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Water resources conservation and nitrogen pollution reduction under global food trade and agricultural intensification

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Global food trade entails virtual flows of agricultural resources and pollution across countries. Here we performed a global-scale assessment of impacts of international food trade on blue water use, total water use, and nitrogen (N) inputs and on N losses in maize, rice, and wheat production. We simulated baseline conditions for the year 2000 and explored the impacts of an agricultural intensification scenario, in which low-input countries increase N and irrigation inputs to a greater extent than high-input countries. We combined a crop model with the Global Trade Analysis Project model. Results show that food exports generally occurred from regions with lower water and N use intensities, defined here as water and N uses in relation to crop yields, to regions with higher resources use intensities. Globally, food trade thus conserved a large amount of water resources and N applications, and also substantially reduced N losses. The trade-related conservation in blue water use reached 85 km^3 y^{-1}, accounting for more than half of total blue water use for producing the three crops. Food exported from the USA contributed the largest proportion of global water and N conservation as well as N loss reduction, but also led to substantial export-associated N losses in the country itself. Under the intensification scenario, the converging water and N use intensities across countries result in a more balanced world; crop trade will generally decrease, and global water resources conservation and N pollution reduction associated with the trade will reduce accordingly. The study provides useful information to understand the implications of agricultural intensification for international crop trade, crop water use and N pollution patterns in the world.