48	440.13	382.33	332.11	401.02
WH 1295	439.43	430.31	378.54	314.46	390.68
WH 1296	497.73	488.21	423.37	367.56	444.22
WH 1297	467.00	457.47	403.26	348.51	419.06
WH 1298	506.86	497.49	440.48	376.57	455.35
WH 1299	479.12	469.77	413.26	354.23	429.10
WH 1402	510.07	501.69	436.30	380.54	457.15
WH 1403	408.73	399.37	345.59	284.66	359.59
WH 1404	552.17	543.67	476.50	421.26	498.40
WH 1405	539.09	530.22	459.63	404.19	483.28
WH1406	428.72	420.57	371.23	296.88	379.35
WH 1407	561.98	552.70	492.39	430.25	509.33
Mean	485.67	476.57	417.42	357.52	
CD (p=0.05)	Variety (V) = 19.12 , Salinity (S)= 10.22, V x S = NS				

Table 9.10: Grain yield (g/m^2) of pearl millet genotypes as affected by different saline waters

Genotype	EC_{iw} (dS/m)				Mean
	Canal (0.3)	2.5	5.0	7.5	
94555A X ISK51	228.10	220.80	201.47	173.90	206.07
0499A X EBL-12-237	210.40	201.47	182.97	167.20	190.51
48A X EMR-15-109	237.72	229.80	208.80	179.83	214.04
47A X HPT-2-12-32	221.77	212.47	190.63	165.33	197.55
47A X H78/711	217.21	208.73	184.43	161.27	192.91
53A X SGP-10-107	243.49	234.30	213.67	189.67	220.28
41A X HB15/085	206.67	198.64	177.75	155.37	184.61
Mean	223.62	215.17	194.24	170.37	
CD (p=0.05)	Variety (V) = 12.35, Salinity (S) = 9.33, V x S =NS				

Table 9.11: Seed yield (g/m^2) of mustard genotypes under AVT-1 as affected by waters of different salinities

Genotype	EC_{iw} (dS/m)				Mean
	Canal (0.3)	2.5	5.0	7.5	
CSCN-01	207.65	198.83	175.60	154.73	184.20
CSCN-02	211.31	202.96	181.52	155.63	187.85
CSCN-03	309.81	299.65	276.13	244.73	282.58
CSCN-04	217.43	208.98	190.67	157.48	193.64
CSCN-05	240.67	232.13	211.87	178.89	215.89
CSCN-06	276.51	266.98	245.84	207.65	249.24
Mean	243.90	234.92	213.60	183.18	
CD (p=0.05)	Salinity (S) = 12.52,	Variety (V) = 15.33,	SxV= NS		

Table 9.12: Chlorophyll content (SPAD units) of mustard genotypes under AVT-1 as affected by waters of different salinities

Genotype	EC_{iw} (dS/m)				Mean
	Canal (0.3)	2.5	5.0	7.5	
CSCN-01	39.70	36.17	37.93	33.30	36.78
CSCN-02	44.67	35.20	39.93	34.33	38.53
CSCN-03	48.73	44.00	46.37	38.03	44.28
CSCN-04	43.30	39.53	42.98	35.77	40.40
CSCN-05	47.60	42.37	44.98	40.63	43.90
CSCN-06	48.17	39.20	43.68	34.33	41.35
Mean	45.36	39.41	42.65	36.07	
CD (p=0.05)	Salinity (S) = 2.81,	Variety (V) = 3.44,	SxV= NS		

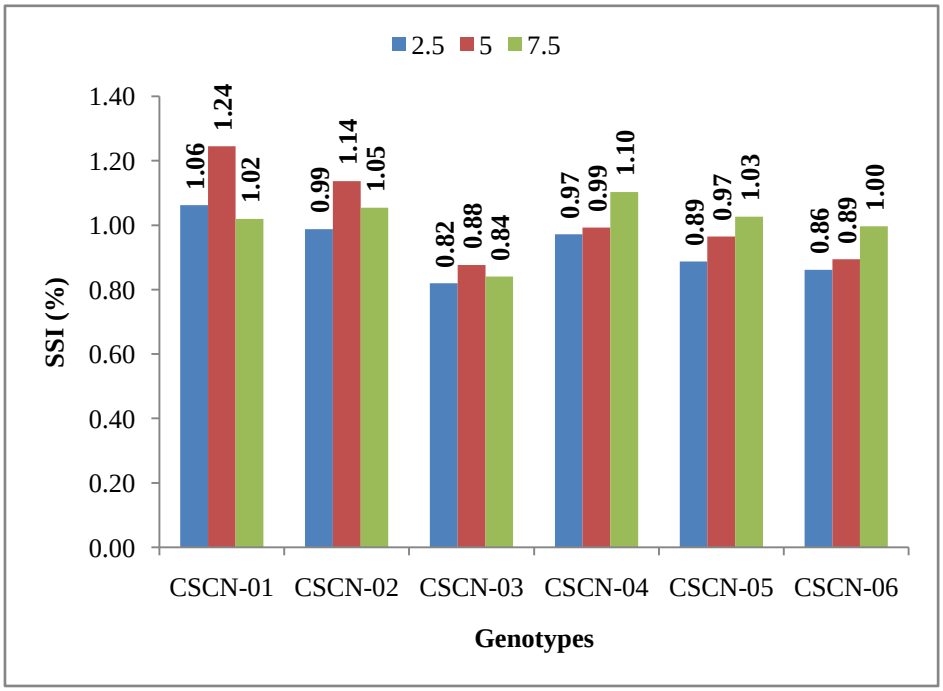


Fig 9.1 Salinity Susceptibility Index (SSI) of mustard genotypes under AVT-1 as affected by waters of different salinities

Table 9.13: Salinity at different soil depths after the mustard harvest

Depth (cm)	EC_e (dS/m)			
	Canal	2.5	5.0	7.5
0-15	1.98	4.43	7.71	10.24
15-30	1.80	4.00	6.96	10.04
Mean	1.89	4.22	7.34	10.14

- **Performance of Brinjal cultivars under different irrigation water quality (Bathinda)**

The experiment was conducted to asses to salt tolerance efficiency of different brinjal cultivars. Ten (10) cultivars were grown under two quality water (canal water and Tube well water) having different chemical compositions (Table 9.14). According to CSSRI classification of water for irrigation, the canal water quality was good (EC iw (dS/m)- <2; SAR iw (m mol/L)- <10; RSC (meq/L) <2.5), however, the tube well water was high SAR- saline water (EC iw (dS/m)- >4; SAR iw (m mol/L)- >10; RSC (meq/L)- <2.5).

Table 9.14 Composition of canal and tube well water used for irrigation (Mean of 8 irrigations)

	Canal water	Tube well water
Particulars	**Mean**	**Mean**
EC (dS m^{-1})	0.32	4.33
Na^{+}(me l^{-1})	0.88	34.92
Ca^{+2}+ Mg^{+2} (me l^{-1})	2.06	7.44
Cl^{-1} (mel^{-1})	0.53	8.46
CO_3^{-2} (mel^{-1})	Nil	Nil
HCO_3^{-} (mel^{-1})	1.63	7.20
K (mg l^{-1})	0.67	7.65
RSC (mel^{-1})	Nil	Nil
SAR	0.86	18.43

The number of fruit/ plant increased by 7% to 117% with use of tube well water compared to canal water. The maximum increased (117%) in fruits/ plant was reported in cultivar KBSR-343-1 followed by PBL-235, PB Neelam and MR-322. The cultivar PBL-215 showed minimum fruits/plant in saline water, whereas, decreased in fruits/plant was reported in cultivar PBR-27. The fruit weight was increased by 20% in cultivar MR-322 followed by 11% in PBL-235 and 4% in KBSR-343-1 with use of canal water. Whereas, the fruit weight was increased by 7% in cultivar BL-2013-4-3-1 followed by 4% in SL-8PB-1-3-1-4 with use of saline water (Table 9.15). The Table 9.15 also showed that all the tested cultivars showed more fruit yield/ plant (except PBR-27) with use of saline tube well water compared to canal water. Maximum increased in fruit yield was reported with cultivar KBSR-343-1 (110%), followed by PBL-235 (96 %) and PBSR-302 (44%).

Table 9.15: Performance of different brinjal cultivars

	No. of Fruits/Plant		Fruit Weight (gm)		Yield (kg/plant)	
	TW	CW	TW	CW	TW	CW
PBL-215	22.73	21.27	40.40	40.27	0.93	0.87
PBL-235	8.87	4.20	48.20	53.87	0.45	0.23
PBSR-302	13.77	9.17	37.73	39.27	0.52	0.36
MR-322	5.57	3.67	109.33	131.53	0.61	0.49
KBSR-343-1	4.27	1.97	281.93	294.53	1.22	0.58
PBR-27	4.50	8.77	78.80	81.60	0.38	0.78
BL-2013-4-3-1	10.00	8.50	101.87	94.40	1.02	0.79
SL-8PB-1-3-1-4	9.93	8.53	56.47	54.00	0.56	0.47
PSB	9.03	6.77	61.13	61.27	0.55	0.42
PB NEELAM	3.40	2.10	275.40	284.73	0.92	0.65

- **Performance of Jattikhatti (*Citrus jambhiri*) rootstocks under salinity conditions (Bathinda)**

Citrus varieties are usually not propagated on their own roots. Usually citrus plants are raised by budding scion varieties on the suitable rootstock. The rootstocks impart certain desirable character i.e. improve fruit quality, higher productivity, adaptability to agro climatic conditions, resistance to disease, pest etc. In Punjab rough lemon (JattiKhati) is the most commonly used rootstock for most of citrus varieties. Its seeds are extracted in August- September.

The citrus species are classified as salt sensitive; however, there is great variation in their capabilities to tolerate salinity. We investigated the suitability of saline water for root stock growth. The Jatti-khatti seed were sown in the month of September. The seeds were sown directly in black polythene bags (Size 7" x 12", 250 gauge) filled with good quality soil. Ground water with different salinity EC < 1.0 dS/m, 1.0-2.0 dS/m, 2.0-3.0 dS/m, 3.0-4.0 dS/m and > 4.0 dS/m) were used for irrigation the seedlings, and 10 bags were maintained for each treatment.

The observations were recorded as follow:

1) Reductions in plant growth are commonly seen under saline conditions and growth is more suppressed as the salinity increased (Table 9.16).
2) The stem diameter, and cell sap was also reduced in saline irrigated seedlings and root stock takes more time for budding as compared to good quality (canal water) irrigated seedlings.

Table 9.16: Plant height and stem diameter under different saline irrigation

Water salinity EC (dS/m)	**Plant height (cm)**		**Stem diameter (mm)**	
	Range	**Mean**	**Range**	**Mean**
< 1.0	64.5-77.5	71.3	9.3-13.2	11.34
1.0-2.0	55.5-81.5	68.7	9.5-12.4	11.24
2.0-3.0	36.5-90.5	65.2	6.6-9.4	8.24
3.0-4.0	45.5-85.1	64.5	4.4-8.3	6.2
> 4.0	40.3-73.5	58.3	4.4-7.2	5.8
average of 10 plants				

Similarly, the Jatti-khatti seed was sown in the month of September in field conditions with good quality (canal water, EC 0.35 dS/m) and saline water (tube well water, EC 4.2 dS/m) under degraded soil conditions (Table 9.17). In the field experiment, the following observations were recorded:-

1. The Jatti- Khatti seeds did not germinate on degraded soil with saline water.
2. Very poor germination was recorded with good quality water in degraded soil. The seedlings did not survive at latter stage with good quality water also.

Table 9.17**:** Soil characteristics of the field soil

pH (1:2)	EC (1:2)	OC (mg/kg)	P_2O_5 (Kg/ha)	K_2O (Kg/ha)	Fe (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Mn (mg/kg)
8.76	0.54	2.31	18.59	436.28	4.68	0.23	0.73	3.97
Normal Soil ($pH_{(1:2)}$ -8.13; $EC_{(1:2)}$ - 0.21)								

10. Operational Research Programme (ORP) and Demonstrations

10.1 Operational Research Programme (ORP) for the use of underground saline water at farmers' fields

In operational Research Project (ORP), the field demonstrations for the use of poor quality water have been initiated from kharif 1993 in Karanpur village of Mathura district. The village is located at Fareh-Achhnera road only 6 km away from Fareh town. In 1999 the program was extended to two other villages i.e. Nagla Hridaya and Bhojpur. At these sites, medium and high SAR saline water was available. In the year 2000 the program was further extended to Savai village of Agra district to demonstrate the technologies on the use of alkali water. In kharif 2004, ORP was also started at Odara village of Bharatpur district in medium and high SAR saline water (ECiw 6.0 to 23.5 dS/m and SAR 11-30 (mmol/l)1/2. In 2006, one other site was also selected for dry land salinity demonstrations at Nagla Parasuram in Bharatpur District. In 2015-16, eleven farmers were selected using saline water (ECiw ranges 7.1 to 13.0 dS/m) of different villages i.e. Deen Dayal Dham (Nagla Chandra Bhan), Dhana Khema, Nagla Jalal, Garhi Pachauri and Dalatpur in district Mathura (U.P.) and Odara in Bharatpur district (Rajasthan). From the year 2017 this program was shifted to three other villages i.e. Signa in Bichpuri block of Agra district and Nagla Jalal & Kurkunda in Fareh block of Mathura district. At these sites medium and high SAR saline water is available. In the year 2020-21, twenty five farmers were selected. The groundwater quality in terms of ECiw, SARiw and RSCiw for selected farmers varied from 3.8 to 13.3 (dS/m), 13.6 to 36.9 $(mmol/l)^{1/2}$ and nil, respectively. The pH was almost normal in all the farmers' tube well water samples. The sodium ranged from 28.9-110.7me/q. The Ca+Mg were present in all the water samples but this value was ranged from (9.1 to 22.3). In all collected water samples, CO_3 did not found but HCO_3 was present in all the samples (Table 10.1).

Table 10.1: Groundwater quality in case of selected farmers

Farmer's name	ECe	pH	Na	Ca+Mg	CO_3	HCO_3	Cl	SO_4	SAR	RSC
1.Mr.Kishan Gopal	6.0	7.5	47.2	12.8	-	10.5	21.7	27.8	18.7	Nil
2. Mr. Vijay Pal Singh	11.5	7.3	96.7	18.3	-	15.8	45.2	54.0	32.0	Nil
3. Mr. Mahesh Singh	5.8	7.2	47.5	10.2	-	9.7	19.6	28.7	21.1	Nil
4. Mr. Deepak Singh	10.2	7.4	90.2	11.9	-	10.2	31.5	60.3	36.9	Nil
5. Mr. Nand Kishor	6.3	7.3	49.6	13.2	-	12.7	20.8	29.5	19.3	Nil
6. Mr. Pratap Singh	7.2	7.4	59.1	12.8	-	11.9	27.5	32.6	23.4	Nil
7. Mr. Babu lal	5.3	7.6	40.3	12.7	-	11.5	20.7	20.8	15.9	Nil
8.Mr.RamVeer Bhagat	13.3	7.3	110.7	22.3	-	18.7	56.5	57.8	33.2	Nil
9. Mr. Bhanwar Singh	6.5	7.6	54.4	10.7	-	9.5	26.6	28.9	23.5	Nil
10. Mr.Tufan Singh	6.4	7.5	52.1	11.9	-	11.9	27.1	25.0	21.4	Nil
11.Mr.Satish Sharma	3.8	7.5	28.9	9.1	-	7.8	10.2	20.0	13.6	Nil
12.Mr.Chandra Pal	5.8	7.6	42.3	15.7	-	10.8	27.5	19.7	15.1	Nil
13.Mr.Nathi Lal	5.3	7.7	38.9	14.1	-	10.4	26.7	15.9	14.4	Nil
14.Mr.Ter Singh	8.3	7.7	61.3	21.7	-	16.8	32.3	35.9	18.5	Nil
15.Mr.Prem Singh	5.8	7.7	45.5	12.5	-	11.2	28.1	18.7	18.2	Nil
16.Mr.Sodhan Singh	6.2	7.8	47.3	14.7	-	12.3	31.2	18.5	17.5	Nil
17.Mr.Satya Veer	4.9	7.6	36.8	12.2	-	11.4	25.6	12.0	14.9	Nil
18.Mr.Subhash	4.5	7.8	31.2	13.8	-	12.1	20.4	12.5	11.9	Nil
19.Mr.Raj veer	6.1	7.7	48.4	12.6	-	11.3	22.2	27.5	19.4	Nil
20.Mr.Giriraj Saran	5.2	7.8	39.8	12.2	-	13.3	24.8	13.9	16.2	Nil
21.Mr.Kali Charan	6.5	7.7	52.2	12.8	-	11.9	28.2	24.9	20.7	Nil
22.Mr Lakho Singh	5.7	7.8	41.9	15.1	-	12.2	28.9	15.9	15.2	Nil
23.Mr. Oli	4.6	7.8	37.2	8.8	-	10.2	19.8	16.0	17.8	Nil
24.Mr.Mohar Singh	4.4	7.7	33.8	10.2	-	10.7	20.6	12.7	15.0	Nil
25.Mr.Netra Pal	5.3	7.8	37.9	15.1	-	10.4	28.3	14.3	13.8	Nil

In *kharif* season the demonstrations were conducted at 20 farmers' fields, 18 farmers in rabi season and seven farmers field in summer season of 2020-21 (Table 10.2). Out of 25 selected farmers, pearl millet crop sown on 7 farmers' fields, sorghum for green fodder on 5 farmers' fields and sesame on 8 farmers' fields. In rabi season, mustard crop was has sown on 10 farmers' fields and wheat on 8 farmers' fields. In rabi one farmer taken the crop of cauliflower, one farmer taken cabbage crop, one farmer sown coriander and two farmer sown Beet root. In summer season one farmer sown tomato, one farmer sown onion crop and six farmers sown summer green gram crop. The N.P.K fertilizer was applied @ 120:60:60 kg/ha and same doses of N.P.K fertilizers were given to wheat crop. The variety CS-58 and CS-60 of mustard and KRL-210 of wheat crop were sown at farmer's field. In mustard crop two irrigations of saline water were given at 25 DAS and flowering stage and in wheat, cauliflower, beet root tomato. Coriander, onion crops 4-5 irrigations were given. 3-4 irrigations were given in growing summer green gram by the ORP farmers as conjunctive use mode.

Table 10.2 Irrigation mode of ORP farmers and other farmers (2020-21)

Farmers name	Crop	ORP farmers	Other farmers
Mustard			
1. Mr. Nand Kishor	Mustard	All saline water	All saline water
2. Mr. Mahesh Singh	Mustard	All saline water	All saline water
3. Mr. Chandra Pal	Mustard	All saline water	All saline water
4. Mr. Subhash	Mustard	All saline water	All saline water
5. Mr. Raj Veer	Mustard	All saline water	All saline water
6. Mr. Giriraj Saran	Mustard	All saline water	All saline water
7. Mr. Babu Lal	Mustard	All saline water	All saline water
8.Mr.Sodhan Singh	Mustard	All saline water	All saline water
9. Mr. Pratap Singh	Mustard	All saline water	All saline water
10Mr. Tufan Singh	Mustard	All saline water	All saline water
Wheat			
1. Mr. Deepak Singh	Wheat	1SW:2CW	All saline water
2. Mr. Prem Singh	Wheat	1SW:2CW	All saline water
3.Mr. Vijay Pal Singh	Wheat	1SW:1GW	All saline water
4. Mr.Ram Ver Bhagat	Wheat	2SW:1CW	All saline water
5. Mr.Sodhan Singh	Wheat	1SW:2GW	All saline water
6.Mr. Nathi Lal	Wheat	2SW:2GW	All saline water
7.Mr.Satish Sharma	Wheat	1SW:1GW	All saline water
8. Mr. Satyya Veer	Wheat	2SW:1GW	All saline water
Beet Root			
Mr. Satya Veer	Beet root	1SW:1GW	Nil
Mr Kishan Gopal	Beet root	2GW:2SW	Nil
Cauliflower			
Mr.Tufan Singh	Cauliflower	1SW:1GW	Nil
Cabbage			
Mr. Kishan Gopal	Cabbage	1GW:1SW	Nil
Tomato			
Mr.Tufan Singh	Tomato	1SW:2GW	Nil
Onion			
Mr.Tufan Singh	Bottle gourd	2SW:1GW	Nil
Coriander			
Mr. Tufan Singh	Coriander	1SW:1GW	Nil
Cluster bean			
Mr. Tufan Singh	Cluster bean	2SW:2GW	Nil

Carrot			
Mr. Tufan Singh	Carrot	1SW:1GW	Nil
Summer Green gram			
Mr.Deepak Singh	Green gram	2GW;1SW	All saline water
Mr. Rabi Singh	Green gram	1SW:1GW	All saline water
Mr. Nand Ram	Green gram	1SW:2GW	All saline water
Mr. Kalicharan	Green gram	2GW:2SW	All saline water
Mr. Subhash	Green gram	1GW: 1SW	All saline water
Mr. Devendra	Green gram	2SW:1GW	All saline water
Water melon			
Mr. Tufan Singh	Water melon	2GW:1SW	Nil
Mr. Satya Veer	Water melon	1SW:1GW	Nil

SW-Saline water, GW-Good quality water, CW-Canal water

1) Pearl millet:

Technological package for ORP demonstration:

The general information of pearl millet crop i.e. variety, No. of irrigations, date of sowing and date of harvest are given in Table 10.3. Conjunctive use of saline and good quality water during *Kharif* and *rabi* season. It resulted in less salt build up compared to saline water irrigation alone and helped in better germination, better crop stand better yield. ORP farmers were provided with hybrid variety of pearl millet and they applied recommended dose of fertilizers.

Table 10.3 General operations on farmers field in Pearl millet crop (2020-21)

Name	Crop	Variety	No.of irrigations	Date of sowing	Date of harvesting
1.Mr.Vijay Pal Singh	Pearl millet	Pro agro m45	2	15-07-2020	26-09-2020
2. Mr. Nand Kishor	Pearl millet	Pro agro m45	2	14-07-2020	26-092020
3.Mr Nathi Lal	Pearl millet	Pro agro m45	2	16-07-2020	27-092020
4. Mr. Mahesh Singh	Pearl millet	Pro agro m45	2	15-07-2020	24-0-2020
5.Mr. Kalicharan	Pearl millet	Pro agro m45	2	14-072020	25-092020
6. Mr.Bhawar Singh	Pearl millet	Pro agro m45	2	15-07-2020	28-092020
7.Mr. Tufan Singh	Pearl millet	Pro agro m45	2	17-072020	27-092020

The growth parameters i.e. germination (%), plant height, No. of effective tillers per plant and ear length (cm) per plant were observed and are presented in Table 10.4. All these characters were found at par in all the seven farmers' fields.

Table 10.4: Yield attributing characters of Pearl millet (2020-21)

Name of farmers	Variety	Germination (%) per running metre	Plant height (cm) at harvest	No. of effective tillers par plant	Ear length (cm)
1.Mr.Vijay Pal Singh	Pro agro m45	11.8	278.3	1.7	29.2
2.Mr. Nand Kishor	Pro agro m45	10.9	275.8	1.5	28.8
3.Mr. Nathi Lal	Pro agro m45	10.7	278.6	1.6	30.2
4.Mr. Mahesh Singh	Pro agro m45	10.8	281.7	1.7	27.7
5.Mr. Kalicharan	Pro agro m45	11.7	280.3	1.6	30.1
6. Mr. Bhanwar Singh	Pro agro m45	11.3	278.2	1.7	29.2
7.Mr. Tufan Singh	Pro agro m45	10.9	274.7	1.6	29.8

The ORP farmers and other farmers pearl millet yield is presented in Table 10.5. It clearly indicated that ORP farmers pearl millet grain yield ranged from (25.8 to 29.2 q/ha) was too higher as

compared with other farmers (22.7 to 26.3 q/ha). At the harvest of pearl millet crop, ECe ranged from 4.4 to 6.3 (dS/m) and pH value ranged from 7.7-7.9.

Table 10.5 Grain yield of Pearl millet at ORP and other farmer's field and soil characteristics (0-30cm) at harvest (2020-21)

Name of farmers	ORP farmers yield (q/ha)	Other farmer yield (q/ha)	% in increase over farmers field	At harvest ECe(dS/m) (0-30cm)	pH (0-30cm)
1.Mr.Vijay Pal Singh	26.8	24.2	9.7	6.3	7.9
2. Mr. Nand Kishor	26.1	23.8	8.8	4.9	7.8
3.Mr Nathi Lal	27.2	24.5	9.9	4.8	7.7
4. Mr. Mahesh Singh	25.8	22.7	12.0	4.6	7.8
5.Mr. Kalicharan	26.7	23.6	11.6	4.4	7.8
6. Mr.Bhawar Singh	29.2	26.3	9.5	4.8	7.8
7.Mr. Tufan Singh	26.6	24.2	9.0	4.4	7.7

The Cost of cultivation, gross income, net profit and B: C ratio:

The cost of cultivation, gross income, net profit (Rs/ha) and B:C ratio of pearl millet crop were calculated and presented in Table 10.6. Which indicate clearly that the cost of cultivation of ORP farmers was less as compare to other farmer's field. The gross income (Rs/ha) was higher in ORP farmers field as compared with other farmers field. The net profit (Rs/ha) and B: C ratios were also higher in ORP farmers as compared to other farmers.

Table 10.6: Cost of cultivation, gross income, net profit and B: C ratio of pearl millet grown on ORP farmers and other farmers field (2020-21)

Farmers name	ORP farmers				Other farmers			
	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio
1.Mr.Vijay Pal Singh	22,520	57,630	35,110	2.6	23,250	51,870	28,620	2.2
2. Mr. Nand Kishor	21,750	56,475	34,725	2.5	22,870	50,685	27,815	2.2
3.Mr Nathi Lal	21,910	59,055	37,145	2.7	22,220	52,365	30,145	2.4
4. Mr. Mahesh Singh	22,220	55,215	33,485	2.6	22,730	48,390	25,660	2.1
5.Mr. Kalicharan	21,650	57,510	35,290	2.6	23,295	50,,265	26,970	2.2
6. Mr. Bhawar Singh	21,650	56,955	35,305	2.6	22,930	50,685	27,755	2.2
7.Mr. Tufan Singh	22,230	57,600	35,370	2.6	23,270	51,720	28,450	2.2

Soil studies at sowing and harvest of Pearl millet crop:

At the time of sowing and harvest of pearl millet crop, the soil ECe and pH were calculated and presented in Table 10.7. In surface layer at sowing (0-15 cm), the ECe and pH ranged from 4.1 to 5.7 (dS/m) and 7.7 to 7.9, respectively. At harvest of pearl millet crop, soil salinity was increase, the ECe and pH ranged from 4.4 to 6.2(dS/m) and 7.7 to 7.9.

Table 10.7: Soil studies at sowing and harvest of pearl millet crop in ORP farmer's field (2020-21)

Farmers name	Soil Depth(cm)	At sowing		At harvest	
		ECe (dS/m)	pH	ECe (dS/m)	pH
Mr.Vijay Pal Singh	0-15	5.7	7.9	6.2	7.9
	15-30	5.6	7.7	5.3	7.8
Mr.Nanad Kishor	0-15	4.5	7.9	5.1	7.9
	15-30	4.1	7.8	4.8	7.8
Mr.Nathi Lal	0-15	5.2	7.8	5.4	7.7
	15-30	4.7	7.7	4.2	7.8
Mr.Mahesh Singh	0-15	4.3	7.8	4.4	7.8
	15-30	4.5	7.8	4.7	7.8
Mr.Kali Charan	0-15	4.3	7.7	4.5	7.8
	15-30	4.0	7.7	4.2	7.8
Mr.Bhawar Singh	0-15	4.6	7.8	4.7	7.8
	15-30	4.6	7.8	4.8	7.7
Mr. Tufan Singh	0-15	4.2	7.7	4.5	7.7
	15-30	4.3	7.7	4.3	7.8

2) Sesame

Technological package for ORP demonstration:

The general information of sesame crop i.e. variety, No. of irrigations, date of sowing and date of harvest are given in Table 10.8. Generally farmers grow sesame crop in flat field and broadcasting method of sowing is practiced. Also saline groundwater is used for irrigation. However, sesame crop was grown on flat bed under ORP. Conjunctive use of saline groundwater and good quality canal water was practiced. The yield was increased due to good germination and low mortality and sowing on beds.

Table 10.8 General operations on farmers field in Sesame crop (2020-21)

Name	Crop	Variety	No. of irrigations	Date of sowing	Date of harvesting
1.Mr.Vijay Pal Singh	Sesame	Sekher	2	12.07.2020	28.10.2020
2.Mr. Kalicharn	Sesame	Sekher	2	12.07.2020	28.10.2020
3.Mr. Lakho Singh	Sesame	Sekher	2	12.07.2020	27.10.2020
4. Mr. GiriRaj	Sesame	Sekher	2	14.07.2020	29.10.2020
5. Mr. Ashok	Sesame	Sekher	3	14.07.2020	28.10.2020
6. Mr. Olli	Sesame	Sekher	2	13.07.2020	27.10.2020
7.Mr.Mohar Singh	Sesame	Sekher	3	13.07.2020	28.10.2020
8. Mr. Satya Veer	Sesame	Sekher	3	15.07.2020	27.10.2020

The growth parameters i.e. germination (%), plant height (cm), no. of branches per plant and length of capsule (cm) were observed and are presented in Table 10.9. All these characters were found at par in all 8 farmers field.

The ORP farmers and other farmers sesame yield is presented in Table 10.10. Which clearly indicate that ORP farmers sesame grain yield ranged from (7.6 to 9.1 q/ha) was too higher compare with other farmers (6.8 to 6.9 q/ha). At the harvest of sesame crop, ECe ranged from 4.2 to 5.0 (dS/m) and pH value ranged from 7.7-7.8.

Table 10.9: Yield attributing characters of Sesame (2020-21)

Name of farmers	Variety	Germination (%) per running meter	Plant height (cm) at harvest	No. of branches	Length of capsule(cm)
1.Mr.Vijay Pal Singh	Sekher	68.0	114.2	8.7	3.3
2. Mr. Nand Kishor	Sekher	72.2	110.8	9.2	3.6
3.Mr Nathi Lal	Sekher	65.1	122.2	8.6	3.5
4. Mr. Mahesh Singh	Sekher	72.2	118.7	9.8	3.2
5.Mr. Kalicharan	Sekher	68.5	116.9	8.3	3.4
6. Mr.Bhawar Singh	Sekher	68.3	122.6	7.8	3.6
7.Mr. Tufan Singh	Sekher	70.0	120.7	7.9	3.5
8.Mr.Satya Veer	Sekher	68.0	119.2	8.9	3.8

Table 10.10: Grain yield of Sesame at ORP and other farmer's field and soil characteristics (0-30cm) at harvest (2020-21)

Name of farmers	ORP farmers yield (q/ha)	Other farmer yield (q/ha)	% in increase over farmers field	At harvest ECe (dS/m) (0-30cm)	pH (0-30cm)
1.Mr.Vijay Pal Singh	8.2	6.8	17.0	5.0	7.8
2. Mr. Nand Kishor	7.8	6.9	11.5	4.6	7.8
3.Mr Nathi Lal	9.1	7.5	17.5	4.5	7.8
4. Mr. Mahesh Singh	8.8	7.8	11.4	4.4	7.8
5.Mr. Kalicharan	7.9	6.8	13.9	4.4	7.8
6. Mr.Bhawar Singh	8.6	7.4	13.9	4.5	7.7
7.Mr. Tufan Singh	8.3	7.2	13.3	4.8	7.8
8.Mr.Satya Veer	7.6	6.9	9.2	4.2	7.7

The Cost of cultivation, gross income, net profit and B: C ratio:

The cost of cultivation, gross income, net profit (Rs/ha) and B:C ratio of sesame crop were calculated and presented in Table 11 which clearly indicated that the cost of cultivation of ORP farmers was less as compare to other farmer's. The gross income (Rs/ha) was higher in ORP farmers field as compared with other farmers field. The net profit (Rs/ha) and B: C ratio was also higher in ORP farmers as compared to other farmers (Table 10.11).

Table 10.11: Cost of cultivation, gross income, net profit and B:C ratio of sesame crop growing on ORP farmers and other farmers field (2020-21)

Farmer name	ORP farmers				Other farmers			
	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio
1.Mr.Vijay Pal Singh	23,500	82,000	58,500	3.4	24,500	68,000	43,500	2.8
2. Mr. Nand Kishor	22,800	78,000	55,200	3.4	23,100	69,000	45,900	2.9
3.Mr Nathi Lal	21,900	91,00	69,100	4.2	22.800	75,000	52,200	3.3
4. Mr. Mahesh Singh	23,100	88,000	64,900	3.8	23,950	78,000	54,050	3.2
5.Mr. Kalicharan	22,750	79,000	56,250	3.5	23,210	68,000	44,790	2.9
6. Mr.Bhawar Singh	21,950	86,000	64,050	3.9	22,750	74,000	51,250	3.3
7.Mr. Tufan Singh	22,210	83,000	60,790	3.7	23,210	72,000	48,790	3.1
8.Mr.Satya Veer	21,870	76,000	54,130	3.5	22,220	69,000	46,780	3.1

Soil studies at sowing and harvest of sesame crop:

At the time of sowing and after harvest of sesame crop, the soil samples were collected and analysed for soil ECe and pH were calculated and presented in Table 10.12. In surface layer at sowing (0-15 cm), the ECe and pH ranged from 3.9 to 5.5 (dS/m) and 7.7 to 7.8, respectively. After harvest of sesame crop, soil salinity was increase, the ECe and pH ranged from 4.1 to 5.6 (dS/m) and 7.7 to 7.8.

Table 10.12: Soil studies at sowing and harvest of sesame crop in ORP farmer's field (2020-21)

Farmers name	SoilDepth (cm)	At sowing		At harvest	
		ECe (dS/m)	pH	ECe (dS/m)	pH
1.Mr. Vijay Pal Singh	0-15	5.5	7.8	5.6	7.8
	15-30	5.3	7.8	5.5	7.7
2. Mr.Kalicharn	0-15	4.2	7.7	4.5	7.8
	15-30	4.4	7.7	4.6	7.8
3. Mr.Lakho Singh	0-15	4.2	7.8	4.4	7.7
	15-30	4.4	7.8	4.6	7.7
4. MrGiriRaj	0-15	4.0	7.7	4.3	7.8
	15-30	4.2	7.7	4.5	7.9
5. MrAshok	0-15	3.8	7.8	4.2	7.8
	15-30	4.1	7.8	4.5	7.7
6. Mr. Olli	0-15	4.1	7.7	4.3	7.8
	15-30	4.4	7.7	4.6	7.9
7. Mr.Mohar Singh	0-15	4.5	7.8	4.7	7.8
	15-30	4.7	7.8	4.9	7.8
8. Mr.Satya Veer	0-15	3.9	7.7	4.1	7.8
	15-30	4.2	7.7	4.3	7.7

3) Sorghum for green fodder:

Technological package for ORP demonstration:
The general information of sorghum green fodder crop, i.e. Variety, No. of irrigations, date of sowing and date of harvest are given in Table 10.13. This crop was sown for fodder purpose and conjunctive use of saline ground water with good quality water was used. Multi cutting varieties were sown for better fodder yield.

Table 10.13: General operations on farmers' fields at Sorghum green fodder (2020-21)

Name	Crop	Variety	No.of irrigations	Date of sowing	Date of harvesting
1.Mr.Subhash Singh	Sorghum	Purvi white	3	16.06.2020	17.08.2020
2. Mr. Raj Veer Singh	Sorghum	Purvi white	4	16.06.2020	18.08.2020
3. Mr. Chandra Pal Singh	Sorghum	Purvi white	3	18.06.2020	17.08.2020
4. Mr. Netra Pal Singh	Sorghum	Purvi white	4	18.06.2020	19.08.2020
5.Mr. Kishan Gopal	Sorghum	Purvi white	4	17.06.2020	20.08.2020

The ORP farmers and other farmers sorghum green fodder yield is presented in Table 10.14. The Table 14 clearly indicated that ORP farmers sorghum green fodder yield ranged from (342.8 to 362.1 q/ha) was too higher compare with other farmers (328.9 to 342.7 q/ha). At the harvest of sorghum crop, ECe ranged from 4.2 to 4.8 (dS/m) and pH value ranged from 7.7-7.8.

Table 10.14: Fodder yield of sorghum (fodder) (q/ha) 2020-21

Name of farmers	ORP farmers yield	Other farmer yield	% in increase	At harvest ECe(dS/m) (0-30cm)	pH 0-30cm
1.Mr.Subhas Singh	358.6	330.2	7.9	4.2	7.8
2. Mr. Raj Veer Singh	362.8	341.7	5.8	4.6	7.8
3. Mr. Chandra Pal Singh	355.2	338.2	4.8	4.7	7.8
4. Mr.Netra Pal Singh	342.8	328.9	4.1	4.8	7.7
5.Kishan Gopal	362.1	342.7	5.4	4.5	7.7

The Cost of cultivation, gross income, net profit and B: C ratio:

The cost of cultivation, gross income, net profit (Rs/ha) and B: C ratio of sorghum green fodder crop was calculated and presented in Table 10.15. It clearly indicates that the cost of cultivation of ORP farmers was almost less as compare to other farmers. The gross income (Rs/ha) was higher in ORP farmers field as compare to other farmers field. The net profit (Rs/ha) and B: C ratio was also higher in ORP farmers as compared to other farmers.

Table 10.15 Cost of cultivation, gross income, net profit and B: C ratio of Sorghum (fodder) growing ORP farmers and other farmers (2020-21)

Farmer name	ORP farmers				Other farmers			
	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio
1.Mr.Subhas Singh	32,250	89,650	57,400	2.8	34,200	82,560	48,300	2.4
2. Mr. Raj Veer Singh	31,750	90,700	58,950	2.9	33,100	85,425	52,325	2.5
3. Mr. Chandra Pal Singh	30,670	88,800	58,130	2.8	32,850	84,550	51,700	2.6
4. Mr.Netra Pal Singh	31,270	85,700	54,430	2.7	33,730	82,225	48,495	2.4
5.Kishan Gopal	33,100	90,525	57,425	2.7	34,520	85,675	51,155	2.5

Soil studies at sowing and harvest of sorghum fodder crop:

At the time of sowing and harvest of sorghum crop, the soil ECe and pH were calculated and presented in Table 10.16. In surface layer at sowing (0-15 cm), the ECe and pH ranged from 3.8 to 4.5 (dS/m) and 7.7 to 7.8, respectively. At harvest of sorghum crop, soil salinity increased, the ECe and pH ranged from 4.1 to 4.7 (dS/m) and 7.7 to 7.8.

Table 10.16 Soil analysis at sowing of sorghum fodder of ORP farmer's field (2020-21)

Farmers name	Soil depth (cm)	At sowing		At harvest	
		ECe (dS/m)	pH	ECe (dS/m)	pH
1.Mr.Subhas Singh	0-15	3.8	7.7	4.1	7.8
	15-30	4.1	7.7	4.3	7.8
2. Mr. Raj Veer Singh	0-15	4.2	7.8	4.5	7.8
	15-30	4.5	7.7	4.7	7.7
3. Mr. Chandra Pal	0-15	4.3	7.8	4.5	7.7
	15-30	4.7	7.8	4.8	7.8
4. Mr.Netra Pal	0-15	4.5	7.7	4.7	7.9
	15-30	4.8	7.7	4.9	7.8
5.Kishan Gopal	0-15	4.2	7.7	4.5	7.7
	15-30	4.2	7.6	4.4	7.9

4) Cotton

Technological package for ORP demonstration:

The general information of cotton crop i.e. variety, No. of irrigations, date of sowing and date of harvest are given in Table 10.17. Generally farmers grow cotton crop in flat and sowing is done broadcasting method. In case of ORP, cotton was grown on beds with conjunctive use of saline and good quality water was practiced. Hybrid cotton variety H-777 was used. The higher yield was reported under ORP due to good germination because of sowing on beds.

Table 10.17: General operations on farmers field at cotton (2020-21)

Name	Crop	Variety	No.of irrigations	Date of sowing	Date of harvesting
1.Mr.Sodhan Singh	Cotton	H-777	3	16-06.2020	17.112020
2. Mr. Ter Singh	Cotton	H-777	3	16.06.2020	18.11.2020

The ORP farmers and other farmers cotton (fiber+seed) yields are presented in Table 10.18. It clearly indicated that the ORP farmers cotton (fiber+seed) yield ranged from (23.3 to 24.8 q/ha) was higher as compared to other farmers cotton (fiber+seed) yield (20.7 to 21.9 q/ha).

Table10.18 Cotton (fiber+ seed) yield (q/ha) 2020-21

Name of farmers	ORP farmers yield	Other farmer yield	% in increase	At harvest ECe(dS/m) (0-30cm)	pH 0-30cm
1.Mr.Saudan Singh	24.8	21.9	11.7	6.0	7.8
2. Mr. Ter Singh	23.3	20.7	11.2	6.2	7.8

The Cost of cultivation, gross income, net profit and B: C ratio:

The cost of cultivation, gross income, net profit (Rs/ha) and B: C ratio for cotton were calculated and presented in Table 10.19. It clearly indicated that the cost of cultivation of ORP farmers was less as compared to other farmers. The gross income (Rs/ha) was higher in ORP farmers' fields compared to other farmers' fields. The net profit (Rs/ha) and B: C ratio was also higher in ORP farmers compare to other farmers.

Table 10.19 Cost of cultivation, gross income, net profit and B: C ratio of Cotton ORP farmers and other farmers (2020-21)

Farmers name	ORP farmers				Other farmers			
	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio
1.Mr.Saudan Singh	56,220	1,48,800	92,580	2.6	55,830	1,31,400	75,570	2.3
2. Mr. Ter Singh	58,300	1,39,800	81,500	2.4	56,220	1,24,200	67,980	2.2

5) Rabi season-Mustard

Technological package for ORP demonstration:

The general information of mustard crop i.e. variety, No. of irrigations, date of sowing and date of harvest are given in Table 10.20. Farmers adopted conjunctive use of saline with good quality water. Also, pre- sowing irrigation was done with good quality water and it helped in good germination. The farmers practiced rain water conservation at time of sowing. Application of insecticide and pesticide in mustard crop also enhanced the crop production.

Table 10.20: General operations on farmer's field at Mustard crop rabi (2020-21)

Farmers Name	Crop	Variety	No.of irrigations	Date of sowing	Date of harvesting
1.Mr. Nand Kishor	Mustard	CS-58	2	08-10-2020	26-02-2021
2. Mr. Mahesh Singh	Mustard	CS-60	2	09-10-2020	22-02-2021
3. Mr. Chandra Pal	Mustard	CS-58	2	08-10-2020	28-02-2021
4. Mr. Subhas	Mustard	CS-60	2	08-10-2020	28-02-2021
5. Mr. Raj Veer	Mustard	CS-58	2	11-10-2020	25-02-2021
6. Mr.Giriraj Saran	Mustard	CS-60	2	11-10-2020	25-02-2021
7.Mr. Babu Lal	Mustard	CS-58	2	09-10-2020	26-02-2021
8.Mr.Saudan Singh	Mustard	CS-60	2	10-10-2020	28-02-2021
9.Mr.Pratap Singh	Mustard	CS-58	2	10-10-2020	25-02-2021
10.Mr. Tufan Singh	Mustard	CS-60	2	11-10-2020	25-02-2021

The growth parameters i.e. germination (%), plant height (55 DAS and at harvest), primary and secondary branches per plant (55 DAS and at harvest) were observed and presented in Table 10.21. All these characters were at par in all the 10 farmers' field.

Table 10.21 Growth characters of mustard in saline water irrigation (2020-21)

Name of farmers	Germination %/running meter (21DAS)	Plant height (cm) 55DAS	No. of primary branches/ plant 55 DAS	No. of secondary branches/plant 55 DAS	Plant height Harvest (cm)	No. of primary branches/plant harvest	No. of secondary branches/ plant harvest
1.Mr. Nand Kishor	11.4	134.2	6.8	14.5	184.3	7.1	14.8
2. Mr. Mahesh Singh	11.8	136.8	7.1	13.8	181.7	7.5	14.1
3. Mr. Chandra Pal	11.2	131.2	6.2	13.6	186.9	7.0	13.9
4. Mr. Subhash	11.4	133.7	7.2	14.1	183.8	7.5	14.5
5. Mr. Raj Veer	11.5	132.8	7.3	13.9	181.9	7.4	14.6
6. Mr. Giriraj Saran	11.8	135.9	6.9	15.2	191.3	7.2	15.8
7.Mr. Babu Lal	11.6	137.8	7.2	15.5	195.7	7.5	16.2
8.Mr.Saudan Singh	11.4	136.2	7.3	14.8	188.9	7.8	15.2
9.Mr.Pratap Singh	11.5	135.8	7.3	14.3	189.2	7.5	14.5
10.Mr. Tufan Singh	11.8	137.5	7.8	14.3	191.2	8.1	15.2

The yield attributing characteristics of mustard crop i.e. No. of siliqua/plant, No. of seed /siliqua, grain yield/plant (gm) and length of siliqua (cm) were observed and presented in Table 10.22. The

yield attributing characteristics of mustard crop were found highest in Mr. Tufan Singh field and the lowest in the field of Mr. Nand Kishor.

The mustard yield of ORP farmers and other farmers mustard yield is presented in Table 10.23. Which clearly indicate that the ORP farmers mustard grain yield ranged from (25.8 to 28.2 q/ha) was found higher as compare with other farmers mustard yield (23.2 to 25.8 q/ha). At the harvest of mustard crop, ECe ranged from (5.5 to 6.8 dS/m) and pH (7.7 to 7.8).

Table 10.22: Yield attributing characters of mustard in saline water irrigation (2020-21)

Name of farmers	No. of siliqua/plant	No. of seed /siliqua	Grain yield /plant (gm)	Length of siliqua(cm)
1. Mr. Nand Kishor	433.7	11.5	11.8	6.1
2. Mr. Mahesh Singh	510.2	12.2	12.5	6.2
3. Mr. Chandra Pal	484.3	11.8	13.2	6.1
4. Mr. Subhash	445.2	11.7	12.8	6.3
5. Mr. RajVeer	491.5	12.1	12.5	6.4
6. Mr. Giriraj Saran	478.3	12.2	12.4	6.2
7.Mr. Babu Lal	505.2	12.7	13.1	6.5
8. Mr.Saudan Singh	509.7	12.5	13.3	6.3
9. Mr. Pratap Singh	478.2	11.8	12.8	6.5
10.Mr.Tufan Singh	510.3	12.5	13.5	6.4

Table 10.23. Grain yield of mustard in ORP and other farmers field (q/ha) and soil ECe and pH (0-30 cm) of ORP farmers field at harvest 2020-21

Name of farmers	ORP farmers yield	Other farmer yield	% increase over other farmer	At harvest ECe(dS/m) (0-30cm)	pH (0-30cm)
1.Mr. Nand Kishor	25.8	23.2	10.0	6.2	7.8
2. Mr. Mahesh Singh	27.2	24.5	9.9	5.7	7.7
3. Mr. Chandra Pal	26.5	24.5	8.6	6.8	7.8
4. Mr. Subhash	25.9	23.9	7.7	5.9	7.7
5. Mr. Raj Veer	27.1	24.8	8.5	5.7	7.7
6. Mr. Giriraj Saran	26.7	23.7	11.6	6.4	7.7
7.Mr. Babu Lal	27.8	24.8	10.8	7.0	7.8
8.Mr.Saudan Singh	27.3	25.2	7.7	6.5	7.8
9.Mr.Pratap Singh	26.8	23.6	11.9	6.4	7.7
10.Mr. Tufan Singh	28.2	25.8	8.5	5.5	7.8

The Cost of cultivation, gross income, net profit and B: C ratio:

The cost of cultivation, gross income, net profit (Rs/ha) and B: C ratio in mustard crop were calculated and presented in Table 10.24. It clearly indicates that the cost of cultivation of ORP farmers was found less as compare to other farmers. The gross income (Rs/ha) was higher in ORP farmers field compare to other farmers field. The net profit (Rs/ha) and B: C ratio was also higher in ORP farmers compare to other farmers.

Table 10.24 Cost of cultivation, gross income, net profit and B: C ratio of mustard growing on ORP farmers and other farmers field (2020-21)

Farmers name	ORP farmers				Other farmers			
	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio	Cost of cultivation (Rs/ha)	Gross Income Rs/ha	Net Profit Rs/ha	B:C ratio
1.Mr. Nand Kishor	25,911	1,11,585	85,674	4.3	26,602	1,00,340	73,738	3.8
2. Mr. Mahesh Singh	27,101	1,17,640	90,539	4.3	27,905	1,05,963	78,058	3.8
3. Mr. Chandra Pal	26,508	1,14,613	88,105	4.3	27,000	1,05,963	78,963	3.9
4. Mr. Subhas	24,803	1,12,018	87,215	4.5	25,105	1,03,368	78,263	4.1
5. Mr. Raj Veer	26,511	1,17,208	90,697	4.4	26,903	1,07,260	80,357	3.9
6. Mr. Giriraj Saran	25,803	1,15,478	89,675	4.5	26,115	1,02,502	76,388	3.9
7.Mr. Babu Lal	26,602	1,20,235	93,633	4.5	26,811	1,07,260	80,449	4.0
8.Mr.Sodhan Singh	25,803	1,18,073	92,270	4.6	25,990	1,08,990	83,000	4.2
9.Mr.Pratap Singh	26,611	1,15,910	89,299	4.4	26,705	1,02,070	75,365	3.8
10.Mr. Tufan Singh	27,603	1,21,965	94,362	4.4	27,118	1,11,585	84,467	4.1

Soil studies at sowing and harvest of mustard crop:

At the time of sowing and after harvest of mustard crop the soil samples were taken and analyzed for ECe and pH also presented in Table 10.25. In surface layer (0-15 cm), the ECe and pH ranged from 4.2 to 4.8 (dS/m) and 7.7 to 7.8. At harvest of mustard crop, soil salinity increase due to high SAR saline water irrigation. The ECe and pH ranged from 5.6 to 6.8(dS/m) and 7.7 to 7.8.

Table 10.25 Soil analysis at sowing and after harvest of Mustard of ORP farmer's field (2020-21)

Farmers name	Soil Depth(cm)	At sowing		At harvest	
		ECe (dS/m)	pH	ECe (dS/m)	pH
Mr.Nand Kishor	0-15	4.5	7.7	6.3	7.8
	15-30	4.8	7.7	6.0	7.8
Mr.Mahesh Singh	0-15	4.2	7.7	5.8	7.7
	15-30	4.0	7.7	5.6	7.7
Mr.Chandra Pal	0-15	4.8	7.8	6.7	7.8
	15-30	4.5	7.8	6.9	7.8
Mr.Subhash	0-15	4.2	7.7	6.1	7.7
	15-30	4.4	7.7	5.8	7.7
Mr.Raj Veer	0-15	4.3	7.7	5.9	7.8
	16-30	4.6	7.8	5.5	7.7
Mr.Giriraj Saran	0-15	4.2	7.8	6.5	7.7
	15-30	4.6	7.7	6.2	7.8
Mr. Babu Lal	0-15	4.3	7.8	6.8	7.9
	16-30	4.5	7.7	7.2	7.8
Mr.Saudan Singh	0-15	4.2	7.8	6.7	7.7
	15-30	4.6	7.7	6.2	7.8
Mr. Pratap Singh	0-15	4.6	7.8	6.8	7.8
	15-30	4.5	7.8	5.9	7.9
Mr. Tufan Singh	0-15	4.3	7.7	5.6	7.7
	15-30	4.5	7.8	5.3	7.8

6) Wheat:

Technological details for ORP demonstration:

The general information of wheat crop i.e. variety, No. of irrigations, date of sowing and date of harvest are presented in Table 10.26. Mostly farmers used 100 kg seed per ha but ORP farmers used seed rate @ 120 kg per ha with recommended dose of fertilizers. The ORP farmers use KRL-20 (salt tolerant) variety of wheat. Generally farmers use traditional method but in ORP, farmers applied conjunctive use of saline with good quality water. In general pre- sowing irrigation was done with good quality water hence due to good germination of the crop, yield increased.

Table 10.26: General operations on farmer's field at Wheat crop rabi (2020-21)

Name	Crop	Variety	No.of irrigations	Date of sowing	Date of harvesting
1.Mr.Deepak Singh	Wheat	KRL-210	5	28-11-2020	12-04-2021
2. Mr. Prem Singh	Wheat	KRL-210	4	28-11-2020	10-04-2021
3. Mr.Vijay Pal Singh	Wheat	KRL-210	4	30-11-2020	10-04-2021
4. Mr. Ram Veer	Wheat	KRL-210	5	30-11-2020	06-04-2021
5.Mr.Saudan Singh	Wheat	KRL-210	5	27-11-2020	06-04-2021
6.Mr.Nathi Lal	Wheat	KRL-210	4	27-11-2020	08-04-2021
7.Mr.Satish Sharma	Wheat	KRL-210	4	28-11-2020	10-04-2021
8.Mr. Satya Veer	Wheat	KRL-210	5	30-11-2020	08-04-2021

In the rabi season 2020-21, eight farmers sown wheat crop (Variety KRL-210) in their fields, while other farmers sown different wheat varieties available in market/own. The yield attributing characters i.e .germination (%), plant height, (55DAS and at harvest), Shoot /running meter (55DAS and at harvest), spike length(cm) and No. of grain/spike in wheat were observed and presented in Table 10.27, which clearly indicated that the entire yield attributing characters of wheat crop were found at par in all the selected ORP farmers' fields.

Table 10.27: Yield attributing characters of Wheat crop in saline water irrigation at ORP farmers field (2020-21)

Name	Germination (%)/ running meter (21DAS)	Plant height 55DAS	Shoot/running meter at 55DAS	Shoot/running meter at harvest	Plant height harvest	Spike length (cm)	No. of grain/ spike
1.Mr.Deepak Singh	76.8	35.2	91.7	93.1	11.3	9.9	48.2
2. Mr.Prem Singh	77.3	34.8	90.8	91.6	108.9	9.8	47.3
3. Mr.Vijay Pal Singh	74.8	34.9	89.9	91.8	108.5	9.7	46.2
4. Mr. Ram Veer	73.8	35.1	88.3	92.2	108.8	9.3	45.9
5.Mr.Saudan Singh	74.5	35.5	90.2	91.7	110.5	9.8	46.7
6.Mr.Nathi Lal	75.6	33.8	91.5	92.2	109.2	9.5	47.3
7. Mr.Satish Sharma	76.2	35.2	91.7	93.2	11.5	9.7	46.8
8. Mr.Satya Veer	74.8	35.7	91.9	92.7	108.3	9.6	46.9

Yield of wheat crop:

The grain yield data of ORP farmers and other farmers are presented in Table 10.28, which clearly indicate that ORP farmers wheat grain yield ranged from (44.3 to 48.3 q/ha) was higher than other farmers ranged from (40.3 to 44.9 q/ha). The straw yield of wheat crop also gave the same trend.

The average increase of ORP farmers was 8.5 % more over other farmers grain yield. At harvest of wheat crop the ECe and pH ranged from 5.7 to 9.7 dS/m, pH 7.7 - 7.8, respectively.

Table 10.28: Grain yield of wheat in ORP and other farmers field (q/ha) and soil ECe and pH (0-30 cm) of ORP farmers field at harvest 2020-21

Name of farmers	ORP farmers yield		Other farmer yield		Grain yield increase over traditional farming (%)	ECe at harvest (dS/m) (0-30cm)	pH (0-30cm)
	Grain	Straw	Grain	Straw			
1.Mr.Deepak Singh	48.3	73.3	44.9	65.8	7.0	8.2	7.8
2. Mr. Prem Singh	47.6	72.8	44.1	64.2	7.4	7.3	7.8
3. Mr. Vijay Pal Singh	47.2	74.2	43.7	63.7	7.4	8.2	7.8
4. Mr. Ram Veer	45.6	71.7	41.2	64.2	9.6	9.7	7.8
5.Mr.Saudan Singh	44.3	72.3	40.3	63.7	9.0	6.6	7.7
6.Mr.Nathi Lal	47.9	74.5	43.3	63.3	9.6	7.2	7.7
7.Mr.Satish Sharma	47.5	75.5	43.9	64.5	7.6	6.1	7.8
8.Mr.Satya Veer	46.9	70.6	41.7	64.7	11.1	5.7	7.8

Cost of cultivation, gross income, net profit and B: C ratio:

In case of wheat crop, the cost of cultivation, gross income, net profit (Rs/ha) and B:C ratio were calculate and presented in Table 10.29. It is clearly indicated that the cost of cultivation of ORP farmers almost less compared with other farmers. The gross income (Rs/ha) were higher in ORP farmers field compared with other farmers field. The net profit (Rs/ha) and B: C ratio was higher in ORP farmers compared with other farmers growing wheat crop.

Table 10.29: Cost of cultivation, gross income, net profit and B: C ratio of ORP farmers and other farmers in wheat crop (2020-21)

Farmers name	ORP farmers				Other farmers			
	Cost of cultivation (Rs/ha)	Gross Income (Rs/ha)	Net Profit (Rs/ha)	B:C ratio	Cost of cultivation (Rs/ha)	Gross Income (Rs/ha)	Net Profit (Rs/ha)	B:C ratio
1.Mr.Deepak Singh	36,803	1,16,758	79,955	3.2	36,911	1,07,895	70,984	2.9
2. Mr. Prem Singh	33,902	1,15,220	81,318	3.3	34,102	1,05,855	71,753	3.1
3. Mr. Vijay Pal Singh	33,900	1,14,805	80,905	3.4	34,105	1,04,918	70,813	3.0
4. Mr. Ram Veer	32,805	1,10,918	78,113	3.3	33,113	1,00,055	66,943	3.0
5.Mr.Saudan Singh	34,705	1,08,483	73,778	3.1	34,902	98,118	63,216	2.8
6.Mr.Nathi Lal	36,100,	1,16,288	80,188	3.2	36,510	1,04,008	67,498	2.8
7. Mr. Satish Sharma	35,803	1,15,763	79,960	3.2	35,980	1,05,538	69,558	2.9
8. Mr. Satya Veer	36,111	1,13,215	77,104	3.1	36,222	1,01,193	64,971	2.8

Soil studies at Sowing and harvest of wheat:

At the time of sowing and after harvest of wheat crop, the soil ECe and pH were determined and presented in Table 10.30. In surface layer (0-15 cm), the ECe and pH ranged from 4.2 to 6.2 (dS/m) and 7.7 to 7.8, respectively. At harvest of wheat crop, soil salinity increase due to high SAR saline water irrigation. The ECe and pH ranged from 5.9 to 9.3 (dS/m) and 7.7 to 7.7.

Table 10.30: Soil ECe and pH at sowing and at harvest of wheat crop in ORP farmer's field (2020-21)

Farmers name	SoilDepth (cm)	At sowing		After harvest	
		ECe (dS/m)	pH	ECe (dS/m)	pH
Mr. Deepak Singh	0-15	5.4	7.7	8.5	7.8
	15-30	4.5	7.8	7.8	7.8
Mr. Prem Singh	0-15	5.3	7.7	8.3	7.9
	15-30	4.9	7.7	6.3	7.8
Mr.Vijay P. Singh	0-15	5.6	7.8	8.5	7.6
	15-30	4.9	7.8	7.9	7.8
Mr. Ram Veer	0-15	6.2	7.7	9.3	7.8
	15-30	5.9	7.8	10.1	7.9
Mr. Saudan Singh	0-15	5.8	7.7	6.9	7.7
	15-30	5.2	7.7	6.3	7.8
Mr. Nathi Lal	0-15	5.3	7.8	7.5	7.6
	16-30	5.8	7.8	6.9	7.8
Mr. Satish Sharma	0-15	5.8	7.7	6.3	7.7
	15-30	4.8	7.7	5.8	7.9
Mr. Satya Veer	0-15	4.2	7.8	5.9	7.8
	15-30	4.5	7.8	5.5	7.7

7) Vegetable crops

Technological package for ORP demonstration on Vegetables:

In ORP village mostly farmers were growing vegetables in traditional method but ORP farmers use hybrid varieties, insect & pest, fertilizer, irrigation management. The ORP farmers also used bed and furrow system in sowing of vegetable crops. The spray of micro-nutrient in vegetable crops was also done. Irrigation schedule i.e. conjunctive use of saline water with good quality water also applied and enhanced the yield of vegetable crops. Details of vegetable crops are provided in Table 10.31.

Table 10.31 General operations on farmers field in rabi and summer crops (2020-21)

Name	Crop	Variety	No.of irrigations	Date of sowing	Date of harvesting
Beet root					
Mr. Satya Veer	Beet root	Myhico hybrid	6	05-10-202	02-03-2021
Mr Kishan Gopal	Beet root	Myhico hybrid	5	10-10-2020	05-03-2021
Cauliflower					
Mr. Tufan Singh	Cauliflower	Golden-85	5	15-10-2020	25-02-2021
Cabbage					
Mr.Kishan Gopal	Cabbage	Golden-bold	6	18-10-2020	15-03-2021
Tomato					
Mr.Tufan Singh	Tomato	Golden Hybrid	5	15-01-2021	28-03-2021
Coriander					
Mr Tufan Singh	Coriander	Hybrid	4	25-01-2020	23-05-2021
Cluster bean					
Mr.Tufan Singh	Cluster bean	Ankur Rani	6	22-06-2020	28-10-2020
Onion					
Mr. Tufan Singh	Onion	Nashik red	4	28-11-2020	15-03-2021
Carrot					
Mr. Tufan Singh	Carrot	Hisar red	4	12-09-2020	14-12-2021

Beet root growing in ORP farmer's field in rabi season:

In Beet root crop yield of 282.8 q/ha was recorded in the field of Mr. Satya Veer and 275.8 q/ha in Mr Kishan Gopal. The crop gain Rs. 2,14,390 /ha as net profit and 4.1 benefit cost ratio in Mr Satya Veer and Mr Kishan Gopal Rs 2,12,080 net profit and 4.3 B:C ratio (Table 10.32).

Table 10.32: Yield, cost of cultivation, gross income, net profit and B: C ratio of beet root crop in ORP farmer's field (2020-21)

Farmers name	Beet root yield (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net profit (Rs/ha)	B: C ratio
Mr. Satya Veer	282.8	68,310	2,82,700	2,14,390	4.1
Mr Kishan Gopal	275.8	63,720	2,75,800	2,12,080	4.3

Economics for Cauliflower, Cabbage, Tomato and coriander, cluster bean and Okra during rabi season

In case of Cauliflower, crop yield of 225.0 q/ha was recorded in the field of Mr. Tufan Singh. The crop gain Rs. 1, 25,490 /ha as net profit and 3.3 benefit cost ratio (Table 10.33).

Table 10.33: Yield, cost of cultivation, gross income, net profit and B:C ratio of Cauliflower crop of ORP farmers field (2020-21)

Farmers name	Cauliflower yield (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net profit (Rs/ha)	B:C ratio
Mr. Tufan Singh	225.0	54,510	1,80,800	1,25,490	3.3

In case of Cabbage, crop yield of 365.0 q/ha was recorded in the field of Mr. Kishan Gopal. The crop gain Rs. 1,27,140/ha as net profit and 3.3 benefit cost ratio (Table 10.34).

Table 34: Yield, cost of cultivation, gross income, net profit and B:C ratio of Cabbage crop of ORP farmers field (2020-21)

Farmers name	Cauliflower yield (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net profit (Rs/ha)	B:C ratio
Mr. Kishan Gopal	365.0	55,360	1,82,500	1,27,140	3.3

In case of Tomato, crop yield of 211.8 q/ha was recorded in the field of Mr. Tufan Singh. The crop gain Rs. 1,22,000/ha as net profit and 3.57 benefit cost ratio (Table 10.35).

Table 10.35: Yield, cost of cultivation, gross income, net profit and B:C ratio of Tomato crop of ORP farmers field (2019-20)

Farmers name	Tomato yield (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net profit (Rs/ha)	B:C ratio
Mr. Tufan Singh	211.8	47,440	1,69,440	1,22,000	3.57

In case of Coriander crop yield of 6.0 q/ha was recorded in the field of Mr. Tufan Singh. The crop gain Rs. 65,730/ha as net profit and 3.7 benefit cost ratio (Table 10.36).

Table 10.36: Yield, cost of cultivation, gross income, net profit and B: C ratio of coriander crop of ORP farmers field (2020-21)

Farmers name	Coriander yield(q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net profit (Rs/ha)	B:C ratio
Mr. Tufan Singh	6.0	24,270	90,000	65,730	3.7

In case of cluster bean crop yield of 79.6 q/ha was recorded in the field of Mr. Tufan Singh. The crop gain Rs. 1,24,975/ha as net profit and 4.6 benefit cost ratio (Table 10.37).

Table 10.37 Yield, cost of cultivation, gross income, net profit and B: C ratio of cluster bean crop of ORP farmer's field (2020-21)

Farmers name	Pod yield of cluster bean (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net profit (Rs/ha)	B:C ratio
Mr. Tufan Singh	79.6	34,225	1,59,200	1,24,975	4.6

Okra crop yield of 118.0 q/ha was recorded in the field of Mr. Tufan Singh and 107.0 q/ha in Mr Kishan Gopal. The crop gain Rs. 94,771 /ha as net profit and 2.2 benefit cost ratio in Mr Tufan Singh and Mr Kishan Gopal Rs 81,725 net profit and 2.1 B:C ratio (Table 10.38).

Table 10.38 Yield, cost of cultivation, gross income, net profit and B:C ratio of okra crop of ORP farmers field (2020-21)

Farmers name	Pod yield of okra (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net profit (Rs/ha)	B:C ratio
Mr. Tufan Singh	118.0	82,229	1,77,000	94,771	2.2
Mr. Kishan Gopal	107.0	78,775	1,60,500	81,725	2.1

Soil studies at sowing and at harvest of different rabi and summer crops:

At the time of sowing and after harvest of beet root crop, the soil ECe and pH were also calculated and presented in Table 10.39. In surface layer (0-15 cm), the ECe and pH ranged between 3.8-4.0 (dS/m) and 7.7-7.8. After harvest of beet root crop, soil salinity increase due to high SAR saline water irrigation. In cauliflower crop the ECe 4.3 and pH 7.7 was found at sowing time and after harvest these value were 4.5 and 7.8. In cabbage crop ECe 4.1 and pH 7.8 was found at sowing time and after harvest time these value were 4.1 and 7.8. In tomato crop sowing in winter season the ECe and pH ranged from 4.3 (dS/m) and 7.8 at the time of sowing and at harvest time these value ranged from 4.8 to 7.8 (dS/m). The coriander crop sowing in winter season the ECe and pH ranged from 4.2 (dS/m) and 7.7 at the time of sowing and at harvest time these value ranged from 4.5 to 7.8 (dS/m). In cluster bean crop sowing in rainy season the ECe and pH ranged from 4.2 (dS/m) and 7.8 at the time of sowing and at harvest time these value ranged from 4.5 to 7.8 (dS/m) .In onion crop sowing in rabi season the ECe and pH ranged from 4.0 (dS/m) and 7.8 at the time of sowing and at harvest time these value ranged from 5.2 to 7.8 (dS/m) . In carrot crop sowing in rabi season the ECe and pH ranged from 4.2 (dS/m) and 7.8 at the time of sowing and at harvest time these value ranged from 4.5 to 7.8 (dS/m). In okra crop sowing in rainy season the ECe and pH ranged from 3.8-4.1(dS/m) and 7.7-7.8 at the time of sowing and at harvest time these value ranged from 4.7-4.8 (dS/m) and 7.8.

Table 10.39: Soil analysis at sowing and at harvest of different rabi and summer crops in ORP farmers field (2020-21)

Farmers name	Soil Depth (cm)	At sowing		At harvest	
		ECe (dS/m)	pH	ECe (dS/m)	pH
Beet root					
Mr.Raj Veer	0-15	4.0	7.7	4.5	7.8
	15-30	4.2	7.7	4.8	7.8
Mr Kishan Gopal	0-15	3.8	7.8	4.5	7.7
	15-30	4.1	7.7	4.3	7.7
Cauliflower					
Mr.Tufan Singh	0-15	4.3	7.7	4.5	7.8
	15-30	4.5	7.7	4.7	7.8
Cabbage					
Mr.Kishan Gopal	0-15	4.1	7.8	4.4	7.8
	15-30	4.3	7.8	4.6	7.8
Tomato					
Mr.Tufan Singh	0-15	4.3	7.8	4.8	7.8
	15-30	4.4	7.7	4.9	7.8
Coriander					
Mr. Tufan Singh	0-15	4.2	7.7	4.5	7.8
	15-30	4.4	7.8	4.7	7.8
Cluster bean					
Mr Tufan Singh	0-15	4.2	7.8	4.5	7.8
	15-30	3.9	7.8	4.2	7.8
Okra					
Mr.Tufan Singh	0-15	3.8	7.7	4.8	7.8
	15-30	4.1	7.7	4.5	7.8
Mr.Kishan Gopal	0-15	4.1	7.8	4.7	7.8
	15-30	4.0	7.8	4.3	7.8
Onion					
Mr.Tufan Singh	0-15	4.0	7.8	5.2	7.8
	15-30	3.8	7.8	5.1	7.8
Carrot					
Mr.Tufan Singh	0-15	4.2	7.8	4.5	7.8
	15-30	4.5	7.8	4.8	7.8

Summer green gram-
Technological package for ORP demonstration:

The general information of summer green gram crop i.e. variety, No. of irrigations, date of sowing and date of harvest are presented in Table 10.40. The green gram crop was grown in summer season on selected farmer's field with conjunctive use of saline water with good quality underground water and canal water.

Table 10.40: General operations on farmer's field at green gram in summer crop (2020-21)

Name	Crop	Variety	No.of irrigations	Date of sowing	Date of harvesting
1.Mr.Deepak Singh	Green gram	PDM-139	3	07-04-2021	20-06-2021
2. Mr.Rabi Singh	Green gram	PDM-139	3	07-04-2021	22-06-2021
3. Mr.Nand Ram	Green gram	PDM-139	3	11-04-2021	27-06-2021
4. Mr. Kalichran	Green gram	PDM-139	3	11-04-2021	28-06-2021
5.Mr.Subhash	Green gram	PDM-139	3	13-04-2021	28-06-2021
6.Mr.Devendra	Green gram	PDM-139	3	12-04-2021	29-06-2021

Yield of green gram crop:

The grain yield data of ORP farmers and other farmers are presented in Table 10.41, which clearly indicate that ORP farmers green gram grain yield ranged from (5.8 to 8.3 q/ha) was higher than other farmers ranged from (5.5 to 7.8 q/ha). The straw yield of wheat crop also gave the same trend. The average increase of ORP farmers was 9.1% more over other farmers grain yield. At harvest of green gram crop the ECe and pH ranged from 3.9-4.4 dS/m, pH 7.7 - 7.8, respectively.

Table 10.41: Grain yield of green gram in ORP and other farmers field (q/ha) and soil ECe and pH (0-30 cm) of ORP farmers field at harvest 2021

Name of farmers	ORP farmers yield		Other farmer yield		Grain yield increase over traditional farming (%)	ECe at harvest (dS/m) (0-30cm)	pH (0-30cm)
	Grain	Straw	Grain	Straw			
1.Mr.Deepak Singh	8.1	10.8	7.2	9.2	11.1	4.3	7.8
2. Mr.Rabi Singh	7.8	10.6	7.1	9.5	8.9	3.9	7.7
3. Mr.Nand Ram	8.3	11.6	7.8	9.9	6.0	4.0	7.7
4. Mr. Kalicharan	7.5	12.8	6.5	8.3	13.3	4.4	7.7
5.Mr.Subhash	5.8	8.3	5.5	7.1	5.2	4.4	7.7
6.Mr.Devendra	6.8	9.5	6.1	7.9	10.3	3.8	7.8

Cost of cultivation, gross income, net profit and B: C ratio:

In green gram crop, the cost of cultivation, gross income, net profit (Rs/ha) and B:C ratio were calculate and presented in Table 10.42. It is clearly indicated that the cost of cultivation of ORP farmers almost less compared with other farmers. The gross income (Rs/ha) were higher in ORP farmers field compared with other farmers field. The net profit (Rs/ha) and B: C ratio was higher in ORP farmers compared with other farmers growing green gram crop.

Table 10.42: Cost of cultivation, gross income, net profit and B: C ratio of ORP farmers and other farmers in green gram crop (2021)

Farmers name	ORP farmers				Other farmers			
	Cost of cultivation (Rs/ha)	Gross Income (Rs/ha)	Net Profit (Rs/ha)	B:C ratio	Cost of cultivation (Rs/ha)	Gross Income (Rs/ha)	Net Profit (Rs/ha)	B:C ratio
1.Mr.Deepak Singh	22,800	56,700	33,900	2.5	21,750	50,400	28,650	2.3
2. Mr.Rabi Singh	21,750	54,600	32,850	2.5	22,210	49,700	27,490	2.2
3. Mr.Nand Ram	23,200	58,100	34,900	2.5	22,950	54,600	31,650	2.3
4. Mr. Kalichran	21,780	52,500	30,720	2.4	21,910	45,500	23,590	2.0
5.Mr.Subhash	21,220	40,600	19,380	1.9	21,370	38,500	17,130	1.8
6.Mr.Devendra	19,330	47,600	28,270	2.4	20,210	42,700	22,490	2.1

Soil studies at Sowing and harvest of green gram crop:

At the time of sowing and harvest of green gram crop, the soil ECe and pH was determined and presented in Table 10.43. In surface layer (0-15 cm), the ECe and pH ranged from 3.5 to 4.1 (dS/m) and 7.7 to 7.8, respectively. At harvest of green gram crop, soil salinity increase due to high SAR saline water irrigation. The ECe and pH ranged from 3.9 to 4.5(dS/m) and 7.7 to 7.8.

Table 10.43: Soil ECe and pH at sowing and at harvest of green gram crop in ORP farmer's field (2021)

Farmers name	SoilDepth (cm)	At sowing		At harvest	
		ECe (dS/m)	pH	ECe (dS/m)	pH
Mr.Deepak Singh	0-15	3.8	7.8	4.5	7.8
	15-30	3.4	7.7	4.1	7.8
Mr.Rabi Singh	0-15	3.5	7.8	4.0	7.7
	15-30	3.7	7.8	3.9	7.8
Mr.Nand Ram	0-15	3.9	7.7	4.2	7.7
	15-30	3.7	7.7	3.9	7.8
Mr.Kalichran	0-15	4.1	7.8	4.6	7.7
	15-30	3.8	7.7	4.2	7.8
Mr Subhash	0-15	4.0	7.7	4.5	7.7
	15-30	3.6	7.8	4.3	7.7
Mr.Devendra	0-15	3.6	7.8	3.9	7.7
	16-30	3.4	7.8	3.7	7.8

Water melon:

Technological details for ORP demonstration:

ORP farmers sown water melon on bed system for saving of irrigation water. The irrigation was done in mode of conjunctive use of saline water with good quality water. Water melon yield of 135.0 q/ha was recorded in the field of Mr. Tufan Singh and122.0 q/ha in Mr Satya Veer. The water melon crop gain Rs. 68,900 /ha as net profit and 3.6 benefit cost ratio in Mr Tufan Singh and Mr Satya Veer Rs 60,700 net profit and 3.5 B:C ratio (Table 10.44).

Table 10.44: Yield, cost of cultivation, gross income, net profit and B: C ratio of water melon crop of ORP farmer's field (2021)

Farmers name	Water melon fruit yield (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net profit (Rs/ha)	B:C ratio
Mr. Tufan Singh	135.0	25,650	94,500	68,900	3.6
Mr. Satya Veer	122.0	24,700	85,400	60,700	3.5

Photographs of pearl millet, sorghum, sesame and cotton crops on ORP farmer's field

Photographs of cotton, wheat,Mustard and Beet root crop in ORP Farmers field

Photographs of cauliflower, cabbage and cluster bean crop in ORP Farmers field

Photographs oftomato,okra,**coriander**and**carrot**in ORP farmers field

10.2 ORP at AICRP on SAS&USW, Bapatla

1. Project No: 5
2. Code No. P2-20/1(1)-AAI-F25-0150
3. Name of the Project: An Operational Research Project on alkali soils with different Reclamation Technologies
4.Basis for prioritization: As per the survey conducted by AICRP on management of salt affected soils and use of saline water in agriculture, Bapatla centre,the EC, SAR and RSC of ground water ranged from 0.7 to 2.0 dSm^{-1}, 5.0 to 24.28 and 3.0 to 12.8, respectively. The survey confirmed the presence of alkali ground water in the village. Use of poor quality groundwater for irrigation resulted yields of different crops are less by 10 to 20% compared to nearby villages where ground water quality is good. The soil samples were also collected from the fields of the selected farmer. On the basis of laboratory analysis, it was observed that soil ECe, pHs and ESP ranged from 2.3 to4.7 dSm^{-1}, 9.0 to 10.0 , and 37.0 to 55.4,respectively. The gypsum requirement @ 50% GR was worked out to be 7.5 t/ha.
5. Site of the Experiment: Farmers field (Guntur / Prakasam districts)

Objectives :

- To test and demonstrate the reclamation of alkali soils on farmers fields for crop production and to study the changes in soil properties

8. **Date of Initiation** : 2020-21
9. **Duration** : 3 years

10. Results any achieved so far :

Initial soil characteristics

SN	Name of the farmers	ECe (dS/m)	pH	CEC (c.mol(p+)/kg-1))	Exch. Na (c.mol(p+)/kg-1))	ESP (%)	Type of soils
1.	Sri T. Koteswara Rao	2.9	9.1	43.2	19.8	45.8	Alkali
2.	Sri T. Yerra Kotaiah	2.3	9.1	42.9	15.9	37.0	Alkali
3.	Sri J. Yakobu	3.4	9.0	36.8	20.4	55.4	Alkali
4.	Sri K. Babu Rao	4.7	10.0	19.3	9.2	47.7	Saline alkali
5.	Sri T. Yesu	8.3	9.3	25.2	12.6	50.0	Saline alkali

Final soil characteristics and crop yields

SN	Name of the farmer	ECe (dS/m)	pH	CEC (c.mol(p+)/kg-1))	Exch. Na (c.mol (p+)/kg-1))	ESP (%)	Grain yield (kg/ha)	
							Treated	Untreated
1.	Sri T. Koteswara Rao	2.3	8.7	46.9	17.2	36.7	4625	4150
2.	Sri T. Yerra Kotaiah	1.9	8.8	44.3	13.5	30.5	5360	4530
3.	Sri J. Yakobu	3.0	8.7	39.5	17.7	44.8	4270	3850
4.	Sri K. Babu Rao	4.1	9.5	20.4	7.8	38.2	4750	4230
5.	Sri T. Yesu	7.4	9.0	24.9	10.3	41.3	4590	4150

This experiment was carriedout in five farmer's field at Konanki village during *kharif* 2021 in soil having pH, ECe and ESP values ranging from 9.0 to 10.0, 2.9 to 8.3 and 37.0 to 55.4 respectively. Reclamation practices viz., *insitu* incorporation of dhaincha at 50% flowering stage and application of 50% quantity of gypsum requirement were practiced to reduce the adverse effect of alkali soils. Rice crop (var. NLR 33892) was planted during the month of September, 2021. With the adoption of reclamation technology 10.6 to 18.3% yield increase was observed compared to non-reclaimed soil.

The highest yield of 5360 kg ha^{-1} was recorded in reclaimed soil. The pH, ECe and ESP after harvest of the crop in reclaimed soil ranged from 8.7 to 9.5, 1.9 to 7.4 and 30.5 to 44.8 respectively.

11. Techniques adopted: Green manure (*dhaincha insitu*) , Leaching , Application of Gypsum

12. Data to be collected:

1. Five demonstrations will be carried out.
2. Initial and final analysis of soil samples for pH, ECe and ESP.
3. Grain yield at harvest.

Cost of the experiment:

	Particulars	**Approximate cost (Rs.)/plot**	**Approximate Cost for five plots**
1.	Amendments	20,000/-	1,00,000
2.	Transport	5,000/-	5,000
3.	Labour charges	10,000/-	50,000
	Total	**35,000/-**	**1,55,000**

13. Expected benefit to the farmers on adoption:

- The modification of technologies is beneficial to the farmers in many ways. The production will be improved and helpful to the farmers by adopting the technology for the crops to the higher level.
- Optimum production from alkali

10.3 Extension Activities by AICRP on SAS&USW, Gangavathi

Trainings: As Resource Persons: The followings are the major topics on which both on-campus and off-campus trainings were conducted for farmers, fertilizer and pesticide company dealers, field facilitators etc.

Sl. No.	Date & Venue	Title of the topic
1	02.12.20 KVK, Kawadimatti	Importance of drainage in the command UKP farmers
2	25.01.21 KVK, Gangavathi	Scope and importance of various farm implements and machineries DAESI participants
3	17.01.2020 KVK, Gangavathi	Drip irrigation in saline soil and irrigation water management
4	26.08.20 (Online) (CSAWM), MPKV, Rahuri	CONTROLLED DRAINAGE-A new approach to managing Nutrient loss from subsurface drainage system in Indian soils
5	09.03.21, KVK Gangavathi	Importance of drainage in the command

Technology released for Package of Practice

The following technologies have been approved for Inclusion in Package of Practices (POP) during NARP-ZREAC and ZREFC Kharif meet during 2020-21.

1. Assessment and mapping of salt affected soils of Raichur district in Tungabhadra command area of Karnataka
2. Surface and subsurface drip irrigation methods in Tomato
3. Surface and subsurface drip irrigation technologies in conserving moisture and yield of tomato crop
4. Saline water use in surface and subsurface drip in Tomato
5. Assessment and mapping of salt affected soils of Koppal district in Tungabhadra command area of Karnataka
6. Effect of saline water and use of saline water in agriculture for tomato.

TV/Radio programme

Date of Telecast	Title of the programme
01.02.2021	Management of problematic soils

11. Activities under Scheduled Caste Sub Plan (SCSP)

AICRP on SAS&USW, Agra

SCSP Activities during FY 2020-21

In SCSP programme the field demonstrations for the use of poor quality water have been initiated from Kharif, 2020 in Bhai Barari, Jalal village of Farah block of Mathura district and Laramda village ,block Bichpuri, District- Agra (U.P.). The village Bhai Barari and jalal village is located near Agra – Mathura highway road on the 4 km. away from Farah town. The Laramda village is located near (2 Km.) R.B.S. College, Bichpuri, Agra.

Distribution of Inputs to SCSP farmers for the year 2020-2021

S.No	Name of Farmers	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Crop	Seeds in Kg.	DAP in kg	MOP in kg	UREA in kg.
1	Shri. Mohar Singh	Shri. Vatasi	Bhahaibarari	Farah	Mathura	695729184792	9837458592	Bajra	1.5	25	25	45
2	Shri. Bhart	Shri. Bhoop Singh	Bhahaibarari	Farah	Mathura	602341244808	9557823482	Bajra	1.5	25	25	45
3	Smt. Machhladevi	Shri. Raj Karan	Bhahaibarari	Farah	Mathura	726115505487	7500961808	Bajra	1.5	25	25	45
4	Shri. Chandra Bhan	Shri. Batasi	Bhahaibarari	Farah	Mathura	425001684929	8126886326	Bajra	1.5	25	25	45
5	Shri. Roshni Sing	Shri. Patram	Bhahaibarari	Farah	Mathura	832665788130	9557415619	Bajra	1.5	25	25	45
6	Smt. Keshariya	Shri. Nathilal	Jalal	Farah	Mathura	801318226183	6398933094	Bajra	1.5	25	25	45
7	Shri. Sunhari	Shri. Chaatto	Jalal	Farah	Mathura	249633065083	9012194295	Bajra	1.5	25	25	45
8	Smt. Omvati	Shri. Vijendra	Jalal	Farah	Mathura	761026801576	9586630823	Bajra	1.5	25	25	45
9	Shri. Bisambhar	Shri. Kaloo	Jalal	Farah	Mathura	283049499192	7830103962	Bajra	1.5	25	25	45
10	Shri. Babulal	Shri. Lala Ram	Ladamada	Bichpuri	Agra	201701222589	7037558413	Bajra	1.5	25	25	45
								Grand total	**15**	**250**	**250**	**450**

Particulars	Quantity	Rates	Amount (Rs.)
Bajra	15 kg.	600/- per 1.5 kg.	6,000.00
D.A.P.	250 kg.	1,250 per 50 kg.bag.	6,250.00
M.O.P.	250 kg.	950/- per 50 kg. bag.	4,750.00
Urea	450 kg.	266.50 per 45 kg. bag.	2,665.00
		GRAND TOTAL	**19,665.00**

In Kharif, 2020 season, the pearlmillet seed, D.A.P., M.O.P. and Urea were distributed in between ten SCSP farmers. The five farmers were selected from village Bhai Barari and four farmers from Jalal village, block Farah, District- Mathura. One farmer was taken from Laramda village, Block Bichpuri, District- Agra (U.P.)

Distribution of Inputs to SCSP farmers for the year – 2020-2021

S.No	Name of Farmes	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Crop	Seeds in kg.	DAP in kg.	MOP in kg.
1	Shri. Sahab Singh	Shri. Vatasi	Bhahaibarari	Farah	Mathura	528056069837	9971558186	Mustard	1	25	30
2	Shri. Vani Singh	Shri. Roshan Singh	Bhahaibarari	Farah	Mathura	780759685702	9475815415	Mustard	1	25	30
3	Smt.Man Singh	Shri. Vatasi Ram	Bhahaibarari	Farah	Mathura	643488286767	9625963470	Mustard	1	25	30
4	Smt. Pankaj Devi	Shri. Bedhan Singh	Bhahaibarari	Farah	Mathura	447739105334	9012968986	Mustard	1	25	30
5	Shri. Raj Pal	Shri. Prem Singh	Bhahaibarari	Farah	Mathura	839086464388	7500367893	Mustard	1	25	30
6	Shri. Devi Singh	Shri. Bhavani	Bhahaibarari	Farah	Mathura	852752241196	6398358551	Mustard	1	25	30
7	Shri. Ter Singh	Shri. Shiv Charan	Jalal	Farah	Mathura	662477805616	9761932955	Mustard	1	25	30
8	Shri. Ratan	Shri. Bhola	Bhahaibarari	Farah	Mathura	782720491972	9012968986	Mustard	1	25	30
9	Shri. Kishan Singh	Shri. Ram Singh	Daulatpur	Farah	Mathura	453936965050	7500785490	Mustard	1	25	30
10	Shri. Rupi	Shri. Ram Singh	Bhahaibarari	Farah	Mathura	430018874158	7351661832	Mustard	1	25	30
								Grand total	**10**	**250**	**300**

Particulars	**Quantity**	**Rates**	**Amount (Rs.)**
Mustard seeds	10 kg.	750/- per kg.	7,500.00
D.A.P.	250 kg.	1,200 per 50 kg.bag.	6,000.00
M.O.P.	300 kg.	950/- per 50 kg. bag.	5,700.00
		GRAND TOTAL	**19,200.00**

In Rabi season, 2020-21 total number of ten farmers were selected in this program, from which eight farmers from Bhai Barari, one from Jalal and one farmer from Daulatpur , block Farah, district Mathura were selected. The Mustard seed, D.A.P. and M.O.P. was given to all farmers.

Distribution of Inputs to SCSP farmers for the year – 2020-2021

S.No	Name of Farmes	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Crop	Seeds in kg.	DAP in kg.	MOP in kg.
1	Shri. Mohar Singh	Shri. Vatasi	Bhahaibarari	Farah	Mathura	695729184792	9837458592	Wheat	40	50	35
2	Shri. Bhart	Shri. Bhoop Singh	Bhahaibarari	Farah	Mathura	602341244808	9557823482	Wheat	40	50	35
3	Smt. Machhladevi	Shri. Raj Karan	Bhahaibarari	Farah	Mathura	726115505487	7500961808	Wheat	40	50	35
4	Shri. Chandra Bhan	Shri. Batasi	Bhahaibarari	Farah	Mathura	425001684929	8126886326	Wheat	40	50	35
5	Shri. Roshni Sing	Shri. Patram	Bhahaibarari	Farah	Mathura	832665788130	9557415619	Wheat	40	50	35
6	Smt. Keshariya	Shri. Nathilal	Jalal	Farah	Mathura	801318226183	6398933094	Wheat	40	50	35
7	Shri. Sunhari	Shri. Chaatto	Jalal	Farah	Mathura	249633065083	9012194295	Wheat	40	50	35
8	Smt. Omvati	Shri. Vijendra	Jalal	Farah	Mathura	761026801576	9586630823	Wheat	40	50	35
9	Shri. Bisambhar	Shri. Kaloo	Jalal	Farah	Mathura	283049499192	7830103962	Wheat	40	50	35
10	Shri. Babulal	Shri. Lala Ram	Ladamada	Bichpuri	Agra	201701222589	7037558413	Wheat	40	50	35
Grand Total									**400**	**500**	**350**

Particulars	**Quantity**	**Rates**	**Amount (Rs.)**
Wheat seeds	400 kg.	Supplied by ICAR- CSSRI, Karnal	00.00
D.A.P.	500 kg.	1,200 per 50 kg.bag.	12,000.00
M.O.P.	350 kg.	940/- per 50 kg. bag.	6,580.00
		GRAND TOTAL	**18,580.00**

In the rabi season, 2020-21 ten farmers were selected for wheat crop in rabi season. From which five farmers were from Bhai Barari, Four from Jalal and one farmer from Laramda was chosen. The wheat seed (variety KRL- 210) provided by C.S.S.R.I., Karnal and fertilizer (D.A.P. and M.O.P.) were given to all selected farmers.

Distribution of Inputs to SCSP farmers for the year 2020-2021

S.No	Name of Farmes	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Crop	Seeds in kg.	Urea in kg.	N.P.K in kg.
1	Shri. Mohar Singh	Shri. Vatasi	Bhahaibarari	Farah	Mathura	695729184792	9837458592	Wheat	0	45	1
2	Shri. Bhart	Shri. Bhoop Singh	Bhahaibarari	Farah	Mathura	602341244808	9557823482	Wheat	0	45	1
3	Smt. Machhladevi	Shri. Raj Karan	Bhahaibarari	Farah	Mathura	726115505487	7500961808	Wheat	0	45	1
4	Shri. Chandra Bhan	Shri. Batasi	Bhahaibarari	Farah	Mathura	425001684929	8126886326	Wheat	0	45	1
5	Shri. Roshni Sing	Shri. Patram	Bhahaibarari	Farah	Mathura	832665788130	9557415619	Wheat	0	45	1
6	Smt. Keshariya	Shri. Nathilal	Jalal	Farah	Mathura	801318226183	6398933094	Wheat	0	45	1
7	Shri. Sunhari	Shri. Chaatto	Jalal	Farah	Mathura	249633065083	9012194295	Wheat	0	45	1
8	Smt. Omvati	Shri. Vijendra	Jalal	Farah	Mathura	761026801576	9586630823	Wheat	0	45	1
9	Shri. Bisambhar	Shri. Kaloo	Jalal	Farah	Mathura	283049499192	7830103962	Wheat	0	45	1
10	Shri. Babulal	Shri. Lala Ram	Ladamada	Bichpuri	Agra	201701222589	7037558413	Wheat	0	45	1
								Grand Total	**0**	**450**	**10**

Particulars	**Quantity**	**Rates**	**Amount (Rs.)**
Wheat seeds	00 kg.		00.00
UREA	450 kg.	266.50 per 45 kg.bag.	2,665.00
N.P.K. (O:52:34)	10 kg.	175/- per kg.	1,750.00
		GRAND TOTAL	**4,415.00**

The additional dose of Urea and liquid N.P.K. was distributed to all selected farmers.

SCSP Activities during FY 2021-22

Grant in General Fund:

Distribution of Inputs to SCSP farmers for the year 2021-2022

S.No	Name of Farmes	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Crop	Seeds in Kg.	DAP in Kg.
1	Shri. Mohar Singh	Shri. Vatasi	Bhahaibarari	Farah	Mathura	695729184792	9837458592	Bajra	1.5	50
2	Shri. Bhart	Shri. Bhoop Singh	Bhahaibarari	Farah	Mathura	602341244808	9557823482	Bajra	1.5	50
3	Smt. Machhladevi	Shri. Raj Karan	Bhahaibarari	Farah	Mathura	726115505487	7500961808	Bajra	1.5	50
4	Shri. Chandra Bhan	Shri. Batasi	Bhahaibarari	Farah	Mathura	425001684929	8126886326	Bajra	1.5	50
5	Shri. Roshni Sing	Shri. Patram	Bhahaibarari	Farah	Mathura	832665788130	9557415619	Bajra	1.5	50
6	Smt. Keshariya	Shri. Nathilal	Jalal	Farah	Mathura	801318226183	6398933094	Bajra	1.5	50
7	Shri. Sunhari	Shri. Chaatto	Jalal	Farah	Mathura	249633065083	9012194295	Bajra	1.5	50
8	Smt. Omvati	Shri. Vijendra	Jalal	Farah	Mathura	761026801576	9586630823	Bajra	1.5	50
9	Shri. Bisambhar	Shri. Kaloo	Jalal	Farah	Mathura	283049499192	7830103962	Bajra	1.5	50
10	Shri. Babulal	Shri. Lala Ram	Ladamada	Bichpuri	Agra	201701222589	7037558413	Bajra	1.5	50
11	Shri. kalua	Shri. Lala Ram	Ladamada	Bichpuri	Agra	243607580348	8954695377	Bajra	1.5	50
								Grand Total	**16.5**	**550**

Particulars	**Quantity**	**Rates**	**Amount (Rs.)**
Bajra seeds	16.5 kg.	600/- per 1.5 kg. pkt.	6,600.00
D.A.P.	550 kg.	1,200/- per 50 kg.bag.	13,200.00
		GRAND TOTAL	**19,800.00**

In Kharif, 2021 season, the pearl millet seed and D.A.P. was distributed in between Eleven SCSP farmers. The five farmers were selected from village Bhai Barari and four farmers from Jalal village; block Farah, District- Mathura. Two farmers were taken from Laramda village, Block Bichpuri, District- Agra (U.P.)

Distribution of Inputs to SCSP farmers for the year 2021-2022

S.No	Name of Farmer	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Crop	Seeds in kg.	Vermi Compost in kg	Urea in kg
1	Shri. Mohar Singh	Shri. Vatasi	Bhahaibarari	Farah	Mathura	695729184792	9837458592	Wheat	40	50	90
2	Shri. Bhart	Shri. Bhoop Singh	Bhahaibarari	Farah	Mathura	602341244808	9557823482	Wheat	40	50	90
3	Smt. Machhladevi	Shri. Raj Karan	Bhahaibarari	Farah	Mathura	726115505487	7500961808	Wheat	40	50	90
4	Shri. Chandra Bhan	Shri. Batasi	Bhahaibarari	Farah	Mathura	425001684929	8126886326	Wheat	40	50	90
5	Shri. Roshni Sing	Shri. Patram	Bhahaibarari	Farah	Mathura	832665788130	9557415619	Wheat	40	50	90
6	Shri. Khyali	Shri. Nathi	Bhahaibarari	Farah	Mathura	836063645009	9917216553	Wheat	40	50	90
7	Shri. Soni Ram	Shri. Nathi	Bhahaibarari	Farah	Mathura	888613913473	8218245607	Wheat	40	50	90
8	Smt. Natver Singh	Shri. Firan Singh	Bhahaibarari	Farah	Mathura	843951942718	6398358551	Wheat	40	50	90
9	Shri. Malkhan Singh	Shri. Patram	Bhahaibarari	Farah	Mathura	281791050823	9627459610	Wheat	40	50	90
10	Shri. Babulal	Shri. Lala Ram	Ladamada	Bichpuri	Agra	201701222589	7037558413	Wheat	40	50	90
11	Shri. kalua	Shri. Lala Ram	Ladamada	Bichpuri	Agra	243607580348	8954695377	Wheat	40	50	90
								Grand Total	**440**	**825**	**990**

Particulars	Quantity	Rates	Amount (Rs.)
Wheat seeds KRL-210	440 kg.	Supplied by ICAR- CSSRI, Karnal	16,700.00
Vermi Compost	825 kg.	20/- per kg.	16,500.00
Urea	990 kg.	266.50 per 45 kg.bag	5,863.00
		GRAND TOTAL	**39,063.00**

In the rabi season, 2021-2 2 Eleven farmers were selected for wheat crop in rabi season. From which nine farmers were from Bhai Barari and two farmer from Laramda was chosen. The wheat seed (variety KRL- 210) provided by C.S.S.R.I., Karnal and fertilizer (Urea and Vermi compost) was given to all selected farmers.

Distribution of Inputs to SCSP farmers for the year 2021-2022

S.No	Name of Farmer	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Crop	Seeds in kg	DAP in kg
1	Shri. Mohar Singh	Shri. Vatasi	Bhahaibarari	Farah	Mathura	695729184792	9837458592	Moong	4	50
2	Shri. Bhart	Shri. Bhoop Singh	Bhahaibarari	Farah	Mathura	602341244808	9557823482	Moong	4	50
3	Smt. Machhladevi	Shri. Raj Karan	Bhahaibarari	Farah	Mathura	726115505487	7500961808	Moong	4	50
4	Shri. Chandra Bhan	Shri. Batasi	Bhahaibarari	Farah	Mathura	425001684929	8126886326	Moong	4	50
5	Shri. Roshni Sing	Shri. Patram	Bhahaibarari	Farah	Mathura	832665788130	9557415619	Moong	4	50
6	Shri. Khyali	Shri. Nathi	Bhahaibarari	Farah	Mathura	836063645009	9917216553	Moong	4	50
7	Shri. Soni Ram	Shri. Nathi	Bhahaibarari	Farah	Mathura	888613913473	8218245607	Moong	4	50
8	Smt. Natver Singh	Shri. Firan Singh	Bhahaibarari	Farah	Mathura	843951942718	6398358551	Bottle Gourd	0.5	50
9	Shri. Malkhan Singh	Shri. Patram	Bhahaibarari	Farah	Mathura	281791050823	9627459610	Moong	4	50
10	Shri. kalua	Shri. Lala Ram	Ladamada	Bichpuri	Agra	243607580348	8954695377	Moong	4	50
								Grand Total	**36.5**	**500**

Particulars	**Quantity**	**Rates**	**Amount (Rs.)**
Moong Seeds (Green Gram)	36 kg.	210/- per kg.	7,560.00
Botttle Gourd	500 gm.	1,200/- per kg.	600.00
Pro- DAP	500 kg.	1,190/- per 50 kg.bag	11,900.00
		GRAND TOTAL	**20,060.00**

In Summer, 2022 season, the moong seed and Prom. D.A.P. was distributed in between Nine SCSP farmers. From which eight farmers were selected from village Bhai Barari and one from Laramda village, to one farmer from Bhai Barari, block Farah, District- Mathura was given seed of Bottle Guard and Prom. D.A.P.

Distribution of Inputs to SCSP farmers for the year 2021-2022

S.No	Name of Farmes	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Sprayer Machine
1	Shri. Mohar Singh	Shri. Vatasi	Bhahaibarari	Farah	Mathura	695729184792	9837458592	1
2	Shri. Bhart	Shri. Bhoop Singh	Bhahaibarari	Farah	Mathura	602341244808	9557823482	1
3	Smt. Machhladevi	Shri. Raj Karan	Bhahaibarari	Farah	Mathura	726115505487	7500961808	1

4	Shri. Chandra Bhan	Shri. Batasi	Bhahaibarari	Farah	Mathura	425001684929	8126886326	1
5	Shri. Roshni Sing	Shri. Patram	Bhahaibarari	Farah	Mathura	832665788130	9557415619	1
6	Shri. Khyali	Shri. Nathi	Bhahaibarari	Farah	Mathura	836063645009	9917216553	1
7	Smt. Natver Singh	Shri. Firan Singh	Bhahaibarari	Farah	Mathura	843951942718	6398358551	1
8	Shri. Malkhan Singh	Shri. Patram	Bhahaibarari	Farah	Mathura	281791050823	9627459610	1
9	Shri. Babulal	Shri. Lala Ram	Ladamada	Bichpuri	Agra	201701222589	7037558413	1
							Grand Total	9

Particulars	Quantity	Rates	Amount (Rs.)
Sprayer Machine (Arshi Tech.)	09 kg.	3,000/- per no.	27,000.00
		GRAND TOTAL	**27,000.00**

The sprayer machines were distributed in between eight farmers of Bhai Barari, block Mathura and one farmer of village Laramda.


Grant in Capital (SCSP)

Construction of recharge structure on farmer's field FY 2021-2022

S.No	Name of Farmes	Fathers/ Husband Name	Village	Block	District	Aadhar No.	Mobile No.	Recharge Structure
1	Shri. Soni Ram	Shri. Nathi	Bhanaibarari	Farah	Mathura	888613913473	8218245607	01 Unit
							Grand Total	**01 Unit**

Particulars	Quantity	Rates	Amount (Rs.)
Recharge filter tank of size (8'x8'x5')	1 Unit	49,944/- per unit	49,944.00
		GRAND TOTAL	**49,944.00**

One recharge well was constructed in the field of Shri Soni Ram of village Bhai Barari, district- Farah, Mathura (U.P.)

AICRP on SAS&USW, Bapatla

1. Activities under **SCSP Capital** (Both Shares Rs. 58,666)- ICAR Allocation: Rs. 44,000/-

	Expenditure
Purchase of Sprayers for distribution to the SC farmers	- Rs. 33,040
Preparation of gypsum bed in farmers field (2 Nos.)	- Rs. 25,600
Total	Rs. 58,640

Distribution of Sprayers to SC farmers

S.No.	Name of the farmer	Village/Mandal	Aadhar No:
1	Jogi Israyalu	Peralipadu, KarlaPalem Mandal	785958313952
2	Botimera Anil Kumar	Mulapalem, Bapatla Md	995798154132
3	Nadendla Bhanu Pradad	Karlapame, KarlaPalem Mandal	455006648801
4	Dondamudi Chittiaiah	Gopapuram, Bapatla Md	937009057550
5	Katta Veravasantha Rao	Jammulapalem, Bapatla Md	707048215274
6	Peram Isaku	Betapudi	520940932861
7	Are Jaya Raju	Kankatapalem	824307806569
8	Arrya Mikhayelu	Murukondapadu	272864813598
9	Chebrolu Veeraiah	Chandolu	783162181208
10	Regulagadda Koteswara Rao	Cheruvu Jammulapalem, Bapatla Md	689424507024

1. Activities under **SCSP General** (Both Shares Rs. 66,667) ICAR Allocation: Rs. 50,000/-

	Expenditure
➢ Purchase of groundnut seed material for distribution to the SC farmers	-Rs. 29,700
➢ Purchase of fertilizers for distribution to the SC farmers	-Rs. 4,288
➢ Purchase of pesticides for distribution to the SC farmers	- Rs. 4,204
➢ Collection of soil and water samples from field's of SC farmers ➢ Processing of soil and water samples collected from farmers field ➢ Labour charges for chemical analysis of water and soil samples	-Rs. 28,319
Total	Rs. 66,511

Gypsum bed installed at farmers field, Giddaluru village of Prakasam district

Distribution of fertilizers to SC farmers

S.No.	Name of the farmer	Village/Mandal	Aadhar No:
1	Mikkili Yeliya	Mulapalem, Bapatla Md	358816476366
2	Mikkili Mariya Raju	Mulapalem, Bapatla Md	839832318150
3	Bolimerla Bhushanam	Mulapalem, Bapatla Md	637755394030
4	Regulagadda Rajesh	Mulapalem, Bapatla Md	655951677696
5	Bejjam Manikya Rao	Mulapalem, Bapatla Md	817441177119
6	Dasari Madhu Babu	Matinavaripalem, Pitlavanipalem Md	287336115856
7	Neela Musili	Mantinavaripalem, Pitlavanipalem Md	819291897715
8	Kommuri Devadanam	Khajipalem, Pitlavanipalem Md	609106767531
9	Dasari Samuel	Gopapuram, Bapatla Md	245387324162
10	Kumari Kotaiah	Kankatapalem, Bapatla Md	727702862170
11	Gerra Samuel	Eetheru, Bapatla Md	564553189667
12	Gummadi Daveedu	Gudipudi, Bapatla Md	591956037595
13	Palika Subba Rao	Bhavanamvaripalem, Pitlavanipalem Md	867862502321
14	Dokka Venkaiah	Bhavanamvaripalem, Pitlavanipalem Md	342465335215
15	Regulagadda Koteswara Rao	Cheruvu Jammulapalem, Bapatla Md	689424507024
16	Mikkili Nagendramma	Cheruvu Jammulapalem, Bapatla Md	897353655258
17	Gannepudi Bhaskara Rao	Bhavanamvaripalem, Pitlavanipalem Md	493374243826
18	Vaddimukkala David	Chintavaripalem, Bapatla Md	496928830521
19	Nakka Balavani	Chintavaripalem, Bapatla Md	466729502501
20	Ch. Gidyonu	Sangupalem, Pitlavanipalem Md	435301378692
21	B. Rahul	Mulapalem, Bapatla Md	299742418080
22	K. Samuel John	Ganapavaram	232004532343
23	Yaram Mohana Rao	Yaramvaripalem, Kalapalu Md	549563560880
24	Chebrolu Veeraiah	Chandolu	783162181208
25	Jogi Israil	Peralipadu	785958313952
26	Jogi Asarvadam	Peralipadu	733989158628

Distribution of Groundnut seed to SC farmers

S.No.	Name of the farmer	Village/Mandal	Aadhar No:
1	Gogi Aservadam	Peralipadu	733989158628
2	Jogi Israiel	Peralipadu	785958313952
3	Chebrolu Veeraiah	Chandolu	783162181208

Distribution of Fertilizers to SC farmers at SWS, Bapatla

Distribution of Sprayers to SC farmers

Distribution of fertilizers and pesticides

AICRP on SAS&USW, Bikaner

Details of activities conducted under SCSP head during FY 2021-22

SCSP Capital for FY 2021-22

Name of Centre	AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture, Bikaner
Allocation under SCSP Capital for FY 2021-22	Allocation - Rs. 73000 /- Expenditure – Rs. 72950 /-
Activities undertaken SCSP Capital	

S. N.	Activity details	Date	Place	Number of beneficiaries			Input distributed to farmers
				Male	Female	Total	
1.	One day training cum input distribution programme was conducted at ARS, Bikaner under SCSP head	03.03.22	ARS, Bikaner	12	08	20	04 battery operated sprayer and 16 Seed Storage bins were distributed to farmers

List of Beneficiaries, address and Aadhar number with supporting photo

S.No.	Name of Beneficiaries	Address	Mobile No.	Aadhar No.	Input Distributed
1	Shankar Ram S/o Jetharam	Kavani,Bikaner	-	662738567277	Battery operated Sprayer
2	Asharam S/o Pusharam	Kavani, Bikaner	9928953527	388785076186	Seed Storage Bin
3	Ishwarram S/o Rauram	Kavani, Bikaner	9680961734	822300897897	Seed Storage Bin
4	Kishnaram S/o Jetharam	Kavani, Bikaner	9960193268	686942228232	Seed Storage Bin
5	Umaram S/o Pusharam	Kavani, Bikaner	7357919758	263865601307	Battery operated Sprayer
6	Kujuram S/o Fakira	Kavani, Bikaner	9936347122	446807455238	Seed Storage Bin
7	Lija Devi W/o Poonamram	Kavani, Bikaner	-	945422088352	Seed Storage Bin
8	Chotha Devi W/o Ashuram	Kavani, Bikaner	-	404453417333	Seed Storage Bin
9	Hawa Kumari D/o Bagaram	Kavani, Bikaner	9001603231	457708364091	Seed Storage Bin
10	Bhikhi D/o Natharam	Kavani, Bikaner	-	371976376272	Seed Storage Bin
11	Nano Devi W/o Omaram	Kavani, Bikaner	-	767762793009	Seed Storage Bin
12	Nathathi Devi W/o Fakiraram	Kavani, Bikaner	-	431086005610	Seed Storage Bin
13	Sumitra W/o Ruparam	Kavani, Bikaner	-	205027254672	Seed Storage Bin
14	Ramnarayan S/o Kishnaram	Kavani, Bikaner	9024997719	569493981237	Seed Storage Bin
15	Bhanwal Lal S/o Kasiram	Kavani,	7297993302	934437402341	Seed Storage Bin

		Bikaner			
16	Sanjuram S/o Bhiyaram	Kavani, Bikaner	8000918700	267101262425	Battery operated Sprayer
17	Jalaram S/o Bagaram	Kavani, Bikaner	9950841284	669173538736	Seed Storage Bin
18	Gopal Ram S/o Fakraram	Kavani, Bikaner	-	934068242758	Seed Storage Bin
19	Umedi W/o Kojuram	Kavani, Bikaner	-	394203073454	Battery operated Sprayer
20	Kojuram S/o Biramram	Gersar, Bikaner	9351152832	377444467180	Seed Storage Bin

Training cum input distribution under SCSP Capital Head

SCSP General for FY 2021-22

Name of Centre	AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture, Bikaner
Allocation under SCSP Capital for FY 2021-22	Allocation - Rs. 67000 /- Expenditure – Rs. 65794 /-
Activities undertaken SCSP general	

Details of Activities

S. N.	Activity details	Date	Place	Number of beneficiaries			Input distributed to farmers
				Male	Female	Total	
1	One day on campus training cum seed distribution programme for SC farmers under SCSP Head	26.06.21	ARS, Bikaner	06	-	06	8 kg cluster bean seed provided to each farmer
2.	One day off campus training cum seed distribution programme under SCSP Head	03.07.21	village Kilchu Devran, Bikaner	18	1	19	8 kg cluster bean seed provided to each farmer
3.	one day on campus training on management of salt affected soils and use of saline water in agriculture and distribution of wheat seed and fertilizers for demonstrations under SCSP head	16.11.2021	ARS, Bikaner	10	01	11	Seed 40 kg, Urea 100 kg, SSP 60 kg, MOP 13.5 and Zinc Sulphate 6 kg provided to each farmers

List of Beneficiaries, address and Aadhar number with photo

S.No.	Name of Beneficiaries	Address	Mobile No.	Aadhar No.	Input Distributed
1	Sitaram S/o Asaram	Kitasar Bidawatan, Bikaner	7414061775	937621255840	Clusterbean Seed
2	Dharamram S/o Sugnaram	Jogaliya, Churu	9660274062	958112519614	Clusterbean Seed
3	Chenaram S/o Bhanwar Lal	Kitasar Bidawatan, Bikaner	7568476544	267980514422	Clusterbean Seed
4	Girdhari Lal S/o Bhojraj	Kitasar Bhatiyan, Bikaner	9864257687	863681489696	Clusterbean Seed
5	Mahavir S/o Parbhuram	Kitasar Bidawatan, Bikaner	8889771731	567722161101	Clusterbean Seed
6	Bhanwal Lal S/o Natharam	Kitasar Bhatiyan, Bikaner	8107727350	575209337116	Clusterbean Seed
7	Vijay S/o Kishnaram	Kilchu Devran, Bikaner	7014780601	210030884914	Clusterbean Seed
8	Tolaram S/o Nemiram	Kilchu Devran, Bikaner	9636435352	328037045572	Clusterbean Seed
9	Babulal S/o Rewant ram	Kilchu Devran, Bikaner	7023216329	418051314215	Clusterbean Seed
10	Manak Ram S/o Asuram	Kilchu Devran, Bikaner	6350352863	861778697480	Clusterbean Seed
11	Bhanwari W/o Ashuram	Kilchu Devran, Bikaner	-	372924171077	Clusterbean Seed
12	Raju Ram S/o Ashuram	Kilchu Devran, Bikaner	7742728988	210632089166	Clusterbean Seed
13	Deeparam S/o Imarataram	Kilchu Devran, Bikaner	9602485224	667289101824	Clusterbean Seed

14	Maggaram S/o Nathuram	Kilchu Devran, Bikaner	8290930449	699500493432	Clusterbean Seed
15	Nemaram S/o Nathuram	Kilchu Devran, Bikaner	9636736220	281112752486	Clusterbean Seed
16	Pradeep S/o Hanumanram	Kilchu Devran, Bikaner	8000283360	785493931269	Clusterbean Seed
17	Prahalad S/o Kumbharam	Kilchu Devran, Bikaner	9925376880	721271989768	Clusterbean Seed
18	Poonamchand S/o Hanumanram	Kilchu Devran, Bikaner	9983720617	406648147386	Clusterbean Seed
19	Hanumanram S/o Tolaram	Kilchu Devran, Bikaner	9571731121	237071711659	Clusterbean Seed
20	Ghanshayam S/o Hanumanram	Kilchu Devran, Bikaner	-	217702412629	Clusterbean Seed
21	Gopalram S/o Kishnaram	Kilchu Devran, Bikaner	6377211305	692410333487	Clusterbean Seed
22	Kuluram S/o Dularam	Kilchu Devran, Bikaner	9784966807	494339754332	Clusterbean Seed
23	Rajuram S/o Dullaram	Kilchu Devran, Bikaner	9784966807	748669975272	Clusterbean Seed
24	Lunaram S/o Aduram	Kilchu Devran, Bikaner	9166872621	902885426464	Clusterbean Seed
25	Manakram S/o Dularam	Kilchu Devran, Bikaner	-	550188037897	Clusterbean Seed
26	Omaram S/o Bagaram	Kavani, Bikaner	9660127306	840716039939	Wheat Seed & Fertiliser
27	Manoj Kumar S/o Tikuram	Kavani, Bikaner	7742475282	937367050287	Wheat Seed & Fertiliser
28	Mohan Ram S/o Beraram	Kavani, Bikaner	9660127306	748245818929	Wheat Seed & Fertiliser
29	Surendra Kumar S/o Ganesh Ram	Kavani, Bikaner	8003931419	469590809923	Wheat Seed & Fertiliser
30	Sunil Kumar S/o Fakiraram	Kavani, Bikaner	6378810238	453672609612	Wheat Seed & Fertiliser
31	Bhikaram S/o Pannaram	Kavani, Bikaner	90011858251	873339150612	Wheat Seed & Fertiliser
32	Anil Kumar S/o Ashuram	Kavani, Bikaner	8302594392	623967169300	Wheat Seed & Fertiliser
33	Ashuram S/o Rauram	Kavani, Bikaner	8003931410	937671032029	Wheat Seed & Fertiliser
34	Jetharam S/o Bhairaram	Kavani, Bikaner	9929040554	747080139391	Wheat Seed & Fertiliser
35	Bhanwari Devi W/o Baluram	Kavani, Bikaner	8107337450	809820886104	Wheat Seed & Fertiliser
36	Nathuram S/o Baluram	Kavani, Bikaner	9636928403	873867575737	Wheat Seed & Fertiliser


Training cum seed distribution programme of Clusterbean and Wheat for demonstration

AICRP on SAS&USW, Gangavathi

SCSP General

1. Allocations under SCSP General for FY 2021-22 and Utilization:
   Allocation : Rs. 0.70 Lakh (ICAR Share)
   Utilization : Rs. 0.69754 Lakh (ICAR Share)

2. Activities undertaken under SCSP- General:
   Agricultural Inputs viz., $ZnSO_4$, $FeSO_4$, Soil conditioner (Ca, Mg and S) and Organic magic were distributed and explained the significance their usage in crop production especially in degraded soils.
3. List of beneficiaries, with address and Aadhar number (if available), supporting photo:

List of Beneficiaries under SCSP Program during 2021-22

Sl. No	Name and Address of Beneficiaries
1	Sri. Sharanappa S/o. Pakkirappa, Heroor. Mobile: 9886763086
2	Sri. Vasant Kumar S/o. Smt. Mallamma. Heroor. Mobile: 8548090923
3	Sri. Hemanna S/o Yenkappa Kalmani. Gangavathi. Mobile: 9740419342
4	Sri. Ashok S/o Hanumanthappa, Gangavathi. Mobile: 9741709140
5	Sri. Kanteppa S/o Mayappa. Singhanal. Mobile: 9632604464
6	Kariyamma D/o. Kenchamma. Singhanal. Mobile: 9663229139
7	Sri. Mayappa S/o. Barmamma. Singhanal. Mobile: 9632604464
8	Smt. Shivamma W/o Mayappa. Singanal. Mobile: 9632604464
9	Sri. Adeppa S/o Somappa. Singhanal. Mobile: 9663229139
10	Smt. Mayamma D/o. Barmamma. Singhanal. Mobile: 963229139
11	Sri. Pampapathi S/o. Nagappa. Heroor. Mobile: 9632356686
12	Smt. Iramma W/o. Nagappa. Heroor. Mobile: 9632356686
13	Sri. Lakshmana S/o Golla Hanumantha. Singhanal. Mobile: 8217743073
14	Smt. Murugamma W/o Kariyappa. Singhanal. Mobile: 9743797843
15	Smt. Duragammaa W/o. Huchappa Devaramani. Gangavathi. Mobile: 8197313667
16	Sri. Venkoba S/o Hulagappa. Gangavathi. Mobile: 9743653811
17	Smt. Huligemma W.o Husenappa. Markumbi. Mobile: 9591061965
18	Sri. Sanna Bheemappa Husenappa Khawadi. Markumbi. Mobile: 9591061965
19	Sri. Maresh S/o Hanumanthappa. Mustoor. Mobile: 9945338404
20	Smt. Neelamma W/o Subhash, Jeerala Kalgudi. Mobile: 9591846266

AICRP on SAS&USW, Hisar

- Allocations under SCSP General for FY 2021-22 and Utilization:

Allocation: **500000/Rs. and** Utiliztion**= 48300-Rs.**

- Activities undertaken under SCSP- General: **Distribution of Mineral Mixture for Animal/Wheat Seed**

List of beneficiaries, with address and Aadhar number (if available), supporting photo

Sr. No.	Name of Beneficiary	Adhar Number	Material Provided
1.	Tilk Raj	918109538939	Mineral Mixture for Animal
2.	Abhishek	782166396579	Mineral Mixture for Animal
3.	Pappu	848810941725	Mineral Mixture for Animal
4.	Pardeep	928663632038	Mineral Mixture for Animal
5.	Subhash	736831830029	Mineral Mixture for Animal and wheat seed
6.	Dharmpal	252506823322	Mineral Mixture for Animal
7.	Ram Pratap	972433026970	Mineral Mixture for Animal and wheat seed
8.	Suresh	353593017839	Mineral Mixture for Animal
9.	Ravi	430732251619	Mineral Mixture for Animal and wheat seed
10.	Gautam	978224610121	Mineral Mixture for Animal and wheat seed
11.	Kamal	230396612961	Mineral Mixture for Animal
12.	Ravi	403205790245	Mineral Mixture for Animal
13.	Kuldeep	779405938445	Mineral Mixture for Animal
14.	Vikash	428379218382	Mineral Mixture for Animal
15.	Dharamveer	377279347124	Mineral Mixture for Animal
16.	Krishan Kumar	898047023887	Mineral Mixture for Animal
17.	Kuldeepo	752584451406	Mineral Mixture for Animal
18.	Kanwal Singh	903846115772	Mineral Mixture for Animal
20.	Amarveer	893297863181	Mineral Mixture for Animal
21.	Sachin	509399368882	Mineral Mixture for Animal
22.	Vinod	666388815611	Mineral Mixture for Animal
23.	Babita	489620589479	Wheat seed
24.	Ravi Kumar	601574358978	Wheat seed
25.	Krisan Kumar	358051390622	Wheat Seed
26.	Ajeet	257286289971	Wheat seed
27.	Roshni Devi	730904106429	Wheat Seed
28.	Kuldeep	878973325702	Wheat Seed
29.	Jagmal	775715432167	Wheat Seed
30.	Mani Ram	464076638151	Wheat seed
31.	Satpal	498986683317	Wheat Seed
32.	Sajender Singh	450635434422	Wheat seed
33.	Rajbir	355868802664	Wheat Seed


SCSP
Program
ALL INDIA COORDINATED RESEARCH PROJECT
आजादी का अमृत महोत्सव
चौधरी चरण सिंह हरियाणा कृषि विश्वविद्यालय, हिसार
किसान
QUALITY SEED

AICRP on SAS&USW, Tiruchirappalli

SCSP Capital

- Allocations under SCSP Capital for FY 2021-2022 and Utilization : **1.41 Lakhs**
- Activities undertaken under SCSP – Capital :
  - i) Purchased Cono weeder, Battery operated Sprayer, Spade, LCD Projector and Exhibition board for SCSP Farmers use on need basis and maintained at AICRP.
  - ii) Purchased the Gravity Drip Irrigation kit and demonstrated maintained at AICRP
  - iii) Purchased Sports materials for youths of the adopted village and distribution programme was conducted on 11.07.2022 at Aravakudi village, Manikandam block, Tiruchirappalli and the Sports materials are represented by the adopted village youths.

SCSP General

- Allocations under SCSP General for FY 2021-2022 and Utilization : **1.55 Lakhs**
- Activities undertaken under SCSP – General :
  - i) Purchased and Distributed the Gypsum and Coconut seedlings to the adopted village of Aravakudi village, Manikandam Block, Tiruchirappalli District on 10.12.2021
  - ii) Purchased and Distributed the Vegetable seeds, Grow bags, Vermicompost bags
  - iii) Training and Input Distribution Programme was conducted on 11.07.2022 at Aravakudi village, Manikandam block, Tiruchirappalli.
  - iv) Purchased the LCD Screen for Farmers Training programme and maintained at AICRP

List of the Beneficiaries for Gypsum and Coconut seedlings

Sl.No	Name of the Beneficiaries	Address
1	S.Sakthivel	Aruvakudi village,Kallikudi (N), Trichy-D.t
2	S.Thavasu, S/o Sangapillai	547, Aruvakudi, Trichy D.t
3	S.Saraswathi W/o Ramasamy	562, Aruvakudi, Trichy (D.t)
4	V.IlaiyarajaS/o Vadivel	561/1, Aruvakudi,Trichy(D.t)
5	M.Velayi W/o Muniyappan	South Street, Aruvakudi,Trichy (D.t)
6	N.Dhanalakshmi W/oEdumban	505, Aruvakudi,Trichy (D.t)
7	A.Megala W/o Anbalagan	502, Aruvakudi,Trichy(D.t)
8	A.Murugayi W/oAmmasi	555-1, Aruvakudi,Trichy(D.t)
9	P.Susila W/o Palanisamy	485-1, Aruvakudi,Trichy(D.t)
10	P.Rajamanickam S/oPalanisamy	531, Aruvakudi,Trichy-D.t
11	T.Palanisamy S/oThiruppan	531, Aruvakudi,Trichy-D.t
12	R.Anjammal W/oRamasamy	579, Aruvakudi village,Trichy-D.t
13	P.Palaniyammal W/oPalanisamy	486, Aruvakudi,Trichy-D.t
14	B.Kalapana W/o Bhakkiyaraj	561-2, Aruvakudi,Kallikudi(N), Trichy-D.t
15	T.Neela W/oThangaiya	555-2, Aruvakudi,Trichy-D.t
16	S.Palaniyammal W/oSakthivel	483, Aruvakudi,Trichy – D.t
17	P.Latha W/o Perumal	Aruvakudi, Manikandam Union,Trichy-D.t
18	C.Bhakkiyaraj S/o Chinnaiyan	484, Aruvakudi,Kallikudi(N), Trichy-D.t
19	S.Marikannu W/oSubramani	529-1, Aruvakudi,Kallikudi, SriRangam(T.k)Trichy(D.t)
20	V.Palaniyammal W/o Velan,	529-1, Aruvakudi Village,Kallikudi (N),Sri Rangam T.k, Trichy-D.t
21	S.Sasikumar S/o Subramani	529-1, Aruvakudi village,Kallikudi (N), Trichy Dt
22	S.Diyana W/o Shankar	488, Aruvakudi village,Kallikudi(N), Trichy-D.t
23	V.Shankar S/o Veeramalai	488, Aruvakudi village,Kallikudi (N), Trichy –D.t
24	N.Karuppayi W/o Nagaraj	473/2, Aruvakudi, Kallikudi(N),Trichy-D.t
25	R.Annavi S/o Raman	487, Aruvakudi village,Trichy-D.t
26	A.Karuppan S/oAnnavi	527, Aruvakudi village,Trichy-Dt

27	S.Palaniyammal W/o Selvam	527, Aruvakudi village,Trichy-D.t
28	A.Malliga W/oArumugam	479, Aruvakudi village,Kallikudi (N), Trichy-D.t
29	M.Rajalakshmi W/oMurugavel	513-1, Aruvakudi village,Kallikudi (N),Trichy-Dt
30	M.Mariyammal W/oMarimuthu	513-2, Aruvakudi village,K.Kallikudi,Trichy-D.t
31	S.Chellakannu, W/o Karuppaiya	476, Aruvakudi village,Kallikudi (N), Trichy-D.t
32	S.Marimuthu S/o Sangapillai	492, Aruvakudi village,Kallikudi (N), Trichy-D.t
33	T.Tamilselvi W/oThavasu,	494-2, Aruvakudi village,Kallikudi (N), Trichy-D.t
34	S.Vasanthi W/o Selvaraj	543, Aruvakudi village,Kallikudi (N), Trichy-D.t
35	P.Amsavalli, W/o Ponnan	506, Aruvakudi village,Kallikudi (N), Trichy-D.t
36	S.Prema, W/o Saranraj	434, Aruvakudi village,Kallikudi (N), Trichy-D.t
37	T.Chinnaiyan S/oThiruppan	484, Aruvakudi village,Kallikudi (N), Trichy-D.t
38	M.Chitra, W/oManokaran	512, Aruvakudi village,Kallikudi (N), Trichy-D.t
39	K.Chinnammal W/oKaruppaiya	512, Aruvakudi village,Kallikudi (N), Trichy-D.t
40	K.Chinnapillai, W/o Karuppan	503, Aruvakudi village,Kallikudi (N), Trichy-D.t
41	P.Suganya, W/oPrabakar	503, Aruvakudi village,Kallikudi (N), Trichy-D.t
42	M.Palaniyappan S/o Mookan	498, South street,Aruvakudi village,Kallikudi (N), Trichy-
43	K.Sharmila W/o Kaaturaja	542, Aruvakudi village,Kallikudi (N), Trichy-D.t
44	P.Vigneshwari D/o Palanivel	493, Aruvakudi village,Kallikudi (N), Trichy-D.t
45	K.Sumathi W/oKannan	563, Aruvakudi village,Kallikudi (N), Trichy-D.t
46	K.Lakshmi W/o Kulanthaivel	562, Aruvakudi village,Kallikudi (N), Trichy-D.t
47	P.Pappammal W/oPalaniyappan	580, Aruvakudi village,Kallikudi (N), Trichy-D.t
48	M.Muniyappan S/o Murugan	518, Aruvakudi village,Kallikudi (N), Trichy-D.t
49	M.Chinnaiyan S/o Murugesan	522, Aruvakudi village,Kallikudi (N), Trichy-D.t
50	K.Santhanam S/o Karuppan	510, Aruvakudi village,Kallikudi (N), Trichy-D.t
51	S.Rajeshwari, W/o S.Senthil	510, Aruvakudi village,Kallikudi (N), Trichy-D.t
52	P.Gomathi, W/o Periyasamy	549, Aruvakudi village,Kallikudi (N), Trichy-D.t
53	M.Chinnaponnu W/o Muniyappan	549, Aruvakudi village,Kallikudi (N), Trichy-D.t
54	M.Maruthambal W/o Marimuthu	480, Aruvakudi village,Kallikudi (N), Trichy-D.t
55	Gopalakrishnan S/oMarimuthu	3/518, Aruvakudi village,Kallikudi (N), Trichy-D.t
56	M.Ponnammal, W/o Marimuthu	520, Aruvakudi village,Kallikudi (N), Trichy-D.t
57	P.Muthulakshmi W/o Patchaimuthu	556, Aruvakudi village,Kallikudi (N), Trichy-D.t
58	M.Eswari, W/o Marimuthu	551-1, Aruvakudi village,Kallikudi (N), Trichy-D.t
59	C.Chinnammal W/o Chidambaram	577, Aruvakudi village,Kallikudi (N), Trichy-D.t
60	C.Murugavel, S/o Chidambaram,	577, Aruvakudi village,Kallikudi (N), Trichy-D.t
61	M.Latha W/o Chinnadurai	3-578, Aruvakudi village,Kallikudi (N), Trichy-D.t
62	K.Pappathi W/o Kulanthaivel	571, Aruvakudi village,Kallikudi (N), Trichy-D.t
63	C.Pushpam W/o Chinnadurai	578, Aruvakudi village,Kallikudi (N), Trichy-D.t
64	V.Sindhanaiselvi W/o Vallarasu	4/27, Aruvakudi village,Kallikudi (N), Trichy-D.t
65	S.Indhirani W/o Suppan	575, Aruvakudi village,Kallikudi (N), Trichy-D.t
66	K.Muthulakshmi W/o Vijayakumar	533-2, Aruvakudi village,Kallikudi (N), Trichy-D.t
67	K.Azhagu W/o Kulanthaivel	533-1, Aruvakudi village,Kallikudi (N), Trichy-D.t
68	M.Vijaya W/o Marimuthu	532, Aruvakudi village,Kallikudi (N), Trichy-D.t
69	B.Banumathi W/o Balamurugan	Aruvakudi village,Kallikudi (N), Trichy-D.t
70	K.Vadivel S/o Kandhan	561-1, Aruvakudi village,Kallikudi (N), Trichy-D.t
71	K.Kandhasamy S/o Karuppaiya	474, Aruvakudi village,Kallikudi (N), Trichy-D.t
72	M.Kumaran S/o Murugan	553, Aruvakudi village,Kallikudi (N), Trichy-D.t
73	S.Manjula W/o Sugumaran	3/521-A, Aruvakudi village,Kallikudi (N), Trichy-D.t
74	M.Balasubramani S/o Murugan	553, Aruvakudi village,Kallikudi (N), Trichy-D.t
75	G.Muthumayil W/o Govindharaji	North Street,Aruvakudi village,Kallikudi (N), Trichy
76	J.Sathikumar S/o Jambulingam	509, Aruvakudi village,Kallikudi (N), Trichy-D.t
77	M.Sangapillai	494-1, Aruvakudi village,Kallikudi (N), Trichy-D.t
78	K.Ponnusamy S/o Kaasi,	485-1, Aruvakudi village,Kallikudi (N), Trichy-D.t
79	T.Nadhiya	3/500 A, Aruvakudi village,Kallikudi (N), Trichy-D.t
80	Marimuthu	483, Aruvakudi village,Kallikudi (N), Trichy-D.t

81	N.Jeyarajan, S/o Nataraj	Aruvakudi village, Kallikudi, Trichy – Dt.
82	K.Balasubramani, S/o Kulanthaivel	571, Aruvakudi village,Kallikudi (N), Trichy-D.t
83	K.Chinnammal, W/o Kannan	Aruvakudi village,Kallikudi (N), Trichy-Dt
84	Periyammal	Aruvakudi village,Kallikudi (N), Trichy-D.t
85	P.Muthulakshmi, W/o Ponnambalam	Aruvakudi village,Kallikudi (N), Trichy-D.t
86	K.Pappathi W/o Karuppaiya	Aruvakudi village,Kallikudi (N), Trichy-D.t
87	S.Muthukannu, W/o Sellaiya	Aruvakudi village,Kallikudi (N), Trichy-D.t
88	S.Jothi, W/o Suresh	Aruvakudi village,Kallikudi (N), Trichy-D.t
89	S.Palaniyammal, W/o Chinnakalai,	Aruvakudi village,Kallikudi (N), Trichy-D.t
90	M.Dhanam W/o Marimuthu	Aruvakudi village,Kallikudi (N), Trichy-D.t
91	S.Nallathangal W/o Subramani	Aruvakudi village,Kallikudi (N), Trichy-D.t
92	V.Balakrishnan S/o Vadivel	Aruvakudi village,Kallikudi (N), Trichy-D.t
93	P.Maruthaayi W/o Palaniyappan	Aruvakudi village,Kallikudi (N), Trichy-D.t
94	M.Susila, W/o Muthusamy	Aruvakudi village,Kallikudi (N), Trichy-D.t
95	M.Mariyayi, S/o Muniyappan	Aruvakudi village,Kallikudi (N), Trichy-D.t
96	M.Sakthivel S/o Muniyappan	Aruvakudi village,Kallikudi (N), Trichy-D.t
97	S.Subramani S/o Subban	South Street, Aruvakudi village,Kallikudi (N), Trichy-D.t
98	P.Ponnusamy S/o Periyannan	489, Aruvakudi village,Kallikudi (N), Trichy-D.t
99	P.Ponnambalam, S/o Periyannan	Aruvakudi village,Kallikudi (N), Trichy-D.t
100	S.Murugayiammal W/o Sangapillai	Aruvakudi village,Kallikudi (N), Trichy-D.t
101	M.Muthumayil W/o Mathiyazhagan	Aruvakudi village,Kallikudi (N), Trichy-D.t
102	K.Kaaturani W/o Kumaran	550-1, Aruvakudi village,Kallikudi (N), Trichy-D.t
103	S.Marimuthu S/o Shanmugam	556-2, Aruvakudi village,Kallikudi (N), Trichy-D.t
104	M.Muthalagi	Aruvakudi village,Kallikudi (N), Trichy-D.t

Training and Inputs Distribution Programme on 10.12.2021

List of Beneficiaries for Grow bags, Vermicomposting bag, Vegetable seeds at Aravakudi village

Sl.No	Name of the Beneficiary	Aadhar Number/ Ration Card Number
1.	S.Sivagowri W/o Sakthivel	3669 0411 3894/ NPHH 333478549745
2.	T.Muthulakshmi W/o Thavasu	NPHH 333533690164
3.	T.Tamilselvi W/o Thavasu	NPHH 333639523329
4.	I.Saranya W/o Ilaiyaraja	NPHH 333913300595
5.	P.Chitra W/o Ponnambalam	NPHH 333736043057
6.	M.MuthumayilW/o Mathiyalagan	NPHH 333211199170
7.	P.Susila W/o Palanisamy	NPHH 333127840647
8.	S.Diyana W/o Sankar	2200 3018 2757
9.	P.Palaniyammal W/o Palanisamy	3335 9688 8086
10.	P.Suganya W/o Prabakaran	3335 5271 5322
11.	K.Sellakannu W/o Karuppan	--
12.	S.Sarasvathi W/o Ramasamy	3332 7218 6650
13.	S.Muthukannu W/o Sellaiya	3330 7128 8431
14.	N.Karuppaayi W/o Nagaraj	PHH 333887348835
15.	K.Sumathi W/o Kannaiyah	PHH-AAY-333822058226
16.	P.Gomathi W/o Periyasamy	PHH 333330467501
17.	S.Palaniyammal W/o Sakthivel	NPHH 333805589784
18.	P.Latha W/o Perumal	NPHH 333805589784
19.	S.Vallikannu W/o Ponnusamy	NPHH 333843975879
20.	S.Chinnammal W/o Shanmugam	NHH 333677414182
21.	V.Pappathi W/o Vadivel	NPHH 333138588548
22.	C.Chinnammal W/o Cithambaram	AAY 333983574787
23.	M.Raja W/o Muralitharan	NPHH 333810035854
24.	V.Chinnaponnu W/o Muniyappan	NPHH 333500933131
25.	R.Marimuthu S/o Ramasamy	NPHH 333057863259
26.	C.Chitra W/o Chinnaiyan	NPHH 333851042778
27.	B.Banumathi W/o Balamurugan	PHH 333474857429
28.	S.Nallayee W/o Chithambaram	AAY 333008323414
29.	K.Palaniyammal W/o Ganesan	NPHH 333749129873
30.	S.Mariyammal W/o Shanmugam	NPHAAY 333016451922
31.	A.Murugayee W/o Ammasi	NPHH 333037710769
32.	T.Palanisamy S/o Thiruppan	AAY 333071929901
33.	P.Muthulakshmi W/o Pachaimuthu	PHH 333333418356
34.	M.Vijaya W/o Marimuthu	NPHH 333601578337
35.	T.Nathiya W/o Thennarasu	NPHH 333448100617
36.	P.Adaikalaraj S/o Palaniyappan	PHH 333963039925
37.	M.Chitra W/o Manohar	PHH 333876484825
38.	P.Palanimuthu S/o Poosathiram	PHH 333096308192
39.	M.Susila W/o Muthusamy	PHH 333426033894
40.	A.Malliga W/o Arumugam	PHH 333253609379
41.	M.Mariyammal W/o Marimuthu	NPHH 333090627404
42.	M.Eswari W/o Marimuthu	PHH 333496126180
43.	M.Chinnammal W/o Murugesan	PHH 333268341168
44.	N.Dhanalakshmi W/o Nadarajan	AAY 333357906204
45.	S.Prema W/o Saranraj	NPHH 333217860205
46.	V.Banumathi W/o Vadivel	NPHH 333854689925
47.	T.Neela W/o Thangaiya	NPHH 333093637091
48.	R.Sumithra W/o Rajamanickam	NPHH 333064342747
49.	K.Susila W/o Kumaran	PHH 333855910827
50.	P.Amsavalli W/o Ponnan	AAY 333510230234
51.	A.Periyakkal W/o Annavi	AAY 333646499945

52.	P.Pappammal W/o Palaniyappan	PHH 333659151681
53.	K.Chinnapillai W/o Karuppan	AAY 333894215493
54.	K.Palaniyammal W/o Krishnamoorthy	PHH 333505184626
55.	P.Muthulakshmi W/o Ponnambalam	PHH 333106071670
56.	K.Mariyayi W/o Karuppan	NPHH 333923473559
57.	B.Rajalakshmi W/o Balasubramani	NPHH 333175615012
58.	M.Menaka W/o Marimuthu	NPHH 333262867801
59.	G.Murugeshwari W/o Gopalakrishnan	NPHH 333470063645
60.	K.Manimegalai W/o Karuppaiya	NPHH 333646020185
61.	M.Ponnammal W/o Marimuthu	NPHH 333119701223
62.	S.Indhirani W/o Suppan	AAY 333016877157
63.	M.Rajalakshmi W/o Murugavel	NPHH 333087501430
64.	J.Sakthikumar S/o Jambulingam	AAY 333406695222
65.	M.Palaniyammal W/o Marimuthu	PHH 333295566735
66.	B.Josephine Nirmala W/o Balakrishnan	NPHH 333062359452
67.	P.Karuppayee W/o Raman	AAY 333195595140
68.	S.Periyakkal W/o Selvaraj	NPHH 333451658125
69.	S.Manjula W/o Sugumaran	PHH 333167319421
70.	M.Balasubramani S/o Murugan	PHH 333071092895
71.	M.Mariyayee W/o Muniyappan	NPHH 333561087797
72.	S.Anjalai W/o Subramani	PHH 333024776674
73.	K.Sharmila W/o Katturaja	NPHH 337211055180
74.	K.Alagu W/o Kulandhaivel	PHH 333591398195
75.	N.Valarmathi W/o Nadarajan	NPHH 333875553196
76.	K.Muthulakshmi W/o Kamarasu	NPHH 333459458772
77.	K.Chithra W/o Kandhasamy	NPHH 333741534036
78.	P.Vigneshwari W/o Palanivel	AAY 333117589732
79.	M.Chandra W/o Muniyappan	PHH 333565738670
80.	P.Vallarasu S/o Periyasamy	NPHH 333529549675
81.	B.Kalpana W/o Backiyaraj	NPHH 333599502528
82.	P.Padmavathi W/o Periyasamy	AAY 333450790457
83.	S.Palaniyammal W/o Sangapillai	NPHH 337048041924
84.	M.Katturani W/o Kumaran	NPHH 333112010865
85.	P.Ponnusamy S/o Periyannan	NPHH 333214007247
86.	S.Murugayee ammal W/o Sangapillai	PHH 333996208870
87.	P.Nadarajan S/o Palanimuthu	NPHH 333624587030
88.	P.Periyanallan S/o Pappu	17/G/0346372
89.	S.Malathi W/o Selvam	NPHH 333197542418
90.	S.Kowsalya W/o Saravanan	33852184947
91.	P.Marimuthu S/o Palaniyappan	333077829280
92.	S.Senthilkumar S/o Santhanam	333920949700
93.	M.Selvaraj S/o Muniyappan	333493535543
94.	S.Marikannu W/o Subramani	333088865779
95.	V.Palaniyammal W/o Velan	333185464881
96.	C.Pushpam W/o Chinnadurai	333678538011
97.	C.Latha W/o Chinnadurai	333594933078
98.	K.Govindham S/o Kanagaraj	333652401192
99.	M.Dhanam W/o Marimuthu	333457867607
100.	S.Sasikumar S/o Subramani	333112498150
101.	S.Marimuthu S/o Sangapillai	333704804192
102.	P.Maruthayi S/o Palaniyappan	--
103.	M.Palaniyammal W/o Marimuthu	333295566735
104.	C.Bhakkiyaraj S/o Chinnaiyan	333931844725
105.	M.Velayi W/o Muniyappan	333500517538

106.	M.Sangapillai S/o Masilamani	333633907466
107.	M.Maruthambal W/o Murugesan	333094848265
108.	S.Jothi W/o Sangapillai	4257 7156 2224
109.	S.AMarimuthu S/o Sangili	3335 8646 5878
110.	P.Anbalagan S/o Periyasamy	3336 5937 8888
111.	K.Sandhanam S/o Karuppan	3335 0175 8325
112.	K.Pushpam S/o Karuppaiya	3330 4475 7899
113.	R.Anjammal W/o Ramasamy	3330 5879 7682
114.	M.Muniyappan S/o Murugan	3331 1358 0501
115.	C.Sarathkumar S/o Chinnaiyan	--
116.	C.Kandhasamy S/o Chithiva	--
117.	C.Chinnaiyan S/o Chinnammal	--
118.	S.Vasanthi W/o Selvaraj	8107 7149 7441
119.	M.Karuthammal W/o Marimuthu	6612 2510 5459
120.	M.Roja W/o Murali	5584 1550 5216
121.	P.Rani W/o Palanimuthu	7536 0889 4383
122.	Kulanthaivel	8115 9566 7302
123.	B.S.Arun S/o Sakthivel	9939 5277 3555
124.	P.Divyadharshini	4184 5179 1490
125.	P.Ponnambalam	2302 5773 3929
126.	S.Ranjith S/o Sakthivel	6424 6132 0045
127.	P.Thilagavathi	4093 7194 7210
128.	K.Devika	7448 6706 1400
129.	B.Pratheeswari	3064 0557 4188
130.	S.Jothi	4307 8609 0735

Sports Materials are received by the Village Youths of Adopted village – Aravakudi, Manikandam block, Trichy Dist

Sl.No	Name of the Beneficiary	Aadhar Number/ Ration Card Number
1.	S.Ranjith S/o Sakthivel	6424 6132 0045
2.	M.Muniyappan S/o Murugan	3331 1358 0501
3.	B.S.Arun S/o Sakthivel	9939 5277 3555
4.	P.Anbalagan S/o Periyasamy	3336 5937 8888
5.	M.Sangapillai S/o Masilamani	333633907466
6.	S.Sasikumar S/o Subramani	333112498150
7.	S.Senthilkumar S/o Santhanam	333920949700
8.	P.Marimuthu S/o Palaniyappan	333077829280
9.	J.Sakthikumar S/o Jambulingam	AAY 333406695222
10.	M.Balasubramani S/o Murugan	PHH 333071092895

அன்பில் தர்மலிங்கம் வேளாண் கல்லூரி சார்பில் பட்டியலின விவசாயிகளுக்கு திறன் பயிற்சி மற்றும் இடுபொருட்கள் வழங்கும் நிகழ்ச்சி

■ திருச்சி, ஜூலை.13-

திருச்சி மாவட்டம் மணிகண்டம் ஒன்றியம், அரவக்குடி கிராமத்தில் அன்பில் தர்மலிங்கம் வேளாண்மைக் கல்லூரி மற்றும் ஆராய்ச்சி நிலைய மண்ணியல் துறையின் அகில இந்திய களர் உவர் மண் ஆராய்ச்சி நிறுவனத்தின் சார்பில் பட்டியலின விவசாயிகளுக்கு திறன் பயிற்சி மற்றும் இடுபொருட்கள் வழங்கும் நிகழ்ச்சி கல்லூரி முதல்வர் முனைவர் செ.வன்னியராஜன் தலைமையில் நடைபெற்றது.

இந்நிகழ்ச்சில் தமிழ்நாடு வேளாண்மைக் பல்கலைக்கழகத்தின் இயற்கை வள மேலாண்மை இயக்குநர் முனைவர் ப. பாலசுப்ரமணியம் தலைமை தாங்கி இயற்கை வேளாண்மை மற்றும் மண் வளத்தின் முக்கியத்துவம் குறித்து சிறப்புரையாற்றினார். மண்ணியல் துறை பேராசிரியர் மற்றும் தலைவர் முனைவர் மு.பாஸ்கர் களர் உவர் மண் சீர்திருத்த தொழில்நுட்பம் பற்றி உரையாற்றினார். மேலும் மண் வள மகத்துவ மைய இயக்குநர் முனைவர் ச.மீனா மண் வளம் காத்தல் தொடர்பான ஆலோசனைகளை வழங்கினார். நுண்ணுயிரியல் துறையின் பேராசிரியர் முனைவர் மு.சுந்தர் களர் உவர் நிலத்தில் நுண்ணுயிர் உரங்களின் பயன்பாடுகள் குறித்தும், மண்ணியல் மற்றும் வேளாண் வேதியியல் உதவி பேராசிரியர் முனைவர் த.ஜானகி கம்போஸ்ட் தயாரிப்பு தொழில்நுட்பம் குறித்தும் விளக்கினார்கள். உழவியல் துறை உதவி பேராசிரியர் முனைவர் செ.ராதிகா மண்புழு உரம் தயாரித்தல் பற்றி செயல் விளக்கம் அளித்தார்.

இவ்விழாவில் 100க்கும் மேற்பட்ட விவசாயிகள் கலந்து கொண்டனர். மேலும் அவர்கள் பயன்பெறும் விதமாக காய்கறி விதைகள், செடி வளர் பைகள் மற்றும் மண் புழு உர பைகள் வழங்கப்பட்டன. மேலும் கிராமப்புற இளைஞர்களை ஊக்குவிக்கும் வகையில் உடற்பயிற்சி உபகரணங்களும் வழங்கப்பட்டன. முன்னதாக உழவியல் துறை உதவி பேராசிரியை முனைவர் செ.ராதிகா வரவேற்க, இறுதியாக உதவி வேளாண்மை அலுவலர் திருமதி ஆ.அறிவுச்செல்வி நன்றி கூறினார்.

Training cum Inputs & Sports Materials Distribution Programme on 11.07.2022

	
Kitchen Gardens	
	
Battery Operated Sprayer	**Spade with wooden Handle**

Expenditute Statement FY 2021-22

SCSP - General Budget - ICAR Share (75%): Rs. 1.55 Lakhs; TNAU Share (25%): Rs. 0.51 Lakhs; Total Share (100%): Rs. 2.06 Lakhs

Sl.No	Name of the Particulars	Quantity /No.	Amount (Rs.)	Remarks
1.	Gypsum	8 tonnes	46,400	104 nos. of beneficiaries
2.	Coconut Seedlings	110 nos.	6,600	104 nos. of beneficiaries
3.	Vegetable seed packets	750 packets	15,000	130 nos. of beneficiaries
4.	Grow Bag (10x12 inch) (Diameter x Ht)	1250 nos.	48,675	i) 910 nos. issued for 130 nos. of beneficiaries ii)340 nos . used for vegetable demonstration unit and training purpose at AICRP
5.	Grow Bag (12x12 inch) (Diameter x Ht)	900 nos.	40,356	i)390 nos. issued for 130 nos. of beneficiaries ii)510 nos. used for vegetable demonstration unit and training purpose at AICRP
6.	Vermicomposting Bag	130 nos.	38,350	130 nos. of beneficiaries
7.	LCD Screen	1 No.	10,738	Being used for SCSP Training activities
8.	Miscellaneous (Freight charge, etc.,)	--	548	For Grow bag Transport
		Total	**2,06,667**	

SCSP - Capital Budget - ICAR Share (75%): Rs. 1.41 Lakhs; TNAU Share (25%): Rs. 0.47 Lakhs; Total Share (100%): Rs. 1.88 Lakhs

Sl.No	Name of the Particulars	Quantity/ No.	Amount (Rs.)	Remarks
1.	Cono Weeder	10 nos.	15,000	Being used for SCSP beneficiary farmers on need basis for paddy crop
2.	Battery Operated Sprayer	4 nos.	12,600	Being used for SCSP beneficiary farmers on need basis for paddy crop
3.	Spade with Wooden Handle	20 nos.	7,600	Being used for SCSP beneficiary farmers on need basis for paddy crop
4.	Gravity Drip Irrigation kit	11 nos.	48,048	Being maintained for demo unit for vegetable crops at AICRP premises
5.	LCD Projector	1 no.	48,970	Being used for SCSP Training activities
6.	Sports & Gym facilities at SCSP village	1 facility	31,266	A Sports & Gym facility was created at SCSP beneficiary village Aravakudi village, Manikandam block of Tiruchirappalli for the daily use of SCSP beneficiary Youths
7.	Exhibition Felt Board	1 no.	23,800	Maintaining at AICRP for SCSP Farmers Training
8.	Nylon Rope	4 kg	420	Use for Sports & Gym Materials
9.	Coir rope	2 kg	220	Use for Sports & Gym Materials
10	Log Book	1 no.	76	Use for Sports & Gym Materials
Total			**1,88,000**	

AICRP on SAS&USW, Bathinda

Name of the centre: Bathinda (Volunteer Centre)

SCSP Capital
Allocations under SCSP Capital for FY 2020-21- **NIL**
Utilization: NA
Activities undertaken under SCSP- NA
List of beneficiaries, with address and Aadhar number (if available), supporting photo: NA

SCSP General-
Allocations under SCSP General for FY 2020-21-**40,000/-**
Utilization: 38,800/-
Activities undertaken under SCSP- General:

Activity 1: Distribution of Vegetable Kit and Paddy seed (PB-126) to schedule cast farmers under the Scheme "AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture" to help the Schedule Cast Society/ Individuals.

List of beneficiaries, with address and Aadhar number (if available), supporting photo:

Fig.1: Distribution of vegetable kit and paddy seeds to farmers.

S.No	Farmer's Name/ Mobile No.	Father's Name	Address/Village	Adhar No.
1	Veer Singh	Darabara Singh	Jodhpur Romama	5822 5639 4265
2	Ram Sewak	Bhagriath	AmarpuraBastiBathinda	7821 43405950
3	Satpal Singh	Surjeet Singh	JassiPauwali	3770 3989 2086
4	Nachhatar Singh	Ajmer Singh	JassiPauwali	7135 2730 9706
5	Ajaib Singh	Kaudoo Singh	JassiPauwali	2635 2993 3473
6	Baldev Singh	Koddu Singh	JassiPauwali	6813 4624 2890
7	Raja Singh	Baldev Singh	JassiPauwali	2982 1888 8956
8	Amritpal Singh	Baldev Singh	JassiPauwali	5416 1794 4528
9	Balwant Singh	Balvir Singh	Katar Singh Wala	8444 0538 3438
10	Sandeep Singh	Gurjant Singh	Birtalab	3508 2960 6685
11	Harjinder Singh	Malkit Singh	Birtalab	3800 3283 3727
12	Jagtar Singh	Mahinder Singh	Katar Singh Wala	9109 3966 0028
13	Surjit Ram	Chuna Ram	Bandi	4757 2129 4449
14	Shikander Singh	Mander Singh	Bandi	7422 4317 9154
15	Roshan Singh	Gurdev Singh	Bandi	3238 8431 3142
16	Gulab Singh	Resham Singh	Bandi	8275 8146 7373
17	Gurpiar Singh	Harpal Singh	Bishnandi	7183 9485 5402
18	Jagsir Singh	Baldev Singh	Bandi	4833 4585 6024
19	Bohar Singh	Joginder Singh	Bandi	3483 7068 5110
20	Kuldeep Singh	Gurjant Singh	Birtalab	6614 5982 9711
21	Amandeep Singh	Jora Singh	Bandi	8557 0995 5403
22	Atma Singh	Gurjant Singh	MehmaSawai	3177 0782 1505
23	Lakhinder Singh	Gurjant Singh	MehmaSawai	5148 5683 6331
24	Gurdeep Singh	Gurcharan Singh	MehmaSawai	9286 6993 8082
25	Lilu Ram	Thula Ram	Katar Singh Wala	3870 6442 9381

Activity 2: Farmers awareness programme in village – Bhagi wander, Bathinda and delivered the lecture on "Use of poor quality water for crop production".

Distribution of fruit plants to schedule cast farmers under the Scheme "AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture" to help the Schedule Cast Society/ Individuals.

List of beneficiaries

Amritpal Singh	Baldev Singh	JassiPauwali	5416 1794 4528
Moni Singh	Inder Singh	Gehri Devi Nagar, GehriBhagi	8403 3823 7130
Raja Singh	Baldev Singh	JassiPauwali	2982 1888 8956
Balwant Singh	Balvir Singh	Katar Singh Wala	8444 0538 3438
Raja Singh	Baldev Singh	JassiPauwali	2982 1888 8956
Roop Singh	Gurdev Singh	Gehri Devi Nagar, GehriBhagi	2838 4886 3324
Lilu Ram	Thula Ram	Katar Singh Wala	3870 6442 9381

Fig.2: Distribution of Fruit Plants to SC Farmers in village – Bhagiwander, Bathinda

SCSP Report (2021)

Name of the centre: Bathinda (Volunteer Centre)

SCSP Capital
Allocations under SCSP Capital for FY 2021-22- **25,000/-**
Utilization: NIL
Activities undertaken under SCSP Capital- NIL
List of beneficiaries, with address and Aadhar number (if available), supporting photo: NA
SCSP General-
Allocations under SCSP General for FY 2020-21-**40,000/-**
Utilization: NIL
Activities undertaken under SCSP- General: NIL
List of beneficiaries, with address and Aadhar number (if available), supporting photo: NA

AICRP on SAS&USW, Indore

Name of Centre	Volunteer Centre of AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture, Indore
Allocation under SCSP Capital for FY 2021-22	Allocation - Rs. 50000/- Expenditure – Rs. 48950/-
Activities undertaken SCSP Capital	Installation of Drip irrigation system on farmer's field
List of Beneficiaries, with address and Aadhar number (if available) , supporting photo	



Name of farmer & Address	Aadhar No.	Mobile No.	Land holding in Acre	Remark
Shri Sheru S/O Shri Dagdu Village – Amlatha; Tehsil -. Barwaha; District – Khargone State – M.P.	890473269027	9977306511	03	SC Farmer

SCSP General for FY 2021-22

Name of Centre	Volunteer Centre of AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture, Indore
Allocation under SCSP General for FY 2021-22	Allocation - Rs. 45000/- Expenditure - Rs. 44690/-
Activities undertaken SCSP General	Distribution of inputs and training activities
List of Beneficiaries, with address and Aadhar number (if available) , supporting photo	

S.No.	Name of Beneficiaries	Mobile No.	Aadhar No.
1	Ranchod	9165663723	253062533515
2	Chet Ram	6264971577	729690174142
3	Rewa Ram	9326712353	287887746296
4	Rajendra Surage	9326712353	652107303772
5	Mohan Surage	9757580772	783968845776
6	Champa Lal	9757580772	594195747773
7	Smt Kadvi Bai	9757580772	966272688904
8	Deepak	8461085090	393005316679
9	Keshav	8461085090	530199735155
10	Anil	9977999357	794833903002
11	Gajanand	8224353188	587210691305

	12	Girdhari	9126413351	857886421249	
	13	Mansa Ram	9926496099	639418028705	
	14	Narendra Surage	9669025432	767373436791	
	15	Laxmi Chand Surage	9926093607	255176161764	
	16	Arun Surage	9126539514	668097344392	
	17	Ritik Surage	9144526701	269200076911	
	18	Sitaram Khande	7024406253	963149415552	
	19	Deepak Khande	9165334991	980244968740	
	20	Dilip Khande	9165334991	252293103086	
	21	Deepak Oswal	9907718883	791031496074	
	22	Jagdish Gangle	9977227797	229234327341	
	23	Vijay Singh	6262805764	433876793749	
	24	Sundar Lal	6262805764	471317826070	
	25	Smt. Chhaya Bai	7973098601	445519173022	

A training and input distribution was conducted at Salinity Research Farm, Barwaha on dated 26.08.2021. In this training about 25 SCSP farmers were participated of adjoining areas of Barwaha, district Khargone, Madhya Pradesh. The training was conducted on the topic of **RECLAMATION AND MANAGEMENT OF SODIC VERISOLS**. In addition to that, we distributed Phospho-gypsum to the participants under SCSP, Project of Volunteer centre of SAS Project, College of Agriculture, Indore. The training and input distribution was conducted by Dean, COA, Indore (Dr. A.K. Sharma) and Sr. Scientist (Dr. B.B. Parmar) and Nodal Officer (Dr. K. S. Bangar).

Distribution of Phospho-gypsum to the SCSP Farmers at Salinity Research Farm, Barwaha (26.08.2021)

Another training and input distribution was also conducted at Salinity Research Farm, Barwaha on dated 02.02.2022. In this training about 25 SCSP farmers were participated of

adjoining areas of Barwaha, district Khargone, Madhya Pradesh. The training was conducted on the topic of **EFFICIENT USE OF FERTILIZERS IN SALT AFFECTED VERTISOLS.** Distribution of NPK fertilizers to the participants under SCSP, Project of Volunteer centre of SAS Project, College of Agriculture, Indore was done as a part of the event. The training and fertilizer distribution was conducted by the scientists, COA, Indore (Dr. N.K. Gupta, Dr. S.C. Tiwari and Dr. K.S. Bangar).

A training to the SCSP Farmers at Salinity Research Farm, Barwaha (02.02.2022)

Distribution of NPK fertilizers to the SCSP Farmers at Salinity Research Farm, Barwaha (02.02.2022)

AICRP on SAS&USW, Panvel

SCSP Capital :-

Allocations under SCSP Capital for FY 2021-22 and Utilization:

Allocation during 2021-22 under SCSP-Capital : 0.25 lakh
Utilization during 2021-22 under SCSP-Capital : 0.25 lakh

Activities undertaken under SCSP- Capital: The SCSP one day training programme conducted at Khar land research station, Panvel on 29.03.2022 during the year 2021-22. A lecture on "सुक्ष्म अन्नद्रव्ये तपासणीमहत्व-"was delivered and also distributed agricultural inputs *viz.,* vaibhav sickle, spade, khanti and poultry birds (egg layers) were also distributed.

List of beneficiaries, with address and Aadhar number (if available) :

Sr. No.	Name of farmer	Address	Aadhaar card No.
1	Ramdas Dharma Gaikwad	Shenawli, Tala	6377 8744 3342
2	Maruti Chintaman Jagtap	Pitsayi, Tala	2021 9939 7301
3	Suyog Shantaram Jagtap	Pitsayi, Tala	4810 7646 7442
4	Sangita Pandurang Gaikwad	Pitsayi, Tala	2981 0441 8405
5	Kashiram Dagdu Jagtap	Pitsayi, Tala	4988 6767 9925
6	Vishal Vishwanath Jagtap	Pitsayi, Tala	7043 4598 4241
7	Pandurang Hiru Jagtap	Pitsayi, Tala	7111 9430 1388
8	Ganpat Dagdu Jagtap	Pitsayi, Tala	2094 4705 8302
9	Gopal Gangaram Jagtap	Pitsayi, Tala	4382 5794 5911
10	Vithhal Chandrakant Jagtap	Pitsayi, Tala	5778 3418 7571
11	Dilip Sitaram Lokhande	Pitsayi, Tala	6913 0579 0083
12	Nana Keru Jagtap	Pitsayi, Tala	7085 8886 1401
13	Naresh Ambaji More	Pitsayi, Tala	8850 6526 2982
14	Harishchandra Bhagurav Gaikwad	Pitsayi, Tala	2094 4705 8302
15	Rajesh Manohar Mahale	Pitsayi, Tala	7098 5836 5996

SCSP General :-

Allocations under SCSP General for FY 2021-22 and Utilization:

Allocation during 2021-22 under SCSP-General : 0.54 lakh

Utilization during 2021-22 under SCSP-General : 0.54 lakh

Activities undertaken under SCSP- General:

a) The programme under the ICAR project AICRP on "Management of Salt Affected Soils and Use of Saline Water in Agriculture" under the head **"SCSP-General" during financial year 2021-22** conducted first one day training Programme at village Tala, Dist-Raigad, Maharashtra state and delivered lecture on "जमिनीची सुपिकता व उत्पादन क्षमता वाढ्विण्यासाठी युरिया डिएपी ब्रिकेटसचा वापर"and also distributed agricultural inputs (Urea-DAP Briquettes) to the beneficiary farmers on 24.12.2021.

b) Second one day training Programme conducted at village Tala, Dist-Raigad, Maharashtra state and delivered lecture on "जमिनीची आरोग्य पत्रिका" and distributed agricultural inputs *i.e.* Urea-DAP Briquettes, Agricultural diary, coconut seedlings, vermicompost and poultry birds (egg layers) to the beneficiary farmers on 30.03.2022.

- **List of beneficiaries, with address and Aadhar number**

Sr. No.	Name of farmer	Address	Aadhaar card No.
1	Vishal Vishwanath Jagtap	Pitsayi, Tala	7043 4598 4241
2	Pandurang Hiru Jagtap	Pitsayi, Tala	7111 9430 1388
3	Gopal Gangaram Jagtap	Pitsayi, Tala	4382 5794 5911
4	Vithhal Chandrakant Jagtap	Pitsayi, Tala	5778 3418 7571
5	Dilip Sitaram Lokhande	Pitsayi, Tala	6913 0579 0083
6	Ganpat Dagdu Jagtap	Pitsayi, Tala	2094 4705 8302
7	Sangita Pandurang Gaikwad	Pitsayi, Tala	2981 0441 8405
8	Kashiram Dagdu Jagtap	Pitsayi, Tala	4988 6767 9925
9	Harishchandra Bhagurav Gaikwad	Pitsayi, Tala	2094 4705 8302
10	Rajesh Manohar Mahale	Pitsayi, Tala	7098 5836 5996
11	Ramdas Dharma Gaikwad	Shenawli, Tala	6377 8744 3342
12	Maruti Chintaman Jagtap	Pitsayi, Tala	2021 9939 7301
13	Suyog Shantaram Jagtap	Pitsayi, Tala	4810 7646 7442
14	Nana Keru Jagtap	Pitsayi, Tala	7085 8886 1401
15	Naresh Ambaji More	Pitsayi, Tala	8850 6526 2982

- **SCSP Capital**

Allocation under SCSP Capital for FY 2021-22: Rs 0.200 lakhs
Activities under SCSP Capital:

Distribution of 4 coconut tree climbers ,4 knapsack sprayers, and 2 spades

Table 1 . Items supplied to SCSP farmers

Sl.No	Name of item	No	Expenditure
1	Knapsack sprayer 16 L	4	7600.00
2	Coconut climber	4	11700.00
3	Spades	2	700.00
	Total		**20000.00**

List of beneficiaries

Table 2BENEFICIARIES OF KNAPSACK SPRAYER			
Sl No.	**NAME**	**ADDRESS**	**AADHAR NUMBER**
1	C. K. MOHANAN	CHETTIYAKUNNEL HOUSE, VELIYANAD PH. NO. 9074895126	
2	SAJI P. K.	PUNNELIL HOUSE, THIRUMARAYUR PH. NO. 9744346492	514222042759
3	RAJANEESH K. R.	KORKUZHIYIL HOUSE, KAIPPATTOOR P. O PH. NO.9947635658	788661521934
4	RAJAN C. P.	CHELAKKATTIL HOUSE, VELIYANAD PH. NO.9961673291	

- **Distribution of Knapsack Sprayers**

Table 3. BENEFICIARIES OF COCONUT TREE CLIMBERSANDSPADES			
Sl No.	**NAME**	**ADDRESS**	**AADHAR NUMBER**
1	ANIL KUMAR	THAIPARAMBIL HOUSE,KAIPATTOR P. O, AARAKKUNNAM , ERNAKULAM Ph. No. 9947783460	
2	GOPI C. K.	CHALITHKARATT HOUSE, MAARITHAZHAM P. O., KANJIRAMATTOM Ph. No. 8606883557	433856434422
3	SOMAN M. A.	MANJAKKADUKUNNEL HOUSE, EDAKKATTUVAYAL Ph. No. 7558870943	
4	KANNAN	POTTAMTHADATHIL HOUSE, EDAKKATTUVAYAL Ph. No.9074009692	787007162550

Distribution of knapsack sprayers

- **SCSP General**

Allocations under SCSP General for FY 2021-22: Rs 0.600 Lakhs

Sl.No	Name of item	Expenditure
1	Seeds and biocontrol agents	60000.00

Activities under SCSP- General:

1) Muhamma, Alappuzha

Training cum exhibition programme for scheduled caste farmers under the scheduled caste sub plan of AICRP (SAS &USW) was conducted along with the inauguration of state level njattuvela festival on 01/07/2021 at 10.00 am at Gowrinandanam Auditorium in Muhamma. Hon. Minister for Agriculture and Farmers Welfare Sri P. Prasad inaugurated the function. The hon. Vice chancellor, Registrar, president, vice president and members of Muhammagrama panchayath attended the function. A total of 50 farmers participated in the training programme. The inputs such as vegetable seeds, coconut seedling and bio-control agents (Verticillium, Pseudomonas, Beauveria and Trichoderma and vegetable trap) were distributed to the SC farmers who attended the training programme.

2. Mulanthuruthy, Ernakulam

A training programme under the scheduled caste sub plan of AICRP (SAS &USW) was conducted in collaboration with Thiruvathiranjattuvela conducted by State Department of Agriculture on 02/07/2021 at T. M. Jacob Memorial Hall, Mulanthuruthygramapamchayat for scheduled caste farmers. A total of 100 farmers participated in the training programme. Hon MLA Sri. Anoop Jacob inaugurated the programme. The director of extension of KAU and the members of Mulanthurutygramapanchayat attended the programme. Various vegetable seeds, biocontrol agents and coconut seedlings were distributed to SC farmers at the end of the training programme.

3.Edakkattuvayal

A training programme on vegetable production for scheduled caste farmers was held on 9th June, 2022 at 10.00 am in the Farmer's Hall, Edakkattuvayal, as part of the AICRP's scheduled caste sub plan (SAS & USW) in association with the Krishibhavan, Edakkatuvayal and agriculture knowledge centre, Mulanthuruthy block. The programme was a great success with the participation of 60 scheduled caste farmers from Edakkatuvayal panchayath. As part of the programme, Dr.

Amrithakumari S, Assistant Professor (Entomology), RRS, Vyttila, led a session on vegetable cultivation. The president and members of Edakkattuvayal were also actively involved in the programme.

Tissue culture banana seedlings (robusta and nendran : 120 Nos.) basellaseedlings (120 Nos.) and biocontrol agents like Trichoderma, Pseudomonas and Beauveria (60×3 Nos.), coconut saplings(120 Nos.) were distributed to all the participants at the end of the training programme.

Training session on vegetable production by Dr. Amrithakumari S

Distribution of coconut, tissue culture banana and basella saplings

Distribution of coconut, banana saplings and biocontrol agents

Table 4. Participants of vegetable training programme conducted at Edakkattuvayal

Sl No.	NAME	ADDRESS	AADHAR NUMBER
1	RADHAMANI SASI	Chendanamkuzhi (H), Kaipatttoor P. O , Arakkunnam Ph. No. 9744411679	618931931394
2	SUMESH P T	Parukalayil House, Pazhoor P. O;Ph. No.9526122331	
3	MANOJ C .C	ChelakkattilHouse,Veliyanad P.O. Ph. No.6238960592	
4	KUMARAN C. C.	Chaliyathkarott House, Maarithazham P. O. Ph. No. 9539294823	
5	N RADHAKRISHNAN	A. M. Nivas, Veliyanad;Ph. No. 9605293166	
6	SOMAN M. A	ManjakkadukunnelHpouse, Edakkkattuvayal Ph. No. 7558870943	
7	V. A. KUMARAN	Vengolathadathal House, Chethikkad; Ph. No. 9744585099	
8	KANNAN	Pottamthadathil House, Edakkattuvayal; Ph. No.9074009692	787007162550
9	A V JAYAN	Pattappara	
10	M . P. SUKUMARAN	Nellikkakunnel House, Thottur, Kaippattoor P O Ph. No. 9562406414	
11	CHANDRAN O. K.	Ormulakunnel House, Kattimutttam; Ph. No. 9656133216	
12	KOCHUKUNJU	Athrasheril House; Ph. No. 9025742476	
13	SAJEEV P. N.	Pouthuruthil House Ph. No. 8606043298	
14	M. K. KRISHNANKUTTY	Marattikunnel House, Kaippattoor P. O , Ph. No.9387791010	
15	ANIL KUMAR	ThaiparambilHouse,Kaipattor P. O, Aarakkunnam , Ernakulam ; Ph. No. 9947783460	
16	GOPI C. K.	Chalithkaratt House, Maarithazham P. O., Kanjiramattom Ph. No. 8606883557	433856434422
17	ALLY K. U	Kolliyodath House; Thirumarayoor; Ph. No.9745154712	678716334994
18	C. P. MADHAVAN	Chelakkattil House, Veliyanad; Ph. No. 9496490944	
19	VINAYAN K. C	Kochuparambil House, Kaippattoor ; P. O Ph. No.9746194155	
20	SAJI P. K.	Punnelil House, Thirumarayur; Ph. No. 9744346492	514222042759
21	KAMALA THANKAPPAN	Thekkeparanayil House; Kaippattoor; Ph. No.9745972031	
22	C. K. MOHANAN	Chettiyakunnel House, Veliyanad; Ph. No.9074895126	
23	SURENDRAN	Paranayil House, Azhakathu; Ph. No. 9961277217	
24	RAJANEESH K. R.	Korkuzhiyil House, Kaippattoor P. O; Ph. No.9947635658	788661521934
25	GOKULAN	Korkuzhiyil House, , Kaippattoor P. O; Ph. No.9526118442	725625008236
26	UNNI C. C	Chaliyathkarott House, Maarithazham P. O. Ph. No. 9447026486	207432170503
27	P. T. SAJAN	Palakkattukuzhiyil House, Edakkattuvayal; Ph. No. 8086261141	809680637955
28	KUNJUKUNJU	Kunnuparambil House, Edakkattuvayal	
29	P. N. KUMARAN	Padathumelil House, Edakkattuvayal Ph. No. 8157072982	482859256947
30	MANILAL T. K.	Thamarasseriyil House, Edakkattuvayal Ph. No.9539083142	
31	SURESH O. K	Olippurath House; Kaippattoor P. O; Ph. No. 9544001425	
32	SARITHA SURESH	Olippurath House; Kaippattoor P. O; Ph. No.9961029733	
33	SHANTHA PUSHPAN	Valliyakunnel House, Edakkattuvayal; Ph. No.7902782368	365648455151
34	RAJENDRAN K. A	Kudayadiyil House, Kaippattoor P. O , Arakkunnam, Ph. No. 9446803453	

35	RAJU M. T	Marattikunnel House , Kaippattoor; Ph. No.8301959205	
36	SUKUMARAN P. K.	Parekkattil House, Thottoor , Kaippattoor P. O. Ph. No. 9526287367	
37	SUNIL KUMAR	Vallikunnel House, Edakkatuvayal; Ph. No. 9747413691	
38	ANANTHU	Thekkekkara House, Kaippattoor P. O; Ph. No.8137895262	
39	RAMANI AYYAPPAN	Mekkaimukalil House, Edakkattuvayal; Ph. No. 9544924082	
40	A JITHA	Koladathil House, Oorakam; Ph. No. 9526080340	
41	MURUKESH	Olimoozhiyil House, Edakkattuvayal; Ph. No. 9961806512	
42	LEELAMMA	KollamparambilHouse,Edakkattuvayal ; Ph. No.9383498830	
43	BEENA RAJAN	Olimoozhithadathil House, Kaippattoor P. O Ph. No. 9188600831	211818260665
44	C. P. VIJAYAN	Chelakkattil House, Veliyanad; Ph. No.9947998978	379584848598
45	RAJAN C. P.	Chelakkattil House, Veliyanad; Ph. No.9961673291	
46	SURRESH M. K.	Marattikunnel House , Kaippattoor P. O, Thottoor Ph. No. 9562191457	
47	KOCHUKUNJU	Ormalakunnel House, Chethikkode; Ph. No. 9895258707	
48	C. K . THANKAPPAN	Ormalakunnel House, Chethikkode	
49	GOPI P. C	ThevarkattilHouise , Veliyanad; Ph.No. 8589882097	
50	SHYAMALA P. R.	Pakkathukunnel House, Veliyanad; Ph.No. 8606164214	
51	MURALOIDASAN	Olimoozhiyil House, Edakkattuvayal; Ph.No. 8301858843	636682945637
52	KUNJAN	Theenaparambil House; Chethikkode, Ph.No. 9847489226	
53	BALU C. A	Chelliyampurath House; Edakkattuvayal; Ph. No. 9847308923	
54	MARY PAPPACHAN	Kalapurakkal House; Naduva; Ph. No. 9747060643	
55	RAMANAN	Thekkekunnel House, Veliyanad; Ph. No. 8304887011	
56	OMANA	Putturrkuzhiyil, Ezhakkaranadu; Ph No. 9605318836	477265145511
57	JAYA E K	Karuvamchottil house, Ezhakkaranadu; Ph No. 8606280061	536364170660
58	KUNJUPENNU	Arukuzhiyil house , Nechoor; Ph. No.8606342729	576572958653
59	SHIBU M R	Malayil, Edakkattuvayal; Ph. No 9446545736	229334146804
60	KUNJUMOL J	Veliyathumkuzhiyil, Mulamthuruthy; Ph No.9747745785	675545429146

12. GENERAL

7.1 Organization
7.2 Mandate of Cooperating Centres
7.3 Staff Position
7.4 Weather Data
7.5 List of Publications
7.6 Finance

12.1 ORGANIZATION

The All India Coordinated Project on Use of Saline Water in Agriculture was first sanctioned during the IVth Five Year Plan under the aegis of Indian Council of Agricultural Research, New Delhi at four research centres namely Agra, Bapatla, Dharwad and Nagpur to undertake researches on saline water use for semi–arid areas with light textured soils, arid areas of black soils region, coastal areas and on the utilization of sewage water respectively. During the Fifth Five Year plan, the work of the project continued at the above four centres. In the Sixth Five Year Plan, four centres namely Kanpur, Indore, Jobner and Pali earlier associated with AICRP on Water Management and Soil Salinity were transferred to this Project whereas the Nagpur Centre was dissociated. As the mandate of the Kanpur and Indore centres included reclamation and management of heavy textured alkali soils of alluvial and black soil regions, the Project was redesignated as All India Coordinated Research Project on Management of Salt Affected Soils and Use of Saline Water in Agriculture. Two of its Centres located at Dharwad and Jobner were shifted to Gangavati (w.e.f. 01.04.1989) and Bikaner (w.e.f. 01.04.1990) respectively to work right at the locations having large chunks of land afflicted with salinity problems. During the Seventh Plan, Project continued at the above locations. During Eighth Five Year Plan, two new centres at Hisar and Tiruchirappalli were added. These Centres started functioning from 1 January 1995 and 1997 respectively. Further, during Twelfth Five Year Plan, four new Volunteer centres namely Bathinda, Port Blair, Panvel and Vyttila were added to this AICRP. These four centres started functioning from 2014.

As per recommendations of QRT (2011-2017) of ICAR-CSSRI, Karnal, Indore centre was converted from main cooperating centre to volunteer centre. The Kanpur and Port Blair centre were closed on 31 March 2020. During 2017-2020 Plan, Project continued with an outlay of Rs. 2522.18 lakh at these centres with the Coordinating Unit at Central Soil Salinity Research Institute, Karnal. The ICAR share was of Rs. 1980.60 Lakh while state share was of Rs. 541.58 Lakh. The year wise actual allocation in terms of ICAR share for financial year 2017-18, 2018-19 and 2019-20 was Rs. 615.00 Lakhs, Rs. 649.67 Lakhs, Rs. 527.03 Lakhs, respectively. Annual allocation for 2020-21 and 2021-22 was Rs. 560.70 Lakhs and Rs. 479.17 Lakhs, respectively.

12.2 MANDATES OF COOPERATING CENTRES

Centre Wise Mandate (as finalized in Annual Review Meeting 04-05 June 2018)

In view of scientific staff position reduction from 37 to 16 during SFC 2017-20, research prioritization exercise was done during Annual Review Meeting of the scheme held at ICAR- CSSRI, Karnal during 04-05 June 2018. After discussion with all concerned including ICAR nominated experts, priority areas for each centre was finalized. Priority research areas of the centres, which will continue during 2020-2025, are provided below (Table 7.1).

Table 7.1. Research priorities for different centres

Sr. No.	Name of the Centre	Priority Areas for Research
	Main Cooperating Centres	
1	Agra	• Survey and mapping of groundwater quality • Use of poor quality water use including waste water • Screening for salt tolerance • Survey and mapping of Salt Affected Soils (with ICAR-CSSRI)
2	Bapatla	• Survey and mapping of groundwater quality of AP • Conjunctive use of fresh and saline water with emphasis on *doruvu* technology upscaling • Reclamation and management of irrigation induced salinization (including sodification). • Alternate land use
3	Bikaner	• Survey and mapping for ground water quality of Rajasthan • Use of saline water through micro irrigation for vegetables/field/horticultural crops etc.
4	Gangavathi	• Reclamation and management of irrigation induced salinization (including sodification). • Subsurface drainage including controlled drainage • Micro irrigation in drainage areas/ shallow water areas/ poor quality area • Map of SAS of TBT command area
5	Hisar	• Ground water quality mapping of Haryana • Micro irrigation for saline water use along fertility treatments • Screening for salt tolerance
6	Tiruchirappalli	• Ground water survey and mapping for groundwater quality in coastal Tamil Nadu • Reclamation and management of alkali water and irrigation induced sodification • Rain water harvesting based conjunctive use • Screening of crops and varities for sodicity tolerance
	Volunteer Centres	
7	Akola	• Survey and mapping of groundwater quality • Management of saline /alkali groundwater for irrigation • Dryland salinity/sodicity management • Screening for salt tolerance
8	Bathinda	• Ground water quality mapping of South West Punjab • Land Shaping Technology for waterlogged saline soils (in collaboration with CIFE Rohtak Centre and CSSRI fishery scientist)
9	Indore	• Control of Resodification in Sodic Vertisols • Revised/Updated map of ground water quality and SAS in MP • Irrigation water management for sodic Vertisols • Alternate land use • Updated map of SAS in Madhya Pradesh (with ICAR-CSSRI)
10	Panvel	• Survey and mapping of ground water quality of Konkan region • Rainwater harvesting based IFS models • Increasing cropping inetnsity during rabi season (Establishment of vegetable crops during the Rabi season through management practices)
11	Vytilla	• Mapping of groundwater quality/ SAS in the coastal Kerala • Integrated farming system including management of acid sulphate soils

Existing and proposed mandate for the AICRP

Name of the scheme (Present):

AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture,
ICAR-Central Soil Salinity Research Institute, Karnal, Haryana- 132001

Proposed:

In the NRM Division meeting dated 18 Nov. 2019, the issue of revision of the title of AICRP was discussed and the following title was finalised.

"AICRP on Management of Saline Water & Associated Salinization in Agriculture"

Objectives of the scheme (Present):

Survey and characterization of the salt affected soils and ground water quality in major irrigation commands.

- Evaluate the effects of poor quality waters on soils and crops and plants.
- Develop standards/guidelines for assessing the quality of irrigation waters.
- Develop management practices for utilization of waters having high salinity/alkalinity and toxic ions.
- Develop and test technologies for the conjunctive use of poor quality waters in different agro-ecological zones/major irrigation commands.
- Develop alternate land use strategies for salt-affected soils
- Screen crop cultivars and tree species appropriate to saline/alkali soil conditions.

Proposed:

- Survey, characterization and mapping of groundwater quality for irrigation purpose
- Evaluation of effects of poor quality groundwater irrigation on soils and crops under different agro-climate conditions
- Development of management practices for irrigation induced salinization / guidelines for saline water irrigation (including micro irrigation) under different agro-climatic regions
- Screen crop cultivars and tree species appropriate to soil salinity and alkalinity conditions

12.3 STAFF POSITION

Sanctioned staff positions at centres as per the SFC 2021-26 of AICRP on SAS&USW are provided in Table 7.3

Table 7.3 Sanctioned staff positions at the cooperating centres as per SFC 2021-26 proposal (Status on 31-12-2021)

Category	Agra		Bapatla		Bikaner		Gangavathi		Hisar		Tiruchirappalli		Total	
	San.	Filled	San.	Filled	San.	Filled	San.	Filled	San.	Filled	San.	Filled	San.	Filled
Scientific	2	2	2	2	2	2	2	2	2	2	2	2	12	12
Technical	2	2	2	2	2	1	2	2	2	2	2	2	12	11
Admini-strative	1	1	0	0	0	0	0	0	0	0	0	0	01	01
Supporting	1	1	0	0	0	0	0	0	0	0	0	0	01	01
Total	**6**	**6**	**4**	**4**	**4**	**3**	**4**	**4**	**4**	**4**	**4**	**4**	**26**	**25**

Table 7.4. Details of centre wise staff positions (31-12-2021)

S. No	Designation	No. of posts sanctioned	No. of posts vacant	Name of the employee posted	From	To	Remarks
	Agra						
1	Jr. Soil Physicist	1	0	Dr. R.B. Singh	30.11.1987	Contd.	Filled
2	Jr. Agronomist	1	0	Dr. S.K.Chauhan	15.03.1996	Contd.	-do-
3	S.T.A. (Soils)	2	0	Dr. R.S.Chauhan	01.08.1991	Contd.	-do-
				Dr. P.K. Shishodia	11.07.1994	Contd.	-do-
4	U.D.C.	1	0	Mr. Rajeev Chauhan	04.09.1991	Contd.	-do-
5	Lab. Assistant	1	0	Mr. Sarnam Singh	18.12.1989	Contd.	-do-
	Bapatla						
1	Principal Scientist (Agro.) & Head	1	0	Dr. Y. Radha Krishna	19-07-2018	28.02.2021	Superannuated
2	Senior Scientist (Agro.) & Head	1	0	Dr. K. Anny Mrudhula	07.05.2021	Contd.	filled
3	Senior Scientist (SS)	1	0	Dr. P. Venkata Subbaiah	05-10-2019	Contd.	Filled
4	Agril. Extn. Officer	2	0	1.Sri S. Baba Vali	05-09-2018	Contd.	Filled
				2.Sri M. Venkata Rao	02-01-2012	Contd.	Filled
	Bikaner						
1	Chief Scientist (in scale of Professor) Discipline of Soil Science	1	0	Dr. Ranjeet Singh, Assoc. Prof.	04.01.2019	Contd.	Filled
2	Scientist (in scale of Asstt. Prof.) Discipline of Agronomy / Soil	1	1	Dr Ranveer Kumar Yadav	3-04-2021	Contd.	Filled

	water Conservation Engg.						
3	Field Technician/ Asstt.	1	1	Vacant	---	-----	Vacant
4	Lab. Technician	1	0	Sh. S.K. Bazad, Lab. Asstt.	14.02.1994	Contd.	Filled
	Gangavathi						
1.	Principal Scientist (Soil Sci)	1	0	Dr. Vishwanath J.	04.01.2012	Contd.	Filled
2.	Scientist (Drainage Engg.)	1	0	Er. A.V. Karegoudar	12.12.2009	Contd.	Filled
3.	Lab Assistant	1	0	Mr. Prakash Banakar	04.01.2012	Contd.	Filled
4.	Field Assistant	1	0	Mr. Ramappa Talwar	12-12-2009	Contd.	Filled
	Hisar						
1.	Chief Scientist	1	0	Dr. Satyavan Principal Scientist (Agronomy)	01.02.2016	31.01.2021	Superannuated
2.	Chief Scientist (Soil)	1	0	Dr. Ram Prakash Assistant Scientist	2.02.2021 (Joined the scheme on 24.05.2011)	Contd.	Filled
	Assistant Scientist (Agronomist)	1	0	Dr. S. K.Sharma	08.10.2021	26-04—2022	Filled
3.	Field Tech./Field Assistance	1	0	Sh. Bhagwan Dass Agriculture Inspector	03.12.2020	Contd.	Filled
4.	Lab. Tech.	1	0	Sh. Bhanwar Singh	1.11.2018	30.09.2021	Superannuated
				Sh. Sarwan Kumar	01.03.2022	Contd.	Filled
	Tiruchirapalli						
1	Chief Scientist (Soil Science)	1	0	Dr. P. Balasubramaniam	02.03.2016	Contd.	Filled
2	Scientist (Agronomy)	1	0	Dr. A.Alagesan	07.04.2015	Contd.	Filled
3	Field Technician	1	0	Mr. P. Sakthivel	01.07.2016	04.12.2021	Deceased
				Tmt. A.Arivuselvi	22.06.2020	Contd.	Filled
4	Laboratory Technician	1	0	Mr. P. Sakthivel	01.07.2016	Contd.	Filled

Nodal officers and SRFs at Volunteer Centres (31-12-2021)

S. No	Designation	No. of posts sanctioned	No. of posts vacant	Name of the employee	From	To
1	**Bathinda**					
	Nodal Officer	1	0	Dr. Brijesh Kumar Yadav	16.05.2014	Contd.
	SRF	2	2	NA	NA	
2	**Indore**					
	Nodal Officer	1	0	Dr. KS Bangar	01-04-2020	Contd.
	SRF	2	2	NA	NA	
3	**Panvel**					
	Nodal Officer	1	0	Dr. KV Vaidya	1-07-2020	Contd.
	SRF	2	1	Smt. SS Khobragade	1-07-2021	Contd.
4	**Vytilla**					
	Nodal Officer	1	0	Dr. AK Sreelatha	3.07.2014	Contd.
	SRF	2	1	Dr. Irene Elizabeth John	05.08.2019	31.03.2020
				Ms.Nisha Paul	19.11.2020	Contd.

12.4 WEATHER DATA (2021)

Main Centres

AGRA

Latitude - $27^0 20'$ N Longitude - $77^0 90'$ E

Month	Temperature		Relative Humidity %		Rainfall (cm)	Evaporation (mm/day)	Water Table* (m)
	Max	Min	Morning	Evening			
January	20.5	8.2	-	79.6	0.31	0.9	21.3
February	28.6	12.1	-	77.0	0.0	2.2	21.6
March	35.9	8.7	-	67.5	0.19	4.1	21.4
April	39.7	20.6	-	59.4	0.0	6.8	21.4
May	38.7	24.9	-	65.8	9.66	5.7	21.8
June	40.3	26.9	-	67.6	2.16	6.1	22.0
July	37.3	28.2	-	77.3	34.96	5.2	21.5
August	34.8	26.8	-	87.0	17.57	3.2	21.2
September	33.4	25.6	-	92.3	9.64	2.8	21.2
October	32.9	20.5	-	78.7	7.81	3.3	21.2
November	27.6	12.1	-	79.8	0.0	1.5	21.3
December	23.0	8.8	-	80.0	0.0	1.0	21.2

BAPATLA

Latitude - $15^{\circ} 54'$ N Longitude - $80^{\circ} 28'$

Month	Temperature		Relative Humidity %		Rainfall (cm)	Evaporation* (mm/day)	Wind velocity (km/hr)
	Max	Min	Morning	Evening			
January	30.7	19.7	85	58	0	-	03/02
February	30.9	18.6	84	53	23.0	-	03/01
March	33.6	21.0	84	55	0	-	02/01
April	35.6	25.6	68	59	0	-	06/03
May	36.8	27.4	61	53	46.8	-	03/01
June	36.6	26.9	62	49	92.3	-	04/02
July	33.9	25.3	77	63	175.6	-	05/03
August	34.0	25.0	80	68	205.7	-	03/02
September	33.3	25.0	84	74	240.5	-	02/01
October	33.1	24.2	86	76	178.2	-	01/01
November	29.1	22.7	88	83	276.0	-	03/02
December	29.9	18.4	87	67	0	-	02/01

* **Note:** The data of Evaporation is not available at Saline Water Scheme, Bapatla.

BIKANER

Latitude – 28° 01’ N Longitude – 73° 35’ E

Month	Temperature		Relative Humidity %		Rainfall (cm)	Evaporation (mm/day)	Wind velocity (km/hr)	Water Table (m)
	Max	Min	Morning	Evening				
January	22.4	4.7	78.5	37.4	0.00	7.6	3.4	
February	29.5	10.4	66.3	21.8	0.00	9.2	4.3	
March	35.2	16.6	58.6	25.4	0.26	8.0	6.1	
April	38.6	20.3	39.2	16.8	0.16	10.2	6.6	
May	40.4	25.6	49.8	26.2	1.02	9.5	8.4	
June	40.5	27.6	57.1	34.2	5.90	8.9	10.0	
July	39.5	27.8	68.6	45.3	6.46	9.3	10.0	120.70
August	38.3	26.9	66.0	41.2	5.42	9.4	8.6	
September	35.0	24.8	84.8	57.6	11.98	7.7	5.0	
October	34.4	19.2	71.7	35.3	1.26	9.1	4.6	
November	30.5	10.5	67.7	24.2	0.00	8.4	3.2	
December	23.8	5.7	78.9	34.9	0.00	7.4	2.6	

GANGAVATHI

Latitude – 15° 00’N Longitude – 76° 00’ E

Month	Temperature		Relative Humidity %		Rainfall (cm)
	Max	Min	Morning	Evening	
January	29.90	17.64	-	-	6.8
February	30.96	15.89	-	-	0.50
March	34.64	16.96	-	-	0.0
April	38.27	23.84	85.80	25.94	4.0
May	37.17	24.70	87.03	35.32	70.8
June	33.67	23.98	90.60	47.80	65.0
July	31.91	24.12	91.39	57.94	2.50
August	31.92	23.71	93.61	57.83	49.5
September	30.79	23.29	96.87	66.43	104.5
October	32.06	22.51	99.58	57.48	40.5
November	29.70	21.28	99.67	63.53	115.5
December	30.37	17.90	99.81	45.71	4.50

HISAR

Latitude - 29° 10’ N Longitude - 75° 46’ E

Month	Temperature		Relative Humidity %		Rainfall (mm)	Evaporation (mm/day)	Wind velocity (km/hr)
	Max	Min	Morning	Evening			
January	17.4	6.0	98.0	69.0	0.3	1.1	4.4
February	25.1	7.5	97.0	47.0	0.3	1.8	2.5
March	31.0	13.5	87.0	37.0	0.2	3.8	4.3
April	36.3	16.1	62.0	21.0	0.0	6.8	4.9
May	37.7	22.8	66.0	36.0	1.1	7.6	6.7
June	38.3	26.2	71.0	43.0	2.2	6.5	6.9
July	36.9	27.5	81.0	60.0	5.6	6.4	7.6
August	35.5	26.6	86.0	63.0	2.2	5.0	5.8
September	32.4	25.4	91.0	75.0	15.3	3.5	5.3
October	32.0	19.6	88.0	47.0	0.2	3.2	2.9
November	27.9	10.0	89.0	34.0	0.0	1.8	1.8
December	21.3	6.3	95.0	50.0	0.0	1.3	2.2

TIRUCHIRAPPALLI

Latitude – 10° 45’ N Longitude – 78° 36’ E

Month	**Temperature**		**Relative Humidity (%)**		**Rainfall (cm)**	**Evaporation (mm/day)**	**Wind velocity (km/hr)**
	Max.	**Min.,**	**Morning**	**Evening**			
January	30.8	22.5	80.6	62.8	182.5	3.5	4.3
February	31.6	23.0	81.8	52.3	-	5.9	4.1
March	34.6	23.8	79.9	38.8	59.4	-	4.4
April	36.4	24.9	81.1	38.9	2.2	6.4	4.8
May	36.5	26.0	79.9	40.1	85.6	6.4	5.7
June	36.6	26.5	79.4	43.6	210.4	7.0	7.0
July	36.3	25.3	78.3	45.5	104.6	5.7	7.0
August	35.8	24.9	76.5	39.7	119.3	5.7	7.3
September	35.6	24.2	79.5	47.9	212.0	5.5	4.3
October	33.4	24.3	87.1	53.3	263.8	4.8	3.3
November	30.7	23.6	90.0	69.2	528.4	2.1	2.6
December	31.2	22.0	90.6	68.8	46.2	3.5	2.3

KARNAL

Latitude – 29° 43’ N Longitude – 76° 58’ E

Month	Max.	Min.	Dry Bulb		Wet Bulb		VP		RH		Max. Temp		Min. Temp	
			I	II	I	II	I	II	I	II	High/date	Low/date	High/date	Low/date
Jan.	16.7	07.4	08.7	16.3	08.6	15.1	08.5	12.4	98.4	88	23.5/05	9.0/02	15.1/05	2.6/28
Feb.	23.5	09.2	10.2	23.1	10.1	19.3	09.3	14.7	98.6	69	30.0/28	16.0/13	17.0/27	4.0/01
Mar.	29.6	13.7	15.3	29.1	14.7	22.8	12.2	17.1	93.4	59	36.2/30	23.2/24	18.4/23	9.5/01
Apr.	36.2	16.4	20.7	35.4	16.0	21.1	12.6	10.9	57.5	24	41.4/30	28.5/24	21.8/29	9.2/02
May.	36.1	22.2	25.6	34.7	21.5	24.6	16.9	17.0	90.8	43	41.0/28	26.1/20	26.8/18	18.8/07
June	36.4	25.3	27.6	35.0	25.1	26.4	21.7	20.2	78.3	49	42.0/10	30.5/02	29.9/09	20.0/01
July	34.2	26.6	28.0	32.4	26.3	27.9	24.8	25.5	87.7	72	40.6/01	26.0/15	31.0/01	23.2/03
Aug.	33.0	26.4	27.3	31.7	26.4	28.3	25.3	26.8	92.4	77	35.7/20	26.4/22	29.1/01	22.8/30
Sept.	31.6	24.8	25.9	30.8	25.3	27.3	23.9	25.1	94.9	76	33.6/20	25.8/23	27.0/06	22.5/24
Oct.	31.5	19.0	20.5	30.7	19.5	22.9	16.9	16.4	88.9	50	35.5/13	23.2/19	25.0/04	13.2/30
Nov.	27.4	10.9	11.7	26.4	11.2	17.1	09.7	09.1	93.0	35	29.6/09	24.8/27	16.0/02	8.7/24
Dec.	21.2	07.6	08.5	20.2	08.3	15.9	08.2	10.9	97.2	62	26.8/05	15.6/19	12.8/02	3.2/30
Total	357.4	209.5	230.2	345.9	213.0	268.7	190.1	206.1	1071.1	703.5				
Aver.	19.2	17.5	19.2	28.8	17.8	22.4	15.8	17.2	89.3	58.6				

Month	Soil temperature° C (Depth cm)						Total Rainfall					Average	
	5.0 cm		10.0 cm		15.0 cm		Monthly	Rainday	Rain Fall	Evaporation		Sunshine	Wind
	I	II	I	II	I	II	(mm)		High/Date	mm/day	mm/month	Hrs/day	Km/hrs
Jan.	8.5	19.3	8.9	16.1	11.8	13.8	36.4	04	25.8/06	00.9	27.3	03.1	02.7
Feb.	10.3	26.7	10.9	23.5	14.5	18.6	23.8	03	14.0/04	01.8	51.4	06.9	01.8
Mar.	16.1	36.1	17.0	31.5	21.5	26.2	04.0	03	2.0/08	04.2	129.7	07.3	01.5
Apr.	21.2	45.2	21.9	38.4	26.3	32.9	02.8	03	1.0/21	07.8	233.4	08.4	01.9
May.	25.2	43.0	26.0	39.5	29.1	34.6	37.4	06	17.8/21	07.3	226.3	07.5	02.1
June	28.2	45.1	28.8	41.5	31.4	37.0	89.3	06	34.0/01	06.8	198.2	08.5	*
July	28.4	38.0	29.1	36.2	29.6	31.5	668.1	15	245.0/14	05.2	145.2	06.0	*
Aug.	27.3	35.7	28.0	33.9	29.2	32.2	146.1	07	38.2/22	03.6	110.6	06.3	01.4
Sept.	26.3	33.3	26.5	31.9	27.7	29.7	224.6	11	117.4/24	03.1	089.8	05.2	01.0
Oct.	20.3	31.0	20.6	28.9	22.1	25.2	85.6	04	45.0/05	03.0	086.0	07.3	01.1
Nov.	11.2	27.1	12.0	23.0	15.6	19.7	00.0	00	00.0	01.9	057.6	07.1	00.6
Dec.	07.7	23.9	08.5	18.8	11.6	15.3	01.2	01	1.2/27	01.2	035.9	04.5	00.6
Total	230.6	404.4	238.3	363.2	270.5	316.7	1319.3	63.0		46.8	1391.4	78.1	14.7
Aver.	19.2	33.7	19.9	30.3	22.5	26.4				3.9	116.0	6.5	1.5

Volunteer Centres

BATHINDA

Latitude – 30° 23’ N Longitude – 74° 95’ E

Month	Temperature		Relative Humidity %		Rainfall (cm)	Evaporation (mm/day)	Wind velocity (km/hr)
	Max	Min	Morning	Evening			
January	17.1	5.0	95.4	97.6	4.2	1.5	1.0
February	24.9	8.6	93.9	78.2	2.0	3.7	0.5
March	30.5	14.0	78.4	51.2	0.0	6.6	1.5
April	35.5	16.9	58.7	29.6	16.8	11.0	1.7
May	37.4	22.5	64.6	43.4	32.0	11.6	1.8
June	39.3	25.8	75.4	52.6	25.8	11.5	1.5
July	36.5	25.9	81.0	63.4	105.6	8.0	1.7
August	35.4	25.3	80.5	59.8	120.4	7.8	0.7
September	33.2	24.2	85.5	69.3	139.1	5.6	0.9
October	32.4	17.5	80.6	54.2	61.4	4.7	0.6
November	27.7	9.4	84.7	45.0	0.0	2.9	0.5
December	21.9		93.6	60.7	0.0	1.6	0.2

INDORE (Indore College Station Weather Station)

Latitude – 22° 14’ N Longitude - 76° 01’ E

Month/Year	**Temperature**		**Relative Humidity %**		**Rainfall (mm)**	**Evaporation (mm/day)**	**Wind velocity (km/hr)**
	Max	**Min**	**Morning**	**Evening**			
January 2021	25.2	11.1	84.0	83.0	0.0	Not Available	0.40
February 2021	25.7	9.5	73.0	70.0	0.0	-	0.25
March 2021	34.9	17.1	81.3	77.2	5.3	-	0.54
April 2021	38.7	21.6	79.3	74.9	0.0	-	0.91
May 2021	38.6	25.4	78.4	73.8	8.0	-	2.08
June 2021	34.8	24.2	87.6	78.2	250.9	-	2.65
July 2021	30.1	24.2	89.8	88.9	204.7	-	2.65
August 2021	27.5	22.9	91.5	87.5	219.3	-	1.52
September 2021	28.7	22.7	91.4	85.1	377.6	-	0.38
October 2021	30.8	18.9	86.4	81.6	66.8	-	0.02
November 2021	28.4	12.6	77.6	82.4	0.0	--	0.04
December 2021	23.4	10.8	84.9	86.6	17.3	--	0.03
				TOTAL	**1149.9**	-	

Rainfall and evaporation recorded at Barwaha Experimental Station, Barwaha Research Farm, Village: Bafalgaon, Tehsil: Barwaha, District: Khargone, M.P. (at distance of 65 km)

Latitude - $22^0$14'46" N - 22º 14´ 59.9˝ N Longitude - $76^0$00'24" E - 75º 59´ 53.4˝E

Month	Evaporation (m)	Rainfall (mm)	Rainy day	Month	Evaporation (mm)	Rainfall (mm)	Rainy day
Jan - 21	59	2.8	1	Jul-21	124	302.2	16
Feb - 21	92	3.8	1	Aug-21	59	142.9	12
Mar - 21	235	2.8	1	Sep-21	39	260.1	17
Apr-21	342	0.0	0	Oct-21	89	71.9	4
May-21	404	23.7	3	Nov-21	101	0.0	0
Jun-21	239	128.6	10	Dec-21	59	11.9	2
				Total	**1842**	**950.7**	**67**

PANVEL

Latitude – 18° 59' N Longitude – 73° 06' E

Month	Temperature		Relative Humidity %		Rainfall (mm)	Evaporation (mm/day)	Wind velocity (km/hr)
	Max.	Min.	Morning	Evening			
January	34.88	18.47	88.1	56.23	5.6	2.29	1.41
February	34.99	17.49	87.11	56.57	11.6	3.65	0.75
March	39.93	20.64	74.16	41.58	0.0	5.39	2.19
April	37.62	24.58	79.24	54.14	0.0	5.08	4.18
May	36.35	25.91	83.77	79.26	60.2	5.63	5.28
June	31.6	22.6	94.4	86.1	917.4	2.54	4.90
July	30.2	24.6	94.6	89.9	1444.8	1.60	6.70
August	29.8	22.4	94.6	90.1	308.8	2.06	3.10
September	28.7	21.5	95.4	88.2	883.8	2.00	7.40
October	35.9	19.3	83.6	80.5	163.4	3.09	2.60
November	36.3	17.4	86.6	72.6	30.2	2.65	3.10
December	33.1	13.7	93.3	71.6	84.6	2.44	3.90

VYTILLA

Latitude –9^{0}5’35’’ N Longitude 76^{0}19’18’’

Month/Year	Temperature		Relative Humidity %		Rainfall (cm)	Evaporation (mm/day)	Wind velocity (km/hr)
	Max	Min	Morning	Evening			
January	31.16	23.01	-	_	1.827	2.49	_
February	32.06	23.14	-	_	NIL	2.67	_
March	32.62	24.59	-	_	4.050	3.01	_
April	32.13	24.45	-	_	8.150	2.98	_
May	31.03	24.04	-	_	62.100	2.64	_
June	30.17	23.90	-	-	45.300	2.31	-
July	29.65	23.80	-	_	53.300	2.56	_
August	29.32	24.30	-	_	49.550	2.42	_
September	29.42	23.20	-	_	24.450	2.88	_
October	30.01	23.01	-	_	38.700	2.78	_
November	29.64	23.41	-	_	30.800	2.84	_
December	29.11	23.19	-	_	0.800	2.91	_

12.5 List of Publications

Agra

Singh, RB, Kaledhonkar, MJ, Shishodia, PK, Chauhan, SK and Chauhan, RS. 2021. Low cost groundwater recharge technology for poor quality groundwater areas in Agra and Bharatpur region. Journal of Soil and Water Conservation 20(4), 411-417, October-December 2021.

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Singh PK, RK Naresh, Shahi UP, Tomar SS, Singh RB, Yadav KG, Kumar Mukesh, Kumar Mukesh, Mishra AK, Sharma VK and Tiwari Rakesh (2020). Effects of Manure and Synthetic Fertilizer with Residue Returning on Soil Organic Carbon Storage; Interactions with Intra-Aggregate Pore Structure and Water Stable Aggregates in High Input Cropping System: A Review. *Int.J.Curr.Microbiol.App.Sci.* 9(06): 2877-2892.

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Mrudhula KA, Rani YS, Subbaiah PV and Sambaiah A (2021).Studies on Exogenous application of organics for alleviating salt*. International Journal of Plant and Soil Science*,33(19):177-180.

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ChoudharyAshok, AKSingh, KumarRamesh, Kaswan PK, SinghRanjeet, Godara AS, Kaledhonkar MJ and Meena BL (2020).Performance of different varieties of groundnut under surface and sub surface drip irrigation using saline and good quality waters. *Journal of Soil Salinity and Water Quality*, 12(1):65-69.

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Gangavathi

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RathodHarshawardhan, VishwanathJ, RudramurthyHV, VeereshHand AnandaN(2021). Assessment of spatial and temporal changes in salinity and alkalinity of natural streams/nala water in Sindhanurtaluk of Tungabhadra command area in Karnataka. *J. Farm Sci.*, 34(3): 269-277.

Hisar

Popular Articles

Seema,Dahiya, Rita, and Ram Prakash(2020). Response of Major Plant Nutrients under Salt Affected Soils. Haryana Kheti

Tiruchirappalli

Gunavathi P and Janaki D and Balasubramaniam P and Alagesan A and Geethanjali S(2021).Characterization and identification of elemental sulphur, iron pyrite, mineral gypsum, Phospho gypsum and marine gypsum by using ATR-FTIR}.*The Pharma Innovation Journal,*10(5): 80-86.

Monisha N, Balasubramaniam P, Janaki D, Ramesh T and Mahendran PP (2021). Assessment of groundwater quality and mapping in coastal blocks of Pudukottai district, Tamil Nadu. *The Pharma Innovation Journal,* SP-10(10): 777-781.

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SabarishK, Paul S,Sebestian, MaheswariM, BalasubramaniamP and Ejilane J(2021).Production and Characterization of Paper Board Mill ETP Sludge Derived Hydrochar by using International.*Journal of Environment and Climate Change*, 11 (11): 1-8.

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Bathinda

Kahlon P, Yadav BK and Sharma S (2021). Assessment of dehydrogenase and phosphatase activities under cotton-wheat and rice-wheat cropping systems in Sangat block of Bathinda district, Punjab.*Journal of the Indian Society of Soil Science***69**: 96-104.

Ramya S, Pandove G, Kalia A, Kaur S, Oberoi H and Yadav BK(2021). Appraisal of seed priming with liquid microbial inoculants on growth and yield attributes of forage cowpea. *Legume Research-An International Journal*44: 1109-1117.

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Bangar KS, Tiwari SC, Khandkar, UR, Verma, SK, Kumawat, N, Kaledhonkar, MJ and Tagore, GS. 2021. Characterization and mapping of groundwater quality of Gird region in central India. Journal of Soil Salinity and Water Quality 13(2), 268-277.

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Vytilla

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ThomasD, PrabashlalP, VigneswaranVand SreelathaAK (2021).Sustainable Nutritional and Income Security Through Integrated Farming in Coastal Saline Pokkali Ecosystem of Kerala**.** *In:* Sarangi S K, Mahanta KK, Raut S, Bhutia RN and Prakash NR (Eds.). Book of Abstracts: International Symposium on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food andIncome Security, 16 - 19 March, 2021. Indian Society of Coastal Agricultural Research, ICAR-CentralSoil Salinity Research Institute, Regional Research Station, Canning Town – 743 329, West Bengal, India, 298 p.

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Popular articles

NehaUnni and Sreelatha, A. K. 2021.*"PonnuVillayunnaPokkalipadangal*". *HarithaBhoomi*11(9).

PC Unit:

Rundan V, Singh Magan, Kumar S, Meena BL, Dutta Susanta and Parveen BR (2021) Assessment of Nutrient Management Practices on Productivity and Profitability of Fodder Maize+Ricebean Intercropping under Irrigated Condition. *Indian Journal of Ecology*, 48(5): 1397-1402.

Kumar A, Mann Anita, Kumar Arvind, Kumar N and Meena BL (2021) Physiological response of diverse halophytes to high salinity through ionic accumulation and ROS scavenging. *International Journal of Phytoremediation*, 23(10): 1041-1051

Baljeet, BL Meena, M Singh, S Kumar, S Bhattcharjee and S Onte (2021) Effect of potassium and foliar spray of zinc on yield, nutrient biofortification, and economics of fodder maize (Zea mays L.). Ann. Agric. Res. New Series, 42 (4): 382-390.

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Bhakar Ankur, Singh M., Kumar Sanjeev, Meena R.K., Meena B.L., Kumar Rakesh., V.K. Meena (2021) Growth, Productivity and Profitability of Fodder Sorghum and Cluster Bean as Influenced by Mixed Cropping and Nutrient Management. *Legume Research - An International Journal*, 44 (11):1308-1314.

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Radha Krishna, Y. Mrudhula, A. Sailaja, V. Naidu, MVS, Kaledhonkar, MJ and Meena, BL. 2020. Performance of fodder crops in salt affected soils. Salinity News. Vol. 26 (2), Jul. Dec. 2020, p6.

Bangar, KS, Kumawat, N, Tiwari, SC, Kaledhonkar MJ and Parmar, BB. 2021. Groundwater quality map of Madhya Pradesh for irrigation purpose. Salinity News. Vol. 27 (1), Jan. June 2021, p2.

BL Meena,RK Fagodiya, RL Meena and MJ Kaledhonkar (2020-21) Faslon mein loh tatv kee aapurti ke liye chelated urvarkon ka upyog (Hindi). *Krishi Kiran*, 13:21-25.

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Minhas, PS and Kaledhonkar, MJ. 2021. Sustainable management of saline water for irrigation. In Book: Managing Salt Affected Soils for Sustainable Agriculture (Eds. Minhas, PS, Yadav, RK and Sharma, PC), DKMA, ICAR, Pusa, New Delhi 457-484 (ISBN: 978-81-7164-196-3).

Kaledhonkar, MJ, Jhorar, RK, Gupta, SK. 2021. Modeling for root-zone salinity and crop yield predictions. In Book: Managing Salt Affected Soils for Sustainable Agriculture (Eds. Minhas, PS, Yadav, RK and Sharma, PC), DKMA, ICAR, Pusa, New Delhi 548565 (ISBN: 978-81-7164-196-3).

Contribution of AICRP on SAS&USW Centres to Global Symposium on Salt Affected Soils (Halt soil salinization, boost soil productivity) Organized by FAO (INSAS.GSP) online during 20-22 Oct. 2021.

Theme 1. Assessment, mapping, and monitoring of salt-affected soils:

- Serawat A., Singh R., Yadav S.R., Singh S.P., Yadav R.K., Kaledhonkar M.J. 2021. Survey and characterization of underground waters of north western part of Jodhpur, Rajasthan, 114-116.
- Sreelatha A.K., Paul N., Kaledhonkar M.J . 2021. Assessment of ground water quality for irrigation in Alappuzha district of Kerala, India 116-117.

Theme 2. Integrated soil – water – crop solutions in rehabilitation and management of salt-affected areas

- Alagesan A., Balasubramaniam P., Masilamani P., Kaledhonkar M.J. 2021. Amelioration of sodic soil and conjunctive use of canal and alkali ground water for sustainable rice production, 138-139.
- Balasubramaniam P., Alagesan A., Masilamani P., Kaledhonkar M.J. 2021. Evaluation of Sorghum (Sorghum bicolor L.) varieties for their toleranceto sodicity level for sustained productivity in salt affected soils. 149-150.
- Rajkumar R.H., Dandekar A.T., Nemichandrappa M., Vishwanatha J., Ayyanagowdar M.S., Polisgowdar B.S., Satyanarayana R., Karegoudar A.V., Kaledhonkar M.J. 2021. Effect of saline water with different irrigation methods on soil, yield and water use efficiency of tomato (Solanum Lycopersicum) under Tungabhadra Project Command, 221-222.
- Rajkumar R.H., Vishwanatha J., Anand S.R., Karegoudar A.V., Dandekar A.T., Kaledhonkar M.J. 2021. Effect of irrigation management on soil properties, growth and yield of sugarcane (Saccharum officinarum) in waterlogged saline Vertisols under Tungabhadra Project Command area, 223-224.
- Singh A.K., Singh R., Yadav S.R., Yadav R.K., Kaledhonkar M.J. 2021. Impact of saline water in groundnut-wheat cropping system in hyper arid-region of Rajasthan, 238-239.
- Vaidya K.P., Borse D.K., Khobragade S.S., Kaledhonkar M.J., Dodake S.B. 2021. Effect of planting windows and irrigation schedules on yield of dibbled wal (Field bean) under zero tillage in coastal saline soils of Konkan region of Maharashtra, 248-249.
- Yadav B.K., Garg N., Pandove G., Kaledhonkar M.J. 2021. Mitigation of salinity effect through seed priming with microbial inoculants, 258-259.

Theme 3. Agenda for action to prevent and rehabilitate salt-affected soils, protect natural saline and sodic soils, and scale-up sustainable soil management practices

- Subbaiah V.P., Mrudhula A., Kaledhonkar M.J. 2021. Salt affected soils in Prakasam district of Andhra Pradesh - Livelihood diversification of farmers, 296-297.
- Karegoudar A.V., Vishwanath J., Rajkumar R.H., Anand S.R., Kaledhonkar M.J. 2021. Controlled subsurface drainage for the management of water table, soil salinity and nutrient losses in waterlogged saline vertisols of TBP command area of Karnataka, India, 338-342.
- Rajkumar R.H., Vishwanatha J., Karegoudar A.V., Anand S.R., Dandekar A.T., Kaledhonkar M.J. 2021. Laser land leveling: Enhancing water productivity in Tungabhadra command area, 354-356.

Awards & Recognition

Dr. MJ Kaledhonkar

- **ISAE Commendation Medal Award 2020** was given to Dr. MJ Kaledhonkar for valuable contributions in field of Soil and Water Engineering during 55th ISAE Annual Convention to be held during November 23-25, 2021 at Patna.
- **ISAE JAE Best Paper Award 2020** was given to research paper "Performance Evaluation of Subsurface Drainage System under Waterlogged Saline Vertisols for Sugarcane Crop in Ukai Kakrapar Canal Command, Gujarat" Anil R. Chinchmalatpure, Sagar D. Vibhute, M. J. Kaledhonkar, Sanjay Vasant Kad, Shrvan Kumar, David Camus, Indivar Prasad, S. K. Kamra and P.C. Sharma during 55th ISAE Annual Convention to be held during November 23-25, 2021 at Patna.
- **Best Poster Award (2nd Position)** to Effect on irrigation management on soil properties, growth and yield of sugarcane (Saccharum officinarum) in waterlogged saline Vertisols under Tungabhadra Project Command area. by Rajkumar, RH, Vishwanatha J, Anand SR, Karegoudar AV, Dandekar AT and Kaledhonkar, MJ during Global Symposium on Salt Affected Soils Organized by FAO (INSAS.GSP) during 20-22 Oct. 2021.

Dr BL Meena:

- **Best Research Paper Award** – 2019 in the category of Social Science has been awarded to Subhash Chand, **Babulal Meena**, Ghoshal Chaudhary, R.C. Srivastava and Khyali Ram Chaudhary for the paper entitled *"Leased farming degrading the farmlands? Analysis of farmers' perceptions in Andaman and Nicobar Islands, India"* published in Indian Journal of Soil Conservation (Volume 47, Issue 3, Pages 273 to 279) during "Annual Award Ceremony" of The Indian Association of Soil and Water Conservationists (IASWC) and the ICAR-IISWC Dehradun on 23 September 2021.
- **Awarded 3rd prize in on-line Soil Salinity** Quiz organized during the Seminar on "Ecological Restoration of Salt Affected Soils to Boost Productivity" by the Academy of Natural Resource Conservation and Management on 4th December, 2021.

12.6 FINANCE

During 2017-2020 Plan, Project continued with an outlay of Rs. 2522.18 lakh at these centres with the Coordinating Unit at Central Soil Salinity Research Institute, Karnal. The ICAR share was of Rs. 1980.60 Lakh while state share was of Rs. 541.58 Lakh. The year wise actual allocation in terms of ICAR share for financial year 2017-18, 2018-19 and 2019-20 was Rs. 615.00 Lakhs, Rs. 649.67 Lakhs, Rs. 527.03 Lakhs, respectively. Annual allocation for 2020-21 was Rs. 560.70 Lakhs. The centre wise allocations during FY 2020-21 are provided below.

Main Centres

1. Agra (100% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	700000.00	700000.00
2	Salary	14399833.00	14303340.00
3	TA(SWS)	30000.00	24831.00
4	TA(ORP)	3000.00	2410.00
5	Res.Cont.(SWS)	100000.00	97611.00
6	Res.Cont.(ORP)	48000.00	46644.00
7	Operational(SWS)	447000.00	420358.44
8	Operational(ORP)	44000.00	40712.00
9	SCSP (General)	62000.00	61860.00
	Total	**15833833.00**	**15697766.44**

2. Bapatla (75% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	650000.00	648339.00
2	Salary	6058000.00	4794137.00
3	TA(SWS)	12000.00	11213.00
4	TA(ORP)	7500.00	0.00
5	Res.Cont.(SWS)	200000.00	199937.00
6	Res.Cont.(ORP)	40000.00	39944.00
7	Operational(SWS)	300000.00	299907.00
8	Operational(ORP)	100000.00	99759.00
9	SCSP (General)	75000.00	75000.00
	Total	**7442500.00**	**6168236.00**

3. Bikaner (75% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	593000.00	483538.50
2	Salary	7800000.00	5442002.25
3	TA(SWS)	40000.00	10207.50
4	TA(ORP)	0.00	0.00
5	Res.Cont.(SWS)	230000.00	199106.25
6	Res.Cont.(ORP)	0.00	0.00
7	Operational(SWS)	370000.00	350244.00
8	Operational(ORP)	0.00	0.00
9	SCSP (General)	60000.00	59214.00
	Total	**9093000.00**	**6544312.50**

4. Gangavathi (75% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	612000.00	285481
2	Salary	4840000.00	4418722.00
3	TA(SWS)	12000.00	4130.00
4	TA(ORP)	0.00	0.00
5	Res.Cont.(SWS)	200000.00	103951.00
6	Res.Cont.(ORP)	0.00	0.00
7	Operational(SWS)	300000.00	218285.00
8	Operational(ORP)	0.00	0.00
9	SCSP (General)	70000.00	69714.00
	Total	**6034000.00**	**5100283.00**

5. Hisar (75% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	515000.00	294154.00
2	Salary	4670000.00	4033775.00
3	TA(SWS)	20000.00	20000.00
4	TA(ORP)	0.00	0.00
5	Res.Cont.(SWS)	250000.00	250000.00
6	Res.Cont.(ORP)	0.00	0.00
7	Operational(SWS)	300000.00	300000.00
8	Operational(ORP)	0.00	0.00
9	SCSP (General)	24000.00	24000.00
	Total	**5779000.00**	**4921929.00**

6. Kanpur (75% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital		
2	Salary	1451167.00	1451167.00
3	TA(SWS)		
4	TA(ORP)		
5	Res.Cont.(SWS)		
6	Res.Cont.(ORP)		
7	Operational(SWS)		
8	Operational(ORP)		
9	SCSP (General)		
	Total	1451167.00	1451167.00

(Note: Kanpur centre was closed on 31st March 2020 as per approved QRT (2011-17) recommendations.

7. Tiruchirapalli (75% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	413000.00	413000.00
2	Salary	5273000.00	3959543.00
3	TA(SWS)	10000.00	8899.00
4	TA(ORP)	0.00	0.00
5	Res.Cont.(SWS)	400000.00	400000.00
6	Res.Cont.(ORP)	0.00	0.00
7	Operational(SWS)	513500.00	513500.00
8	Operational(ORP)	0.00	0.00
9	SCSP (General)	189000.00	189000.00
	Total	**6798500.00**	**5483942.00**

Volunteer Centres

1. Bathinda (100% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	0.00	0.00
2	Salary	0.00	0.00
3	TA(SWS)	5000.00	4252.00
4	TA(ORP)	0.00	0.00
5	Res.Cont.(SWS)	80000.00	76000.00
6	Res.Cont.(ORP)	0.00	0.00
7	Operational(SWS)	140000.00	139000.00
8	Operational(ORP)	0.00	0.00
9	SCSP (General)	40000.00	40000.00
	Total	**265000.00**	**259252.00**

2. Indore (100% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	550000.00	543269.00
2	Salary	0.00	0.00
3	TA(SWS)	30000.00	30000.00
4	TA(ORP)	0.00	0.00
5	Res.Cont.(SWS)	100000.00	92000.00
6	Res.Cont.(ORP)	0.00	0.00
7	Operational(SWS)	200000.00	196000.00
8	Operational(ORP)	0.00	0.00
9	SCSP (General)	40000.00	40000.00
	Total	**920000.00**	**901269.00**

3. Panvel (100% ICAR Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	550000.00	547100.00
2	Salary	0.00	0.00
3	TA(SWS)	30000.00	29843.00
4	TA(ORP)	0.00	0.00
5	Res.Cont.(SWS)	100000.00	99478.00
6	Res.Cont.(ORP)	0.00	0.00
7	Operational(SWS)	293000.00	292996.00
8	Operational(ORP)	0.00	0.00
9	SCSP (General)	50000.00	50000.00
	Total	**1023000.00**	**1019417.00**

4. Vytilla (100% Share)

			(Rs.)
SN	**Details**	Released	Expenditure
1	Capital	150000.00	150000.00
2	Salary	0.00	0.00
3	TA(SWS)	15000.00	15000.00
4	TA(ORP)	0.00	0.00
5	Res.Cont.(SWS)	100000.00	100000.00
6	Res.Cont.(ORP)	0.00	0.00
7	Operational(SWS)	250000.00	250000.00
8	Operational(ORP)	0.00	0.00
9	SCSP (General)	60000.00	60000.00
	Total	**575000.00**	**575000.00**

5. PC Unit (100% ICAR Share)

			(Rs.)
SN	Details	Released	Expenditure
1	Capital	267000.00	255079.30
2	Salary	0.00	0.0
3	TA(SWS)	0.00	0.0
4	TA(ORP)	0.00	0.0
5	Res.Cont.(SWS)	40000.00	40000.00
6	Res.Cont.(ORP)	0.00	0.0
7	Operational(SWS)	532000.00	464862.00
8	Operational(ORP)	0.00	0.0
9	SCSP (General)	16000.00	0.0
	Total	**855000**	**759941.30**


REDMI NOTE
AI QUAD CAMERA


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AICRP ON MANAGEMENT OF SALT AFFECTED SOILS AND
USE OF SALINE WATER IN AGRICULTURE
A.N.G.R AGRICULTURAL UNIVERSITY, APATLA
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