Reductions in GHG Mitigation Due to Carbon Leakage after Setting-Aside Cropland from Agricultural Production in the Conservation Reserve Program

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Project website: http://www.nrel.colostate.edu/projects/etacs/

Abstract

Greenhouse gas mitigation is possible through carbon sequestration in agricultural soils following adoption of conservation practices. The Conservation Reserve Program (CRP), which was enacted in 1986, paid farmers to retire land from cultivation, and led to sequestration of carbon dioxide (CO_2) in soils. However, some CO_2 that was sequestered may have been re-emitted following cultivation of previous grazing lands. Our objective was to evaluate the likelihood that carbon leakage occurred with CRP enrollment based on a spatial pattern analysis. We examined the relationship between cropland enrollment in the CRP and conversion of grasslands to cultivated cropland, using regional correlations and spatial cross-correlations. Since it is common practice to regularly rotate cropland and pasture, we reduced our estimates of newly cultivated cropland by the amount of cropland placed into pastures before evaluating the potential for leakage. Even with this modification, positive correlations between CRP enrollment and cultivation of new cropland were found in several Major Land Resource Areas (MLRA) of Montana and South Dakota, with coefficients ranging from 0.40 to 1. We also found positive spatial cross-correlations among counties in these regions, as well as in western Colorado. We estimated approximately 20-30 percent leakage from MLRAs in Colorado and Montana and as much as 100 percent leakage in parts of South Dakota. CRP enrollment within these MLRAs ranged from about 80,000 hectares to over 1,000,000 hectares. While we conclude that there is high potential for CRP leakage in these regions, further studies will be needed to determine that cropland conversion was stimulated by participation in the CRP.

Introduction

- The Conservation Reserve Program (CRP) helps farmers improve water quality, reduce soil erosion and enhance wildlife habitat by planting resource-conserving permanent vegetative cover
- Sign-ups began in 1986 with contracts lasting 10 - 15 years
- Total cropland enrollment for the U.S. in 1992 was about 12.1 million hectares
- Conversion of cultivated cropland to CRP can sequester CO_2 in the soil, however it is possible that practices elsewhere are leaking CO_2 to the atmosphere
- We hypothesize that there is potential for leakage if continuous hay or pasture lands are cultivated following cropland enrollment in the CRP
- We are examining three mechanisms for potential leakage:
  i. ***Market-based*** - Continuous pasture or hay is converted into cropland due to a reduction in grain supply that induces a subsequent increase in commodity prices
  ii. ***Substitution*** - Continuous pasture or hay is converted into croplands as the producer enrolls some croplands in the CRP, thereby maintaining current levels of crop production
  iii. ***Coincidental*** - Grassland cultivation occurring at the same time as CRP enrollment that is not directly related to enrollment

Photos courtesy of USDA-NRCS

Objectives

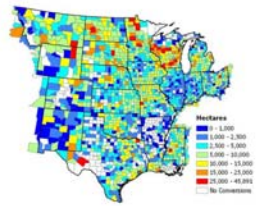
Determine the amount of potential leakage in the 21-state study region and examine possible mechanisms causing leakage from 1982 - 1992.

Methods

- Selected a study region that encompasses most of the land (over 80%) enrolled in the CRP
- Used the National Resources Inventory (USDA-NRCS) to estimate the amount of annual cropland enrolled in the CRP and the amount of continuous pasture and hay lands converted into annual croplands at the county level from 1982-1992

Determination of potential leakage associated with the CRP:

Annual Croplands Converted to Hay or Pasture



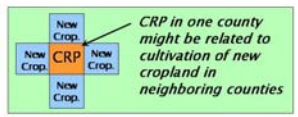
- Accounting for background substitution - Some croplands are continually rotated between annual cropland and hay or pasture. We accounted for the area of cropland being converted to hay or pasture in leakage calculations as a measure of "background" substitution (i.e., not associated with CRP enrollment).

- Created index for potential CRP-associated leakage:

$$\text{Leakage Index} = \frac{\text{CRP enrollment} - (\text{New Cropland} - \text{Background Substitution})}{\text{CRP enrollment}}$$

(Percent of CRP area converted to new cultivation elsewhere = 1 - Leakage Index)

- We conducted a correlation analysis of counties within Major Land Resource Regions (MLRA)
- We also conducted a spatial cross-correlation analysis to determine if there is a regional influence on potential leakage



Raw Data

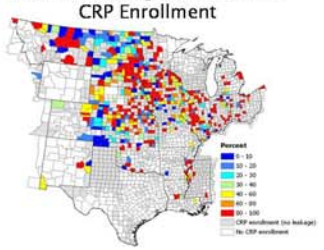
Area by County of CRP Enrollment

Area by County of Net New Cropland

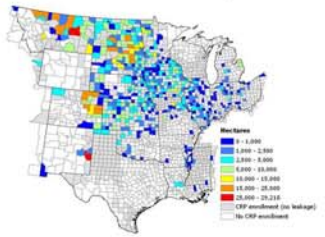
Results

Potential CRP Leakage

Potential Leakage as Percent of CRP Enrollment



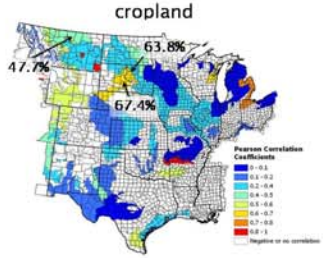
Area of Potential Leakage



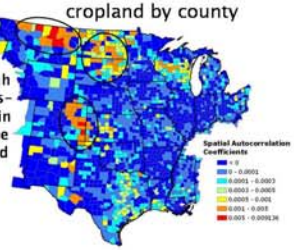
State	Potential Leakage	
	Index (%)	Area (ha)
Arkansas	6.2	6,435
Colorado	9.1	150,059
Illinois	38.3	81,747
Indiana	22.9	32,456
Iowa	39.3	200,241
Kansas	28.3	189,800
Louisiana	1.4	5,747
Michigan	6.9	29,704
Minnesota	31.3	127,073
Mississippi	5.7	3,764
Missouri	6.7	42,371
Montana	17.5	203,559
Nebraska	32.8	120,881
New Mexico	6.3	31,444
North Dakota	29.4	224,846
Ohio	17.5	20,235
Oklahoma	10.1	22,622
South Dakota	50.0	242,490
Texas	0.0	0
Wisconsin	0.0	0
Wyoming	0.0	0
Total	17.1	1,735,473

Regional Correlations and Spatial Relationships

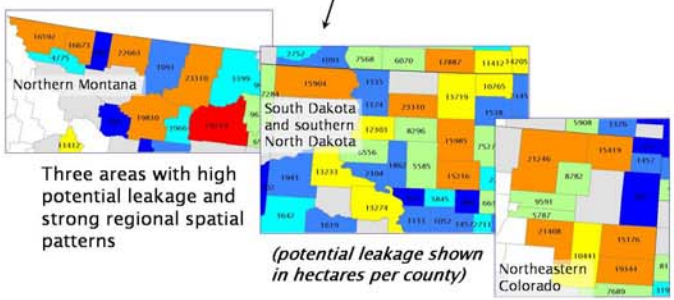
Correlation by MLRA of CRP enrollment and cultivation of new cropland



Spatial cross-correlation of CRP enrollment and cultivation of new cropland by county



Areas of high spatial cross-correlation in Montana, the Dakotas, and Colorado

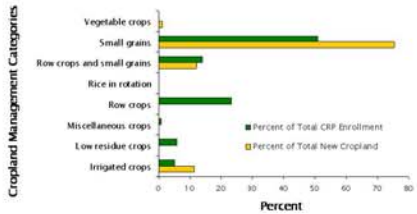


Three areas with high potential leakage and strong regional spatial patterns

(potential leakage shown in hectares per county)

Results

Potential leakage by crop types

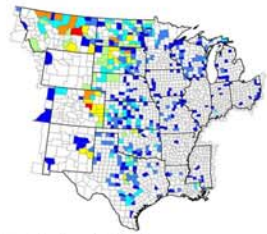


- Since potential leakage may be more strongly tied to certain annual crops, we determined enrollment in the CRP and cultivation of new cropland by specific crop categories. Small grains had the highest potential for leakage.

Raw Data for Small Grains

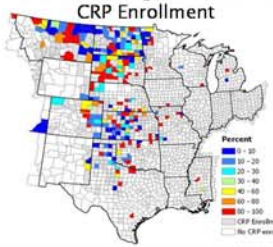
Area by County of CRP Enrollment

Area by County of Net New Cropland



Potential CRP Leakage Associated with Small Grains

Potential Leakage as Percent of CRP Enrollment



Area of Potential Leakage

Conclusions

- Leakage associated with CRP enrollment is potentially occurring in the study region
- Parts of Montana, Colorado and South Dakota exhibit strong spatial patterns and the highest potential for leakage
- Small grains contribute more to potential leakage than other crop types
- Further study is needed to determine if potential leakage is linked to market-based mechanisms and/or substitution associated with CRP enrollment
  - Otherwise potential leakage may be coincidental

Acknowledgements

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