Air quality improvements can strengthen China's food security

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China, with nearly 20% of the world's population, achieves self-sufficiency in major grain production using only about 10% of the global arable land. To further ensure food security in China, it is crucial to gain a deep understanding of the driving factors behind grain production. Climate change, water scarcity, and air pollution pose serious threats to food production. Air quality in China is among the poorest in the world, thus quantifying its impact on grain production not only holds significance for maintaining its food security but also provides valuable insights into future air quality management policies. Here, we conducted a comprehensive analysis of the impact of aerosols and ozone on crop growth by integrating long-term, high spatial-temporal resolution remote sensing SIF data, crop planting information, and nationwide air pollution concentration data using nonlinear functional relationships and a two-way fixed-effects statistical model. The results show a consistent negative impact of ozone pollution on crop growth, while the effect of aerosols is varied by crop type and geographic location. By establishing a quantitative response relationship between crop growth and pollutant concentrations, we found that when China reaches the standard of 35 µg m⁻³ PM₂.⁵, the average yields of corn, rice, and wheat nationwide will change by 0.45 ± 0.8%, 0.70 ± 0.22%, and −5.28 ± 2.97%, respectively. At the same time, reaching a warm-season ozone concentration of 60 µg m⁻³ in China will result in average national yield increases of 7.40 ± 1.32%, 3.40 ± 0.56%, and 8.71 ± 1.85% for corn, rice, and wheat, respectively. If China simultaneously meets both air pollution standards, the average daily per capita calorie intake of the three major crops will increase by 4.51%. Finally, our study suggests that, compared to reducing PM₂.⁵, reducing ozone can more effectively increase domestic grain supply and further maintain China's food security.