Sustainable Management of Salt Affected Soils through Different Practices

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Outline

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- ✓ Soil Types, WTDs and Groundwater Quality
- ✓ Extent of Salinity
- ✓ Reclamation through Organic/Inorganic and Continuous Cropping
- ✓ Biological Reclamation of Saline-Sodic Soil
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Salinity – A Complex phenomenon in Southern Indus Basin

Salinity is a natural part of the Indus Basin (IB) landscape, it has grown substantially in recent decades in large part due to increases in irrigated agriculture.

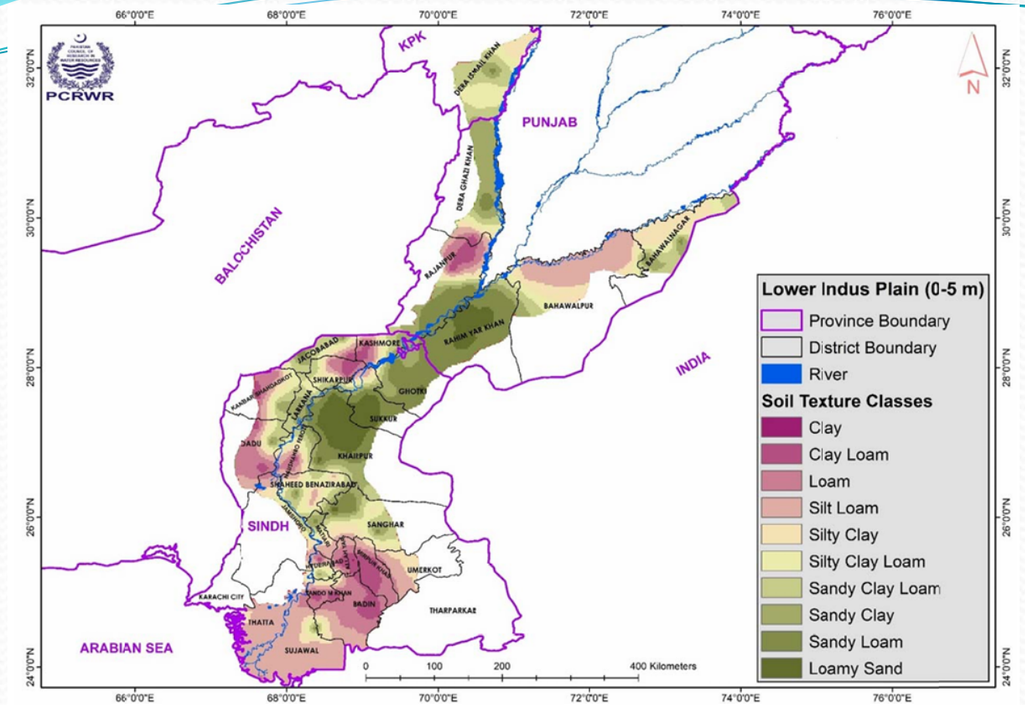
Indus river brings 31.6 Mt salts annually, 19.95 Mt deposits @ 1.25 t/ha, 8.81 Mt drained, and 2.8 Mt retained in wetlands or join GW (Saiqa et al., 2022).

Currently, 1.2 million private tubewells are abstracting 60 BCM (85% in Punjab, 6.4% in Sindh, 3.8% in KP, and 4.8% in Baluchistan) (Qureshi, 2020) that adds 45 Mt of salts (41.5 Mt in Punjab, and 3.5 Mt in Sindh (Qureshi and Perry, 2021).

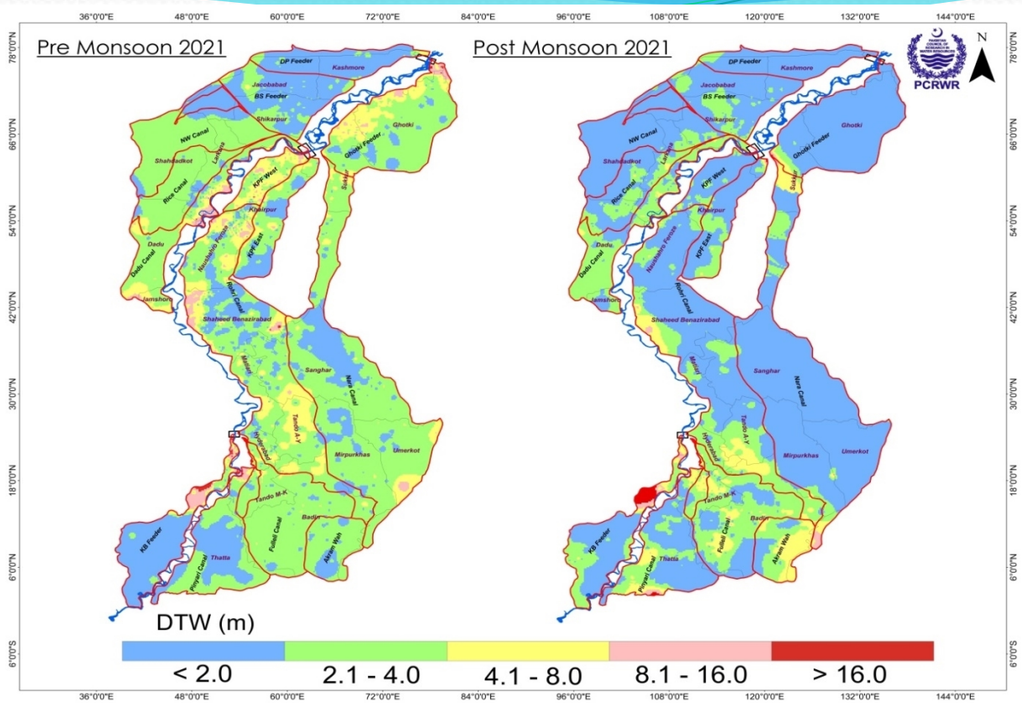
Salinity is largely irreversible, and learning to adapt and live with salinity may be the only viable option for farming communities to improve their livelihoods.

To improve salinity management through accessible knowledge on different biological, chemical and forestry practices that match local farming community needs.

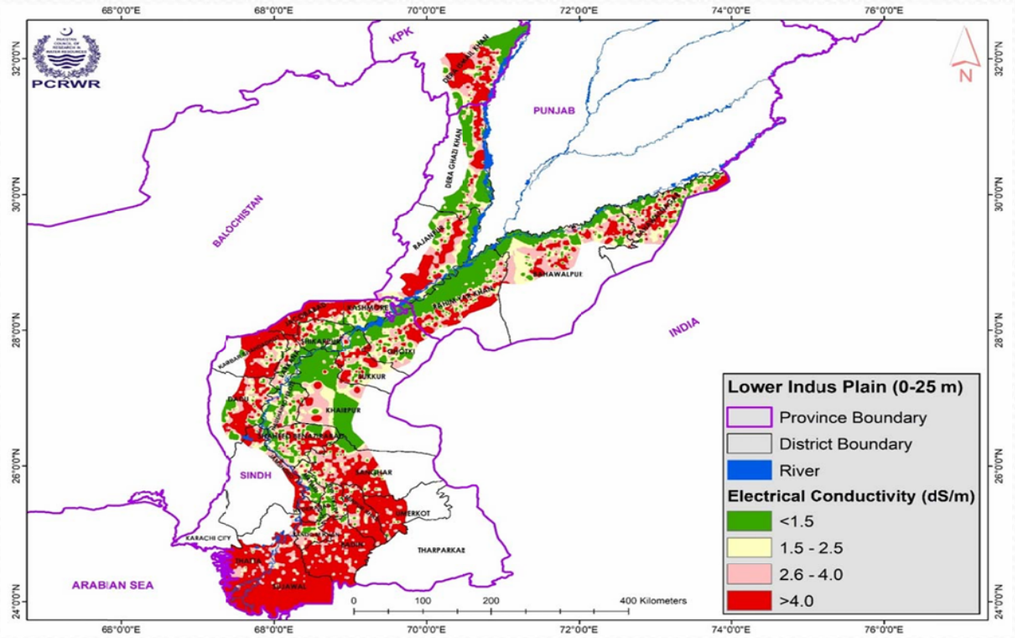
Soil Types, WTDs and Groundwater Quality



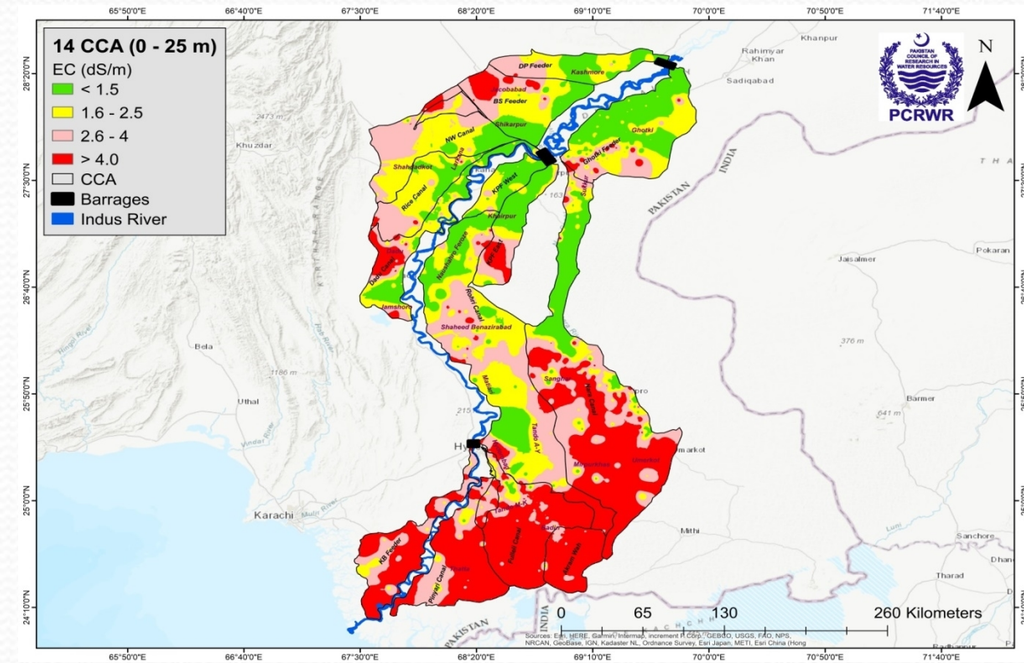
Soil Types (Iqbal et al., 2020)



Depth to Water Table (Salam et al., 2023)



Groundwater Quality (Iqbal et al., 2020)



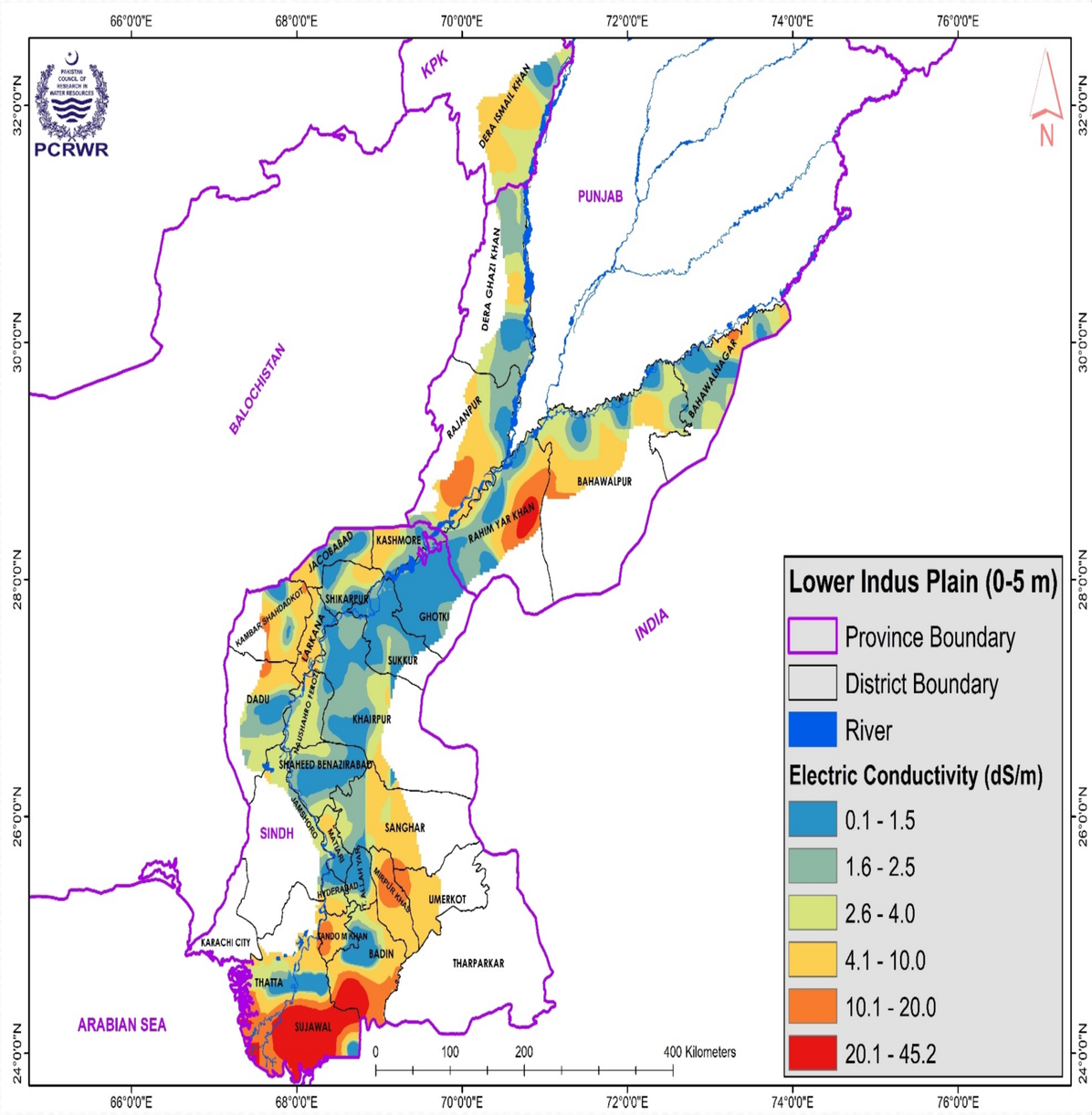
Groundwater Quality (Salam et al., 2023)

Extent of Salinity

In Pakistan, salinity affects 6.2 Mha which is approximately 40% of the 16 Mha irrigated land and 29% of the 22 Mha of the total cultivable area of the country. Out Of 6.2 Mha, 4.3 Mha are severely affected (Ali, A., 2023).

Salinity is more prominent in the lower part of the Basin, where about 54% of the cultivated area is saline (Qureshi et al., 2008).

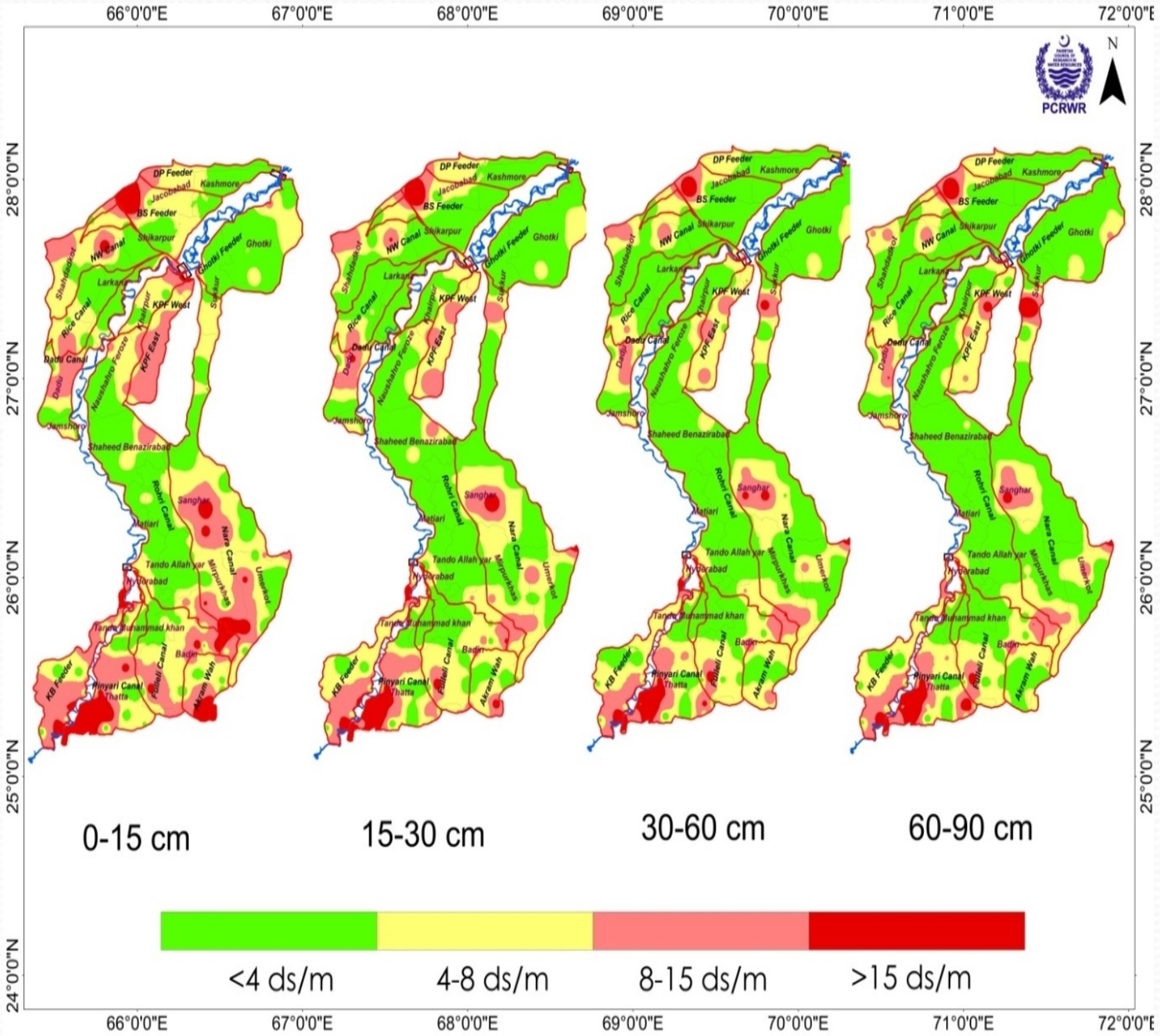
About 28% of the soil profile (0-5 m depth) in the SIB is saline and 20% is saline-sodic (Iqbal et al., 2020),



Source: Iqbal et al., 2020

Extent of Salinity

A study conducted by PCRWR (2020) in 14 canal command areas of Sindh revealed that downstream segments of the Nara, Akram Wah, Phuleli, Pinyari, and Begari canals exhibit moderate salinity (ECe 8 - 15 dS/m) to strong salinity (ECe > 15 dS/m) levels, extending from the surface to deeper depths (90 cm) in the Mirpurkhas, Sanghar, Badin, Sujawal, Thatta, and Jacobabad districts.



Source: Salam et al., 2023

Reclamation through Organic/Inorganic and Continuous Cropping

Research study	Methodology	Core findings
Reclamation of Saline Sodic Soils by Gypsum - (1988-1991) at NIA	WTD: 0.80 m; Loam and silt loam Initial EC, pH, SAR and ESP 10.5 dS/m; 8.2; 23.3 and 24.2. GR: 14 ton/ acre ft of soil; T1: 100% GR; T2: 75% GR and T3: 50% GR (applied before ploughing). ET of rice was 1500 mm and 700 mm of berseem.	100% gypsum more effective as EC, SAR and ESP reduced **80%,** while pH only 7%. Rice due to high ET **best reclaiming agent** then besreem. High rice yield **2900-3000 kg/ha** at.75-100% gypsum.
Comparative effect of organic, Inorganic and Biological Reclamation of Saline-Sodic Soil under Tile Drainage (1989-1991) at Bughio	WTD: 1.00 m; initial EC: 13.13 dS/m; SAR: 34.35; pH: 8.78; density: 1.48 g/cm^3; T1: 100% GR; T2: 50% GR, T3: Kallar grass, T4: press mud 50 ton/ha; , T5: press mud 25 ton/ha; T6: press mud 50 ton/ha + 50% GR; T7: press mud 25 ton/ha + 50% GR. ET of rice was 1500 mm and 450 mm of berseem.	50% gypsum more effective as EC, pH and SAR reduced **85**, 17 and 63%. Press mud and kallar grass also effective but took more time. Rice yielded **2920, 2890 and 3010 kg/ha** at 100% and 50% GR and press mud (50 tons/ha). Press mud (25 tons/ha) with gypsum yielded low (2000 kg/ha). Berseem yielded 29-41 ton/ha with 50-100% GR.
Improvement of Salt Affected Soils through Continuous Cropping (1997-2000) at NIA	T1: berseem followed by sorghum; T2: mustard followed by cluster bean; T3: barley followed by sesbania; T4: alfalfa followed by pearl millet. ET varred from 250 mm (pearl millet and cluster bean) to 1360-1400 mm (sesbania and berseem).	Barley-sesbania cropping effective as **reduced 41% ECe**. Berseem-sorghum rotation **reduced 33% ECe**. Green manuring of sesbania highly effective in reducing EC, pH and ESP.

Source: Kahlown et al., (2003)

Biological Reclamation of Saline-Sodic Soil

Research study	Methodology	Core findings
Biological Reclamation of Saline-Sodic Soil by Growing Sorghum, Maize, and Sudan Grass Fodders at NIA Farm (1991-1993)	Growing of sorghum, maize, and sudan grass twice a year. ECe: 10-12 dS/m, pH: 7.6-8.4; SAR and ESP: 18-20	Sorghum **reduced 56% ECe**, pH 8.5%, 41 and 46% SAR and ESP reduced. Maize and Kallar grass next crops to cause the reduction in ECe and SAR. Maize yield **increased 47% from 10 to 14.8 ton/ha**. sorghum yield **increased 92% from 24 to 47 ton/ha**. Kallar grass yield **increased 53% from 18 to 28 ton/ha**.
Reclamation of Saline-Sodic Soils by Rice Husk at NIA Farm (1994-1996)	Rice Husk dosage i.e. 0.1% of the soil weight (7000 kg/ha); 0.2% (14000 kg/ha) and 0.4% (28000 kg/ha). Initial ECe (8-10 dS/m); ESP 18-24; OM 0.5-0.6%.	Rice husk applied at 0.4% **reduced 30-42% ECe** at 0-15 and 16-30 cm depths. ESP reduced 49%. At 0-15 cm depth, organic matter content increased 32%. Cotton produced 820 kg/ha and **wheat 1870 kg/ha**.
Biological Reclamation of High Saline-Sodic Soils at NIA Farm (1996-1999)	Growing of Rice, Berseem, Kallar Grass, Jantar, and Fallow Land Initial ECe:15-25 dS/m and ESP 15-20;	Rice-berseem rotation **reduced ECe by 82%** at 0-15 cm depth, wheeras Berseem-Jantar rotation recued ECe at lower depths. ESP reduced 29-42% at 0-15 to 60-90 cm depths. Rice yield **increased from 200 to 760 kg/ha**, berseem yielded 200 to 1110 kg/ha. Jantar yielded 320 to 700 kg/ha.

Source: Kahlown et al., (2003)

Biological Reclamation of Saline-Sodic Soil

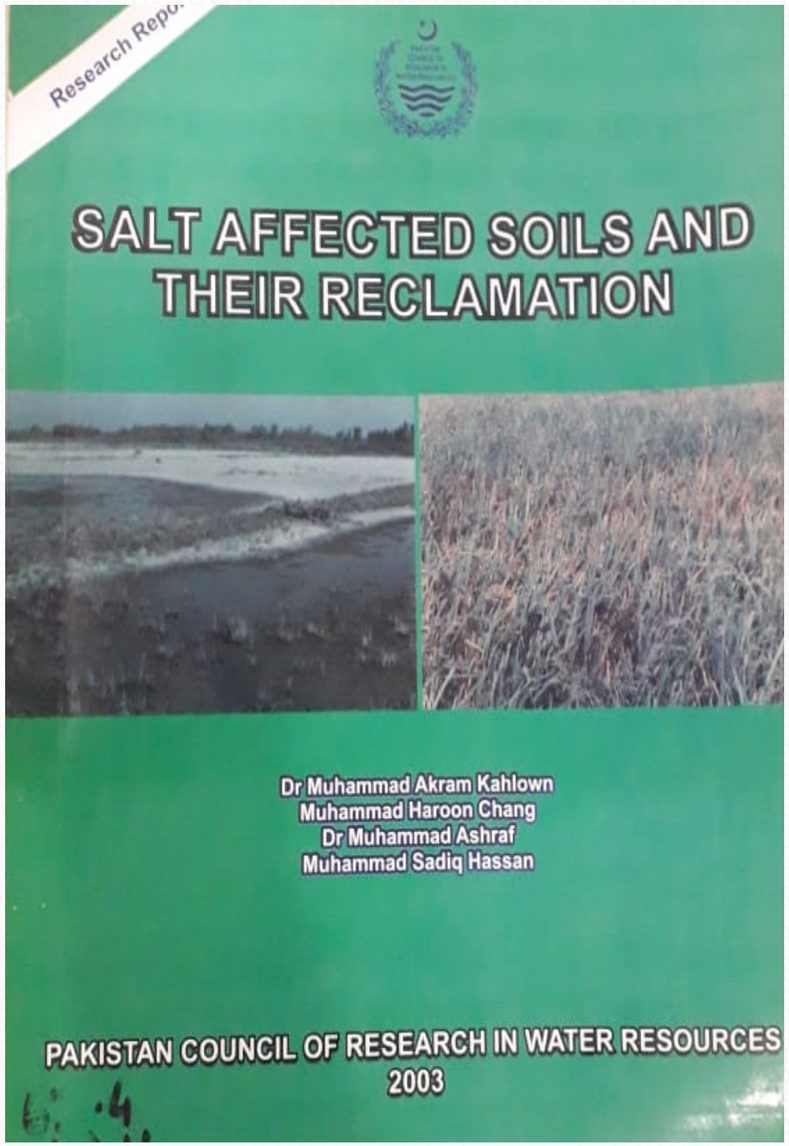
Research study	Methodology	Core findings
Reclamation of Strongly Saline Soils by Different Methods under Tile Drainage System at NIA Farm (2000-2001)	T1: Without crop leaching; T2: Dhancha and berseem; T3: rice and berseem	Rice-berseem rotation **reduced ECe by 35%** at 0-15 cm depth, whereas dhancha -berseem rotation **reduced ECe by 25%** at lower depths. Leaching without cropping **reduced 24% ECe** at upper layer, but increased at lower layers. Rice yielded 500 kg/ha, whereas berseem 1000-1200 kg/ha.
Comparison of Physical and Biological Methods for Reclamation of Saline Soils at NIA farm (1998-2001) **Dhancha – green manured and berseem partly**	T1 and T2: shallow and deep ploughing (wheat and cotton) T3 and T4: shallow and deep ploughing (dhancha and berseem)	Cotton yielded **450-660 kg/ha with deep and 320-500 kg/ha with shallow ploughing**. Wheat yielded **1620-2780 kg/ha with deep and 1360-1990 kg/ha with shallow ploughing**. Berseem yielded 3450-4120 kg/ha with deep and 2820-3310 kg/ha with shallow ploughing. Dhancha yielded 1280-1480 kg/ha with deep and 1120-1350 kg/ha with shallow ploughing.

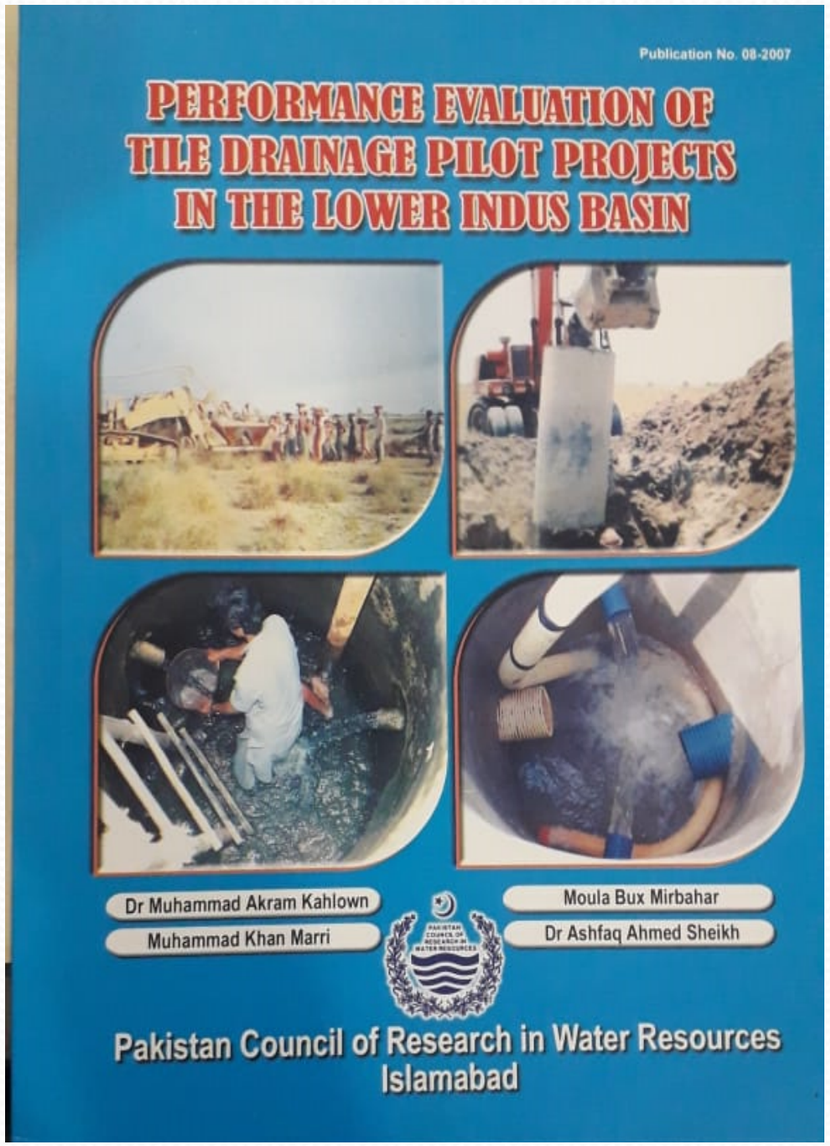
Source: Kahlown et al., (2003)

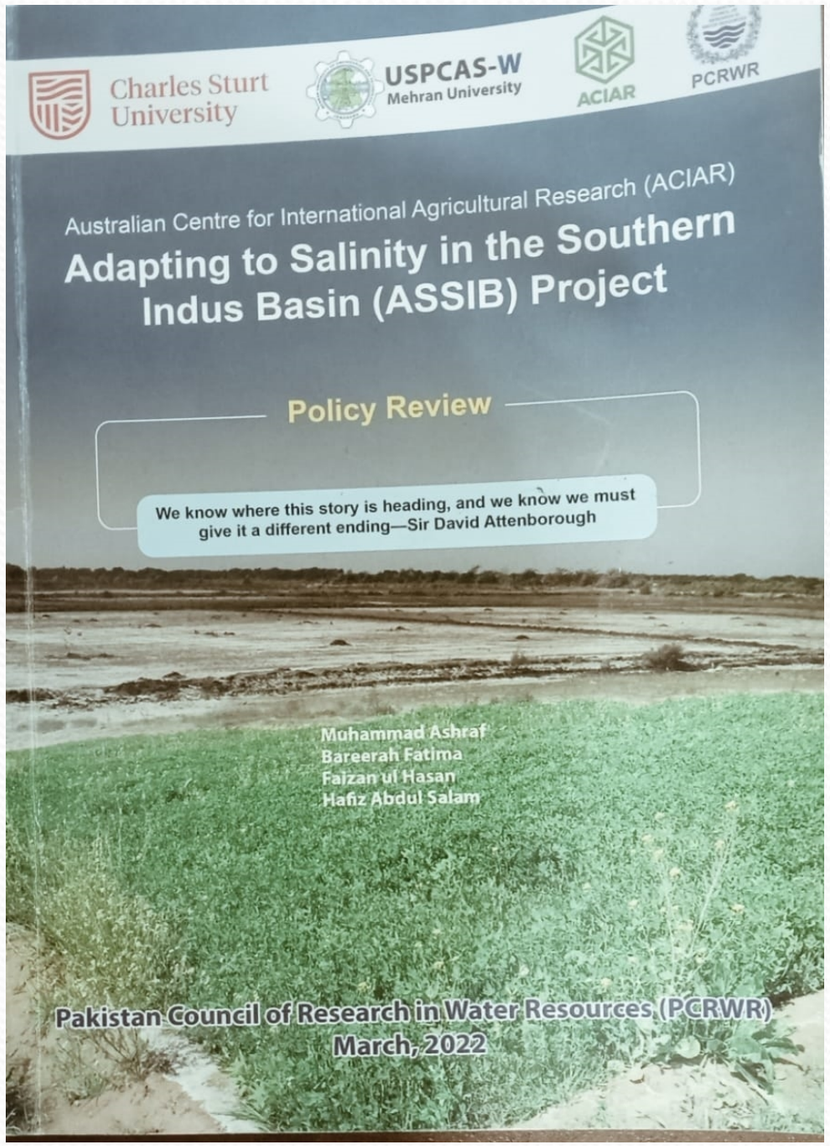
Growing Trees and Shrubs in Saline Landscapes – A Review

Trees and Shrubs	Name of Project / Study	Year	Reference
Conocorpous, Accacia Nilotica and Ber	Role of trees for reclamation of salt affected soil in Mirpurkhas district of Sindh province by LIM, WAPDA	2005 to 2009	Channa et al., 2010
Acacia nilotica, Acacia ampliceps and Prosopis pallida.	Groundwater uptake and sustainability of Acacia and Prosopis plantations in Southern Pakistan	1996-98	Khanzada et al., 1998
Eucalyptus, Acacia and Prosopis	Response of saline groundwater on growth and water use of the young plants of Eucalyptus, Acacia and Prosopis by NIAB	1994-98	Mahmood et al., 2001
Eucalyptus seedlings, Salt Bush seedling	Joint Satiana Pilot Project (JSPP) by PARC, IWASRI and UAF	1995-97	IWASRI, 1995
Atriplex lentiformis, Leptochloa fusca, Sporobolus arabicus (Poaceae), Suaeda fruticosa and Kochia indica	Comparison of biomass production of various salt tolerant shrubs	2007	Ashraf, 2007
Salt tolerant trees, shrubs and fodders, including fish farming and gypsum application	Pakistan Community Development Project for Rehabilitation of Saline and Waterlogged Land- Phase I & II by IWASRI	1998-2002 and 2006-10	Shah et al., 2011
Dates, Jujube, Lemon, eucalyptus, sapodilla, acacia, and shrubs	Nawazabad Farm, Mirpurkhas, Sindh	Since 1989	Salam et al., 2024
Sapodilla trees	Nuclear Institute of Agricultural (NIA), Tandojam	Since	Kahlown et al., 2007

Knowledge products of PCRWR on waterlogging and salinity management







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THANKS

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