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The nexus between agricultural management practices, biomass burning, air quality and ozone induced crop yield losses

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In the tropics and subtropics, agricultural systems are dominated by small landholdings and diverse year round multi-cropping patterns. In these systems farmers are not only passive victims of crop production losses due to elevated surface ozone levels associated with poor air quality, but also actors whose agricultural management decisions influence the regional air quality. For example, post-harvest crop residue management through open biomass burning of the stubble and agroforestry plantation choices strongly affect the air quality. In the north west Indo Gangetic Plain (N.W. IGP), emissions from post-harvest agricultural crop residue fires drive peak hourly daytime ozone in excess of 70 ppb during the growing seasons in summer and winter. Measurements of the total ambient OH reactivity which is a robust proxy for the total reactive pollutant loading of air, increase by more than two-fold from 28 s^{-1} to 64 s^{-1} during the crop residue fire influenced period in summer with a large fraction of the ambient chemical composition remaining unaccounted (40% missing OH reactivity), and associated with rapid photochemical formation of several nitrogen containing compounds including isocyanic acid, a toxic gas. The sensitive growth stages of one crop often coincide with the burning of the residue of other crops grown within the same region, affecting the crop yields of summer crops (moong pulses and vegetables), cotton, sugarcane, late monsoon crops (potatoes and peas) and early wheat and late paddy varieties. Wheat production losses due to ozone determined using the POD_6 metrics and the DO_3SE model amount to 20-40% for wheat sown in the second week of November and could be reduced to $\sim$5% if the right wheat cultivar is sown early (in the last week of October). Finally, we show that trees planted as part of the agro-forestry practises are a significant source of regional isoprene that majorly impacts atmospheric chemistry and air quality in the agricultural landscape. Thus, for meaningful interventions aimed at improving air quality and agricultural productivity in such regions, policy makers need to account for the prevalent nexus between agricultural management practices, biomass burning, air quality and ozone induced crop yield losses.