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## MORE INTENSIVE CROP NUTRITION EVADES GREENHOUSE GASES

**Doesn't fertilizer actually increase emissions of greenhouse gases?** Well, yes, in its manufacture and in its use, but... when one looks at the big picture instead of the partial details, it's surprising how much the answer to a question can change! The higher yields of better-fertilized crops have spared land from conversion to agriculture, avoiding emissions of a huge quantity of greenhouse gases.

**Agricultural intensification can reduce greenhouse gas emissions.** A recent study published in the Proceedings of the National Academy of Sciences estimates that the gains in crop yields since 1961 have, globally on a net basis, spared emissions of 350 to 650 million short tons of carbon dioxide equivalents. Those higher-yielding crops do emit more greenhouse gases, but not as much more as alternative scenarios in which larger areas of land would have been converted to agriculture.

**Crop yields have more than doubled since 1961.** The increased yields have made it possible to feed the world's growing population with only a 27% increase in land area. Without the yield increases, 292% more land would have been required to attain the crop production levels of 2005. Even to simply maintain the per-capita production levels of 1961 would have required a 221% expansion in cropland.

**Converting land to crop production entails very large emissions.** The removal of trees, shrubs, and other vegetation, and breakdown of soil organic matter under cultivation releases carbon dioxide. The authors of the report—Jennifer Burney, Steven Davis, and David Lobell in Stanford, California—analyzed the literature carefully and concluded that, around the globe, the average acre available to be converted to crop production would lose the equivalent of 172 tons of CO<sub>2</sub> per acre. That emission is huge in comparison to the emissions increase related to higher input use.

**Fertilizer use grew from 34 to 182 million tons of primary nutrients since 1961.** In the alternative scenarios, fertilizer use per acre would have stayed constant, but the total use would have increased to between 74 and 97 million tons. Greenhouse gases are emitted when fertilizers are manufactured, and application of N fertilizers can increase emissions of nitrous oxide, a potent greenhouse gas. The fertilizer-associated emissions, however, were dwarfed by those associated with land use change in the comparison of these scenarios.

**Increasing yields to avoid greenhouse gas emission has been cost-effective.** The authors calculated that the cost of investment in crop yield improvement (including public and private research) amounted to less than four dollars per ton of emission reduction. That compares favorably with many other mitigation efforts being considered currently.

**Continued improvement in crop yields is a viable strategy for a healthy planet.** The study's authors concluded, "Further yield improvements should therefore be prominent among efforts to reduce future greenhouse gas emissions."

**The carbon footprint of fertilizer needs to include its contribution to yield improvement.** Higher crop yields arose not only from fertilizer, but from a combination of better genetics, better management, and better crop nutrition. Improving nutrient use efficiency can only be a viable greenhouse gas mitigation strategy in the context of continued increases in the productivity of cropping systems.

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For more information, contact Dr. Tom Bruulsema, Northeast Director, IPNI, 18 Maplewood Drive, Guelph, Ontario N1G 1L8, Canada. Phone: (519) 821-5519. E-mail: [Tom.Bruulsema@ipni.net](mailto:Tom.Bruulsema@ipni.net).

Abbreviations: N = nitrogen.