The Multiple Benefits of Agriculture Initiative
Briefing Paper

Results and Policy Implications of Modeling Diversified Farming Systems in Watersheds in OH and MN

BACKGROUND

Lake Erie is again experiencing dead zones. Scientists are not certain why. With respect to agricultural pollutants into Lake Erie, one small mostly agricultural watershed, Rock Creek a tributary to the Sandusky River at Tiffin, provides an interesting case study of changes. The trend for suspended sediments in major rivers is declining due to adoption of conservation tillage. However, discharge volumes are increasing and the rivers and creeks such as Rock Creek are becoming more flashy, likely due to changes in hydrology in the watersheds. Nitrate nitrogen runoff has been increasing since the 1970s. Corn acres have increased and pasture acres fallen by about 4% in the Rock Creek area since 1990. As conservation tillage increased since the 1990s dissolved phosphorus loads have tripled and total phosphorus loads have declined. Half the soils in northwestern Ohio have soil test levels above crop needs and conservation tillage leads to accumulations of phosphorus in upper soil area. Rock Creek and other headwaters and small streams typically have less than 50% attainment for biological integrity indices, while larger rivers show the reverse. In the Upper Sandusky River, a total maximum daily load has been approved calling for load reductions of total phosphorus by 25%.[1,2,3,]

Significant losses of nitrogen and sediment are occurring from the **Upper Mississippi River Basin**. Lake Pepin, a natural widening of the river between Minnesota and Wisconsin, may fill up with sediment within 300 years at current rates of soil loss from the Minnesota River Basin that drains the southern two-thirds of Minnesota. The Environmental Protection Agency has set a goal for 30% reduction in in-stream nitrogen to reduce the large dead zone in the Gulf of Mexico. Habitat for grassland birds has declined significantly as corn and soybeans have become the dominant land-use in the Corn Belt, replacing pasture and diversified crop rotations. Now with corn ethanol boom, corn acres are increasing and corn following corn may become commonplace. [4,5]

From 1997to 2006 commodity crop producers received 30% of their net farm income in **direct government payments** of major “program” crops. At times it has been even higher.[6]

> Study goals
> - Quantify benefits from landscape level diversification versus individual farms here and there
> - Estimate the value of non-market public benefits
> - Describe necessary policy changes

New trends may compound these situations.

- Annual precipitation has increased in southern Minnesota by 17% since 1970.[7] Modeling predicts that erosion could increase by 66% with an increase in intensity and frequency equally of 40% unless conservation systems are applied instead of single practices.[8]
- Nitrogen oxides released after fertilizer applications contribute to global warming. Methane from animal production does, too. However high numbers of ruminant animal numbers lived in the prairie regions pre-white settlement.
- Carbon sequestration appears to require continuous living color and permanent lack of soil disturbance to maintain or increase carbon storage.[9]
- Land retirement programs may not be sufficient to maintain pheasant numbers.[10] Working land programs such as CSP will likely be required to diversify a portion of row crop lands to provide habitat.[11]

METHODS

Scenarios were developed with citizens, farmers and agency staff from a given area to consider “what if” options to diversify the agricultural landscape. Sediment, nitrogen (N), and phosphorus (P) loadings were estimated for baseline land use and for each scenario using ADAPT (agricultural drainage and pesticide transport), a field-scale model for water table management. ADAPT provides edge-of-field estimates for nutrient and soil losses and can model fields with tile drainage. We estimated sediment, N, and P delivery to the mouth of each stream with a modification of ADAPT that aggregates field-edge estimates across each study area. A GIS was used to create data input files for the ADAPT model, reflecting the spatial distribution of current production practices in the study areas using the STATSCO database. We conducted studies in Rock Creek watershed (25,500) ac in northwestern Ohio, the Chippewa River study area in western Minnesota (44,445 ac) and the Wells Creek Watershed study area in southeastern Minnesota (40,172 ac).[12,14]

Economic estimates were made based on OSU or Farm Business Management Association expenses in Minnesota for enterprises. Aggregate production costs for each scenario were calculated as an area-weighted summation of production costs for each system. Prices were 5 year average weighted real output prices in Ohio and Minnesota, except beef production in Ohio which was based on a grass-finished product.[13,14]

ROCK CREEK RESULTS

Figure 1 shows the five scenarios that were developed and modeled using ADAPT. Figure 2 shows a progressive decrease in N, P and sediment loading with implementation of BMPs and especially with greater perennial cover for pasture-based beef production or cellulosic energy buffers. In this case total phosphorus was not actually modeled. It was correlated to changes in sediment, using a ratio of about 85% of sediment loss. Scenario 5 was required to meet the 25% in-stream phosphorous load TMDL goal.

Figure 2:Potential for Rock Creek, OH
Watershed-Level Trends Aggregated In-Stream

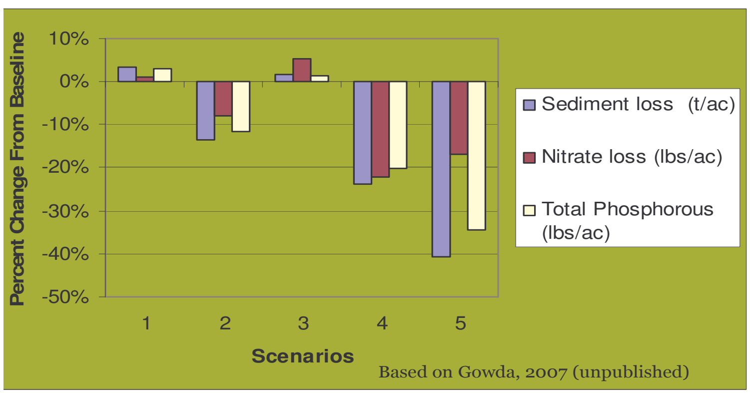

Figure 1: Scenarios for Rock Creek, Ohio

1. Current land use (2005)
Soybeans +1% Corn +4% Pasture -5%, 50% use of Cons tillage Corn =$2.48/bu

2. Adoption of best management practices
Shift to conservation tillage on 75% of crop land , 10% less nitrogen, 100 ft riparian buffers (570 ac)

3. Increased corn for ethanol
Soybeans -25%,more corn +25% compared to baseline. Corn =$2.48/bu

4. Added Pastures with Rotational Grazing
Decreased row crops by 30% of cropped acres, increased pastures (2800 acres) with managed grazing, beef +1400 cows, added CRP buffers. Animals =$110/cwt

5. Cellulosic Energy Buffers
Planting hay and eventually cellulosic perennial crops on 500' fields (also serving as buffers but not in CRP) +(2852 ac). Figured as hay 2.8t/ac

Watershed level economic calculations estimated that sales revenue and returns to labor and management from sales would be highest with the cellulosic buffers (at $109/ton price). Government payments for crops would be lowest with the pasture-based system, assuming a conversion of 20% of cropped acres, and highest for the corn to ethanol scenario. Government payments have the effect of reducing the risk of commodity systems and narrowing the differences shown across market sales.[13]

Figure 3:	**Baseline**			**Scenarios**		
Rock Creek Watershed Economics		1	2	3	4	5
Sales Revenue	$4,594,156	2%	3%	5%	6%	16%
Gov't Payments	$308,881	3%	3%	10%	-12%	-8%
CRP	$68,627	0%	61%	0%	60%	-100%
Total Revenue	$4,971,664	2%	3%	5%	6%	13%
Production Costs w/o Labor/Mgmt	$4,435,558	2%	1%	5%	5%	11%
Return to Labor/Mgmt from Sales	$158,598	2%	39%	7%	41%	156%
Per acre return	$6.72	6.85	9.37	7.20	9.49	17.19
Return to Lab/Mgmt/Gov't +CRP	$536,106	2%	21%	8%	13%	28%
Per acre return	$22.72	23.20	27.51	24.47	25.63	29.18

MINNESOTA RESULTS

Figure 4 includes four scenarios that were developed and modeled using ADAPT. Figure 5 shows a progressive decrease in N, P and sediment loading from BMPs in row crops to greater crop diversification and continuous living cover scenarios. In Wells Creek the biggest bang for the buck was estimated to be between scenarios B and C, especially for N and P. In the Chippewa, crop diversification away from row crops was required to achieve a 30% in-stream reduction of nitrogen. In Wells Creek, fertilizer rates were higher than necessary and so BMPs were adequate. Additional multiple benefits were analyzed and found to show similar trends with increasing diversification. These included fish health, bird habitat, avoided sedimentation costs, greenhouse gas production and carbon sequestration.[14]

Figure 5: Potential for MN Watershed-Level Changes Aggregated In-Stream

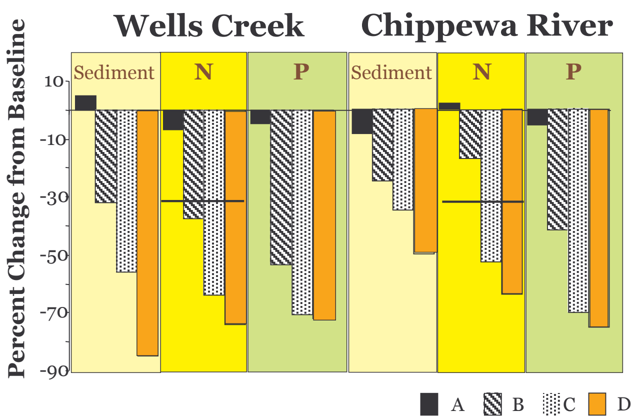

Figure 4: Scenarios for Chippewa and Wells Creek Study Areas in MN

A. Extension of current trends
Increased field size, focus on annual crop production

B. Adoption of best management practices
Shift to conservation tillage, use recommended nutrient application rates, 100 ft riparian buffers

C. Expanded diversity
Five year crop rotation (with 5% marketing organic), more grazing and wetland restoration

D. Managed year-round vegetative cover
Cover crops, 300 ft buffers, and grass on higher slopes for energy, seed, increased managed grazing --cattle numbers up by:

	Chippewa	Wells Creek
Dairy	+640 (252%)	+6785 (125%)
Beef	+515 (90%)	+1710 (125%)

Figure 6: Economic Impacts in Wells Creek

Scenario	Baseline	A	B	C	D
Production costs	$13,521,781	-1%	-3%	-8%	45%
(based on 1999)					
Net farm income	$2,089,045	-1%	-1%	12%	105%
(based on 2000)					
Commodity payments	$1,369,864	-1%	-6%	-44%	-63%
(based on 2000)					
CRP payments	$114,896	0%	113%	110%	378%
(based on 2000)					
Commodity + CRP	$1,745,261	-1%	3%	-27%	-24%
Avoided sedimentation	$213,131	4%	-31%	-56%	-84%

The economics data for the Minnesota watersheds (see Figure 6) showed a similar trend. Total government payments were lowest for the diversified crop system. Net farm income was highest for Scenario D, with more perennial acres for grazing or energy production. Conservation Reserve Program payments were highest for large buffers, assuming they were set aside for high quality habitat. [14]

CONCLUSIONS

- Pay farmers for public benefits and non-market goods such as ecosystem services that result from adoption of more perennial crops and resource conserving crop rotations, and conservation systems.
- Pay on basis of results, not only practices.
- Strategically restore wetlands and encourage diversified crops, perennials and on at least a portion of row crop acreage on sensitive lands in watersheds, and encourage livestock systems that restore animals on the land.
- Create new markets and fair pricing/access.
- Include flexibility, local decision-making and public input in farm program design and implementation.

Are citizens willing to pay for environmental benefits in the study areas? We used contingent valuation to estimate the economic value associated with environmental benefits. Our contingent valuation centered on a 50% reduction in soil erosion and agricultural nutrient runoff, a 25% reduction in small to moderate flooding from agricultural lands, a 10% to 20% reduction in greenhouse gases from agriculture, and a 50% increase in bird and wildlife habitat on Minnesota farmland. These levels are consistent with scenarios C and D. We used a statewide mail survey to assess willingness to pay for environmental changes. A random sample of 1000 households yielded 834 potential respondents. We received 394 responses, a 47% response rate. Respondents indicated that they were willing to pay $201 annually per household to reduce environmental impacts.[14] Additional studies have found that financial risks may be overestimated by farmers and bankers for the adoption of systems such as rotational grazing.[15]

FARM BILL POLICY IMPLICATIONS FROM LSP POLICY PROPOSALS[16]

Currently the commodity support programs encourage production that can overwhelm the impacts of conservation programs. Conservation programs have been focused on individual cost-share practices and land retirement programs and need to encourage the adoption of farming systems on working farmland that provide multiple benefits. More significant incentives may be needed until markets pay sufficient prices and risk is reduced.

Why is Conservation Security Program for useful?

- It requires that farmers meet nondegradation standards for the resource of concern, meaning that the resource will not be depleted or damaged.
- Enhancement payments are made for systems that improve resources above the nondegradation level.
- CSP encourages and rewards the adoption of conservation farming systems such as management intensive rotational grazing, and resource-conserving crop rotations that address all resources of concern on a farm.
- CSP can be used to encourage the planting of perennial prairie systems on marginal lands for cellulosic energy production.
- A recent study conducted by Michael Fields Agricultural Institute, LSP and others in five states found that farmers enrolled in CSP are being encouraged by the program's incentives to add new practices. The most common measure added were those relating to wildlife habitat.[12]
- CSP has caused Natural Resources Conservation Service to develop approaches that begin to predict performance such as the Conservation Security Program such as the Soil Conditioning Index. However, broader indices are needed to reflect systems such as organic and other farming systems that result in multiple benefits.

What can be done to improve and expand CSP?

1. Adequate Funding. CSP needs at least $1 billion in the 2007 Farm Bill above the baseline.
2. Continuous Sign-Up. Continuous sign-up would allow a producer who didn't qualify for CSP one year, to make the needed conservation improvements, and then gain access during the next sign-up period, a short time away. The current program only allows producers to attempt enrollment once every 8-15 years.
3. Nationwide Implementation. For CSP to have a real impact on family farmers and produce major conservation outcomes, it needs to be implemented in every watershed across the nation more quickly than currently possible.
4. High Integrity of CSP Enrollments. CSP needs to have strong conservation and environmental integrity. Eroding the qualifying criteria is not a solution to getting more conservation on working lands.
5. Recognize and reward proven conservation farming systems. In its current form, CSP does not sufficiently recognize some important sustainable farming practices, especially resource-conserving crop rotations and organic farming systems. Other indexes such as the Soil Management Assessment Framework are needed to supplement the SCI to give a better understanding of soil health and soil quality trends on farms.
6. Remain in Title II and Under the Direction of the Natural Resource Conservation Service (NRCS). In addition, more resources should be targeted to NRCS to support expanded and greater implement of CSP in the 2007 Farm Bill.
7. Renewable Contracts. One of CSP's strengths is that producers agree to a 5 or 10 year contract during which they increase conservation on their farm or ranch. Allowing for the renewing of these contracts is important in

sustaining the conservation practices established and encourages more to be done. Currently under CSP, contracts cannot be renewed.

In addition the Land Stewardship Project supports the Beginning Farmer and Rancher Opportunity Act and provisions to strengthen Community Based Food Systems and Economic Development. These types of efforts will be necessary.

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