The present study was carried out to study the mobility and persistence of the pesticides-carbendazim and paraquat in soil (half-life 1-13 years) for the wheat crop along with their translocation from soil into the wheat grains as no field studies are available for these pesticides. The experiments for the two crop seasons (2018-19 and 2019-20) were conducted at the plot scale in the agricultural fields Pusa, Delhi, India. The soil texture was classified as sandy loam. Paraquat dichloride 24% SL (herbicide) and carbendazim 50 wp (fungicide) were applied at the recommended doses on five fields; four fields were kept under different irrigation treatments and the fifth field was held at the rain-fed condition. Carbendazim and paraquat in soil and in the wheat grains were analyzed using HPLC. The Spatio-temporal variation of the soil moisture contents and pesticide's residue in soil in the each of the five fields were determined for both the seasons.

Carbendazim was found either to be degraded or in traces in the soil at the harvest time of the wheat crop seasons. Also, no traces of carbendazim residue in the wheat grains were found in any of the fields for both the seasons. Therefore, carbendazim was not found to be contaminating the soil and the wheat grains and was not considered in the numerical simulation and regulation studies.

Paraquat was found in the background concentration before its application in all the five fields and at all the four soil depths (0-15 cm, 15-30 cm, 30-45 cm, 45-60 cm) in both the seasons. After paraquat application, it was found to be persistent in the top 15 cm soil layer with almost no mobility beyond 15 cm soil depth in all the five fields and in both the crop seasons irrespective of the irrigation treatments. The final concentration of paraquat at the harvest time was found to be more than its initial concentration in the top 15 cm soil depth in all the five fields for both the seasons leading to soil pollution. The moisture flow and transport of paraquat was also simulated using numerical model, HYDRUS-1D to find out the sustainable doses of paraquat to avoid the

soil contamination. The moisture flow model was validated using the field moisture data for all the fields and for both the seasons. There was a good agreement as the relative Root Square Mean Errors (RMSEr) values for the moisture simulations varied from 0.05 to 0.26 and the model efficiencies varied from 0.65-0.95. For paraquat transport modeling, the solute transport parameters were first optimized using inverse modeling with the field data of the Season 1. The temporal variations of the concentrations of paraquat in the soil were then calibrated with the optimized solute transport parameters for the Season 1. The RMSEr values for the paraquat transport simulations varied from 0.015 to 0.167 and the model efficiencies varied from 0.61-0.97, indicating good concentration simulations. Paraquat transport model was further validated, using the optimized solute transport parameters of the Season1, on the field data of the Season 2. There was a good agreement, and the RMSEr values for paraquat transport simulations for the Season 2 varied from 0.012 to 0.139 and the model efficiencies varied from 0.64-0.98. After the model validation, the numerical model was further used for paraquat regulation strategies under different scenarios for different irrigation treatments. It was seen that paraquat contaminated the soil even at the reduced doses as it was found to be persisted in the soil at the end of the wheat crop seasons under all the simulations.

Paraquat residue in the wheat grains was also found in all the fields and in both the seasons, ranging between 21.6 to 49.02 mg kg-1 against the maximum residue level of 0.1 mg kg^{-1}. From the multiple linear regression analysis, paraquat residue in the wheat grain was not found to be sensitive to the depth of irrigation water whereas % clay in soil was found to be the predominant factor. In view of the longer persistence of paraquat in the soil, alarming paraquat residue in the wheat grains and its associated toxic impact on human health, paraquat use is not recommended for the wheat crop based on the present study.