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CASE STUDY

Evaluating Economic and Environmental Impacts of Strip Tillage Adoption in Illinois Corn and Soy

Photo: © Richard Hurd

At a Glance

- **Operation:** Wurmnest Farm, 1,200 acres of corn and soybeans on silt loam soil in central Illinois.
- **Goal:** Reduce soil losses on sloped fields.
- **Practice change:** Convert from conventional till to strip till.
- **Benefits of strip till:**
  - Improved soil conservation, energy use and Greenhouse Gas Fieldprint® scores.
  - 4.5% greater profits over conventional till.

Stewardship Is a Priority Among Illinois Farmers


Photo: NRCS

In fields that are prone to soil losses, minimizing soil disturbance by reducing tillage can be an effective practice to conserve soil. Eliminating tillage completely is not always feasible for an operation; instead, many growers are choosing strip tillage, which strikes a compromise between the benefits and drawbacks of both conventional and no-till systems. Strip tillage limits soil disturbance to a narrow band for residue management, fertilizer application and planting, resulting in less soil erosion and better water quality downstream. And because strip tillage requires fewer trips across the field, it provides added benefits, including reduced energy use and resulting greenhouse gas emissions.

About Wurmnest Farm

Mike Wurmnest and his family grow corn and soybeans in Tazewell County, Illinois, on 1,200 acres of combined rented land and land that has been owned and farmed by his family for more than 100 years. The potential for erosion on his farm varies with the topography and drainage, ranging from rolling hills and moderately well drained (5 – 10% slopes, with more potential for soil erosion) to flat and somewhat poorly drained (0 – 5% slopes, with low erosion potential). The soil types are highly productive silt loams. The two fields for which Mike compared tillage results are Tazewell Farm (80 acres) and Home West (132 acres).


Mike Wurmnest (Photo: PCM)

TABLE 1. Comparison of nitrogen application rate and nitrogen use efficiency between strip and conventional, 3-pass tillage.

Field	Tillage Type	Yield (bushels per acre)	Nitrogen Applied (pounds per acre)	NUE
Tazewell Farm	Strip	232	188	0.81
Home West	3-Pass	245	198	0.81

Implementing Strip Tillage

To reduce soil erosion in hilly areas, Mike establishes his strip tillage in the fall using 16-row, 30-inch equipment that he has customized over the years. No longer reliant upon tillage to manage weeds, Mike sprays perennial weeds in strip-tilled fields in the fall for burn-down. Having tried strip tillage previously, Mike wanted to compare strip till with conventional tillage. This comparison relied on 2017 data compiled through Mike's participation in Precision Conservation Management[1] (PCM, www.precisionconservation.org). Results have been sufficiently positive that he is looking to expand use of strip tillage to some of his flatter land. Mike is constantly making adjustments, and says he plans to continue farming until he gets it right.

Greater Efficiency and Lower Costs

Strip tillage produced yields similar to those of conventional tillage. In 2017, Tazewell Farm, which was strip tilled, yielded 232 bushels per acre, while Home West, which was conventionally tilled, yielded 245 bushels per acre (Table 1.). Although Home West had a higher yield, the field also received additional nitrogen, which increased the overall cost of production on that field.[2] The nitrogen use efficiency (NUE, pounds of nitrogen applied divided by yield) was identical for the two fields that year; both fields had an NUE of 0.81.

PCM used aggregate data from multiple farms encompassing thousands of acres of Illinois farmland.[3] Preliminary results (Table 2.) show that, on average, strip till brings better economic returns than three-pass conventional tillage ($252 and $241 per acre, respectively). The lower direct costs for strip till are a result of lower N application rates amongst strip-till farmers.

TABLE 2. Three-year comparison of average per acre costs and revenue for strip- and conventionally tilled fields.

Strip	Till	3-Pass	Difference
Corn Yield (bu/A)	207	199	8
Crop Revenue	$718	$690	$28
ARC/PLC	$22	$22	$0
Gross Revenue	**$740**	**$712**	**$28**
Total Direct Costs	$346	$324	$22
Field Work	$17	$38	-$19
Other Power Costs	$88	$82	$6
Overhead Costs	$36	$36	$0
Total Non-Land Costs	**$487**	**$470**	**$17**
Operator & Land Return	**$252**	**$241**	**$11**

TABLE 3. Comparing Fieldprint analyses of two different tillage types. Fieldprint scores are given on a scale of 1 to 100; lower scores are desirable and indicate a lower environmental impact.

Metric	3-Pass	Strip Till	Difference
Energy Use	66.27	39.50	-40%
Greenhouse Gas Emissions	61.44	48.00	-22%
Land Use	4.00	9.85	246%
Soil Conservation	0.50	0.20	-60%

Multiple Environmental Benefits

In a 2017 Fieldprint analysis of a conventionally tilled field and strip-tilled field on Wurmnest Farm, the adoption of strip till had an overall positive environmental impact (Table 3.). When measuring the effect of strip tillage relative to conventional tillage, Soil Conservation Fieldprint scores were reduced by 60%, Energy Use scores were reduced by 40% and Greenhouse Gas Emissions were reduced by 22%. The Land Use Fieldprint score in the strip-tilled field was higher due to the slightly higher yields seen under conventional tillage.

Summary

At Wurmnest Farm, converting to strip tillage from conventional has clear economic and environmental benefits. More precise nutrient application in strip-tilled fields led to greater returns per acre. By reducing soil disturbance on his hilly fields, Mike was able to improve not only his Soil Conservation Fieldprint score but his Energy Use and Greenhouse Gas Fieldprint scores as well. For farmers in central Illinois, PCM results show strip till provides favorable economic return in addition to reduced risk of nutrient loss. As Mike has learned more, he has also invested time in helping his landlords understand and see the value of strip till in preserving the value of their land assets.

[1]PCM was developed by the Illinois Corn Growers Association (ICGA) to meet the management needs of farmers and offers a tool that integrates agronomic information with environmental sustainability insights from the Fieldprint Platform and financial analytics.

[2] Differences in results may not be fully attributable to the differences in tillage. More years of data will be necessary to evaluate the full economic impacts of different tillage types.

[3] Preliminary results from the PCM summary are based on analysis of farmer practices with applied custom rate economic values. Custom rate and other financial data are taken from the most recent Illinois Farm Business Farm Management data and were generated by Dr. Gary Schnitkey and Mr. Dale Lattz at the University of Illinois Department of Agricultural and Consumer Economics. Financial values are therefore not receipt-based and do not reflect land value/costs.

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CASE STUDY

Reducing Erosion in Indiana Corn and Soy Using Vertical Tillage and Cover Crops

At a Glance

- **Operation:** Wallpe Farm, 1,800 acres of corn and soybeans in Benton County, Indiana.
- **Goal:** Reduce erosion in hilly areas.
- **Practice changes:** Vertical tillage and cover crops.
- **Benefits:** Less gully erosion, higher soil organic matter.

Wallpe Family

Protecting the Farm's Most Valuable Asset

Protecting soil is the driving force behind the adoption of conservation tillage and cover crops. Conservation tillage practices, such as vertical tillage, minimize soil disturbances, slow the breakdown of organic matter and reduce soil losses by erosion. Vertical tillage strikes a compromise between conventional and no-till systems. It aids in residue management at planting, helps dry and warm the soil, reduces surface compaction, provides good soil-to-seed contact and helps with water infiltration. The addition of cover crops between cash crops boosts soil organic matter and helps protect the soil from erosion by wind and water.

About Wallpe Farm

Steve Wallpe's farm is located in Benton County, Indiana, about midway between Indianapolis and Chicago. Steve farms with his family, on about 1,800 acres of mostly corn and soybeans; only one acre of his operation is rented. The topography of his farm is mostly flat, with some rolling ground on which he has had regularly had erosion issues. Soils are relatively uniform, ranging from silty loam to some clay on the hillsides. Steve and his family have approximately 30 acres of filter strips and grassed waterways installed on their land, and they have about half their acreage, roughly 1,000 acres, in cover crops each year.

Mixed species filter strip

Vertical Tillage and Cover Crops

Steve's commitment to conservation is best shown in the practices he uses on his farm. He has been using cover crops for nine years and has adopted vertical tillage. His primary goals have been to substantially reduce erosion, and to protect and improve his soils in this rich farming area. Seeding cover crops with vertical tillage provides Steve the ability to manage residue, ensure good seed-to-soil contact and plant cover crops in one pass, reducing the likelihood of soil compaction and providing more flexibility in the use of cover crops on corn and beans. Broadcasting with vertical tillage means cover crops are in the ground sooner, allowing more time to establish a better crop.

Soil Conservation and More Organic Matter

Steve has seen substantial benefits from cover crops in reducing erosion. A recent example occurred in February 2018, when more than five inches of rain fell in just a few days. Although there was some surface flow in his steeper fields, the presence of cover crops prevented major gullies from forming as they have in the past, and as was the case on nearby land without cover crops.

Steve has monitored organic matter levels in indicator fields over four years, and has seen a rise in organic matter in those fields ranging from 0.1% to 0.2%. Although those increases are incremental, as are most changes in organic matter, they are nonetheless encouraging.

TABLE 1. Comparison of average cost estimates strip tillage vs. vertical tillage.

Source*	Strip Tillage/ Acre	Vertical Tillage/ Acre	Difference/ Acre	Savings/ 1,000 Acre
FBFM 2017	$16. 10	$11.40	$4.70	$4,700
Iowa State U. 2018	$17.30	$19.20	$1.90	$1,900

Multiple Economic Benefits

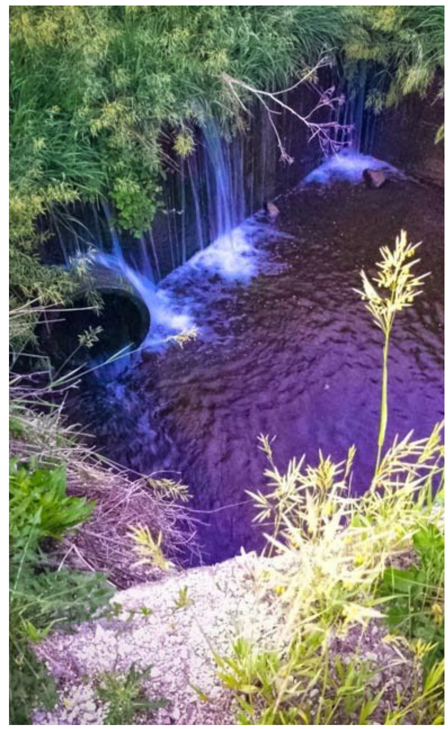
The minimal tillage system on Wallpe Farm, in addition to its agronomic and environmental benefits, also produces efficiencies that reduce overall tillage costs. The system reduces the number of field passes that are needed each year, allowing for faster speeds in the field because lighter implements are used than in strip tillage or conventional tillage; this results in lower energy costs.

It is clear that strip tillage provides an economic advantage. The University of Illinois data in Table 1 is drawn from the Farm Business Farm Management database. The Iowa rates are derived from an annual survey of custom rates that began specifically including strip tillage in 2018. Although these derived rates may vary somewhat from Steve's actual per-acre costs, the use of vertical tillage on the farm indicates a real cost savings when compared with strip tillage, and also provides benefits to the management of his operation and the condition of his fields.

From the beginning of his use of cover crops, Steve opted away from having the crops flown on, due to the added expense of aerial application. He feels that field application and vertical tillage gave him the best prospects for a good cover crop stand. Steve has also managed costs well, reducing the rate of both the cereal rye and wheat he applies. He has basically cut the rate in half from what he initially used, such that he now applies one-half bushel to the acre, thereby cutting his costs from about $15/bushel to $6 – $7/bushel for the rye he buys from a neighbor. At those rates, he can save from $4,500 to $5,000 on seed costs for rye cover crop on 500 acres before soybeans. Steve has achieved further savings by raising his own wheat, with the added advantage of having the straw for the 20 beef cattle he runs on his farms. Growing his own wheat for cover crops saves Steve roughly $3,000 – $4,000 per year. In addition to his savings in field erosion and improvement in soil quality, Steve has been able over time to cut his cover crop costs by $7,500 – $9,000 a year.

Summary

Steve Wallpe and his family have demonstrated a genuine commitment to conservation in their community and on their farm. Their use of cover crops and minimal tillage has allowed them to reduce erosion and protect and improve soil quality while finding ways to reduce costs and save money. His recommendation to others is to try new practices on a small scale first and learn how to best use them.



*FBFM/ University of Illinois Machinery Cost Estimates: Field Operations June 2017 (http://farmdoc.illinois.edu/manage/machinery/field_operations_2017.pdf)

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CASE STUDY

Combining Cover Crops with Reduced Tillage Conserves Soil and Boosts Soil Carbon in an Iowa Corn-Soy Rotation

At a Glance

- **Operation:** Gordon Wassenaar Farm, 1,200 acres of corn and soybeans in Jasper County, Iowa.
- **Goal:** Manage highly erodible soils to protect water quality and conserve soil while maintaining positive cash flow.
- **Sustainable practices:** Strip tillage and cover crops.
- **Documented benefits:** Improved soil conservation and soil carbon; USDA cost-share reduced cover crop seed costs.

Better Soil Health in Iowa

Conservation tillage, including no-till and strip-till systems, has been well-documented to conserve soil along with the organic matter and crop inputs contained within. By minimizing soil disturbance, conservation tillage preserves soil aggregates so they are less likely to erode. When cover crops are incorporated into the farming system, the benefits of conservation tillage are amplified. Cover crop roots hold soil in place, and the canopy covers and protects the soil from erosive forces. Together, conservation tillage and cover crops can help increase the amount of carbon in the soil, which is a component of soil health.

About Will Cannon and Gordon Wassenaar Farm

Will Cannon farms a little more than 1,200 acres of corn and soybeans in Jasper County, Iowa, with his partner, Gordon Wassenaar. Soils on the farm are mostly silt loam with some areas of tight, eroded clay. The farm's topography consists of flat creek bottoms and short, sloping hills from 2% to 18% grade. Out of the 50 fields on the farm, only three are not considered highly erodible. They have a unique challenge in that every acre on the farm is either being paid for or rented.

Currently, Will is using no till on the soybeans and strip till on his corn. He uses variable rate technology on the majority of acres, backed by regular zone soil sampling to help him make sound agronomic decisions.

Fine-Tuning the System

Overall, no-till soybeans have worked great. Soybeans compensate for and overcome any early-season troubles. After several years of no-till soy and corn, Will noticed his corn yields were substantially lower than those of one of the top farmers in their area, who was using full tillage. In 2004, he switched to strip tillage to boost yields without compromising soil conservation. Strip-till corn has been a success overall but requires careful management.

Cover crops further reduce erosion at Wassenaar Farm. Cereal rye seeded in the fall before soybeans does not depress yields, and may even give a yield gain. Cover crops before corn have overall been a success, but over the past five years there have been fields that require unique management decisions to help preserve yield.

Better Water Quality, Less Erosion and Healthier Soils

The primary conservation results have been to improve soil quality and water quality. In 2016, Will did a yearlong study on the farm to test the nitrate concentration in their creek. The tile lines consistently had nitrate below the 10 parts per million threshold.

The conservation efforts have led to much less soil erosion on Will's fields. He previously had to clean or reshape a couple of waterways each year because of soil that washed into them or gullying that would form in the middle of them. However, for the past three straight years he has not needed to renovate waterways on any of the fields.

Photo: Gordon Wassenaar © Southeast FarmPress

Photo: © United Soybean Board

Will has also seen improvement in soil tilth. In the spring when the rye is growing, he can dig up the soil and crumble it in his hand with almost no effort. Organic matter has been improving over the past eight years, rising from around 3.5% to 6.5% in about a quarter of the samples tested.

Crop Resilience and Controlling Costs Pay Off

Two years ago, Will and his partner, Gordon, beat the previous-year yields on several hillsides by 45 bushels per acre. Will credits the high yields to cover crops, split application of nitrogen and fungicide applications. For the past four years, they have matched the county average yield or beat it by up to 15 bushels an acre on corn. Soybeans yields have been typically one to five bushels ahead of the average during the same period.

Reducing costs is the main way in which Will is making the economics work for his cover crops. He is minimizing planting costs, using a new drill for cover crop planting and reducing seeding rates. Table 1 shows a comparison of Will's cover crop planting costs with standard rates reported in a recent Iowa survey.*

Based on these figures and assuming a mix of 600 acres of corn and an equal acreage of beans, Will can realize as much as much as $10,000 in savings on cover crops over the average planting costs in the survey.

Will is now using cover crop cost share from NRCS, and has gotten useful help and advice from the staff in Jasper County. The cost share has been important in that it has increased his ability to produce substantial conservation benefits, and has freed up money that might have been spent on seed for the purchasing of critical equipment that will further those efforts.

Summary

Will is part of the new generation of farmers who are committed to farming as a way of life, to using sustainable practices, to improving the land — and to establishing a strong financial foundation for their operations.
"For me, I get most of my ideas from brainstorming myself, watching other farmers on social media to see what they're trying, reading lots of materials and books. If an idea intrigues me I'll try to attend any type of field day or meeting possible, quiz people I know have experience or understanding, and I'll read, read, read! After all of that I'll usually come to some type of conclusion I think will work, and we'll begin experimenting with it. Any idea usually takes a few tries to find what works best in our fields."

Table 1. Comparison of Will Cannon's cover crops cost per acre with Iowa State University/SARE estimates.

Cover Crop	Cover Crop Species	Seeding Rate per Acre	Seed Price per Acre	Cover Crops Planting Cost per Acre	Total Cost per Acre	ISU/SARE Cost per Acre	Difference (Savings)
Before Corn	Cereal Rye	21 lbs	$4.13	$13.00	$19.13	$32.84	$13.71
Before Beans	Cereal Rye	50 lbs	$9.82	$19.83	$29.65	$32.79	$3.14

*Plastina, A., Carlson, S., et al. *Economic Evaluation of Cover Crops in Midwest Row Crop Farming Final Report for LNC 15-375*. 2018. https://projects.sare.org/project-reports/lnc15-375/


Photo: © United Soybean Board

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CASE STUDY

Evaluating Economic and Environmental Impacts of Irrigation Scheduling Technology on Irrigation Water Use, Energy Use and Greenhouse Gases in Nebraska Corn and Soybeans

At a Glance

- **Operation:** Spohn Farms, 6,500 acres of corn, seed corn and soybeans in Saline County, Nebraska.
- **Goal:** Conserve water and reduce input costs.
- **Sustainable practices:** Installation of irrigation management technology.
- **Documented benefits:** Improved irrigation water use efficiency, lower energy use and greenhouse gas emission; reduced costs.

Combating the Effects of Drought in America's Heartland

Drought is a recurrent phenomenon in Nebraska. There have been two "exceptional" droughts – defined as prolonged periods of below-average rainfall causing widespread crop losses and water shortages – in Nebraska since 2000. In 2012, 1,000 Nebraska farmers were ordered to stop irrigating their crops because of severe declines in available surface water. To protect the future of water availability for agriculture, Nebraska farmers are voluntarily pursuing practices that have been demonstrated to conserve this vital resource, such as using irrigation scheduling technology and subsurface drip irrigation.

This case study examines the economic and environmental benefits of using in-field technologies to manage irrigation applications. After the 2012 – 2013 drought, the University of Nebraska-Lincoln's Institute of Agriculture and Natural Resources stepped up its efforts to encourage growers to install evapotranspiration (ET) gauges and Watermark® sensors. ET gauges estimate the combined losses of water from direct evaporation from the soil and transpiration from leaves. The rate of ET is determined by weather conditions such as temperature, relative humidity, windspeed and light intensity factored against characteristics of the crop, such as growth stage and species. Watermark sensors measure the actual water status of the soil, which is affected by soil texture. Together, ET gauges and Watermark sensors provide growers with a more accurate indication of when to water, based on actual soil moisture status and the rate of water loss from the field. By better managing irrigation water applications, farmers can also save money. Less irrigation water pumping leads to less wear and tear on pumping equipment and lower fuel costs.

About Spohn Farms

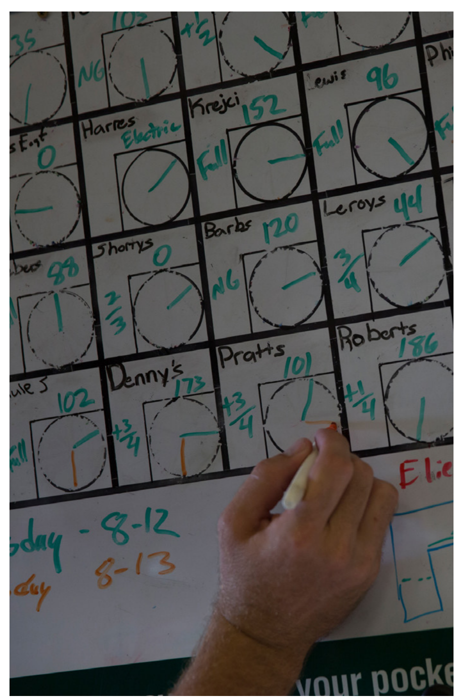
Scott Spohn grows corn, soybeans and seed corn on his family's 6,500-acre farm in Saline County, in southeast Nebraska. The soils are mostly Hastings silt loam, with a little bit of clay. Spohn irrigates his crops with a center-pivot system, which is typical of Nebraska agriculture.

Scott is a sixth-generation farmer, and the fifth generation to grow crops during the 100 years Spohn Farms has operated in this location. Keeping a family farm in continuous production for a century is what sustainability is all about, and Scott's goal is to keep the farm productive and profitable for generations to come.

Making Changes That Make Sense

Scott Spohn is committed to making continuous improvements in the sustainability of his family farm. Over the years, he has implemented a number of practices to protect soil and water, such as installing grass waterways and reducing tillage, where possible. He installed shutoffs on his sprayers to eliminate chemical applications to the ends of rows where there is no crop growing, thereby reducing product losses to the environment and associated costs. Scott made his nutrient


Spohn Family



applications more efficient by using grid sampling and variable rate phosphorus applications. Scott says, "I test out new ideas on a few acres first. If they work, I'll gradually expand to more areas."

Like most Nebraska farming operations, Spohn Farms relies on supplemental irrigation to produce good yields. Crops don't need water just for photosynthesis; soil-applied nutrients and crop protectants must be dissolved in water to be absorbed by plant roots. Scott points out that irrigated systems tend to be more efficient with soil-applied crop inputs than their dryland counterparts, which are prone to losses during drought conditions.

In 2011, Scott was approached by Randy Pryor from the University of Nebraska-Lincoln to participate in a pilot study using ET gauges and Watermark sensors to determine irrigation scheduling. His fields were divided into blocks based on soil texture. Once the gauges and sensors were installed, they were ground-truthed against soil probes to ensure accuracy.

Scott found that the new sensors allowed him to significantly extend the interval between irrigation events, thereby reducing the amount of water applied to his fields without depressing yields. He said that the sensors gave him insight into the soil's moisture status, allowing him to hold off on watering his crops for a few days. "Sometimes we get rain during that time, which lets me wait even longer," he said.

Multiple, Positive Environmental Impacts

Irrigation water use: Thanks to the ET gauges and Watermark sensors, Scott was able to significantly reduce the amount of water he applied to his crops. His soybeans received up to 2 – 3 acre-inches less in some years, and his corn about one acre-inch. On average, he is now applying approximately 1.5 acre-inches less to his entire farm than he was before he installed the technology. This adds up to a whopping 207,829,927 gallons of water saved every year, enough to fill 315 Olympic-size swimming pools.

Energy use: Cutting the volume of water needed to produce the same yield also significantly improved the energy efficiency of Spohn Farm. Considering it requires 394 gallons of diesel to apply 1 inch of water from a center-pivot system, Scott was able to reduce his annual fuel consumption by nearly 22,000 gallons of diesel.

Greenhouse gases: Less diesel combustion translates directly into lower emissions of carbon dioxide (CO2). Every gallon of diesel burned releases approximately 22.3 pounds of CO2 into the atmosphere. At Spohn Farm, by implementing practices to conserve Nebraska's water resources, Scott also reduced CO_2 emissions by almost 500,000 pounds every year.

Conservation Pays Off

Reducing the amount of water applied to his fields resulted substantial cost savings for Scott as well, due to the associated reduction in diesel consumption. In 2016, when diesel prices were relatively low ($1.38/gallon), Scott was able save approximately $30,000 in fuel costs for the year by implementing irrigation scheduling. With diesel prices hovering around $2.40/gallon since December 2018, if those prices hold, Scott will save $50,000 in 2019.

Scott feels that he is also saving money on nutrients and crop protection

because targeted irrigation applications ensure optimal uptake by roots. "My operation has become more efficient by at least 10% compared with 10 years ago and is continuously becoming more productive," he says. He also feels that other farmers in his area are getting better all the time, and are reaping the economic benefits that improved input efficiency can produce.

Summary

Scott Spohn is able to improve his farm's bottom line while simultaneously improving the sustainability performance of his operation. Rather than simply watering by the calendar or subjectively determining when to irrigate, Scott uses ET gauges and soil water sensors to better understand how much water is in the soil at any given time and how rapidly that water is being removed. He can now extend the number of days between irrigation events, resulting in less irrigation water use, less energy use and lower greenhouse gas emissions. Spohn Farm is doing well by doing good: implementing water conservation practices greatly reduces operating costs without compromising yields.

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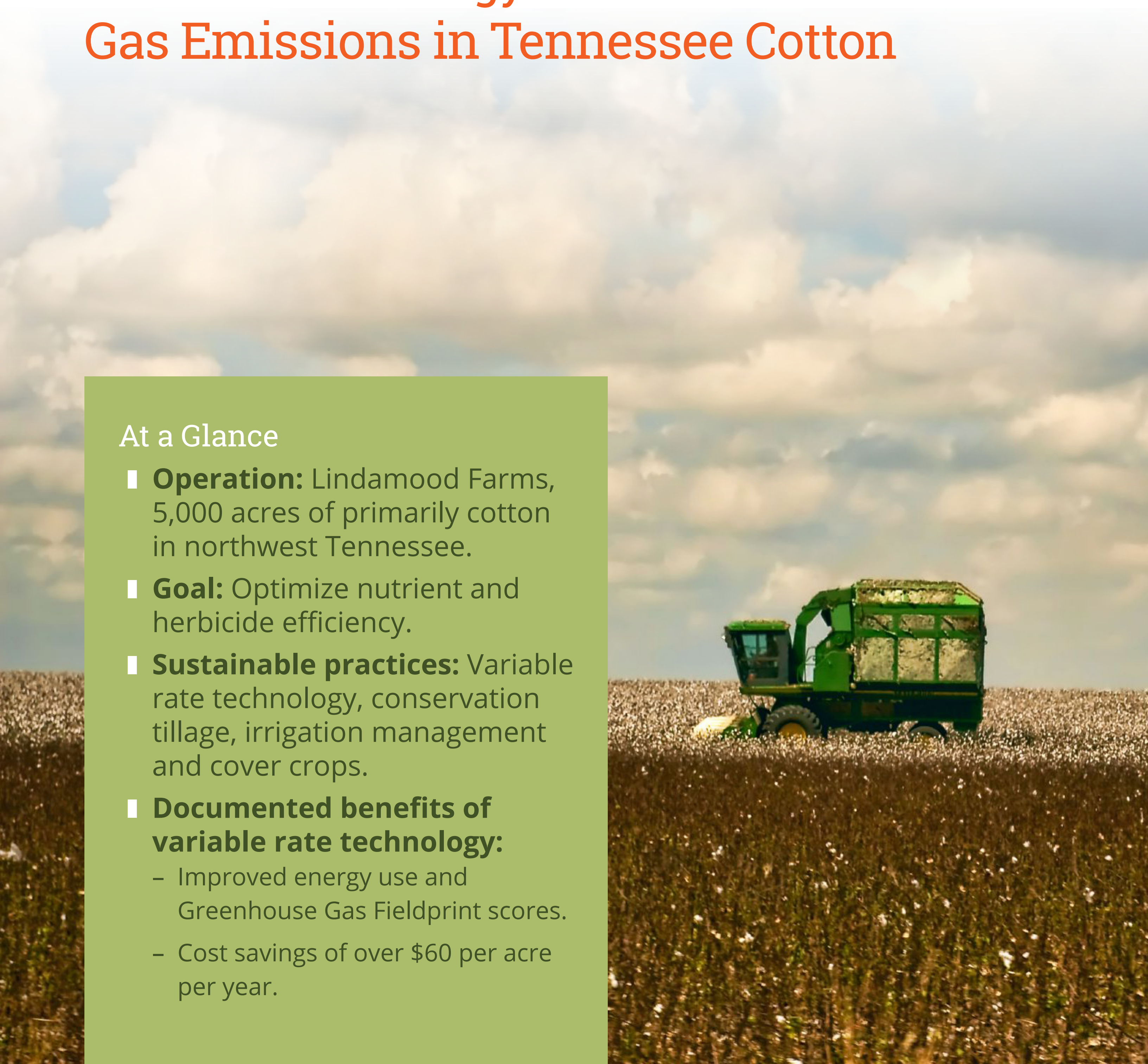
CASE STUDY

Variable Rate Applications Save Money and Reduce Energy Use and Greenhouse Gas Emissions in Tennessee Cotton



At a Glance

- **Operation:** Lindamood Farms, 5,000 acres of primarily cotton in northwest Tennessee.
- **Goal:** Optimize nutrient and herbicide efficiency.
- **Sustainable practices:** Variable rate technology, conservation tillage, irrigation management and cover crops.
- **Documented benefits of variable rate technology:**
  - Improved energy use and Greenhouse Gas Fieldprint scores.
  - Cost savings of over $60 per acre per year.

Why Variable Rate Technology?

Variable rate technology allow site-specific applications of nutrients and crop protectants, resulting in improved crop uptake. These benefits are amplified when variable rate technology is incorporated into a systems approach to farm sustainability. When combined with other sustainable agronomy practices, such as cover crops, tillage reduction and irrigation water management, variable rate technology is a powerful tool to improve farm efficiency and reduce costs. Greater efficiency and input optimization can lead to reduced indirect energy consumption. Indirect energy used in agriculture includes the energy needed to manufacture farm inputs, such as fertilizers and crop protectants.

About Lindamood Farms

John Lindamood farms 3,400 acres of cotton, 450 acres of wheat, 850 acres of soybeans and 450 acres of corn in northwest Tennessee. He owns about 1,300 acres, and the rest is leased. John uses variable rate technology for nutrient management and cover crops. Ninety percent of his acreage is no till, with some vertical tillage where needed.

Managing Nutrient Applications with Variable Rate Technology

John implemented variable rate technology to manage nutrients in 1994. He divided the farm into management zones ranging from eight to 14 acres in size, based on soil texture. Soil nitrogen, phosphorus, potassium and pH in each management zone is tested, and lime is applied accordingly to optimize nutrient solubility and herbicide efficacy.

John also uses split variable rate applications of nitrogen timing placement with the plants' peak need for nutrients. The practice is more efficient and reduces the potential for nitrogen loss from his fields. He has been able to increase yields steadily while reducing the cost of his nutrient program over the past 10 years.

Significant Cost Savings

A study conducted by University of Tennessee researcher Lori Duncan, with support from Cotton, Inc., and in cooperation with John Lindamood, compared the changes in fertilizer use, cost per acre and environmental impacts on 500 acres during 2011 and 2012. The study compared traditional, blanket fertilizer application with variable rate application. Table 1 shows the change in fertilizer use; less N and K were applied both years, compared with traditional methods, and no P was applied in 2012. Overall, the study showed aggregated savings on the 500 acres over a two-year period of 19 tons of N and 15 tons of P_2O_5, resulting in $60,000 in cost savings solely by using variable rate technology for nutrient applications. The results demonstrate the ability to more efficiently apply plant nutrients and reduce costs using variable rate technology, in comparison with standard, uniform application methods.

Table 1. Comparison of amount of fertilizer applied using traditional and variable rate nutrient application for two years.

	POUNDS OF FERTILIZER APPLIED PER ACRE		
	N	P_2O_5	K_2O
Traditional (blanket)	120	30	90
2011 (variable rate)	104	0	60
2012 (variable rate)	71	30	73

Table 2. Decreased energy use and greenhouse gas emissions with variable rate nutrient applications, compared with traditional methods.

	Energy Use per Pound of Cotton Lint (BTU)	Energy Use Fieldprint Score	Carbon Dioxide Equivalent Released per Pound of Cotton Lint	Greenhouse Gas Fieldprint Score
Traditional Application	144,032	64.3	1.75	31.2
Variable Rate Application	108,133	48.2	1.38	24.6
Difference	-35,899	-16.1	-0.37	-6.6

Reducing Indirect Energy Use Improves Farm Sustainability

Optimizing nutrient applications to John's fields reduced energy consumption and greenhouse gas emissions. John was able to reduce the amount of indirect energy needed to produce a pound of cotton lint by 25% (Table 2). This significant energy use reduction brings simultaneous reductions in greenhouse gas emissions. Approximately 21% less carbon dioxide was emitted with variable rate applications in this case than with traditional application methods. In total, 4,221,523,562 BTUs were saved using variable rate technology, enough energy to supply 115 homes in the United States with energy for an entire year, and 426,870 fewer pounds of CO_2e were released into the atmosphere, the equivalent of removing 41 passenger vehicles from the road for one year.

Summary

John Lindamood embraces intensive data collection and information technologies to adapt sustainable farming practices to his farm. He is using those practices to produce demonstrable improvements in his operation — greater efficiency, higher productivity and environmental benefits. Perhaps most important, those improvements are making economic sense by saving money and increasing yields in ways that serve the long-term viability of the practices and his farm. As he looks ahead, John wants to make a bridge to the next generation — he has a young foreman, and is bringing on an intern whom he hopes will become a productive part of the operation. The work they are doing today and their commitment to adopting profitable and sustainable farming practices are ensuring that the farm will remain sound and productive in the future.

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