1. Food Production, Public Health and Intercropping

- The Food and Agriculture Organization (FAO) projects that global food demand will be doubled by 2050 because of the fast growing population. Yet, agriculture, contributing to 95% of ammonia (NH3) emission in China, promotes the formation of fine particulate matter (PM2.5) in downwind regions. Without proper control, increasing food production could become a severe public health issue.

- Intercropping, as a sustainable farming method, is practiced to various extents worldwide. Cultivating multiple crops in the same field with overlapping planting periods, it enables mutualistic effects of legumes and non-legume plants, enhances nitrogen use efficiency and land use efficiency, and reduces reactive nitrogen emissions to the atmosphere.

2. Implementation of Competition Factor in DNDC

- DeNitrification-DeComposition model (DNDC) (Li et al. 1992) is a process-based model. It simulates soil biogeochemistry, plant growth and microbial activities and calculates greenhouse gas emissions from denitrification, nitification, and fermentation etc.

- We revise the plant nitrogen uptake algorithm of DNDC to capture the below-ground competition between intercropping plants:

- We then reproduce the field experiment conducted by Yong et al. (2014) with the revised DNDC and find:

3. Nationwide Adoption of Intercropping in China

- Nationwide adoption of maize-soybean intercropping is simulated using the revised DNDC in all farming areas cultivating monoculture maize or soybean in each province of China. Provincial representative parameters are used as model inputs, including climate, soil properties, farming practices, and conventional fertilizer use.

4. Improvement of Downwind Air Quality

- According to the simulated NH3 reduction, we scale MASAGE, an agricultural NH3 emission inventory, down by province and input it to the 3D global chemical transport model, GEOS-Chem. An improvement of downwind air quality is estimated with declined inorganic PM2.5.

5. Environmental and Economic Benefits

- A cost-benefit analysis is performed to evaluate the feasibility of promoting intercropping as a national farming standard.

- Unit prices of grain yields are obtained from FAO, fertilizer and production costs are market prices while health costs associated with PM2.5 are calculated using the population, annual mortality rate, and value of a statistical life of China, as suggested by Paulot et al. (2013).

References