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Improving Ecosystem Services from US Agriculture: Yield Reserve vs. Land Retirement

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Introduction

- Agricultural activity is the largest source of nitrogen (N) runoff in the US
- Fertilizer use is one of the main factors
- Progress in reducing N runoff from agriculture is slow

N Reduction Choices

- Yield Reserve (intensive margin): compensate farmers to reduce N fertilizer use below standard recommendations
- Land Retirement (extensive margin): Conservation Reserve Program (CRP)

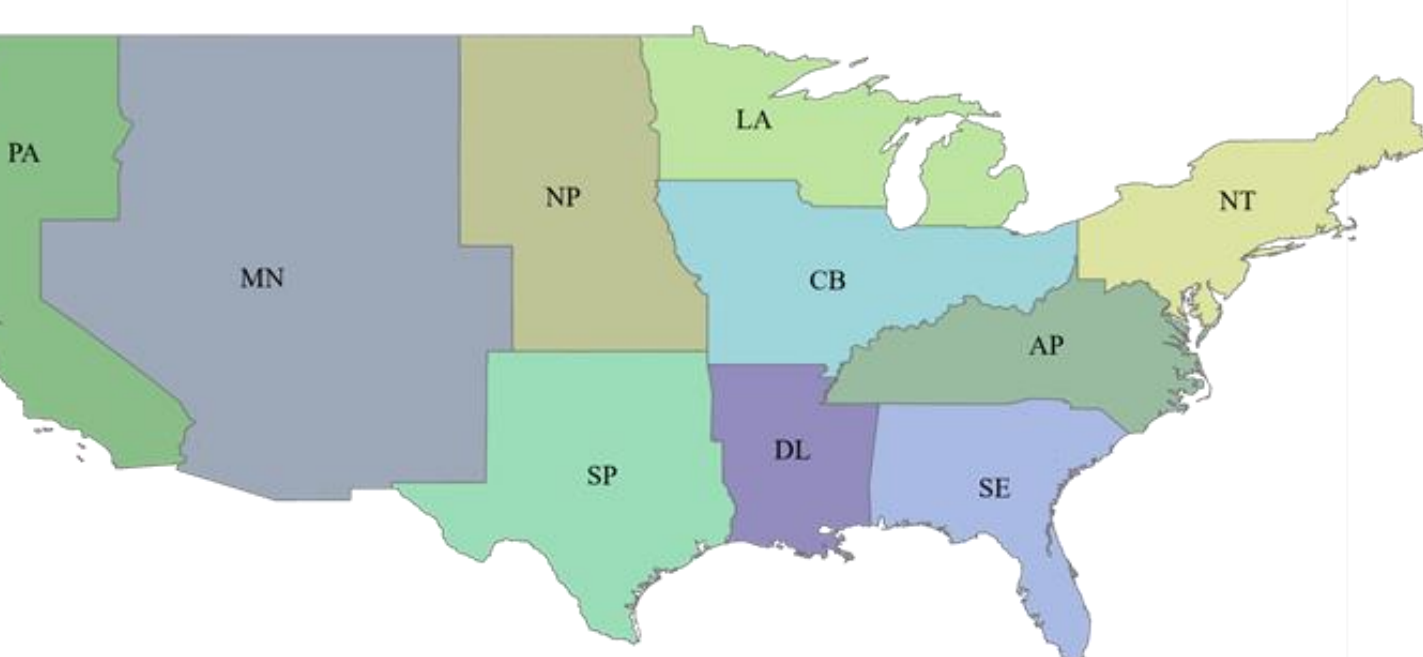
Objective

- use the REAP model to examine how a government budget-equivalent yield reserve program and an expansion of land retirement program (CRP) affect output, costs, and prices from the U.S. agriculture as well as the potential reductions in N loads to the ecosystems

REAP Model

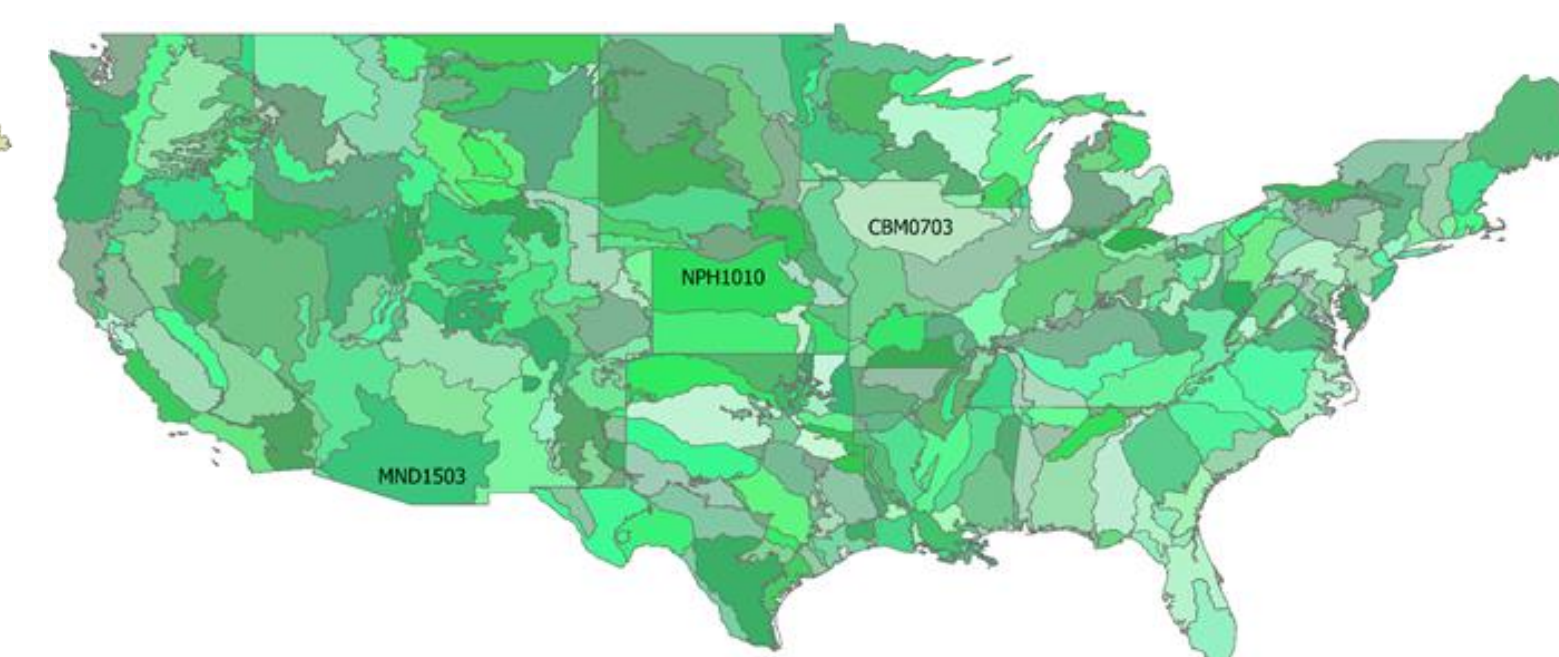
- Regional Environment and Agriculture Programming
- partial equilibrium model implemented in GAMS
- price-endogenous with prices determined by the intersection of demand and supply curves

10 farm production regions



- Livestock production is assumed to be homogeneous within each FPR

273 REAP regions



- Crop production is assumed to be homogeneous within each LRR-HUC-HEL or non-HEL unit (456 regions)

Yield Reserve Program

- Target corn production, corn yield response:

$$Y = 96.57 + 0.73N - 0.001127N^2$$

- Excess N = N fertilizer applied - N removed by corn grain

$$\Delta Excess N = (N_p - 0.87 * Y_{pi}) * A_p - (N_{yr} - 0.87 * Y_{yr}) * A_{yr}$$

- Farmer's subsidy set equal to reduced net revenue:

$$\Delta NR = P_c(Y_{pi} - Y_{yr}) - P_N(N_p - N_{yr})$$

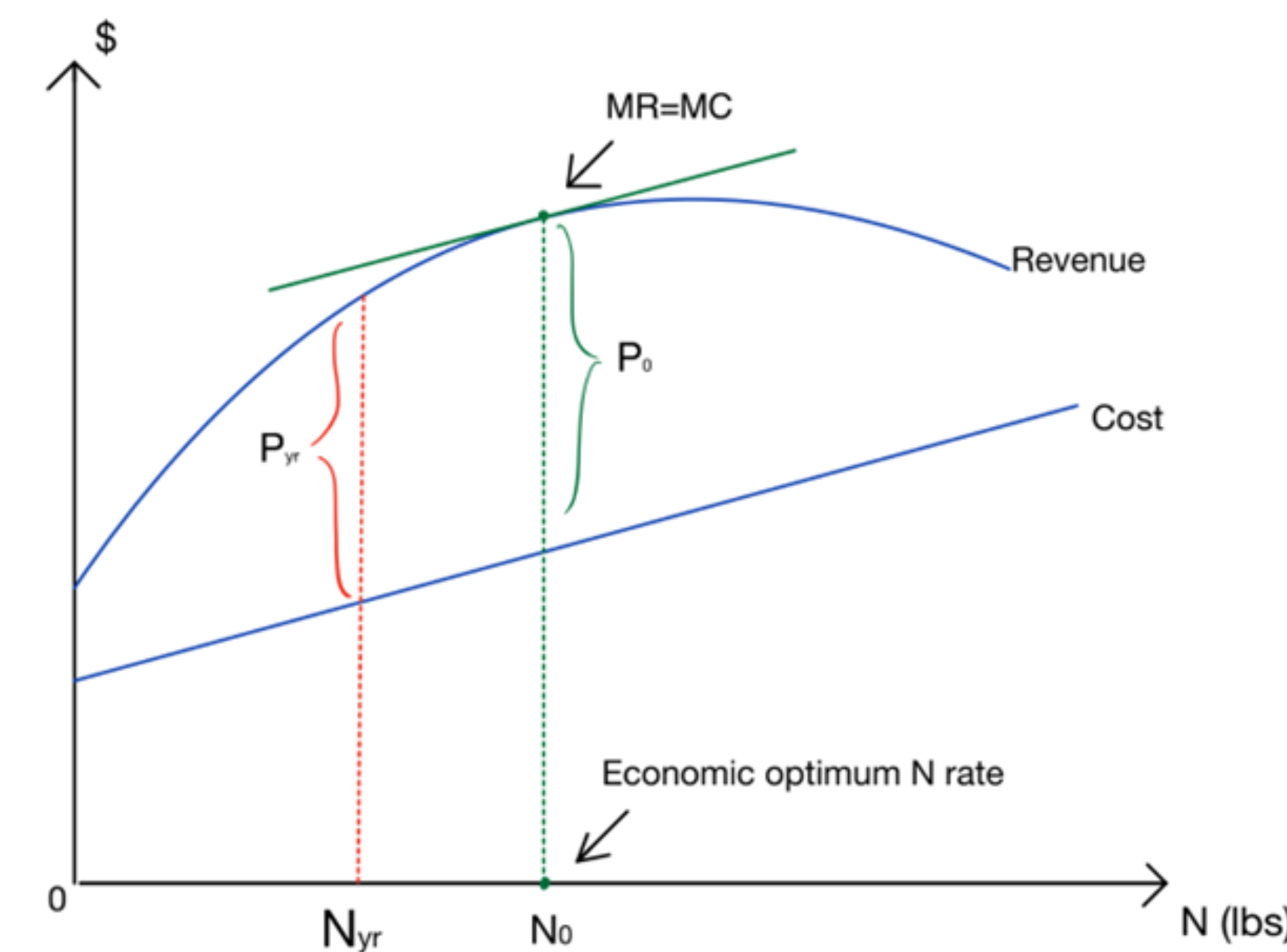


Table 1. N application and corn yield under N reduction scenarios

Expected N reduction (million pounds)	0	900	1,400	1,900
N fertilizer application (pound per acre)	196.5	186.4	180.8	175.2
% change		-5.15%	-8.01%	-10.86%
Corn yield (bushel per acre)	196.5	193.5	191.7	189.9
% change		-1.53%	-2.45%	-3.37%
Yield Reserve Subsidy (million dollars)		683	1,102	1,529
% of total welfare		0.10%	0.16%	0.23%
Total Welfare	668,231	668,360	668,438	668,515
Simulated N reduction (million pounds)		602	974	1,352
% of expected		67%	70%	71%

Land Retirement

- simulate 3 scenarios of CRP land expansion
- Results show strong “slippage effect”

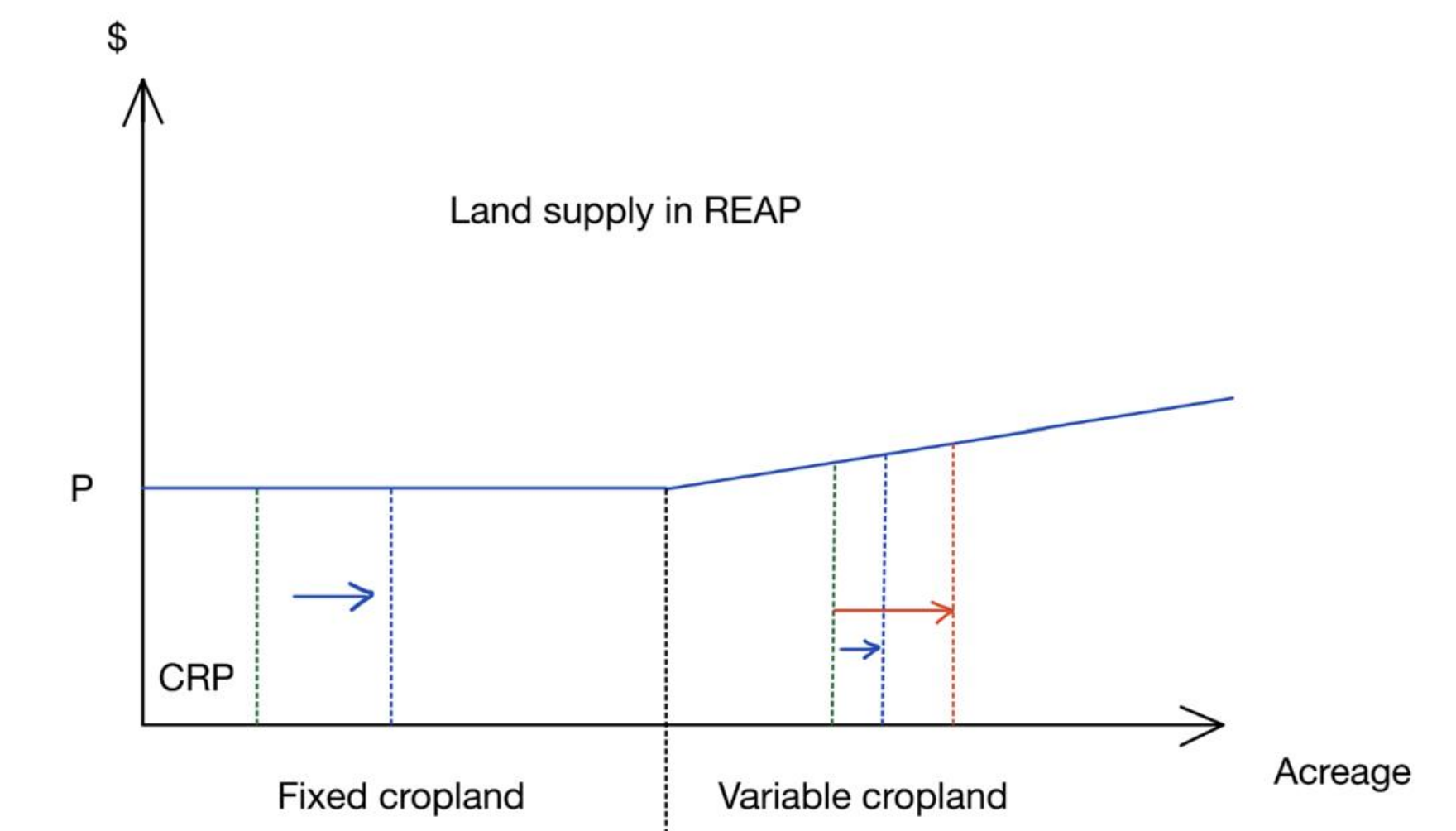


Table 2. CRP and crop acreages under 3 scenarios

scenarios	0	25%	37%	50%
CRP Acreage (million acres)	26.9	33.6	36.8	40.3
Total Crop Acreage (million acres)	297.4	297.3	297.2	297.1

Takeaways and Future Work

- Yield Reserve Program almost reaches the N reduction goal, but the reduction is partially offset by the expansion of corn acreage; Impact on crop and livestock production is minor
- For the CRP program, there is a strong slippage effect
- In the future, we will modify the land supply section to better capture the increasing cost of cultivating marginal land to see how land supply assumptions affect slippage.

Acknowledgments

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