Ammonia Emissions from US Agriculture Carry High Social Cost

By Ben Kaldunski
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New air quality modeling techniques developed by NASA’s Air Quality Applied Sciences Team (AQAST) reveal the high public health costs associated with ammonia emissions from US agricultural exports.

Daniel Jacob and Fabien Paulot at Harvard University used a model of agricultural sources of ammonia coupled to a chemical transport model to estimate the impact of US food exports on concentrations of fine particulate matter (PM2.5), one of six criteria air pollutants controlled under the Clean Air Act.

Ammonia, which is released by agricultural activities, reacts with other chemicals to produce ammonium sulfate and nitrate salts that are a major contributor to PM2.5 formation. Jacob and Paulot’s analysis is the first to quantify the costs of ammonia emissions using the GEOS-Chem model to account for meteorological conditions, chemical reactions and aerosol thermodynamics.

The societal costs associated with PM2.5 emissions from food exports was found to be $36 billion, based on methods used by the EPA, compared to $23.5 billion in net revenue. EPA calculates the value of pollution by determining what people are willing to pay to reduce their risk of premature death or health problems.

The staggering high cost estimates amount to roughly $45 per pound of ammonia emissions compared to the EPA estimate that pegged the detrimental costs of ammonia emissions to $22 per pound. Jacob and Paulot’s estimate is significantly higher which could reflect different treatment of ammonia’s role as a PM2.5 precursor.

Jacob and Paulot’s study, published in Environmental Science and Technology on December 25, determined that food exports account for 11% of total US ammonia emissions (13% of total agricultural emissions). These emissions increase the population-weighted exposure of US citizens to PM2.5 by 0.36 micrograms per cubic meter (μg/m³).

Beef exports were the largest contributor in southern states, while pork, corn, and wheat exports were the largest contributors in the upper Midwest. The model simulations showed that Indiana and Ohio are the two states where ammonia from food exports has the largest effect on PM2.5 with concentrations exceeding 1 μg/m³.

Eliminating ammonia emissions associated with food exports would achieve much greater health benefits than reducing EPA’s federal standard for PM2.5 from 15 to 12 μg/m³. Improved fertilizer and manure management could significantly reduce agricultural ammonia emissions with limited impacts on food production costs. These techniques have proven effective in Europe where ammonia emissions have decreased by nearly 30% from 1990 to 2010.

Jacob and Paulot’s work on ammonia will become increasingly important as EPA and state regulators look for ways to lower PM2.5 to meet stricter standards. The “low hanging fruit” has already been achieved by requiring steep cuts from large point sources like power plants. Controlling emissions from the US massive agricultural sector may be the next frontier in achieving national air quality goals.
Daniel Jacob is the director of AQAST, a NASA-funded team of air quality experts that is striving to use advanced air quality science to develop new tools for air quality managers. Learn more about AQAST at this [website](#). Follow this [link](#) to read the full study by Jacob and Paulot.

This map illustrates the Impact of ammonia emissions from food exports on annual average surface PM2.5 concentrations (Image Courtesy of Harvard University)

These maps illustrate the revenue (left) associated with food exports in each state against the costs of ammonia emissions (right) borne by each state (Image Courtesy of Harvard University)
Sources and media coverage

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