Does Carbon Pricing Benefit Conservation Agriculture?

Carbon pricing is a market-based strategy to lower global carbon emissions and combat climate change. Although the policy is not intentionally designed to target the emissions from agriculture, it can indirectly affect other Sustainable Development Goals (SDGs) associated with agriculture. One of the pathways is by changing Nitrogen (N) fertilizer application decisions. N fertilizer production shows high sensitivity to energy prices, especially natural gas that accounts for 75-90% of operating cost in the production. Carbon price will certainly raise the production cost and ultimately the price of N fertilizer. Crop sectors that intensively use N fertilizer may have to consider cutting back their applications to stay profitable. Of course, the level of profitability depends on a variety of factors beyond fertilizer price itself, including crop prices, marginal product of N fertilizer, and the existence of other policies that could interfere with the fertilization decision. Less fertilizer application saves input cost but can also adversely affect crop yields. Declined crop output tend to drive up food prices thereby endangering the SDG of strengthening food security. However, reduced commercial N fertilizer application also implies less nutrient loss. Nitrate (NO3) leaching to the waterways and nitrous oxide (N2O) emissions to the atmosphere cause severe environmental problems like global warming, groundwater contamination, and eutrophication. Many of these processes vary spatially due to variations in local climate, soil quality, and topographical conditions. Understanding the impacts of carbon pricing on sustainable agriculture requires a multi-scale analysis framework to capture these local conditions and the potential aggregated feedback to the global food market.

This paper aims at examining how carbon pricing could affect agricultural output and nitrate leaching. We employed a grid-resolving global partial equilibrium model dubbed SIMPLE-G-US-CS to approach the question under various levels of carbon prices ranging from $50 to $200 per metric ton of carbon dioxide. In order to show the interaction of carbon policy and conservation policy, we compare the case of carbon pricing alone and the case of combining it with wetland restoration that has been widely recognized as one of the most effective conservation practices to manage nitrate runoff from agriculture. Several findings emerge from our analysis. First of all, combined policies have much larger impacts on N application and crop production than wetland alone. A $150 carbon price almost doubles the cost of N input, reduces N fertilizer application by 13%. As a result, crop output falls by 6% and crop price increases by 5%.

Second, a carbon price of $150 yields equivalent leaching mitigation outcome to wetland restoration. Both individually can reduce the total nitrate loads in the Mississippi River basin by 15%. One source that explains the reduction is of course the less application of N fertilizer. The other source of the reduction turns to be the disappeared displacement of nitrate leaching that occurs when wetland restoration is implemented alone but vanishes once carbon price is combined. This finding aligns with the commonly found outcome of targeted economic policies. Construction of wetland subjects to local feasibility particularly hydric soil, and incurs various costs. Locations with wetland potentials where these costs do not apply tend to expand production under high crop prices and thus lead to more nitrate leaching. Introducing uniform policies like carbon pricing can wash away this spatial spillover effect.

Finally, carbon pricing could jeopardize farm income. When policies are combined, competing effects exist to shape corn-soy planting decisions. On the one hand, high food price incentivizes acreage expansion, while on the other hand low substitution between N fertilizer and land inhibits acreage expansion. We find that the ultimate effect is cropland contraction and falling land returns.