Pecatonica River: Wisconsin Buffer Initiative Pilot Project

Connecting Targeted Phosphorus Reduction with Healthy Watersheds

The pilot Pecatonica River project is testing recommendations by the Wisconsin Buffer Initiative (*http://www.nelson.wisc.edu/people/nowak/wbi/*) to target phosphorus reductions in small watersheds (5,000-25,000 acres). The project integrates targeted management strategies with multi-disciplinary measurements and modeling to better quantify overland flow and in-stream delivery processes between fields and watershed outlets. The small watershed scale is optimal for identifying nonpoint pollution sources, implementing strategies, and measuring success. This multi-disciplinary paired-watershed approach requires close communication and cooperation among scientists, managers, and landowners.

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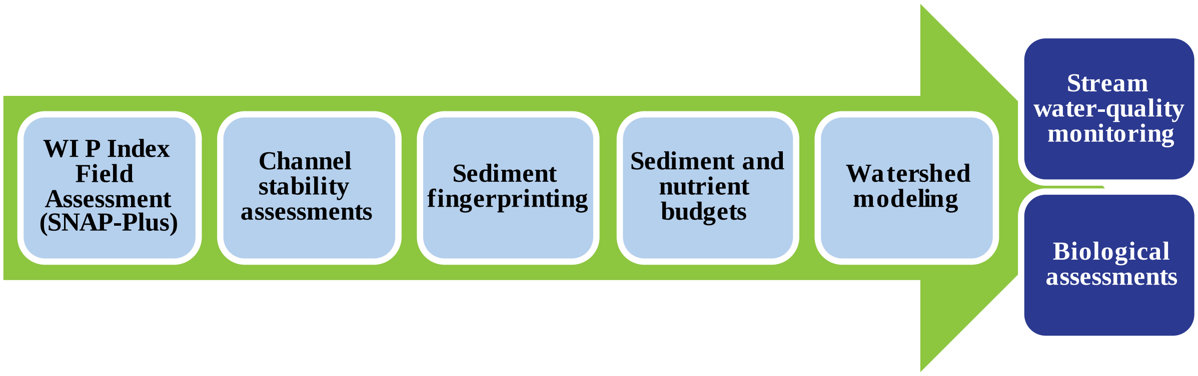
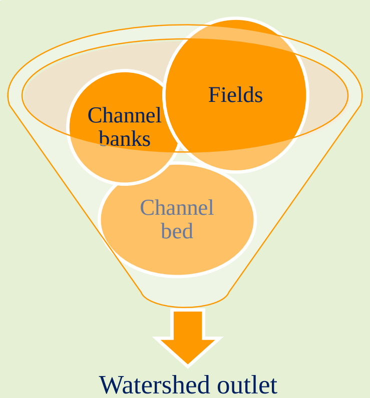


Integrated tools for developing a delivery ratio approach for evaluating **the benefits of targeting** conservation practices

Field Runoff Phosphorus Loss and Erosion Assessment

The first step was to identify fields and pastures contributing high levels of nutrients and/and or sediment using the Wisconsin Phosphorus Index (WPI, *wpindex.soils.wisc.edu*). The WPI uses routine soil test and field management information to estimate runoff phosphorus delivery from a field to a stream or lake under average weather conditions. It is calculated with software developed by the UW-Madison Soil Science Dept. (SNAP-plus, *www.snapplus.net*) that also computes field erosion using the NRCS's RUSLE2 model. The second step in the strategy is to identify and implement alternative management practices for fields with high WPI and/or erosion values to bring them below target levels; this step is underway.



Phosphorus and sediment measured at a watershed outlet originate from multiple upstream sources. Depositional bars in channels may act like a sediment source or sink.

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Channel Stability Assessments and Sediment Fingerprinting

A combination of channel stability assessments, sediment budgets, and radio-isotope sediment source tracking is being used to proportion the potential erosion, transport, deposition, and resuspension of phosphorus and sediment in the test watershed. Channel stability assessments were completed in the fall of 2009 at 30 sites in both the test and control watersheds to estimate additional sources and sinks of sediment between field edges and the watershed outlets. The amount of eroding banks and fine sediment deposition in streams was measured, along with riparian land use and habitat conditions. Data from the channel stability assessments will be used for a watershed sediment budget.

Fine-grained sediment samples that were collected from fields, ephemeral channels, banks, streambed and from suspended sediment samplers in the test watershed are being analyzed for cesium and lead isotopes, nutrients, and organic content. The results will allow scientists to estimate the proportion of sediment coming from different sources in the watershed.

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Photo credit: Mark Godfrey

Photo credit: David Housner

Watershed Modeling

Watershed models can be used to refine watershed water quality planning tools. Because stream channels have the capacity to store and release sediments and associated nutrients, the WPI inventory of potential phosphorus delivery to the stream from watershed fields is not expected to be an adequate way to estimate watershed loads. The field level inventories and the monitoring data from the project watersheds will be analyzed to identify an appropriate model for linking field level assessment and watershed models to identify the WPI and field erosion target reductions required to meet watershed water quality goals.

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Photo credit: Faith Fitzpatrick

Severe soil erosion and gullying were commonplace in the WI Driftless Area in the 1930s. This SCS sediment retention structure is now completely **filled with sediment and hidden** by ttrees and vegetation. Its presence is an obvious clue of a time of much higher erosion

In the Driftless Area, high eroding banks usually contain legacy sediment deposited in overbank areas during past destructive **flood events. These eroding banks illustrate** a component of the episodic delivery process of sediment that occurs over decades and centuries as streams respond to the historical consequences of excessive erosion.

Photo credit: Becky Carvin

Stream Water-Quality Monitoring

Monitoring for phosphorus and suspended sediment loads at the watershed outlets in the test and control watersheds started in October 2006, three years before implementation began. We plan to continue monitoring through practice implementation and beyond. A significant reduction in phosphorus and sediment loads from Pleasant Valley compared to the control watershed will indicate that the implementation strategy is effective.

Photo credit: Steve Richter

Contact: Rebecca Carvin (rbcarvin@usgs.gov), US Geological Survey

Photo credit: Bob Hansis

Biological Assessments

The experimental watershed, Pleasant Valley Branch, is on the Wisconsin Impaired Waters list for degraded habitat from nonpoint sources of sediment. The WI Department of Natural Resources (DNR) conducted fish, macroinvertebrate, and habitat assessments along main stem streams in both the test and control watersheds. The DNR will continue to monitor these stations for changes to biological integrity.

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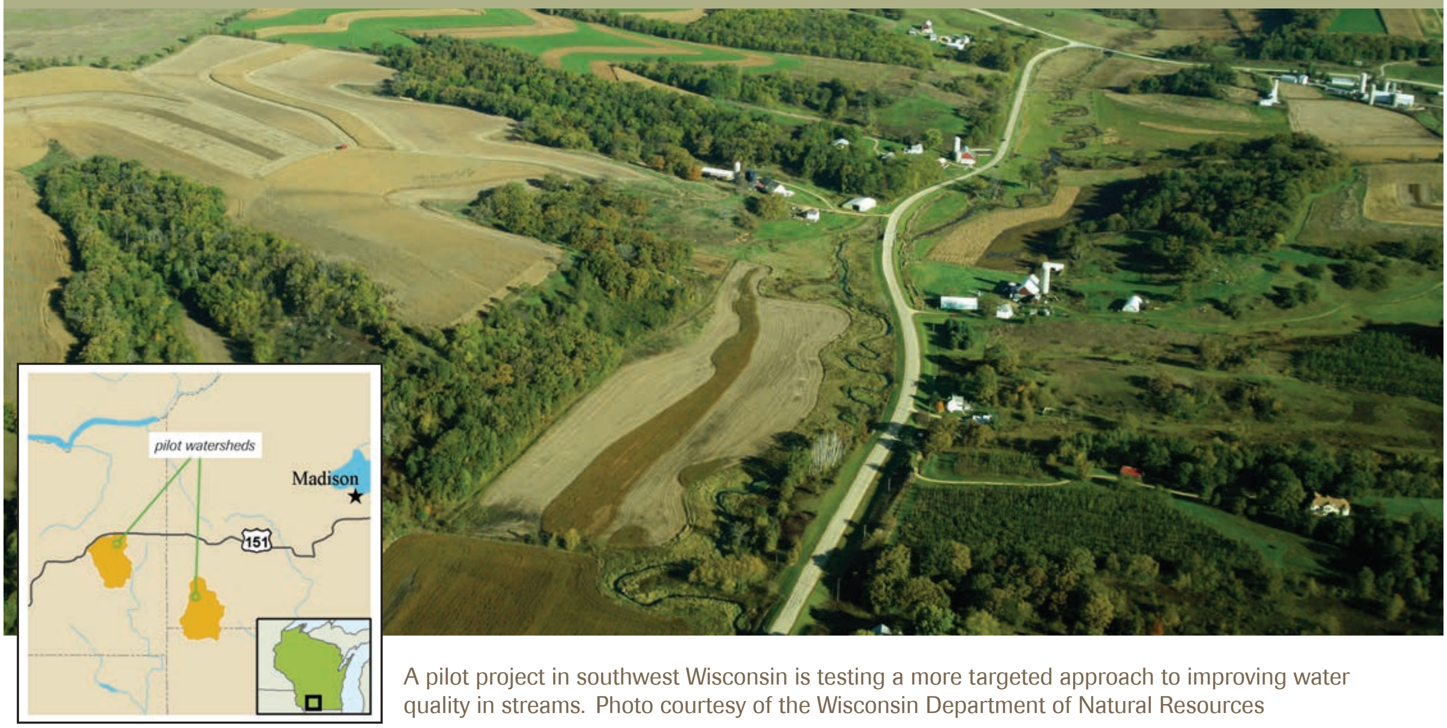
Funding: USDA-NRCS Cooperative Conservation Partnership Initiative, The Nature Conservancy, National Integrated Water Quality Program of the USDA Cooperative State Research, Education, and Extension Service, Dane County, WI DNR; USGS Cooperative Water Program

Pecatonica River:
Wisconsin Buffer Initiative Pilot Project

A Strategic Approach to Protecting Water Quality



A pilot project in southwest Wisconsin is testing a more targeted approach to improving water quality in streams. Photo courtesy of the Wisconsin Department of Natural Resources

An experiment is taking place in southwest Wisconsin that could improve water quality in streams more efficiently and effectively.

One of the challenges facing landowners and managers in Wisconsin and nationwide is keeping sediment and nutrients on the land and out of streams. Is there a way to target efforts to improve water quality so they have the greatest impact at the lowest possible cost?

Farmers, University of Wisconsin scientists, public agencies and The Nature Conservancy through the Great Rivers Partnership are working together to answer this question. Known as the Wisconsin Buffer Initiative (WBI), the group hopes to improve water quality by using science to target conservation efforts on those fields and pastures with the greatest potential for contributing nutrients to streams.

WBI is testing this approach in one watershed—the Pecatonica River watershed in southwest Wisconsin. If successful, the partners will look for opportunities to implement it more broadly across the state.

Pilot Project Launched in Driftless Area

Bypassed by the glaciers, the Driftless Area in southwest Wisconsin is characterized by steep-sided ridges and miles of rivers and smaller tributary streams that eventually drain into the Mississippi River.

The area has a strong agricultural tradition and is an important contributor to Wisconsin's economy. In the 1930s and 40s, farm families here were early pioneers of new techniques to stem soil erosion including contour strips and terracing, practices that endure on area farms today.

The pilot project is located in Dane, Green and Iowa counties on two subwatersheds to the Pecatonica River. These watersheds were chosen for the study because statewide computer models showed a strong likelihood that implementing conservation practices would reduce nutrient levels and improve water quality in the streams.

Targeting Conservation Practices Where Most Needed

Using research by a University of Wisconsin-Madison graduate student and Dane County Land and Water Resources Department conservation staff, the partners have identified a handful of farms in one of the watersheds that contribute comparatively large amounts of phosphorus to the stream.

Strategic changes in livestock handling and other farm practices can reduce sediment and nutrient loss to streams. © Curt Diehl/Dane County Land Conservation Division

Dane County conservation staff are working with these farm owners to identify alternative management practices, including different types of tillage, crop rotations and manure handling that will reduce the amount of sediment and nutrients entering the stream.

Because changing management practices can have financial implications for farmers, UW-Madison researchers from Extension and the College of Agricultural and Life Sciences are helping each farm owner assess the financial costs associated with implementing various management practices on their farms.

The goal is to identify conservation practices that are compatible with the farm's current cropping and livestock system and, where possible, increase or don't significantly reduce profitability. Dane County has secured funding from the NRCS Cooperative Conservation Partnership Initiative to help farmers implement needed changes that aren't financially feasible.

Using Results to Drive Changes

The U.S. Geological Survey, Wisconsin Department of Natural Resources and UW-Madison have gathered baseline data on water quality and fish and invertebrate populations in both watersheds. As the study proceeds, the agencies are collecting data on stream flow, water quality, stream channel sediment and phosphorus transport and storage, and biological indicators to compare differences between the watershed where management practices are being changed and the other watershed, where no action is being taken.

It will take several years for conservation practices to be fully implemented and begin to show results. Ultimately, however, the partners hope to demonstrate that targeting conservation practices where most needed will result in significant water quality improvements and be the most efficient and effective use of limited resources.

"It seems straightforward," says Pete Nowak, WBI Chair. "But it's actually a very innovative approach to water quality improvement that is not currently being utilized in the United States."

If successful, the project will create tools that streamline implementation of targeted conservation efforts in other watersheds. The data will also be valuable to the agricultural community and other decision-makers in re-shaping public policy related to water quality management not only in Wisconsin but across the nation.

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The Nature Conservancy's involvement in the Pecatonica River pilot project is part of its effort, through the Great Rivers Partnership, to protect and restore the Mississippi River. The partnership is a collaboration between the Conservancy, Caterpillar Inc. through its foundation and other corporations and individuals to protect the world's largest and most imperiled freshwater river systems—including the Mississippi, China's Yangtze and the Paraguay-Paraná in Brazil.

Project Funding:
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U.S. Geological Survey
USDA Natural Resources Conservation Service
Wisconsin Department of Natural Resources

Project Partners:
Dane County Land Conservation Division, Department of Land and Water Resources
Green County Land and Water Conservation Department
Iowa County Land Conservation Department
The Nature Conservancy
U.S. Geological Survey
University of Wisconsin-Extension
University of Wisconsin-Madison
Wisconsin Department of Agriculture, Trade and Consumer Protection
Wisconsin Department of Natural Resources
Wisconsin USDA Natural Resources Conservation Service

nature.org/greatrivers

Enhancing Farming System Environmental and Economic Performance in the Pleasant Valley Watershed

Traditional Conservation Programs

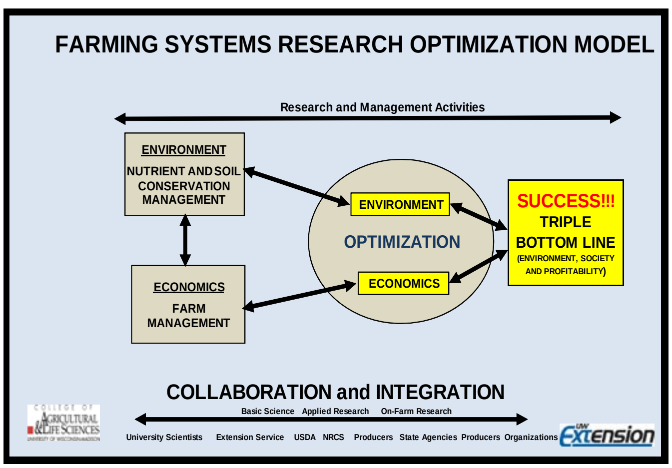
In past years local soil conservation service (SCS) district conservationists worked with farmers to implement more traditional conservation practices to dramatically reduce wind and water soil erosion. Some of our more traditional conservation Best Management Practices (BMPs) included:

- Terracing and Buffer Strips.
- Strip Cropping/Contour Strips.
- Conservation Tillage/Chisel Plowing.
- No-Till Cropping Systems.

Traditional collaborators who worked with farmers to implement these early conservation practices included:

- Farmer
- SCS and Local Conservationists
- UWEX Local/County Agent

These early conservationists implemented the practices with good engineering and field/farm calls to make sure producers could understand how to implement these practices.



New Farming Systems Conservation Approach Aimed at Balancing Environmental Gains with Improved Farm Profitability

Our new conservation approach is designed to improve water quality and environmental performance as well as economic performance: Triple Bottom Line – environment, society, profitability. Traditional conservation practices are still important BMPs, but we are now taking conservation to the next level. Fine-tuning these traditional practices and optimizing the management of whole farming systems are essential to improving environmental performance and farm profitability.

<u>**Process**</u>**:** In order to be successful at implementing triple bottom line soil conservation programs we must follow new management protocols:

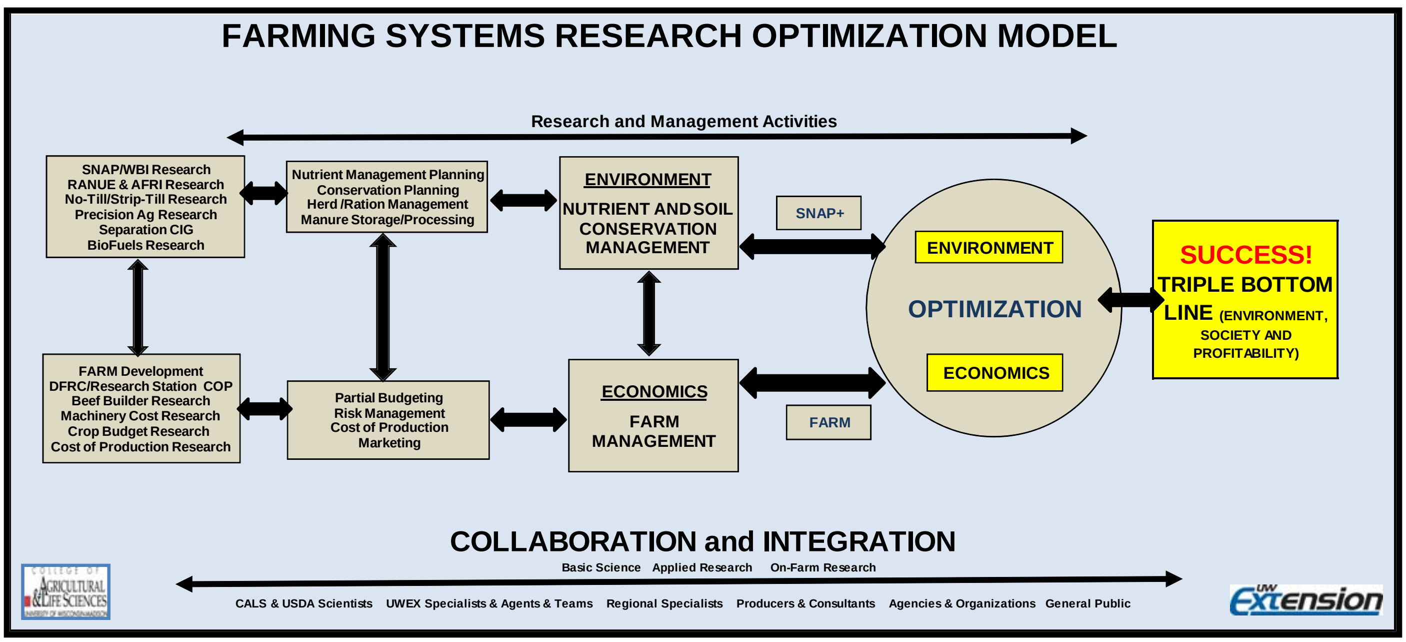
1) ***Inventory current farming system, farmer objectives and constraints***.
2) ***Use Snap⁺ to estimate current soil and P losses, and identify problem areas for remediation***.
3) ***Identify team of key farm system consultants***.
4) ***Identify potential farm management options*** to improve economic and environmental performance.
5) ***Use Snap⁺ to evaluate environmental impacts of identified alternatives***.
6) Use FARM (Financial and Resource Management tool) to ***estimate cost of production and cash flow of alternatives***.
7) Use ***optimization*** to determine "Best" economic/environmental alternatives.
8) Use ***dynamic feedback decision process*** with producers to verify feasibility of "Best" options.

Key Players: Many more professionals are necessary to ensure that the implemented practices improve both environmental performance and profitability. These professionals represent all areas of the farms management and all areas of the conservation service staff. All of the following collaborators take an active roll in helping producers to make profitable and productive environmental decisions:

- Farmer
- NRCS: County Conservationists
- Local/County Conservationist
- UWEX Local/County Agent
- CCA/Agronomist
- UWEX Extension Specialists:
  - Dairy/Livestock: Rations, Breeding, etc
  - Soil/Nutrient/Water Management
  - Agronomy: rotations, tillage, varieties, etc
  - Farm Management: economic/environmental
- Other Private Farm Consultants

New Farming System "BMPs":

- No/Minimum Till vs Conservation Tillage: Corn Grain/Silage, Hay/Forage Crops, Small Grains/Oilseeds.
- Seeding With a Companion Crop.
- Grass/Alfalfa versus Pure Alfalfa Hay/Silage Crops.
- Increasing Hay Acres Relative to Corn Silage Acres in Rotation.
- Shortened Rotations: e.g., 3 YR hay
- More Diversified Rotations: small grains, oilseeds, forage crops, bio-energy crops.
- Manure Management (storage, application) Options.
- Manure Separation Technologies.
- Cover Crops: Examples:15 vs. 30 inch Corn Silage, w/ Winter Rye Cover Crop (Keller Farms); forage (graze/hay) versus green manure
- Precision Ag.
- On-Farm Research: replicated/ randomized treatments and control at site/management specific field scale.



This diagram provides a linkage/flow conceptualization of the Farming Systems Research Optimization Model. Note that all components are sequentially linked via "feedback" loops (dialogues) between decision makers (farmers, regulators) and farming system researchers/consultants using data driven, science based knowledge generation **and** local/regionally based knowledge (experience, intuitions, preferences).

EXAMPLE

A full inventory of the Pleasant Valley watershed identified farm fields with "disproportional" (high levels) of soil and phosphorous loss to the environment for additional "remedial" targeting. Several representative farming systems (farms) containing these targeted areas were selected as "case studies" for intensive whole farm/systems analysis using economic/ environmental optimization/management tools.

Note that SNAP+ results indicate that incremental changes to the cropping system can generate large improvements in environmental performance:

- Changing corn silage tillage from conservation (chisel plow) to no-till (**Original** to **Current** rotation) reduces soil and phosphorous losses 51% and 43%, respectively;
- Adding grass to the alfalfa hay to the **Current** rotation reduces **Original** rotation soil and P losses by 72% and 57%, respectively, and incrementally improves **Current** rotation losses by 42% and 25%, respectively.
- An additional 55% and 33% improvement in soil and P loss can achieved by the "optimal" rotation (87% and 71% improvement over the **Original** cropping rotation).

Using SNAP+ to Evaluate Environmental Performace of "Remedial" Cropping System Options: Keller Crest Farms, Pleasant Valley Project.					
Rotational Soil Loss and WI P Index for Kellercrest Farm Field	**RUSLE 2 Soil Loss**	**WI P Index**		**RUSLE 2 Soil Loss**	**WI P Index**
	% Chg (Original)			**% Chg (Relative)**	
Original rotation	3.9	7		3.9	7
Current rotation: add no-till corn silage (% chg)	-51%	-43%		-51%	-43%
Add no-till alfalfa-grass hay toCurrent (% chg)	-72%	-57%		-42%	-25%
"Optimal" Rotation (% chg)	-87%	-71%		-55%	-33%
Original rotation: 3 years narrow row corn silage, fall chisel plowed followed by fall chisel plowed alfalfa seeding and three years alfalfa hay.					
Current rotation: add no-till corn silage to **Original**.					
Add no-till alfalfa-grass hay to **Current**.					
"Optimal" Rotation: No-till corn silage to winter rye for forage –corn grain –no-till corn silage followed by winter rye, alfalfa-grass seeded into winter rye in following spring, 2 years established alfalfa-grass hay (6-year rotation)*					

However, these cropping systems changes have potential economic and management "spillover" effects across the whole farming system. In particular, are the "remedial" cropping system changes consistent with farmer objectives and constraints (i.e., are they "feasible" in the specific farming system), and do they improve or degrade economic performance???

<u>Farming System Issues</u>:

- Additional management requirements, famer objectives, preferences, and constraints.
- Additional labor and machinery requirements to plant and harvest under new farming system.
- Alfalfa/grass hay changes to dairy ration.
- Implications for total annual forage production and its composition.
- Economic and Environmental cost/benefit ("trade-offs") analysis: Identify potential "***win/win***" alternatives.

A whole farm economic/environmental management approach involving key farming systems participants is required to address these potential "spillover" effects. For example, adding grass mixtures into alfalfa forage cropping raises several issues such as:

- what grass mixtures and varieties, harvest timing (when to cut and labor/machinery availability).
- implications for dairy ration given producer/herd objectives, constraints, and management abilities.

Working with UW Extension agronomist/forage specialist (Dan Undersander) and dairy nutrition specialist (Randy Shaver) provides state of the art University based research to address these whole farm management issues. Milk production and cost impacts of adding different combinations of corn/hay silages to the dairy ration, under different levels of grass/alfalfa mixtures in the hay silage, indicate that milk production (milk composition and quality are also important) can be maintained at a reduced cost/cwt under the "remedial" cropping change (adding more grass to the alfalfa hay). In particular, compared to standard 75:25 % cornsilage:haycrop silage ration, 50:50 % (or 25:75 %) rations, with 0 to 100 % alfalfa:grass mixtures can reduce milk cost of production ($/cwt) from 4% to 11%. These results suggest that there exists the potential for an economic/ environmental "win/win" – if the proposed changes are compatible with farmer objectives, constraints, and management abilities.

Lactating dairy cow diet simulations with varying proportions of corn (CS) and hay/crop (HCS) silage with mixtures of alfalfa (AS) and grass (GS) silage.

	CS:HCS[1]	AS:GS[2]	Purchased Feed Cost5 ($/cow/d)	Purchased Feed Cost/NEL Milk Yield ($/cwt)	Purchased Feed Cost/MP Milk Yield ($/cwt)	% Change Relative to Corresponding BASE (CS:HCS‖75:25) Ration	
r1	25:75	100:0	$2.79	$3.32	$3.13	-11.1%	-11.2%
r2		50:50	$2.95	$3.51	$3.31	-7.1%	-7.2%
r3		0:100	$3.11	$3.74	$3.49	-4.0%	-5.2%
r4	50:50	100:0	$2.94	$3.46	$3.26	-7.4%	-7.5%
r5		50:50	$2.94	$3.50	$3.26	-7.4%	-8.6%
r6		0:100	$3.04	$3.62	$3.34	-7.1%	-9.2%
r7	75:25	100:0	$3.21	$3.73	$3.53	--	--
r8		50:50	$3.25	$3.78	$3.57	--	--
r9		0:100	$3.32	$3.90	$3.68	--	--

[1]Proportions of forage DM from corn silage or haycrop silage. Assumed corn silage composition of 8.5% CP & 45% NDF (DM basis) & 60% ivNDFD (% of NDF).

[2]Proportions of haycrop silage DM from alfalfa silage or grass silage. Assumed 100%-alfalfa silage composition of 21% CP, 40% NDF, & 1.5% Ca (DM basis) & 50% ivNDFD (% of NDF). Assumed 100%-grass silage composition of 16% CP, 55% NDF, and 0.60% Ca (DM basis) & 60% ivNDFD (% of NDF).

Additional issues include changes to annual total forage production and composition (will the farming system have enough forage quantity/quality to meet livestock needs and objectives), availability of labor, machinery, storage and management to implement the proposed change, etc. The **Whole Farming System Economic and Environmental Optimization** approach identifies a range of "remedial" farming system options, documents their likely economic and environmental impacts across the whole farming system, and facilitates implementation via dialogue with the farm manager(s) as to their objectives and constraints, preferences, and management abilities,

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Cooperative Conservation Partnership Initiative

Pecatonica River Pilot Project Tests Conservation Model for Cleaner Water

The Natural Resources Conservation Service (NRCS) Cooperative Conservation Partnership Initiative grant will help fund the Pleasant Valley Pilot Project to reduce Phosphorus loading to the Pecatonica River for five years

Pat Sutter visits with Keller family on their rolling Driftless Area farm, already in contour strips with hay in rotation. Improved manure management, including a spreading plan to better distribute manure to upland fields is key to reducing phosphorus load.

The Pecatonica Pilot Project is testing the ideas proclaimed by The Wisconsin Buffer Initiative: that water quality will be measurably improved by targeting just the farms contributing the very highest amounts of phosphorus to the stream; and that implementing the "soft" low-cost management type practices, first will be more effective than the high-cost structural practices.

"12% of the land base contributes 60% of the phosphorus load."
– Pat Sutter, Dane County Land and Water Conservation Dept.

After inventorying the 62 farms in the watershed, it was clear that majority of the phosphorus flowing into the stream came from only eight farms.

The CCPI money, just over $600,000, was critical to target these few high-phosphorus farms to see if management changes would have significant impact, as predicted by WBI. For these eight, a whole farm conservation plan will be done, with the management practices scheduled first to see the impact of the lower-cost practices. Throughout the project, USGS will monitor water quality changes in the pilot watershed as well as a control watershed.

"CCPI is the critical component, giving farmers the ability and the confidence to make the changes that we want to evaluate." – Steve Richter, The Nature Conservancy

Economics The University of Wisconsin is assessing the economics impacts to see if conservation practices cost the operation money, or if in fact they increase profitability.

Pat Sutter, Dane County Conservationist, talks to Tim Keller about adding grass to their alfalfa seeding mix. Grass added with alfalfa helps reduce erosion and can be just as nutritious compared to direct seeding of alfalfa.
Photos by Mark Godfrey, TNC

CCPI focuses funds from existing programs into a selected area, in tandem with the focused efforts of partners, such as non-profits or local government organizations. In CCPI, partners enter into five-year agreements with NRCS to combine efforts to focus conservation practices on agricultural lands in a selected area. The intent is to leverage investment for greater impact.

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