Trade Driven Relocation of Greenhouse Gas Emission in India

Shekhar Goyal[1], Udit Bhatia[2]

[1]Earth Science Discipline, Indian Institute of Technology Gandhinagar, Palaj, Gandhinagar -382355, India

[2]Civil Engineering Discipline, Indian Institute of Technology Gandhinagar, Palaj, Gandhinagar -382355, India

EGU23-741

1. Introduction

- Agricultural production is a major emitter of GHGs, currently accounting for 18% of total GHG emissions in India (INCCA, 2010).
- Recent studies have show that international trade affects the global distribution of Agricultural Greenhouse Gas (AGHG) emissions, air pollution, and public health. Domestic Interstate Trade (DIT) has similar effects on AGHG within the country but has yet to be comprehensively investigated.
- While there has been an increasing focus on AGHG, limited attention has been paid to its consumption-based drivers.
- Wheat and rice are the staple crop of India, and their increased production has been critical in lowering hunger and malnutrition throughout the country.
- By tracing the consumption-based accounting of emissions in these two major cereal crops, we evaluated the consequences of agricultural DIT on the emission potential in production hubs.

2. Objective

- Contribution of Indian interstate cereal crop trade on greenhouse gas emission in India

3. Study area and data used

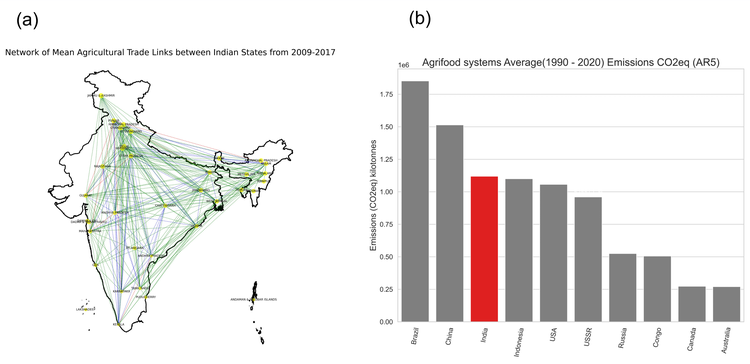

Figure 1 (a) – (b): Interstate Railroad trade network in India and global average AGHG emission.

Data used:

- Indian Agricultural data: http://data.icrisat.org/dld/src/crops.html
- Agricultural Trade Data: http://ftddp.dgciskol.gov.in/login.html
- Synthetic Fertilizer application rate (N): https://eands.dacnet.nic.in/Cost_of_Cultivation.html
- Manure application rate (M): https://eands.dacnet.nic.in/Cost_of_Cultivation.html
- Emission factor: IPCC Tier 1 methodology

4. Methodology

Cropland AGHG Emission

- Agricultural GHG includes Nr losses, CH_4 losses

$$N^i_t = N^i_{fer} + N^i_{man} + N^i_{dep} + N^i_{fix} \quad (1)$$

$$Nr\ loss_i = (EF^{N2O}_i + EF^{NH3}_i + EF^{NO3}_i) * N_t \quad (2)$$

where *i* indicates crop group, *Nr is reactive nutrient losses,* N_{fer} is N from a fertilizer application, N_{man} is N from manure use; N_{dep} is N from deposition; and N_{fix} is N from biological fixation, EF is the emission factor (IPCC table 11.1).

Direct cropland CH_4 emission from paddy rice (IPCC).

$GHG_{content}$ (CO2eq) = *(Nr loss)*265*44/28 + (CH4)*28*

- Trade based emission $GHG_{traded(s,c,y)} = T_{s,c,y} * GHG_{content(s,c,y,)}$ (3)

subscripts T,s, c, and y refer to the considered Trade volume, state, crop and year respectively

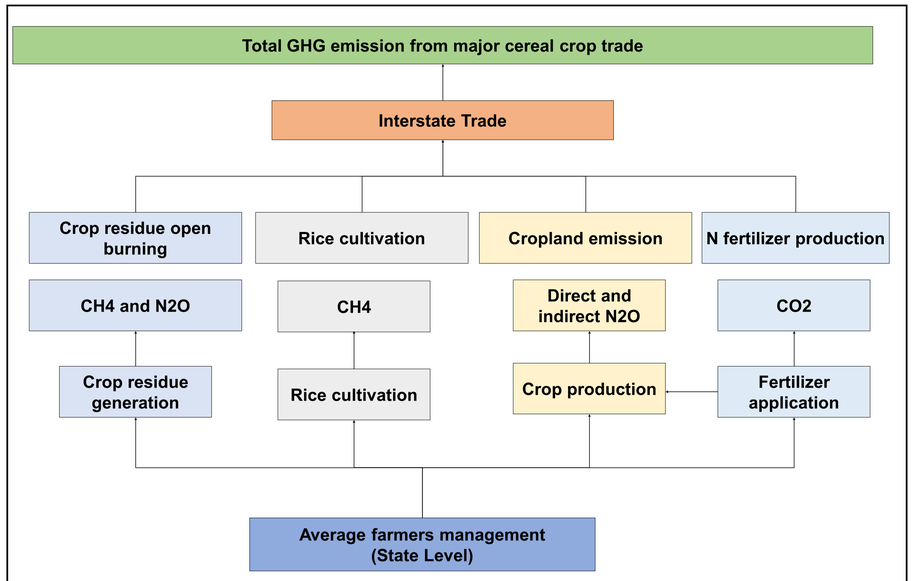

Figure 2: Different components of agricultural greenhouse gas emission accounted in this study

5. Results

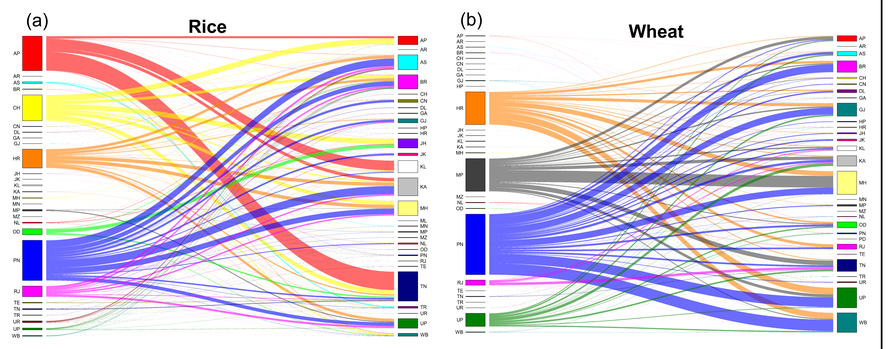

Figure 3 (a) - (b): Interstate rice and wheat trade in India averaged over 2009-2017

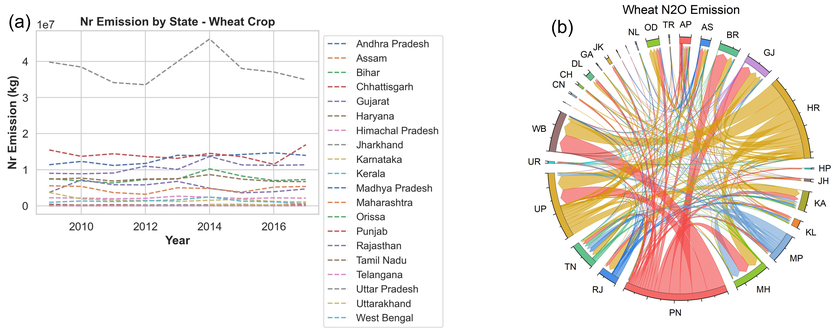

Figure 4 (a) – (b): Total and traded wheat Nr emission losses

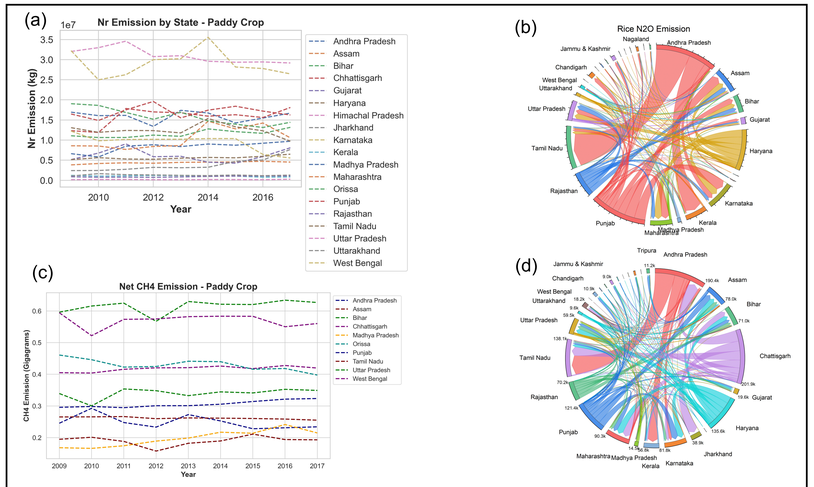

Figure 5 (a) – (d): Total and traded rice Nr and methane emission loss

Figure 6: AGHG emission from interstate trade of wheat and rice in India from 2009-2017 averaged over time

6. Conclusions

- This study attempts to take advantage of interstate domestic road trade cereal crop data to comment on the consumption based drivers of AGHG emission in Indian food bowls.
- Substantial Greenhouse gas emission is being driven by distant consumer demands.
- This work will help towards implementing credit based system towards virtual emission transfer.
- The future work includes translating these emissions in terms of health impact.

7. References

- Carlson, K.M., Gerber, J.S., Mueller, N.D., Herrero, M., MacDonald, G.K., Brauman, K.A., Havlik, P., O'Connell, C.S., Johnson, J.A., Saatchi, S. and West, P.C., 2017. Greenhouse gas emissions intensity of global croplands. *Nature Climate Change*, 7(1), pp.63-68.
- Foong, A., Pradhan, P., Frör, O. and Kropp, J.P., 2022. Adjusting agricultural emissions for trade matters for climate change mitigation. Nature Communications, 13(1), p.3024.
- IPCC Guidelines for National Greenhouse Gas Inventories Vol. 4 (eds Eggleston, H. S., Buendia, L., Miwa, K., Ngara, T. & Tanabe, K.) Ch. 11 (IGES, 2006).
- Shekhar Sharan Goyal, Raviraj Dave, Rohini Kumar et al. Interstate Trade Exacerbates Agricultural Pollution in Food Bowls of India, 07 April 2023, PREPRINT (Version 1) available at ResearchSquare [https://doi.org/10.21203/rs.3.rs-2777545/v1]

8. Acknowledgement

- This research is financially supported by IIT GN.

goyal_shekhar@iitgn.ac.in