Micronutrient constraints in sodic soils of Israna, Haryana (India)

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SOILS: WHERE FOOD BEGINS

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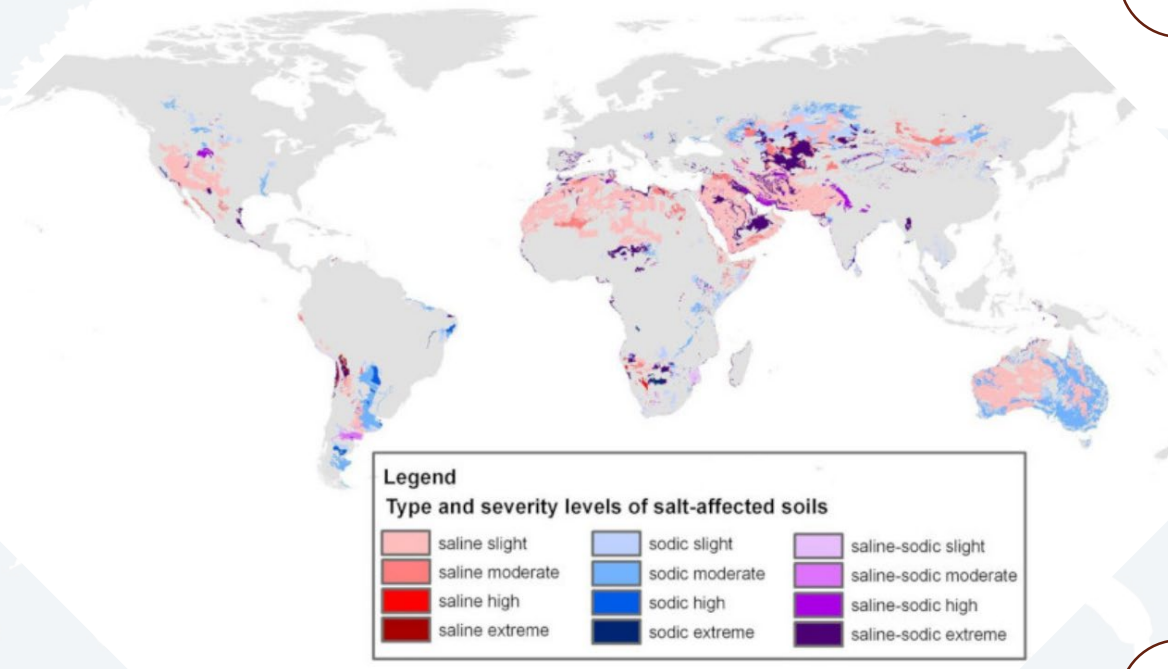
Outline of the presentation



Wicke et al, 2011

- Introduction
- Purpose
- Methodology
- Results
- Conclusion
- Relevance

Sodic soils

Some statistics…

- Sodic soils are widespread in **semi-arid** subtropical regions of world *(Singh et al., 2013)*

- **Global extent** : 581 Mha *(CSSRI-Karnal, 2015)*

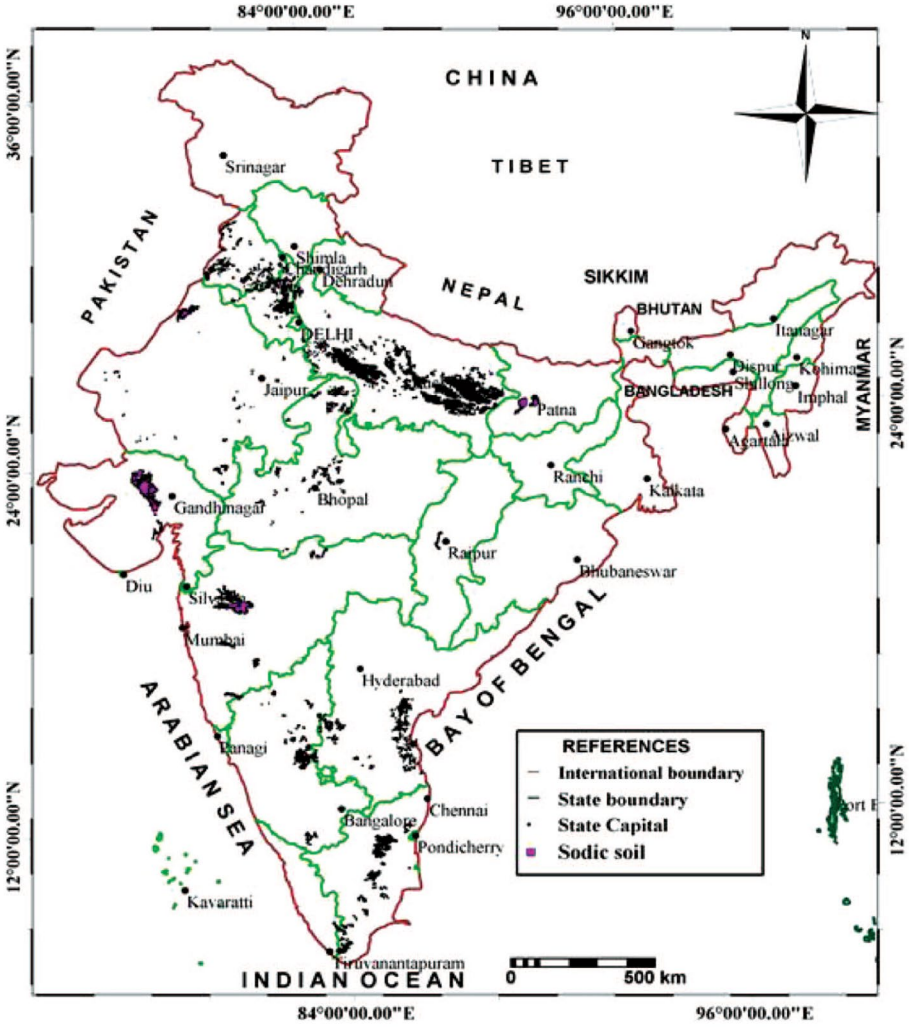
- **Largest sodic area**: Asia and Australia *(Leogrande and Vitti, 2018)*

- **Asian continent**: 249 Mha *(Singh et al., 2013)*

- **India:** 3,770,659 ha *(Chhabra et al., 2005)*

- **Haryana**: 2,55,700 ha

- Mostly in its central part *(Chhabra et al., 2005)*



Mandal et al., 2009

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Micronutrient (MN) constraints in sodic soils

- Low in plant available cationic MNs
- Anionic MNs often display toxicity

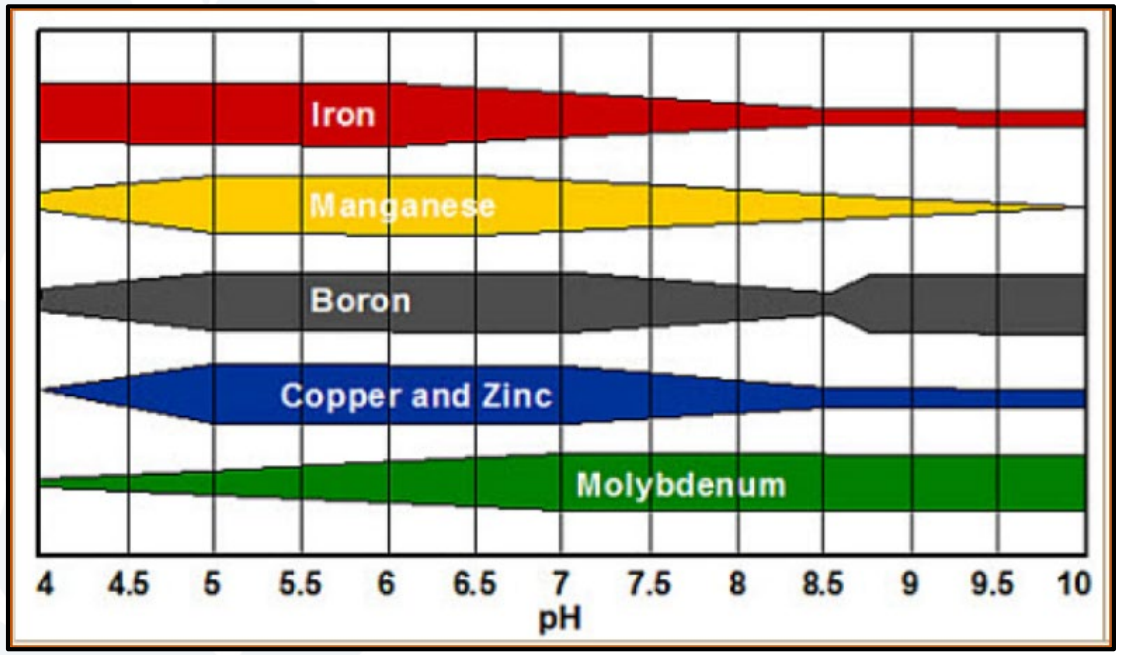
- Various edafic factors affect their availability in soil *(Qadir et al. 2006)*

- MN deficiency is a global problem
- Affects 2 billion people

(De-Regil et al. 2013; Voortman and Bindraban 2015; Dhaliwal et al. 2019)

- Reduces crop output
- Adversely impacts human health

(Graham and Welch 2000)



https://www.mssoy.org/uploads/files/micronutrients-pioneer-mar-2017.pdf

Purpose of the investigation

- To determine the availability of B, Cu, Fe, Mn, Mo and Zn in sodic and farmland soils of Israna, Panipat

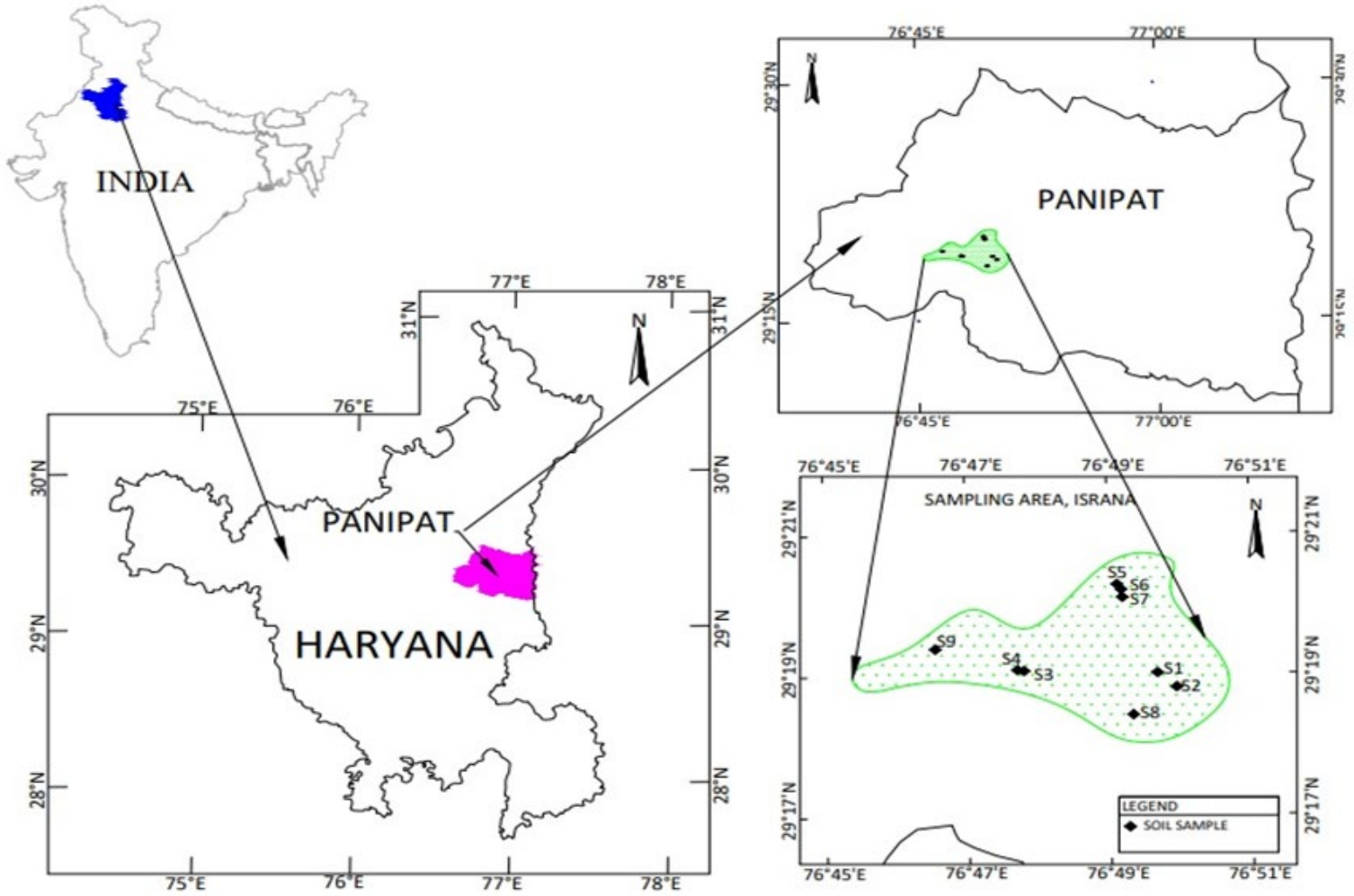
- To study the influence of various edafic variables on their phyto-availability

Methodology

Soil sampling and processing

Soil analyses

Data interpretation



Exchangeable cations

Ammonium acetate method

(Richards 1954)

Cation exchange capacity (CEC)

Ammonium acetate method

(Bashour and Sayegh, 2007)

Total calcium carbonate content

Titrimetric method

(Bashour and Sayegh, 2007)

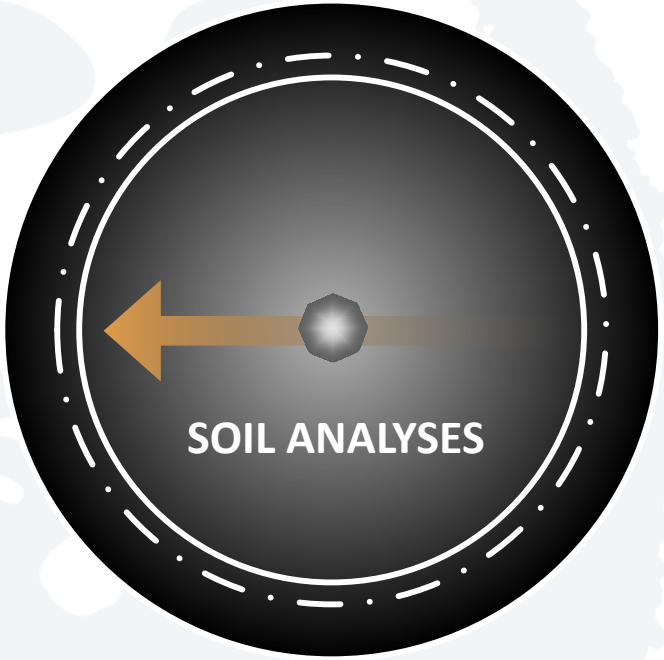
Available B

Hot water soluble method (hws-B) (MoA, 2011)

Available Mo

Ammonium acetate method

(MoA, 2011)



pH and EC

Eutech Cyberscan 510

Texture

Laser particle size analyser

Microtrac S3500

(Konert and Vandenberghe, 1997)

Available Cu, Fe, Mn & Zn

DTPA extraction method

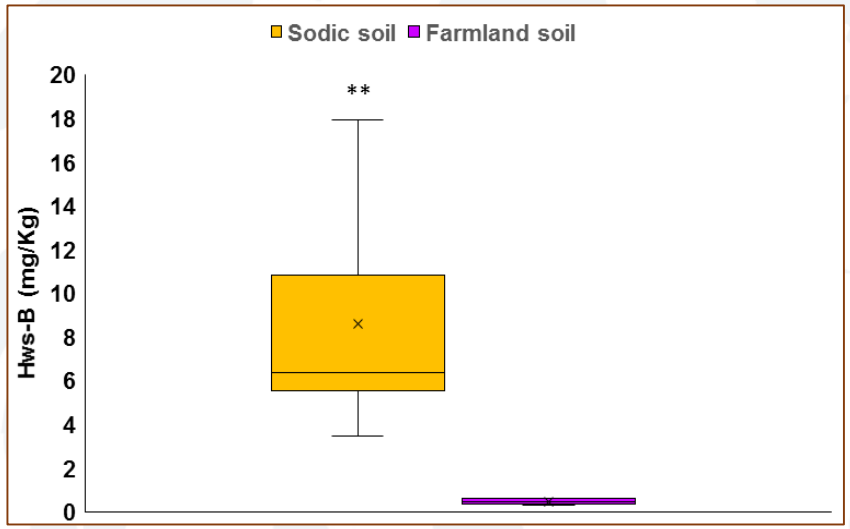
(Lindsay and Norvell, 1978)

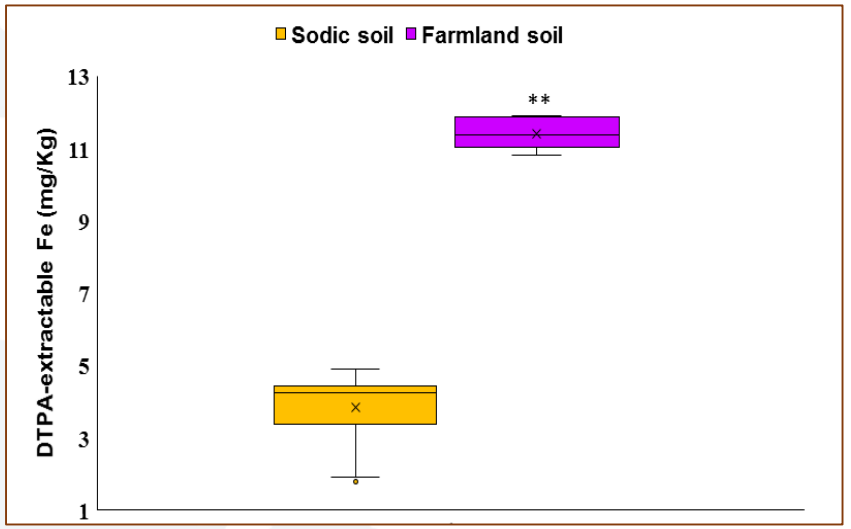
Soil properties and MN availability

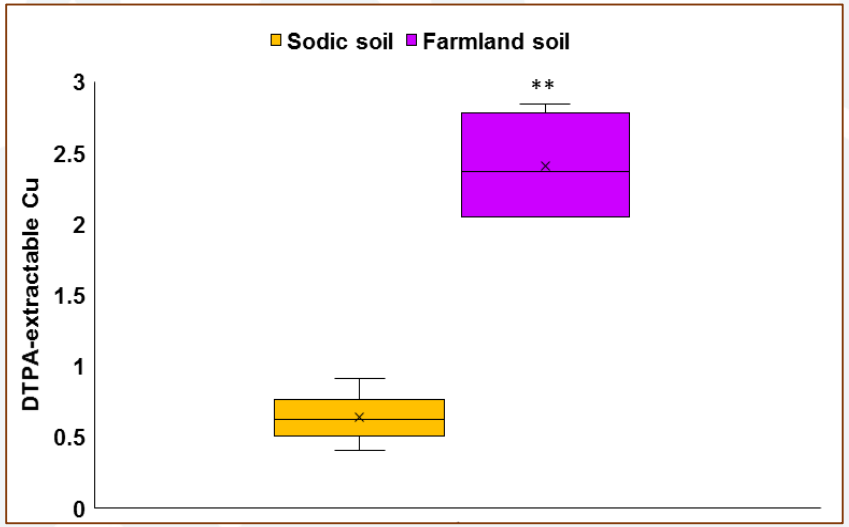
Soil properties	Soil Types	
	Sodic soils	Farmland soils
pH	9.41	7.39
EC (dS/m)	1.38	2.42
ESP (%)	57.64	7.97
Calcite (%)	21.38	11
Sand (%)	15.96	18.59
Silt (%)	69.04	66.44
Clay (%)	14.99	14.98
CEC ($cmol_c$/Kg)	10.06	13.61

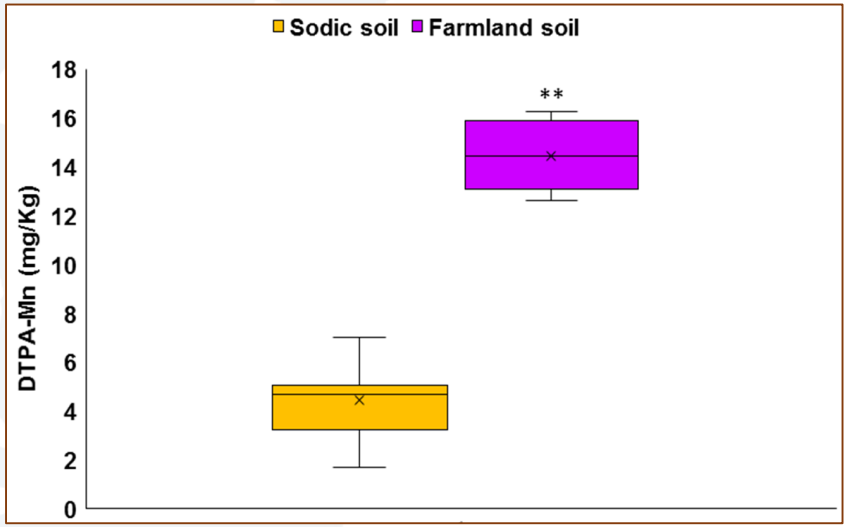
Available micronutrient concentration (mg/Kg)	Soil Types	
	Sodic soils	Farmland soils
B	8.59	0.46
Cu	0.65	2.41
Fe	3.84	11.4
Mn	4.44	14.46
Mo	1.87	0.41
Zn	0.82	2.06

Available content of MNs in surface soils









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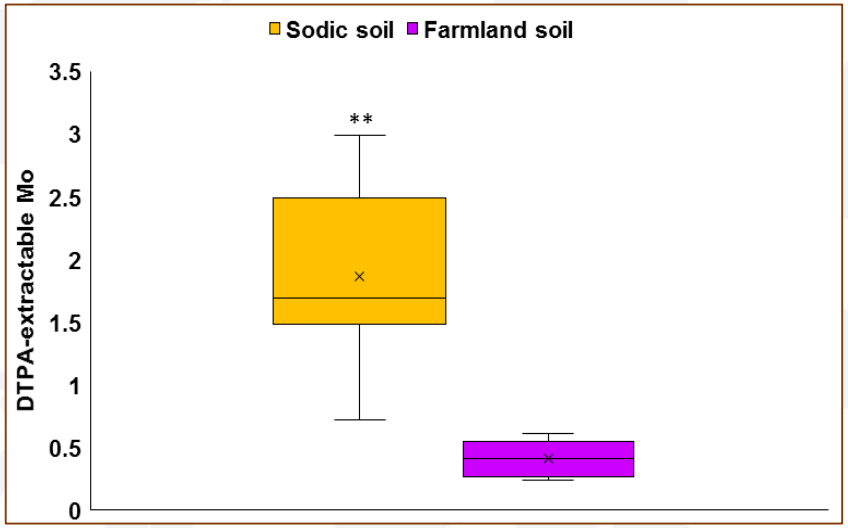

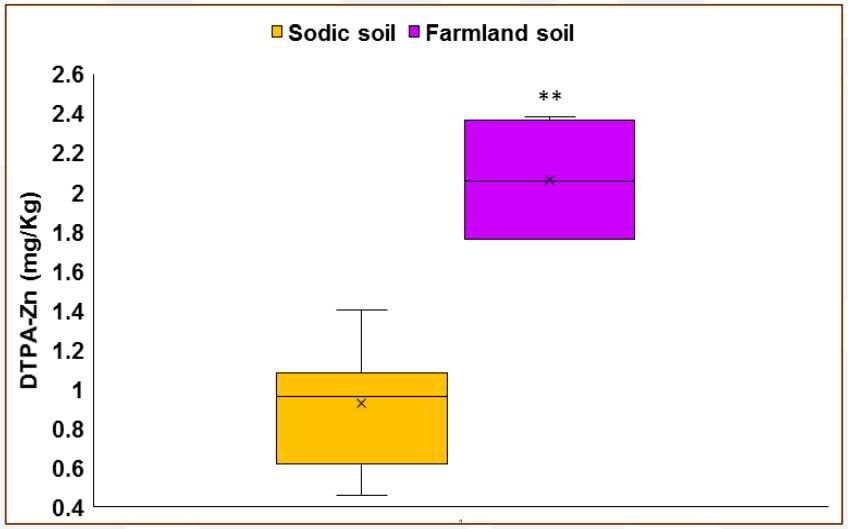

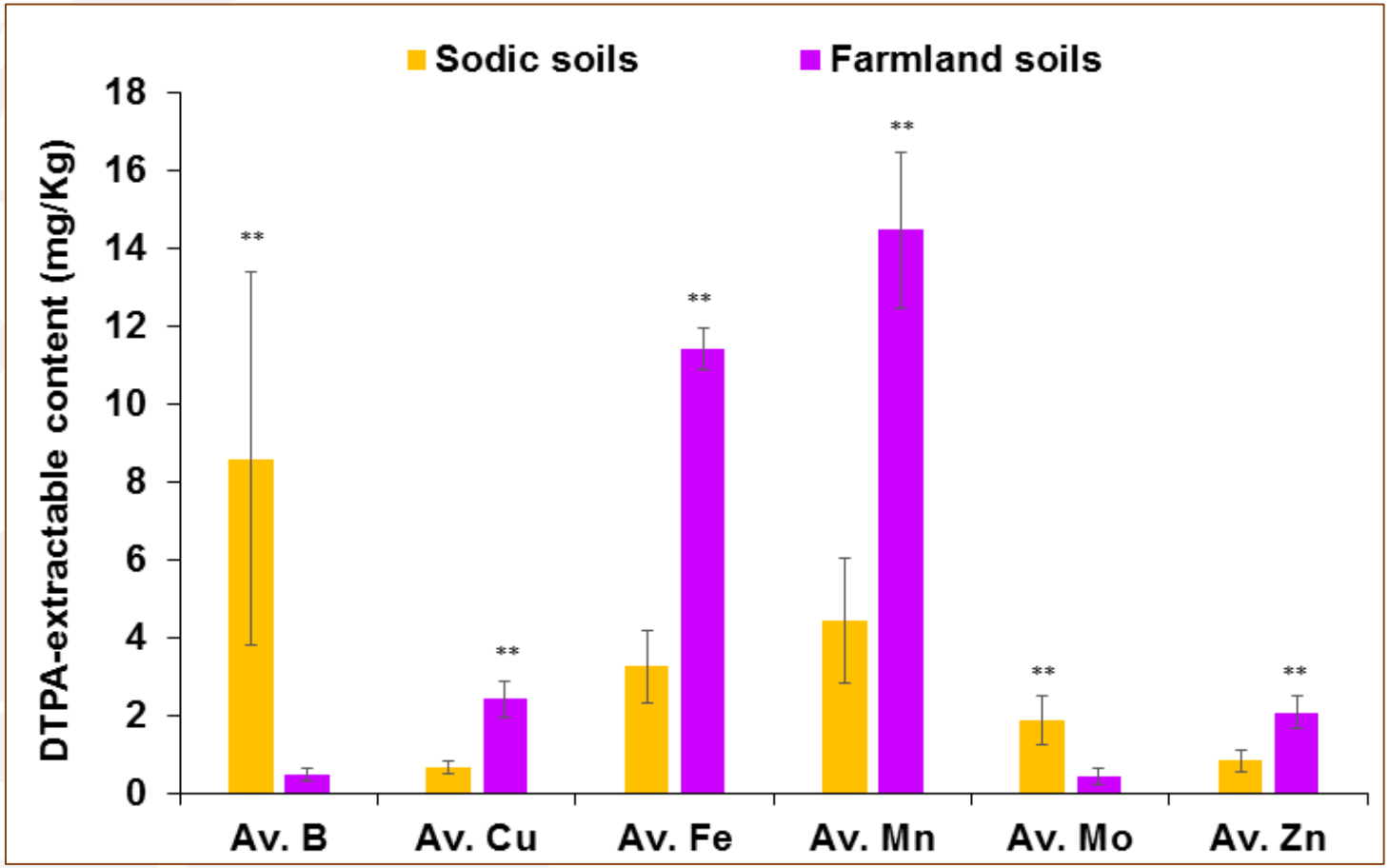

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Correlation and regression analyses

Metal	Extraction method	Equations	R^2
B	HWS	Y = 6.15 pH - 49.30	0.75**
		Y = 5.37 pH + 0.45 Calcite - 51.65	0.90**
		Y = 6.16 pH + 0.28 Calcite - 0.34 Silt - 78.84	0.94*
Cu	DTPA	Y = 2.41 - 0.19 pH	0.65**
		Y = 2.48 - 0.17 pH- 0.01 Calcite	0.77**
		Y = 2.75 - 0.16 pH- 0.02 Calcite- 0.02 Clay	0.82*
		Y = 2.27 - 0.11 pH- 0.02 Calcite- 0.02 Clay + 0.13 EC	0.88*
		Y = 2.21 - 0.07 pH- 0.02 Calcite- 0.02 Clay + 0.21 EC - 0.01 ESP	0.93**
Fe	DTPA	Y = 1.20 + 1.91 EC	0.67**
		Y = 2.96 + 1.88 EC - 0.08 Calcite	0.81**
		Y = 7.58 + 1.42 EC - 0.06 Calcite - 0.46 pH	0.87*
		Y = 7.96 + 0.84 EC - 0.09 Calcite - 0.75 pH + 0.6 ESP	0.93**
Mn	DTPA	Y = 24.02 - 2.08 pH	0.76**
		Y = 16.40 - 1.50 pH + 1.58 EC	0.86**
		Y = 16.87 - 1.71 pH + 1.40 EC + 0.08 Calcite	0.90*
Mo	Ammonium acetate (pH = 7)	Y = 0.14 Silt - 8.09	0.57**
Zn	DTPA	Y = 3.52 - 0.29 pH	0.44**
		Y = 4.28 - 0.30 pH -0.04 Clay	0.60*
		Y = 2.10 - 0.26 pH -0.05 Clay + 0.03 Silt	0.70*

Conclusion

- The micronutrients followed the order:
  - **Sodic soils**: B > Mn > Fe > Mo > Zn > Cu
  - **Farmland soils**: Mn > Fe > Cu > Zn > B > Mo
- Sodic soils had *significantly lower concentrations* of Cu, Fe, Mn and Zn than non-sodic farmland soils
- Mo and B were found to be in *toxic range* in sodic soils
- **pH** and **EC** exhibited strong influences on MN availability
- Regression models suggested that the phyto-availability of MNs was largely controlled by pH, followed by other soil attributes
- **Judicious management** of these nutrients requires regular monitoring of
  a) their status
  b) various soil variables

Relevance

- Sodic soils *cover huge expanse* of terrestrial surface
- Their global extent is projected to *increase in future* as a result of *climate change induced variations*
- **Socio-ecological significance** of such degraded lands *will grow further* in coming years
- Sodic soils display a range of nutrient imbalances
- Affect the crop quality and productivity adversely
- *Profoundly influence* human health as soil is an important source of nutrients in our food supply

You can trace every sickness, every disease and every ailment to a mineral deficiency

Dr. Linus Pauling, Nobel laureate (1954)


Thank you !
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References

- Bashour, I. I., Sayegh, A. H., 2007. Methods of analysis for soils of arid and semi-arid regions. Food and Agriculture Organization of the United Nations, Rome, pp. 49-50.
- Chhabra, R., 2005. Classification of salt-affected soils. Arid Land Res Manag., 19, 61-79.
- CSSRI-Karnal, 2015. Vision 2050. www.icar.org.in/files/Vision-2050-ICAR.pdf
- Voortman R, Bindraban PS (2015) Beyond N and P: toward a land resource ecology perspective and impactful fertilizer interventions in Sub-Saharan Africa. VFRC Report 2015/1. Virtual Fertilizer Research Center, Washington DC, USA, pp. 49
- Graham RD, Welch RM (2000) Plant food micronutrient composition and human nutrition. Commun Soil Sci Plant Anal 31: 1627-1640
- Konert, M., Vandenberghe, J. E. F., 1997. Comparison of laser grain size analysis with pipette and sieve analysis: a solution for the underestimation of the clay fraction. Sedimentology, 44, 523-535.
- Leogrande, R., Vitti, C., 2018. Use of organic amendment to reclaim saline and sodic soils: a review, Arid Land Research and Management, 33: 1, 1-21. doi:10.1080/15324982.2018.1498038
- Lindsay, W. L., Norvell, W. A., 1978. Development of a DTPA soil test for zinc, iron, manganese, and copper. Soil Sci. Soc. Am. J, 42(3), 421-428.
- Mandal, A. K., Sharma, R. C., Singh, G., 2009. Assessment of salt-affected soils in India using GIS. Geocarto International, 24, 437-456.
- MoA, Ministry of Agriculture, 2011. Methods manual: Soil testing in India. Department of Agriculture and cooperation, Govt of India, New Delhi, pp. 106-121.
- Qadir, M., Noble, A. D., Schubert, S., Thomas, R. J., Arslan, A., 2006. Sodicity induced land degradation and its sustainable management: Problems and prospects. Land Degrad. Develop., 17: 6, 661-676.
- Richards, L. A., 1954. Diagnosis and improvement of saline and alkali soils. United States Department of Agriculture, Agriculture Handbook no. 60, Washington, DC.
- Singh, K., Pandey, V. C., Singh, R. P., 2013. *Cynodon dactylon*: An efficient perennial grass to revegetate sodic lands. Ecol. Eng., 54, 32-38.
- Wicke, B., Smeets, E., Dornburg, V., Vashev, B., Gaiser, T., Turkenburg, W., Faaij, A., 2011. The global technical and economic potential of bioenergy from salt-affected soils. Energy Environ. Sci., 4, 2669-2681.
- Dhaliwal SS, Naresh RK, Mandal A, Singh R, Dhaliwal MK (2019) Dynamics and transformations of micronutrients in agricultural soils as influenced by organic matter build-up: A review. Environmental and Sustainability Indicators 1-2:100007Fageria NK, Stone LF (2008) Micronutrient deficiency problems in South America. In: Alloway BJ (ed) Micronutrient deficiencies in global crop production. Springer, Dordrecht, pp. 245-266