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The missing piece in the nutrient reduction puzzle: economic incentives

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Agricultural production in the Midwest is a non-point source polluter of water bodies, affecting their recreational value, increasing costs for water treatment plants, and contributing to the hypoxic zone in the Gulf of Mexico. Midwestern states are addressing this contentious topic through local Nutrient Reduction Strategies. These science-based strategies are intended to serve as guidelines for the implementation of voluntary practices to reduce nitrate and phosphorus loads going into creeks, lakes, and rivers. However, they overlook a critical component of voluntary programs: economic incentives.

This article discusses selected economic incentives faced by farmers when deciding how much nitrogen (N) fertilizer to apply, and rationalizes why farmers tend to apply N at higher rates than the agronomically optimal level. The end goal is to highlight the critical role of economic incentives in voluntary programs and the need for applied research in this area to enhance the effectiveness of local Nutrient Reduction Strategies.

Agronomically Optimal N Rate

The [Corn Nitrogen Rate Calculator](http://cnrc.agron.iastate.edu/) (http://cnrc.agron.iastate.edu/) uses results from multiple agronomic research experiments in Illinois, Iowa, Michigan, Minnesota, Ohio, and Wisconsin to calculate the N application rate that maximizes the net return to N for user-defined combinations of N and corn prices. The Maximum Return to Nitrogen (MRTN) calculation is state- and crop rotation-specific. For example, the MRTN rate for corn following soybean in Iowa when the corn price is $3.80 per bushel and the N price is $0.40 per lb is 138 lb of N per acre, with a profitable range of 124-150 lbs of N per acre. However, a simple regression of actual average annual expenses on "fertilizer and lime" across Iowa farms ([AgDM](www.extension.iastate.edu/agdm/wholefarm/pdf/c1-10.pdf) File C1-10, www.extension.iastate.edu/agdm/wholefarm/pdf/c1-10.pdf) and average annual N prices in

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Handbook updates

For those of you subscribing to the handbook, the following updates are included.

Farmland Value Survey (Iowa State University) – C2-70 (8 pages)

Historical Iowa Farmland Value Survey by County – C2-72 (10 pages)

Your Net Worth Statement – C3-20 (8 pages)

Your Farm Income Statement – C2-25 (8 pages)

Financial Performance Measures for Iowa Farms – C3-55 (8 pages)

Please add these files to your handbook and remove the out-of-date material.

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Inside . . .

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Extension and Outreach

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Iowa (AgDM File A1-20, www.extension.iastate.edu/agdm/crops/pdf/a1-20.pdf) over the period 2010-2018 suggests that the average application rate was about 220 lbs of N per acre per year. What can be driving the "overuse" of N fertilizer when compared to the "optimal" MRTN rate? This article suggests that while limited crop rotations can be locally relevant, cash crop price uncertainty along with a farm safety net anchored in recent farm yields jointly provide prevalent incentives to "overuse" N across the entire Midwest.

Ethanol plants

A production system of continuous corn requires more N. Before the ethanol era, continuous corn accounted for less than 10% of total Iowa farmland in corn and soybean. Between 2007 and 2019, the area on continuous corn averaged 4 million acres, or 17% of total Iowa farmland in corn and soybean. Under the same price assumptions as in the previous example, the MRTN rate for continuous corn in Iowa is 188 lbs of N per acre, with a profitable range of 175-203 lbs of N per acre. The declining profitability in the ethanol sector and recent closings of some of the plants might result in a reduction of acres in continuous corn, and therefore in total N use, in coming years.

Crop price uncertainty

N application typically occurs before the crop is marketed. Consequently, N decisions are made with uncertainty about the price that will be obtained for the crop that is being fertilized. The wider the range of crop prices entertained by a farmer when deciding how much N fertilizer to apply, the wider the profitable range for N application suggested by the Corn Nitrogen Rate Calculator. For example, when expected corn prices range from $3.80 to $4.50 (equal probability of all prices in the range) with N priced at $0.40 per lb, the profitable range for N application goes from 124 to 155 lbs per acre in corn following soybean, and from 173 to 207 lbs per acre for continuous corn. In a corn following soybean rotation, farmers evaluate whether to spend an additional $12.40 on N per acre ($0.40 × 31 lbs.) with the expectation that the extra fertilizer can generate at least 3.27 extra bushels of corn at $3.80, or 2.76 extra bushels of corn at $4.50 to offset the extra cost. In a continuous corn system, farmers evaluate whether to spend an additional $13.60 on N per acre ($0.40 × 34 lbs) with the expectation that the extra fertilizer can generate at least 3.56 bushels of corn at $3.80, or 3.1 bushels of corn at $4.50 to offset the extra cost. The necessary increases in yields to justify the extra costs are typically likely to occur in non-extreme-weather years. To protect the operation from extreme-weather years, farmers purchase crop insurance.

Crop insurance

While crop insurance provides some grounding for crop prices in early spring, and can therefore help mitigate the crop price uncertainty discussed in the previous paragraph when making spring N applications, it also incentivizes the use of N fertilizer to bump up the actual production history (APH) used to calculate crop insurance guarantees. For example, in 2019, a farmer in Calhoun County (Iowa) purchasing Revenue Protection with 80% coverage level and an APH of 170 bushels of corn per acre secured a revenue guarantee of $544 for a premium of $12.10 per acre (Risk Management Agency Cost Estimator). Another farmer in the same county with an APH of 180 bushels per acre could purchase a similar policy and secure a revenue guarantee of $576 for a premium of $12.43 per acre. Comparing the crop insurance policies across farmers, a dime in premiums buys $9.70 extra of revenue guarantee. Ten additional bushels of corn in the APH result in a $32 increase in revenue guarantee per acre. Using an average price of $0.44 per lb of N fertilizer over the 2009-2018 period, and an annual opportunity cost of 5% for the investment in extra N fertilizer, the $32 in extra revenue guarantee would have justified an additional 5.5 lbs of N each year under continuous corn, or 10.75 extra lbs of N for the corn crop under a corn-soybean rotation. Whether applying 5.5 or 10.75 extra lbs of N in continuous corn or in a corn-soybean rotation, respectively, would have generated the 10-bushel increase in the APH depends on the exact characteristics of the farm and the baseline application of N. However, it is clear from this example that crop insurance policies provide long-term incentives to use higher rather than lower levels of N fertilizer.

ARC/PLC

The 2014 Farm Bill introduced the Agriculture Risk Coverage (ARC) and the Price Loss Coverage (PLC) programs as central components of the farm safety net, and the 2018 Farm Bill ratified those

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programs with minor adjustments. The ARC program has a County option (ARC-CO) and an Individual option (ARC-IC), depending on the source of yields used to calculate the ARC revenue guarantee. In particular, the ARC-IC revenue guarantee is based on five-year Olympic average farm yields, and therefore provides long-term incentives to use higher rather than lower levels of N fertilizer similar to those stemming from crop insurance.

The PLC program uses the same set of historical farm yields "for the life of the farm bill" to calculate the size of the payments triggered by low market prices (in comparison to the effective reference prices). In 2014, the default PLC yields were those from the counter-cyclical program dating back to the early 2000s. However, first in 2015 and then again in 2019, farmland owners were offered opportunities to update their PLC payment yields based on their recent farm yields "for the life of the farm bill." In particular, farmland owners have until September 30, 2020 to replace the existing PLC payment yields with higher ones based on their 2013-2017 production history. Consequently, the yield updates in the PLC program also incentivize the use of N to bump up farm yields in the expectation of expanding the protection offered by the farm safety net in the near future.

Incentives are key

People who claim that farmers are not making rational decisions when choosing higher N rates than the MRTN rate fail to recognize that they might not be trying to maximize short-term profits, but trying to maximize long-term profits while minimizing long-term risks through the farm safety net. While limited in scope, this brief analysis illustrates how some of the very same institutions developed to promote agricultural production in the United States generate economic incentives contrary in spirit to the aspirational goals promoted through the local Nutrient Reduction Strategies.

In a very stylized form, it can be argued that farmers want to reduce the negative environmental footprint of agricultural production while making a living out of farming. Given that implementing conservation practices is costly to farmers (in terms of extra management time, increased cash costs, etc.), it can be expected that the former objective will be prioritized during times of low crop margins and financial stress in the farm sector. Even when cost-sharing is available for multiple conservation practices, the fact that the rates of adoption of conservation practices are typically well below the aspirational levels described in the Nutrient Reduction Strategies is a clear signal that private costs to farmers typically more than offset private benefits stemming from to those practices (even after accounting for cost-share payments).

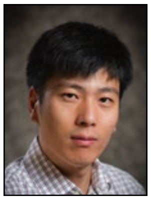
It might be argued that long-term benefits from continued use of conservation practices, such as:

1. improved soil health,
2. higher farmland values,
3. resiliency to weather variability, and
4. potential payments for carbon sequestration - should offset short term costs.

However, it must be noted that:

1. scientists have not yet reached an agreement on how to measure soil health (let alone measure the impact of conservation practices on soil health);
2. there is no market for soil health and farmland is mostly traded on productivity indexes and comparable market values;
3. price and yield risks associated with weather variability are typically managed through crop insurance; and
4. although some incipient markets to purchase sequestered carbon credits from farmers are emerging, the potential to benefit from these markets by Midwest farms with pervasive tiling, harvested cornstalks, no summer cover crops, and limited corn-soybean rotations, might be limited.

Understanding the differences between internal costs to farming operations and external costs imposed by agricultural production on society (externalities), and conducting applied economic research on how to incentivize the internalization of the externalities among farmers (through premiums or extra costs) should be the first step in designing a cohesive incentive structure to promote agriculture while reducing its environmental footprint. Until economic incentives are explicitly recognized as key components of voluntary conservation programs and studied in depth, the nutrient reduction puzzle will continue to miss a central piece.



Iowa farmland value grows 2.3% in 2019, but barely exceeds inflation

By Wendong Zhang, extension economist, Center for Agricultural and Rural Development, 515-294-2536, wdzhang@iastate.edu

It's been a difficult year for farmers — the planting season saw an overabundance of rain and delayed planting, the United States' trade war with China persisted, skewing both commodity prices and demand, and farm bankruptcies rose to the highest level since 2011. However, favorable interest rates, strong yields, and limited land supply combined to help drive Iowa's farmland values up for only the second time in six years.

The statewide value of an acre of farmland is now estimated to be $7,432, which represents an increase of 2.3%, or $168, since 2018. The $7,432 per acre estimate, and 2.3% increase in value, represents a statewide average of low-, medium-, and high-quality farmland.

The reprieve in the land market, unfortunately, is not driven by a much stronger farm economy. This recent modest increase in land values reflects a lower interest rate environment and slowly improving US farm income. However, we are still faced with significant uncertainty, especially the ongoing US-China trade war, which has significantly affected US agricultural exports, especially soybean exports, and led to lower commodity prices and an overall weaker farm income. Stronger than expected crop yields in Iowa, and continuing limited land supply helped contribute to the increase in land values, despite low commodity prices.

While the growth in land values is a positive, I warn that it should not be labeled as a "solid rebound" of the land market. The Market Facilitation Program payments helped soften the blow and stabilize farm income and the land market; however, a no-deal or further escalation of the US-China trade war on Dec. 15 will further amplify trade uncertainties and put downward pressure on farm income and land values. The future of the farmland market still hinges on the pace and speed of Federal Reserve moves on interest rates, progress in the trade talks, and the availability of land parcels.

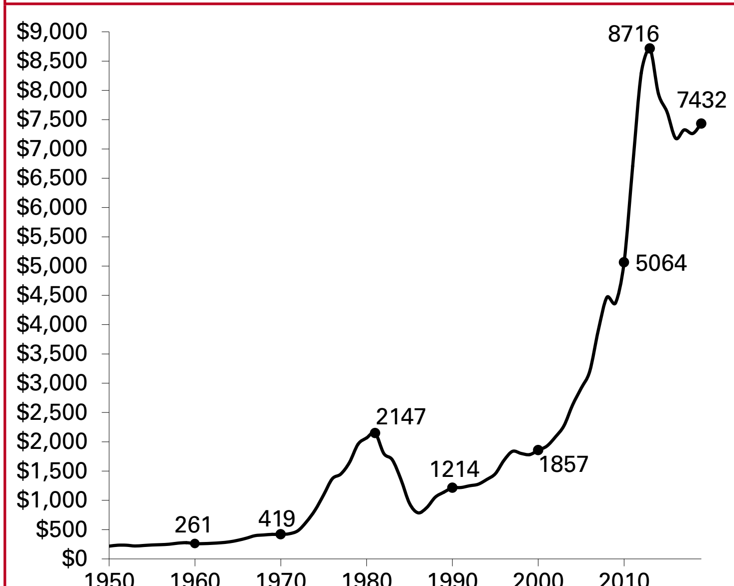
The US also saw 580 farm bankruptcies in 2019, the highest number since 2011. However, the overall share of bankrupt farms is still low, but there are more farms under financial stress due to continued low commodity prices.

The growth in Iowa's land values was noticeably higher this year in the central crop reporting districts (district hereafter). The Central district saw larger increases than other districts due in part to stronger-than-expected crop yields over the past few years and strong urban demand. Also note that strong recreational demand has helped lift the value of low-quality land.

Land values by county

Eighty-two of Iowa's 99 counties reported higher land values, the remaining 17 all saw a decline. For the seventh consecutive year, Scott and Decatur counties reported the highest and lowest values, respectively. Decatur county reported a value of

Figure 1. Average value per acre of Iowa farmland



Iowa's farmland is now valued at $7,432 per acre, an increase of $168 from 2018

Source: Iowa State University Land Value Survey

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$3,586 per acre, a gain of $97, or 2.8%. Scott county reported a value of $10,837 per acre, a gain of $300, or 2.8%.

Both Boone and Story counties reported the largest percent increase at 5.4%. Story county also saw the largest dollar increase by county at $455 per acre. Clayton and Allamakee counties reported the largest percent decrease — both showed a 2.2% loss since 2018. Clayton county reported the largest dollar decrease in values at $151 per acre.

Land values by district

The Northwest district reported the highest overall land values at $9,352 per acre, and the South Central district reported the lowest overall land values at $4,487 per acre.

Land values across districts saw an increase in general, with only the Northeast district reporting a decline in land values (a loss of 2.9%). The losses in the Northeast district are due mainly to financial stress in the dairy sector.

The largest percentage increases were in the East Central and Central districts at 5.9% and 5.5%, respectively. However, the South Central and Southeast districts also reported substantial increases at 3.6% and 3.8%, respectively.

Land value by quality

Low-quality land statewide now averages $4,759 per acre, a 3.3%, or $150 per acre increase; medium-quality land now averages $6,938 per acre, an increase of 2.0%, or $133 per acre; and high-quality land now averages $9,078 per acre, an increase of 2.4% or $215 per acre.

Low-quality land in the Central, East Central, and West Central districts all saw increases of 5.0% or more, but low-quality land in the Northeast district was a 5.0% decline.

All qualities of land in the Northeast district reported a loss, while low-quality land there saw a greater loss than higher quality lands. High-quality land in the Northwest district is the only other high-quality land that saw a decline in value.

Factors influencing land values

Favorable interest rates, strong yields, and limited land supply were the most frequently noted positive factors influencing land values. The most commonly cited negative factors influencing land values were lower commodity prices, the weather, and tariffs on agricultural commodities.

Land values were determined by the 2019 Iowa State University Land Value Survey, conducted in November by the Center for Agricultural and Rural Development (CARD) at Iowa State University and Iowa State University Extension and Outreach. Results from the survey are consistent with results by the Federal Reserve Bank of Chicago, the Realtors Land Institute, and the US Department of Agriculture.

Table 1. Recent changes in Iowa farmland values

Year	Value per acre	Dollar change	Percentage change
1981	$ 2147	$ 81	3.9
1982	1801	-346	-16.1
1983	1691	-110	- 6.1
1984	1357	-334	-19.8
1985	948	-409	-30.1
1986	787	-161	-17.0
1987	875	88	11.2
1988	1054	179	20.5
1989	1139	85	8.1
1990	1214	75	6.6
1991	1219	5	0.4
1992	1249	30	2.5
1993	1275	26	2.1
1994	1356	81	6.4
1995	1455	99	7.3
1996	1682	227	15.6
1997	1837	155	9.2
1998	1801	-36	-2.0
1999	1781	-20	-1.1
2000	1857	76	4.3
2001	1926	69	3.7
2002	2083	157	8.2
2003	2275	192	9.2
2004	2629	354	15.6
2005	2914	285	10.8
2006	3204	290	10.0
2007	3908	704	22.0
2008	4468	560	14.3
2009	4371	-97	-2.2
2010	5064	693	15.9
2011	6708	1644	32.5
2012	8296	1588	23.7
2013	8716	420	5.1
2014	7943	-773	-8.9
2015	7633	-310	-3.9
2016	7183	-450	-5.9
2017	7326	143	2.0
2018	7264	-62	-0.8
2019	7432	168	2.3

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The ISU land value survey was initiated in 1941, the first in the nation, and is sponsored annually by Iowa State University. The survey is typically conducted every November and the results are released mid-December. Only the state average and the district averages are based directly on the ISU survey data. The county estimates are derived using a procedure that combines the ISU survey results with data from the US Census of Agriculture.

The ISU Land Value Survey (card.iastate.edu/farmland/isu-survey/2019) is based on reports by agricultural professionals knowledgeable of land market conditions such as appraisers, farm managers, agricultural lenders, and actual land sales. It is intended to provide information on general land value trends, geographical land price relationships, and factors influencing the Iowa land market. The 2019 survey is based on 679 usable responses from 553 agricultural professionals.

CARD offers a web portal, www.card.iastate.edu/farmland, that includes visualization tools, such as charts and interactive county maps, allowing users to examine land value trends over time at the county, district and state level.

Updates, continued from page 1

Internet Updates

The following Decision Tools have been updated on www.extension.iastate.edu/agdm.

2018 Farm Bill Payment Estimator by County for ARC-CO and PLC – A1-33 (Decision Tool)

Historic Farmland Value Survey (Iowa State University) – C2-70 (Decision Tool)

Financial Performance Measures – C3-55 (Decision Tool)

Current Profitability

The following tools have been updated on www.extension.iastate.edu/agdm/info/outlook.html.

Corn Profitability – A1-85

Soybean Profitability – A1-86

Iowa Cash Corn and Soybean Prices – A2-11

Season Average Price Calculator – A2-15

Ethanol Profitability – D1-10

Biodiesel Profitability – D1-15