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SALINITY NEWS

From Directors' Desk

Since its establishment in 1969, the ICAR-Central Soil Salinity Research Institute (ICAR-CSSRI) has made remarkable progress in developing technologies to reclaim salt-affected soils in India. These efforts have significantly enhanced land productivity and farm incomes in degraded salt-affected regions. India currently has an estimated 6.67 million hectares (Mha) of salt-affected land, but projections indicate this could rise to 16 Mha by 2030 due to climate change and anthropogenic mismanagement. Such an increase could result in economic losses amounting to thousands of crores. Technologies such as gypsum-based amendments, salt-tolerant crop varieties, and sub-surface drainage (SSD) systems, developed by ICAR-CSSRI, have had a transformative impact nationwide. Emerging advancements are now paving the way for alternative reclamation methods based on innovative biological and chemical mechanisms previously unexplored. While these advancements offer promising solutions for improving salt-affected lands, new challenges at both regional and national levels demand sustained and accelerated efforts. Continued research into fundamental processes and the development of improved technologies are crucial to making substantial progress toward ensuring food security.

This volume of Salinity News (January-June, 2025) includes following listed major research achievements: Propagation of Arbuscular Mycorrhizal Fungi (AMF) though Novel Soil Less Technology, Mustard CS 60: Enhancing Farmers Income in the Saline Coastal Belt of West Bengal, Bael-Based Cropping Systems: A Profitable Option for Farmers in Saline Water Areas, Gypsum Technology: A Boon for Doubling Farmer's Income in Sodic Soils, Development of Soil Textural Map of Salt Affected Soil of Rohtak District, Performance of Fennel with Saline Water Irrigation under Dry Land Regions, Digital Soil Map (DSM) of Sodic Soil of Andhra Pradesh and Waterlogged Sodic Soils in Sharda Sahayak Canal Command of Uttar Pradesh: Mapping Spatial Extent for its Reclamation and Crop Planning. This issue also includes photos of 57th ICAR-CSSRI Foundation Day Celebration and other programmes.

(R.K. Yadav)
Director

In This Issue.....

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Propagation of Arbuscular Mycorrhizal Fungi though Novel Soil Less Technology

Arbuscular Mycorrhizal Fungi (AMF) are obligate symbionts and they require a host plant to complete their life cycle. One common method of propagation is substrate-based systems using inert materials like vermiculite or sand offer controlled environments for AMF growth, using host plants grown in sterilized soil mixed with AMF spores, allowing the fungi to colonize the roots and multiply. However, successful propagation depends on factors such as plant diversity, soil conditions, and compatibility between AMF strains and host plants. AMF plays a vital role in plant growth promotion as mitigating salt stress and despite their potential, commercial production of AMF faces challenges including strain selection, maintaining spore viability, and developing effective carrier materials. Hence, addressing these researchable gaps, a study was planned under DST-SERB funded project for development of tailor made protocol for mass production of AMF. This study was carried out in three steps, firstly standardization of suitable host for the propagation of AMF and two different host viz. sorghum and maize were studied which readily form association with AMF and commonly used for AMF propagation. Mycorrhizal association and colonization increased significantly with time in both the host viz. maize and sorghum and results demonstrated significantly higher colonization in maize (86.1%) roots than those of sorghum (77.7%). The same trend was observed for arbuscules abundance. The second step was the standardization of suitable substrate and agro residue based substrate supported the multiplication of AMF and colonization was upto 69.02% in trap crop roots was observed. The results were significantly at par with conventional substrate viz. mixture of sand and soil as colonization was upto 67.2%. in trap crop roots when grown in conventional substrate The third step was the standardization of compatible nutrient source for enhanced sporulation. The nutrient rich solution with different combinations and for varied time interval following phosphorus deficit and drought condition was applied for standardization experiment. Results demonstrated that nutrient rich solution supplemented with tris HCl at pH 6.5 along with phosphorus deficit condition supported highest mycorrhizal colonization (87.2%), arbuscule abundance (37.2 %), spore count (14.7 per root bit), hyphal length density (2.57 m g^{-1}), mycorrhizal root mass (0.897 g $plant^{-1}$), mycorrhizal root length (133.5 m $plant^{-1}$), hyphal length per unit root length (0.464 µm cm^{-1}) in the roots of trap crop. Seven days of drought conditions following the treatments enhanced the sporulation. The results indicated that application of nutrient rich leads to dense root growth which supports higher AMF association. The phosphorus deficit condition around the plant root rhizosphere leads to higher association between AMF and plant roots and the following drought condition in soil led the mycorrhizal hyphae to converts into spores and enhances sporulation. Through the mass production technique in soil less substrate, the propagation of AMF can be done up to 70 kgs of AMF inoculum. The results also demonstrated that with bulk production 50.13 % of AMF colonization can be achieved with 28.33 spore count per root bit and 0.41g $plant^{-1}$ of mycorrhizal root mass. Potential of re-infection to the trap crop decreases with time however 36 % of AMF colonization still can be achieved after 190

Propagation of AMF in polyhouse under standardized medium through novel soil less technology days of storage. Propagation of AMF through novel soilless technology represents a significant advancement for inoculum production of AMF. Traditional methods of AMF cultivation often rely on soil-based systems, which are labor-intensive and difficult to scale. In contrast, soilless approaches with different substrates offer controlled environments that enhance the efficiency and consistency of AMF propagule production and allows large-scale cultivation by optimizing nutrient composition and growth conditions, resulting in higher yields and cost-effectiveness. Substrates mimic natural soil properties while enabling precise manipulation of nutrient levels and application timing, which promotes consistent spore production and allows for non-destructive harvesting. This technology not only improve the scalability of AMF inoculum production but also support agricultural productivity by providing high-quality, standardized fungal propagules.

Priyanka Chandra, Arvind Kumar Rai, Nirmalendu Basak, Parul Sundha, Kailash Prajapat and RK Yadav

Mustard CS 60: Enhancing Farmers Income in the Saline Coastal Belt of West Bengal

Soil and water salinity is the main constraints in successful agriculture crop production in coastal saline region of West Bengal. Additionally poor economic condition of the farmers of the region makes the situation more complex in the context of climate change. Therefore, under the West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP), Govt. of West Bengal, a field trial was conducted to improve minor irrigation infrastructure and promote climate-resilient agriculture by introducing appropriate varieties and scientific practices. We compared the varietal performance of local mustard variety Torai and tolerant CS 60 variety of ICAR, CSSRI, Karnal during 2024-2025 season in the WBADMIP project field and a nearby non-project field, highlighting varietal differences, yield outcomes, and implications for saline agriculture in the saline belt of Sandeshkhali-I Block, North 24 Parganas district. The area falls under the saline belt of the Sundarban region with high soil salinity, especially during the Rabi season due to capillary rise and saline water intrusion, limited irrigation options in non-monsoon periods, low cropping intensity and restricted varietal choices, particularly for oilseeds like mustard. The Torai variety was sown on 5th November (Mr. Raton Mridha) while CS 60 on 11th November, 2024 (Mr. Nimai Mondal). The soil type was silty clay loam with moderate salinity ($EC_{1:2}$ 2-4 dS m^{-1}). The plant stand was moderate in local mustard variety whereas good plant stand was observed in CS 60 variety. The optimum sowing date of CS 60 is mid-October but they were late by 4 weeks leading to lower yield. Even then, we recorded 1.13 t ha^{-1} yield of CS 60 mustard variety (20% higher yield than Local variety) while local variety provided 0.9 t ha^{-1} yield leading to higher income of the farmer. Therefore, salt tolerant mustard variety CS 60 has the potential and can help in enhancing farmers income in the vulnerable salt affected ecologies of coastal Sundarbans of West Bengal in the years to come.

Sanjit Pramanik, Tapan Kumar Maity, Mainak Chakrobarty, Lilufan Nechha, Ashim Datta, Vijayata Singh and Jogendra Singh

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Bael-Based Cropping Systems: A Profitable Option for Farmers in Saline Water Areas

Due to non-availability of fresh water, in many parts of India farmers use saline water for irrigation which reduces crop yields leading to low income. To find better options, AICRP Bikaner centre tested a bael-based farming system for six years (2018–2023) using three types of water – fresh canal water (EC_{iw} 0.25 dS m^{-1}), medium saline tube-well water (EC_{iw} 2.4 dS m^{-1}), and high saline water (EC_{iw} 6.0 dS m^{-1}). During the *kharif* season, cluster bean was grown between bael trees while in *rabi* season, mustard, taramira, oats, or barley were grown. Cluster bean gave the highest yield with fresh water irrigation (9.32 q ha^{-1}) while after medium saline water irrigation yield reduced by 13% to 8.07 q ha^{-1}. However, reduction was observed 46% to 5.04 q ha^{-1} when irrigated with high saline water. During the *rabi season*, mustard, taramira, and barley were less affected by medium saline irrigation. However, oat was most sensitive as 19.98 q ha^{-1} was obtained with fresh water irrigation which further reduced by 3% with medium saline irrigation and reduction increased by 11% with high saline irrigation. Bael trees started giving fruits in year 2022. Yields in 2022 were 38.01 q ha^{-1} when irrigated with fresh water. Reduction of 7% was observed with medium saline water irrigation as yield was 35.30 q ha^{-1} and yield further reduced by 17% to 31.62 q ha^{-1} with high saline water irrigation. In 2023, yield increased with the tree age as 86.46 q ha^{-1} yield was obtained with fresh water irrigation while lower reduction of yield was observed after medium saline water irrigation which is 4% (82.82 q ha^{-1}), and high saline water irrigation which is 14% (74.60 q ha^{-1}). The most profitable cropping system was Cluster bean–Bael–Mustard, giving net income of Rs. 1,30,492 ha^{-1} with fresh water, Rs. 1,16,472 ha^{-1} with medium salinity (11% less), and Rs. 88,101 ha^{-1} with high salinity (33% less). The Profit order was: Mustard > Barley > Taramira > Oat. Hence it can be concluded that, If a farmer has moderately saline water (2.4 dS m^{-1}), he can still earn good income by growing bael along with crops like mustard or barley however cluster bean and oat should be avoided in high salinity (EC_{iw} 6.0 dS m^{-1}). Use drip irrigation, and if possible, mix fresh water with saline water to reduce the harmful effects of salt.

Field view of horticulture based agri-horti system

BS Shekhawat, RL Meena and BL Meena

Gypsum Technology: A Boon for Doubling Farmer's Income in Sodic Soils

Failed wheat crop, 2021-22

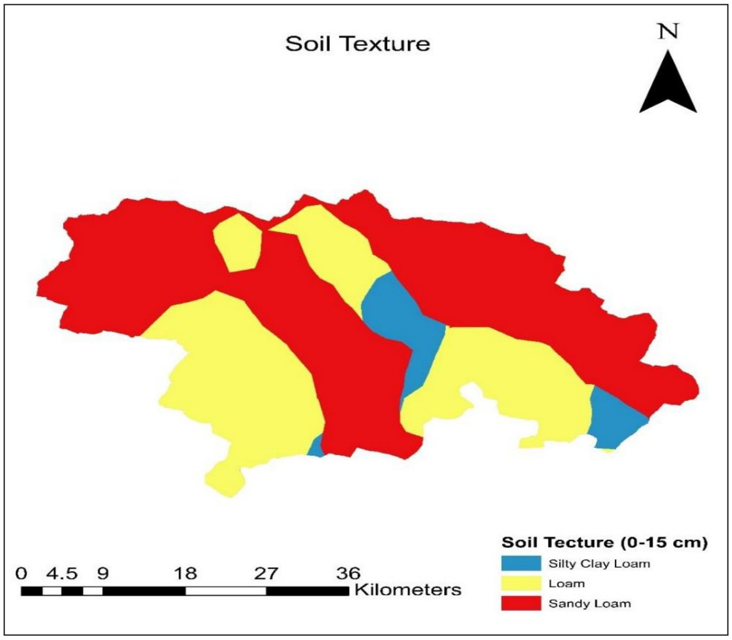
Bumper rice crop, 2022

ICAR-CSSRI, Karnal is technically supporting NABARD in executing a Pilot Project on reclamation of alkaline soils in Punjab & Haryana with two districts each of the states. Under this project, about 512 farmers were covered. In Dharamheri village of Patiala district, in fields of Shri Khora Ram, S/o- Sadhu Ram wheat crop was failed during 2021-22 due to high soil pH ($pH_{1:2}$: 9.65) (see photos). After initiation of the project, gypsum was applied according to gypsum requirement of the soil following the guidelines of gypsum technology of CSSRI, Karnal. The farmer obtained about 5.6 t ha^{-1} rice yield (variety PR 126) in that field after the reclamation. Soil pH after rice harvesting declined significantly to about 8.64 with EC_2 of 0.75 dS m^{-1}. The farmer is very happy with the performance of the rice crop on his farm land and so far the wheat crops stand at present. As per his opinion, such crop yield is an exceptional instance in sodic soils. He demonstrated such result to other farmers of the village for motivation and suggested to follow reclamation with gypsum following technology of ICAR-CSSRI Karnal for degraded sodic soil.

Gajender Yadav, Ashim Datta and Rajender Kumar Yadav

Development of Soil Textural map of Salt Affected Soil of Rohtak District

In salt-affected soil, soil texture plays an important role in the salinization process and its management. Accurate soil texture mapping supports agricultural planning, irrigation management, and precision farming. Soil texture map of Rohtak, one of the most salt-affected districts of Haryana, was developed using a combination of laboratory-analyzed soil samples and geospatial environment in SAGA GIS. 250 geo-referenced soil samples (0-15 cm) were collected from different agricultural land uses and physiographic units. Soil samples were uniformly distributed, covering the district. The samples were air-dried and processed, and sand, silt, and clay fractions were determined using the hydrometer method following Bouyoucos (1962). Based on the percentage composition of sand, silt, and clay, texture classes were assigned following the USDA soil textural triangle. The spatial distribution of sand, silt, and clay content was mapped using ordinary kriging methods in ArcGIS. These sand, silt, and clay content maps in raster format were processed in SAGA GI's "Soil Texture Classification Tool," and a soil texture map was prepared (Fig. 1). The generated map indicates that in Rohtak, mainly three types of soil predominate, i.e., sandy loam, loam, and silty clay loam. Area-wise, sandy loam soil type was highest, followed by loam and silty clay loam. Sandy-type soil is mostly found in the western part of the Rohtak district, mainly in the Meham block. This texture variability reflects alluvial deposition patterns and canal irrigation influences. The final map provides critical input for salinity development, irrigation scheduling, soil fertility assessment, salinity management, and simulation studies. The developed map will provide a valuable asset for agricultural planners and policymakers for sustainable land and water resource management in the saline waterlogged soil.



Soil Texture Map

Bhaskar Narjary, Jitender Kumar, Sagar Vibhute and Satyendra Kumar

Performance of Fennel with Saline Water Irrigation under Dry Land Regions

In the dry land areas of Rajasthan, where farmers depend on saline water for irrigation, Bikaner, Barmer, Nagaur and Churu and districts are set to emerge as hubs of fennel (*Foeniculum vulgare*) production following a three-year-long study of AICRP centre Bikaner that examined the yield of different varieties of the crop through drip irrigation with saline water. A confirmatory trial was also conducted with four levels of water salinity of variable electrical conductivity (EC_{iw}) viz. 0.25 (Best available water; BAW), 4, 6 and 8 dSm^{-1}) and four fennel varieties (AF-1, RF-157, RF-281 and RF-290) at Bikaner centre during rabi 2021-22. The basic objective this study was to measure the yield and salt tolerance of the different fennel varieties. Results indicated that increase in EC_{iw} beyond 6 dS m^{-1} caused significantly reduction in seed yield of fennel. As compared to EC_{iw} of 0.25 (BAW) with EC_{iw} 4.0, 6.0 and 8.0 dS m^{-1} caused yield reduction of 9.49, 18.56 and 33.67 %, respectively. Results further revealed that variety RF-290 was found superior over AF-1 and RF-157 but on par to RF-281 (Table). Saline water with EC_{iw} of 4 dS m^{-1} can be used for irrigating the RF-290 variety of fennel successfully. Farmers in the desert region may grow fennel as an alternative to cumin, which is often destroyed due to frost. Rajasthan and Gujarat are the leading fennel-producing states in the country, contributing about 96% of the

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Interaction between water salinity levels and yield of fennel varieties

Saline Water Treatments EC_{iw} (dSm^{-1})	Fennel varieties				Mean
	AF-1	RF-157	RF-281	RF-290	
0.25	10.08	9.88	12.83	13.56	11.58
4.0	9.44	9.54	11.15	11.78	10.48
6.0	8.81	8.46	10.14	10.29	9.43
8.0	7.19	6.70	6.90	9.95	7.68
Mean	8.88	8.64	10.48	11.17	
CD (0.05)	EC: 1.11; V : 0.81; EC x V :1.35				

Media Coverage

4 districts in Rajasthan set to become hubs of fennel production

Mohammed Iqbal
JAIPUR

Four desert districts in Rajasthan, where farmers depend on saline water for irrigation, are set to emerge as hubs of fennel production following a three-year-long study that examined the yield of different varieties of the crop through drip irrigation with brackish water. The research also yield and tested salt tolerance of the different fennel varieties and found encouraging results.

Taxonomically classified as *Foeniculum vulgare*, fennel is a hardy, perennial herb with yellow flowers and feathery leaves.

'Remunerative option'

Drip irrigation with saline water could expand the area under fennel produc-

Fennel grown at the Agricultural Research Station in Bikaner during

Farmers in the desert region may grow fennel as an alternative to cumin, which is often destroyed due to frost

RAMESHWAR LAL MEENA
Principal scientist, Central Soil Salinity Research Institute, Karnal

from the university.

nated the project's activities, said the saline water selected for fennel production would not have an adverse impact on the productivity of farmland.

"Farmers in the desert region may grow fennel as an alternative to cumin, which is often destroyed due to frost," he said.

Rajasthan and Gujarat are the leading fennel-producing States in the coun-

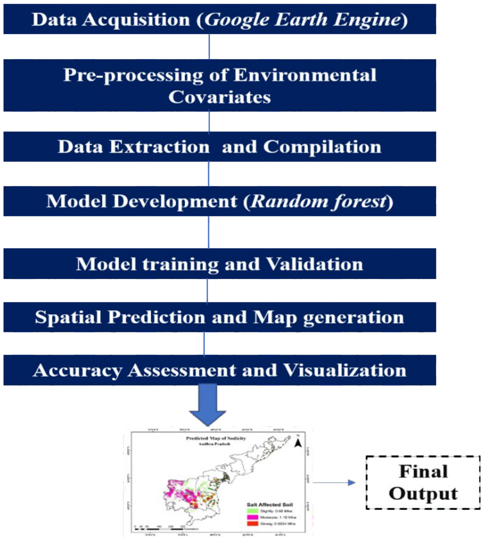
Field view of fennel trial

total production. In Rajasthan, the highest amount of fennel is cultivated in Nagaur district, covering 10,000 hectares. Its cultivation also takes place in Sirohi, Jodhpur, Jalore, Bharatpur, and Sawai Madhopur districts.

BS Shekhawat, Ranjeet Singh, RL Meena and BL Meena

Digital Soil Map (DSM) of Sodic soil of Andhra Pradesh

A high-resolution Digital Soil Map (DSM) of sodic soils in Andhra Pradesh, India, was developed using machine learning and geospatial analysis. The Random Forest (RF) algorithm was employed to model the spatial distribution of sodicity by integrating remote sensing–derived salinity indices with environmental covariates, including topographic, climatic, and soil-related parameters. A Random Forest–based feature selection procedure identified the ten most important predictors, which were subsequently used for model training and mapping. The flow chart of the adopted methodological approach is presented in figure. Ground-based sodicity measurements served as reference data for model calibration and validation. Model performance was evaluated using the Root Mean Square Error (RMSE) and the coefficient of determination (R^2), while spatial prediction uncertainty was assessed to quantify the reliability of the DSM (Figure). The resulting sodicity map provides a detailed and reliable



Flow chart of adopted methodology

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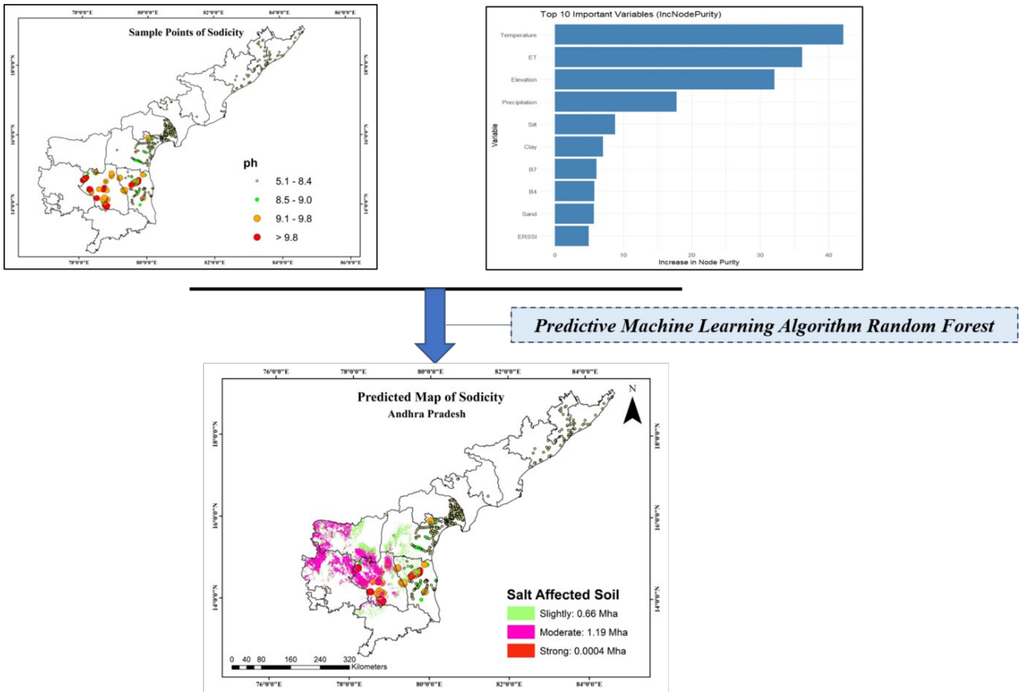


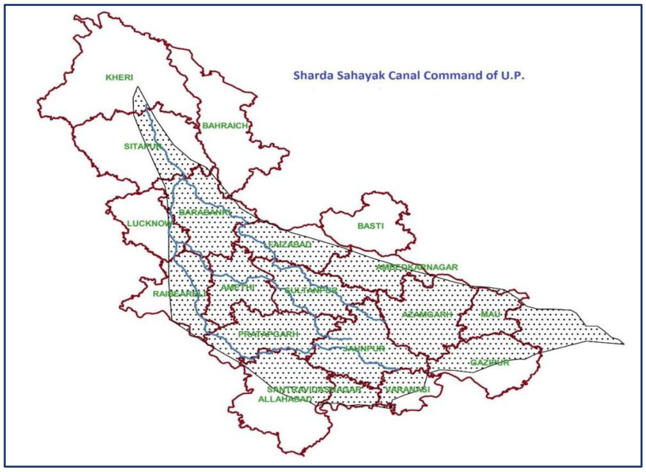
Soil Sodicity map of Andhra Pradesh

representation of sodic soil distribution across the state, offering a valuable resource for soil management, land-use planning, and reclamation strategies in salt-affected areas.

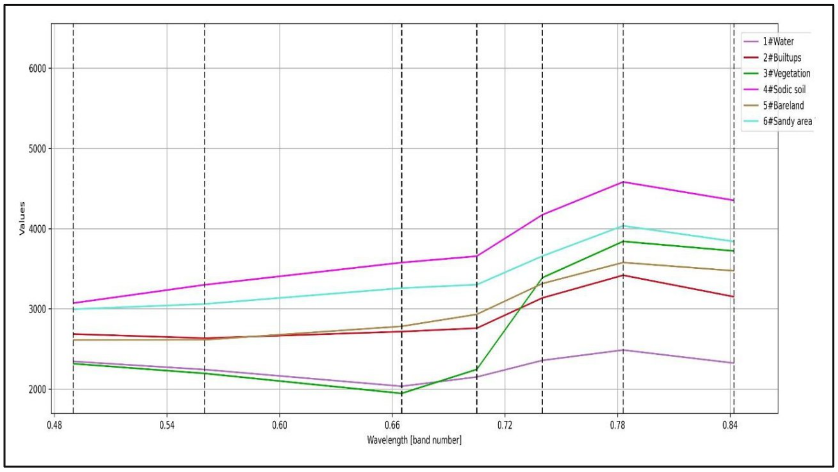
Amresh Chaudhary, Astha Sharma and Bhaskar Narjary

Waterlogged Sodic Soils in Sharda Sahayak Canal Command of Uttar Pradesh: Mapping spatial extent for its reclamation and crop planning

Soil salinization caused by natural and anthropogenic factors is a serious environmental hazard especially in arid and semi-arid regions of the world. Accumulation of salts in the soils is a major threat to crop production and global agriculture which is aggravated by a combination of several factors such as human activities, climatic conditions, land form variability and water table depths. Rapid and precise detection of salt-affected lands is highly critical for presenting soil sustainability and supporting food production. According to Wasteland Atlas of India (NRSC, 2019), wastelands in the year 2015-16 in the state of Uttar Pradesh was 8.53 lakh ha (3.54%) and out of which 2.13 lakh ha (0.88%) are salt-affected. Sharda Sahayak Canal Command has approximately 3.60



Sharda Sahayak Canal Command of Uttar Pradesh



Spectral signatures generated from Sentinel-2 spectral bands (B2……B8)

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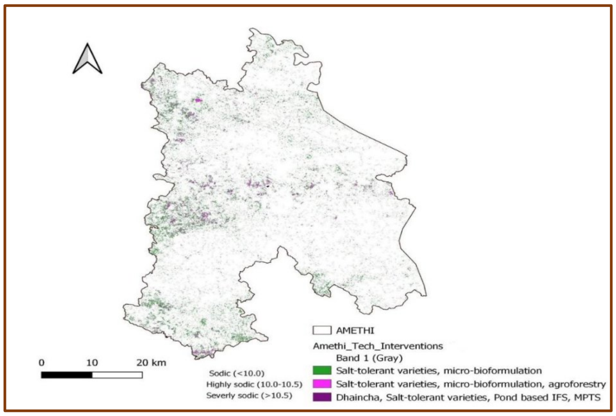
million ha area, consisting of 19 districts of Uttar Pradesh (Figure). There is considerable area under waterlogged sodic soils in Canal Command, the spatial extent of which is not yet known/ mapped. In Sharda Sahayak Command, about 2,60,000 ha area is waterlogged and 2,53,300 ha area is salt affected. Due to Sharda Sahayak Canal in Uttar Pradesh, soils of canal command has become saline-sodic/ sodic because of waterlogging/ seepage of canal water. This sodicity of the soils is resulting in reduction of crops yield in the canal command. These sodic areas need to be reclaimed in order to enhance land productivity for which the mapping of these areas is very important.

Mapping of sodic soils in Sharda Sahayak Canal Command

The soil samples were collected from Amethi, Barabanki, Pratapgarh, Jaunpur and Raebareli districts of Uttar Pradesh and was categorised as high sodic (pH = 9.0-10.0) to very high sodic (pH >10.0). The advancement in remote sensing satellite data quality (spatially and spectrally) has made possible to distinctly identify sodic soils as evident from spectral signatures (Figure 2). The waterlogged sodic soils in these districts have ben accurately mapped through scientific methodology already developed using multi-spectral Sentinel-2 MSI data. Estimated area under sodic soils in five selected districts of Sharda Sahayak Canal Command was 87147.02 ha (5.33%) in May 2023, given in table. From sodic soils map, thematic map of sodicity levels (moderate, high, very high) may be generated, which would facilitate suitable planning at district level in Sharda Sahayak Canal Command. Moreover, district level thematic maps of suitable and adoptable agriculture interventions can be generated with the help of sodic soils map (Figure 3). There is need to have thematic maps of sodicity levels and technological interventions for all the districts falling in Sharda Sahayak Canal Command for planning and decision making by farmers.

District	Geog. Area (ha)	Sodic soils	
		Area (ha)	Area (%)
Amethi	275064.47	17563.67	6.38
Barabanki	358582.32	20125.16	5.61
Pratapgarh	370932.86	11298.54	3.05
Raebareli	227385.70	12054.34	5.30
Jaunpur	403283.57	26105.31	6.47
Total	1635248.92	87147.02	5.33

Estimated area under sodic soils in selected districts of U.P. (May 2023)



Thematic map of sodicity and proposed interventions for Amethi district

R.H. Rizvi, Sanjay Arora and C.L. Verma

Institute Events & Activities

Winter School (20 Feb-12 Mar, 2025)

57th Foundation Day of CSSRI (12 March 2025)

RAC Meeting (March 10-11, 2025)

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