Continuous Living Cover Manual

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Continuous Living Cover Introduction

Photo of Watonwan River, from Linda Meschke

Continuous Living Cover (CLC) means plant cover on the soil and roots in the ground all year long. The Green Lands Blue Waters collaboration works on five Continuous Living Cover practices: agroforestry, biomass, cover crops, perennial forage, and perennial grains. This publication focuses on agroforestry, cover crops, and perennial forage: these practices are well-established and proven in farming systems and in markets. Biomass and perennial grains are emerging practices that are being researched and developed for future use.

Continuous Living Cover is a process and a goal to achieve within agricultural systems. Even modest steps toward implementing year-round cover can have larger-than-expected benefits in terms of reduction of erosion and nutrient loss, improvement in soil health, improvement of water quality, and reduction in purchased farm inputs.

The larger-than-expected benefits can be seen at both the farm scale and the landscape scale. Research from the Prairie STRIPS project in Iowa shows that converting 10% of cropland to perennial prairie cover at the field scale resulted in a 95% reduction in soil loss and an 85% to 90% reduction in nutrient loss.

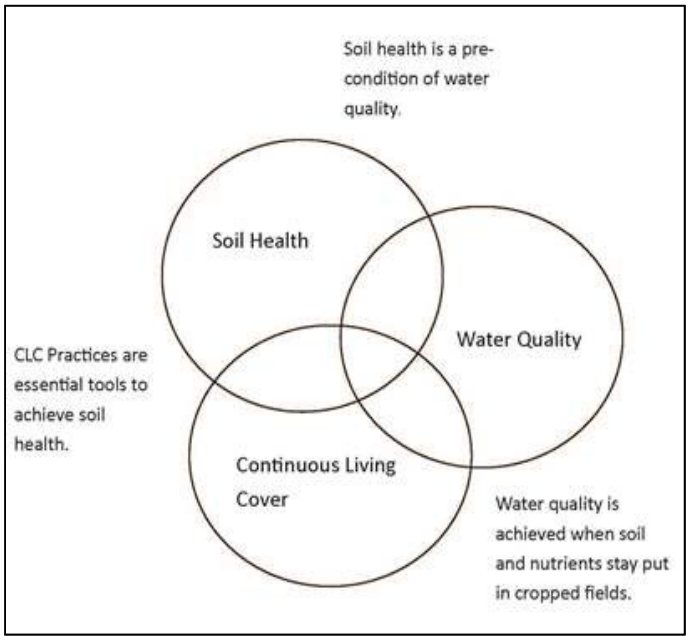
Healthy Soil

- Vibrant soil biology
- Ability to cycle nutrients
- Blocky aggregate structure; porous; allows rapid water infiltration during rainfall events
- Very little run-off of surface water
- Very little leakage of N
- Very little loss of P
- Very little soil erosion

All of these attributes of a healthy soil contribute to clean water leaving the fields, and to robust crop production with reduced purchased inputs.

Soil Biology Primer. http://soils.usda.gov/sqi/concepts/soil_biology/biology.html

Minnesota Soil Management Series. http://www.extension.umn.edu/agriculture/tillage/soil-management/soil-management-series/



Modeling of changes in cropping systems at the regional scale in Iowa's loess hills showed a shift to region-wide improvements in soil and water quality.

Region-wide modeling in Minnesota's Chippewa River Watershed showed that best management practices (BMPs) in the form of reduced tillage, riparian buffers, and recommended N application rates were not by themselves sufficient to achieve a 30% reduction in N loading into the Mississippi River. Increases in acreage under perennials would be required in addition to the BMPs to meet that goal.

Continuous Living Cover on farms is a step on the way to achieving a robust, resilient agriculture that delivers yields, healthy soil, clean water, and a good quality of life for rural and urban citizens.

Sources:

Small Changes, Big Impacts: Prairie Conservation Strips. http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2014-03-small-changes-big-impacts-prairie-conservation-strips.pdf

Impact of Conservation Practices on Soil Erosion in Iowa's Loess Hills https://www.extension.iastate.edu/NR/rdonlyres/26DC3619-5E13-4992-9F38-C104F60E6DBE/135600/Conservation_Practices_on_Soil_Erosion_Loess_Hills.pdf

Multifunctional Agriculture in the United States. 2005. George Boody, Bruce Vondracek, David A. Andow, Mara Krinke, John Westra, Julie Zimmerman and Patrick Welle. BioScience (2005) 55 (1): 27-38. http://bioscience.oxfordjournals.org/content/55/1/27.full

What We Know

- Strategic placement of relatively small areas of continuous living cover practices on the farm can greatly reduce soil erosion.
- Use of cover crops and perennials in the crop rotation can increase soil

organic matter.

- Use of cover crops and perennials in the crop rotation can reduce leakage of nitrate- N.
- Production of perennial forage and managed grazing can be profitable.
- Extended crop rotations that include perennial forages can be profitable.

Why Don't More Farmers Do CLC?

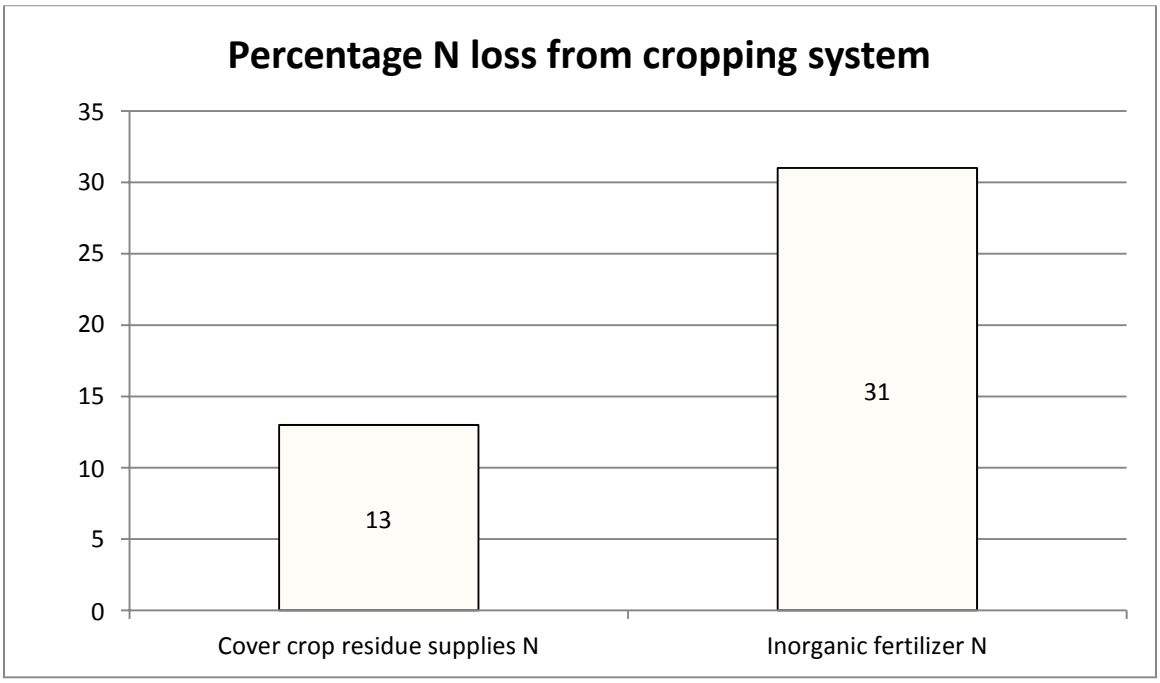
Listening sessions in Iowa clarified some barriers and pathways to adoption of CLC practices.

Concerns	**Pathways to adoption**
Opportunity cost of taking land out of production	• Potential for perennial strips within cropland to provide income • Need for sources of cost-share money to offset establishment costs and opportunity costs
Incompatibility of CLC practices with current farming practices	• Need for demonstration sites • Need advisors to understand and be able to articulate long-term benefits of practices
Conservation agency's ability to provide technical assistance	• More information needed on how practices fit into the "toolkit" of natural resource professionals

Source*: Investigating opportunities for enhancing farmer adoption of strategically targeted prairie strips in Iowa. Leopold Center for Sustainable Agriculture Competitive Grant Report P2012-08.*

Potential for Regulation of Cropping Systems

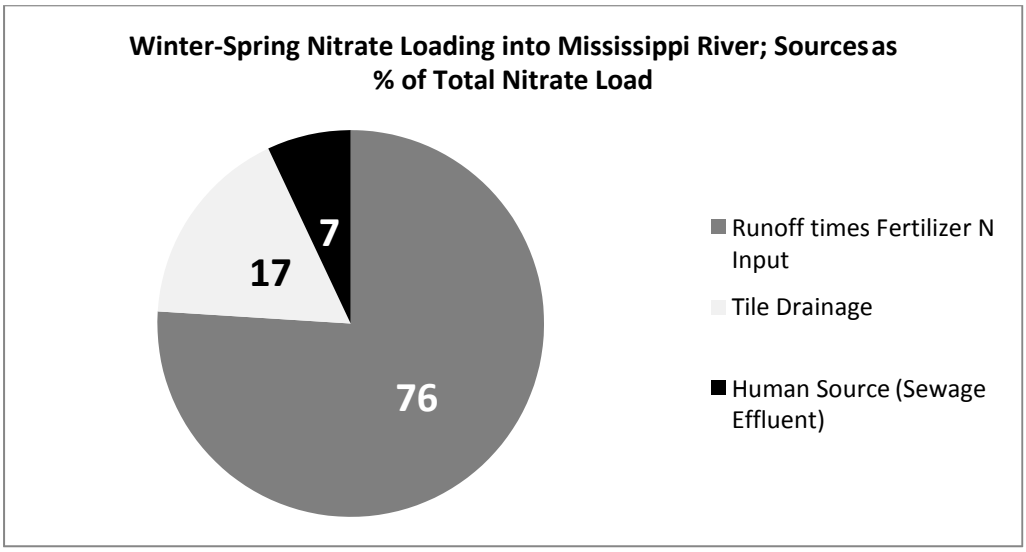
Nitrate-N leakage from row-cropped systems is estimated at 30% of applied inorganic N fertilizer. Nitrate leakage into groundwater is becoming a serious issue for municipal water supplies in some areas. Using cover crops in the system as a green manure to supply N to a subsequent crop has been shown to reduce N leakage from the system as a whole.



Source: *Using Cover Crops and Cropping Systems for Nitrogen Management*. Chapter 9 in *Advances in Nitrogen Management for Water Quality*. Edited by Jorge A. Delgado and Ronald F. Follett. 2010, 424 pages, hardcover. Soil and Water Conservation Society. ISBN 978-0-9769432-0-4.
http://www.swcs.org/documents/filelibrary/advances_in_nitrogen_management_for_water_quality/ANM9_A41356AAD3B6A.pdf

Nitrate, phosphorus, and sediment loading into surface waters from cropland in the many watersheds that ultimately drain into the Mississippi River is a concern both in local areas where there are impaired waters, and downstream at the Gulf of Mexico where the size of the hypoxic zone in July has been clearly linked to the discharge of nitrate-N into the Gulf from the Mississippi River in May.

Nitrate leakage and soil erosion are costing local and state governments in the form of money spent on sediment cleanup and water treatment facilities, and are costing Gulf fisheries in the form of lost productivity. If the nutrient and sediment loading from agricultural fields into surface waters remains intractable under current conditions, regulations on discharges from agricultural fields or restrictions on cropping systems may become reality.



Source: *Sources of nitrate yields in the Mississippi River Basin*. 2010. Mark B. David, Laurie E. Drinkwater and Greg F. McIsaac. Journal of Environmental Quality. 39(5):1657-67.

The Natural Resources Conservation Service (NRCS) estimates that compliance with conservation standards results in $4.96 in off-farm water quality benefits for every ton of soil saved, in 2007 dollars. At what point might that number be turned around into a call to have farmers pay for the loss of water quality resulting from erosion and nutrient loss from their fields?

Proactive efforts now to add Continuous Living Cover practices to cropping systems and to reduce tillage may benefit the farmers not only with direct improvements in their soil, but also with avoidance of future regulation. Regulation may be driven by both local impaired waters concerns in the Upper Midwest, and the hypoxic zone in the Gulf of Mexico.

Size of the Hypoxic Zone

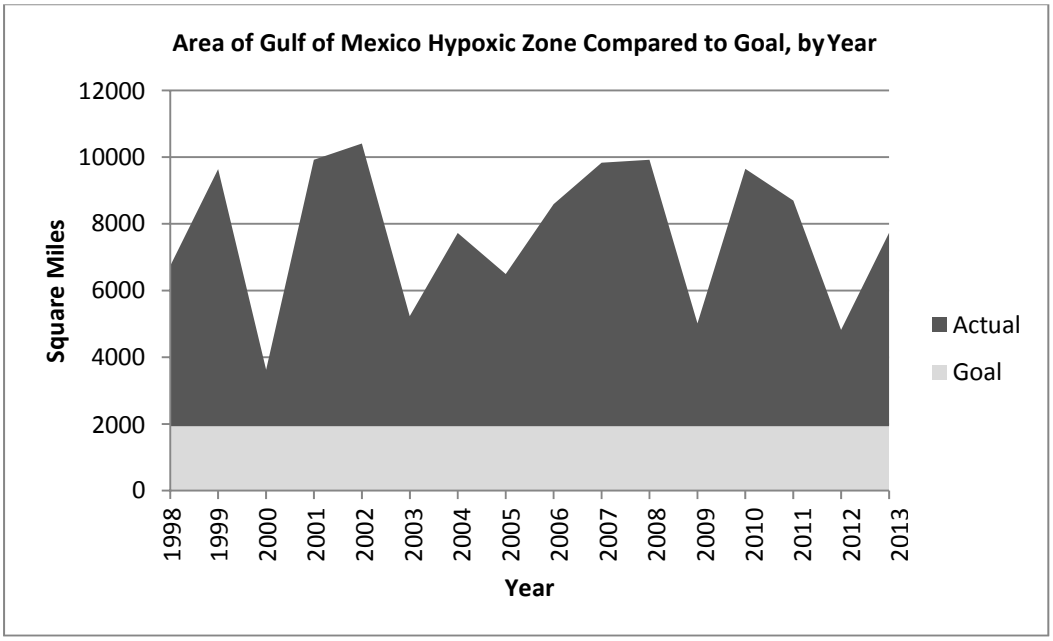
Long-term research by LUMCON (Louisiana Universities Marine Consortium) researchers shows a 90% correlation between the amount of N (nitrate + nitrite) entering the Gulf of Mexico in May of each year, and the size of the hypoxic zone as measured in July of the same year. The amount of nitrate + nitrite N entering the Gulf in May depends on:

1) The amount of nitrate + nitrite N in the Mississippi River water; and
2) The volume of flow of that river water.

In a widespread drought year such as 2012, both the amount of N and the volume of river

flow in May are reduced so the hypoxic zone size is smaller. In the chart below, you can see the dip in hypoxic zone size in 2012.

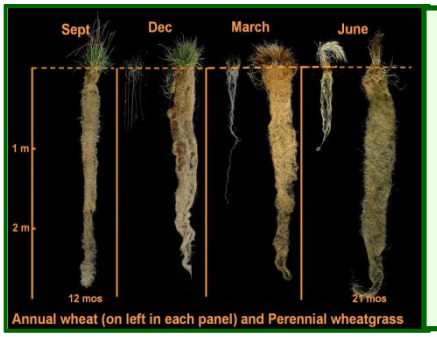
A management goal has been established to shrink the hypoxic zone to a yearly average of 1,930 square miles. Even in the drought year of 2012, the actual size of the hypoxic zone was 2,889 square miles – which is still 1.5 times larger than the goal. If voluntary management to reduce N loading in the Upper Mississippi River Basin can't shrink that zone, regulatory measures may be applied.



References:

2014 Forecast: Summer Hypoxic Zone Size, Northern Gulf of Mexico. June 2014. Nancy N. Rabalais (LUMCON, nrabalais@lumcon.edu) and R. Eugene Turner (LSU, euturne@lsu.edu). http://www.gulfhypoxia.net/Research/Shelfwide%20Cruises/2014/HypoxiaForecast2014.pd f

*Interim Final Benefit-Cost Analysis for the Environmental Quality Incentives Program (EQIP***)**. January 2009. USDA Natural Resources Conservation Service. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_007977.pdf



Continuous Living Cover Practices

Photo: Intermediate wheatgrass roots compared to annual wheat; from The Land Institute

Cattle on lush pasture; photo from Laura Paine, Southwest Badger RC & D Council

Perennial Forages:

Perennial forages are the green plant material (leaves and stems) of perennial grasses and legumes used for livestock feed. Perennial forages include plants eaten directly by animals in pasture, and also preserved forages that can be fed to the animals after the growing season ends.

Well-managed pastures can provide highly nutritious, fresh food for animals to graze, and can add value to marginal fields where row crop production is difficult. Lands used for pasture can show significantly reduced rates of soil erosion and nutrient losses, especially when placed on steep (>5% slope) and highly-erodible lands; and provide habitat for wildlife, birds, and beneficial insects. Production of hay or haylage crops can add valuable organic matter and nutrients back into the soil. Alfalfa is an example of a crop grown for livestock feed which can help improve conditions for row crops grown in succession – alfalfa grown in rotation with corn can reduce the need for nitrogen fertilizer following rotations of corn. Whether grown on marginal cropland or incorporated into rotations, well-managed pastures or forages grown for harvest are also a way to diversify farm income streams.

Cover crop in corn; photo from Rick Cruse, Iowa Water Center

Cover Crops:

Cover crops are used in traditional row crop farming systems to increase productivity and to manage soil erosion and nutrient losses from the field. Shortly before or immediately

after harvesting the primary row crop, the cover crop is seeded into the soil in time for it to establish itself before winter sets in. In spring, the cover crop starts re-growing before it is killed prior to planting the primary crop. The choice of cover crop, and the timing and methods used for planting and tillage, depend on numerous factors including: the primary cash crop planted, the climate and growing season for the region, the soil type of the field, and other agronomic considerations for both the cash crop and the cover crop. Cover crops hold soil in place and add vital nutrients and organic matter to the soil. Cover crops improve productivity of the entire system, but usually do not directly produce an income stream. An exception is the grazing of cover crops, which can offset purchased feed for livestock in the fall or early spring.

Examples of cover crops used in the Midwest include winter small grains, brassicas, legumes, and other crops such as buckwheat. The small grains, including rye, millet, oats or wheat, are typically winter hardy, so they establish well in the fall and regrow in the spring, providing winter soil cover as well as early spring weed control. Brassicas, such as winter canola, rapeseed or field mustard, are fast growing and produce a large amount of aboveground and belowground biomass that can serve as a "green manure" (add organic matter) when tilled in before a subsequent crop. Legumes, including clover, vetch, or field pea, fix nitrogen in the soil as well as producing biomass for a further benefit as a green manure.

Agroforestry:

Hazelnuts; photo from Brent McCown, University of Wisconsin (emeritus)

Agroforestry is an intensive agricultural land-use system where trees or other woody species are integrated with crops and/or livestock.

Incorporating woody species into traditional agricultural systems helps farmers diversify their farm's product markets and income, while improving soil and water quality, and retaining or enhancing wildlife habitat. Saleable agroforestry crops include high quality timber, pulpwood, fruit/nut crops, and Christmas trees as well as specialty crops that can be grown in forests such as mushrooms and ginseng.

The various ways that agroforestry is

implemented include: alley cropping, forest farming, silvopasture, riparian buffers and windbreaks or shelterbelts.

Perennial Grains:

Perennial grains may have many advantages over the annual row crops that currently dominate agriculture. Because perennial grains live for many years, they develop roots that are much deeper than annual roots allowing better access to moisture and nutrients. Because perennial grains cover the ground all year, soil erosion is greatly reduced, soil health is radically improved, and the need for inputs is reduced as a result.

Kernza (intermediate wheatgrass) harvest; photo from The Land Institute, Salina, KS

Over the past 10,000 years, humans have increasingly relied on cereals and other grains to provide a stable source of food. Today, grains provide about 70% of our food worldwide and occupy about 70% of agricultural lands. As our early ancestors selected plants with more and bigger seeds, their biggest successes -- with regard to ease of cultivation and taste and nutrition -- were with annual forms. It took humans thousands of years to develop the high yielding, easy to harvest annual varieties we grow today. Fortunately, through modern genetics tools and plant breeding techniques, we should be able to speed up the process to produce a next generation of edible grain crops that are perennial.

Research is being done on several promising perennials including sunflower, wheat, corn, sorghum, rice, and “Kernza,” an intermediate wheatgrass developed by The Land Institute. Kernza is currently being studied for multi-purpose grain, forage, and biofuel production.

Biomass:

Perennial plants can provide a sustainable feedstock supply for emerging biofuel and bio-product industries throughout the Midwest. Advantages to integrating perennial plants for biomass include, erosion control, sequestration of nutrient run-off from adjacent agricultural practices, and wildlife habitat. Examples of perennial plant material used for biomass products include native grasses, switchgrass, and short rotation willow.

Native, warm-season grasses can be harvested for livestock feed, bedding, and biomass pellets to be used as an energy source. These grasses can be grown on marginal lands with fewer nutrient and water inputs than cool season grasses.

There is a growing demand for woody species biomass to be used as erosion control in disturbed soil projects such as road construction. Wood “strands” and wood “shreds” being produced for this purpose are weed free, wind-resistant, economical, and long-lasting.

Universities and other partners are engaged in research and development projects that advance plant material selection, yield, cropping systems, measure water quality improvements, and evaluate the economies of these systems.

Continuous Living Cover Funding Opportunities

Program Name	Type of funding	Link	CLC Practices Covered
Conservation Reserve Program (CRP)	Financial assistance through contracts. Some incentives and cost-sharing for putting practices into place.	www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp	CP1 • Grassed waterways CP2 • Prairie STRIPS • Riparian buffer CP3 • Riparian buffer • Windbreak/shelterbelt • Silvopasture CP4 • Riparian buffer • Prairie STRIPS • Hedgerow • Windbreak/shelterbelt CP42 • Prairie STRIPS • Riparian buffer
Conservation Reserve Enhancement Program	Financial assistance through contracts.	https://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=cep	• Windbreak/shelterbelt • Hedgerow • Riparian buffer • Prairie STRIPS

(CREP)	Some incentives and cost-sharing for putting practices into place.		• Grassed waterways • Timber production
Healthy Forests Reserve Program	Financial and technical assistance through contracts.	www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/forests/	• Riparian buffer • Silvopasture • Fruit/nut crop
Environmental Quality Incentive Program (EQIP)	Financial and technical assistance through contracts.	www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/	CAP 104 • Cover crops • Riparian buffers CAP 106 • Silvopasture • Riparian buffers • Fruit/nut crop CAP 110 • Silvopasture • Perennial forage/grazing CAP 122 • Windbreak/shelterbelt CAP 142 • Riparian buffer • Prairie STRIPS

			CAP 146 • Prairie STRIPS • Riparian buffer
Conservation Stewardship Program (CSP)	Financial and technical assistance through contracts.	www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/	• Windbreak/shelterbelt • Hedgerow • Riparian buffer • Prairie STRIPS • Grassed waterways • Silvopasture • Timber production • Fruit/nut crop • Perennial forage/grazing • Cover crops
Transition Incentive Program	Contract assistance for retired/retiring landowners.	www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=tipr	• Silvopasture • Perennial forage/grazing • Cover crops
Specialty Crop Block Grant Program	Grant	http://www.ams.usda.gov/AMSv1.0/scbgp	• Fruit/nut crop • Silvopasture • Riparian buffer • Windbreak/shelterbelt • Hedgerow
NCR SARE Farmer Rancher grant program	Grants for education, research, and demonstration	http://www.northcentralsare.org/Grants/Our-Grant-Programs/Farmer- Rancher-Grant-Program	• Windbreak/shelterbelt • Hedgerow • Riparian buffer • Prairie STRIPS

	purposes.		• Grassed waterways • Silvopasture • Timber production • Fruit/nut crop • Perennial forage/grazing • Cover crops
Livestock Equipment Loan Program (MN)	Loan	http://www.mda.state.mn.us/grants/loans/liveequip.aspx	• Perennial forage/grazing • Silvopasture
Livestock Expansion Loan Program (MN)	Loan	http://www.mda.state.mn.us/grants/loans/expansion.aspx	• Perennial forage/grazing • Silvopasture
Livestock Investment Grant (MN)	Grant	http://www.mda.state.mn.us/grants/grants/livestockinvestment.aspx	• Perennial forage/grazing • Silvopasture
Agriculture Best Management Practices Loan	Loan	http://www.mda.state.mn.us/grants/loans/agbmploan.aspx	• Riparian buffer • Prairie STRIPS • Grassed waterways • Silvopasture • Perennial forage/grazing • Cover crops
Beginning Farmer Loan Program (MN)	Loan – beginning farmers only	http://www.mda.state.mn.us/grants/loans/basic.aspx	• Windbreak/shelterbelt • Hedgerow • Silvopasture

			• Timber production • Fruit/nut crop • Perennial forage/grazing • Cover crops
Aggie Bond Beginning Farmer Loan Program (MN)	Loan- beginning farmers only	http://www.mda.state.mn.us/grants/loans/aggiebond.aspx	• Windbreak/shelterbelt • Hedgerow • Silvopasture • Timber production • Fruit/nut crop • Perennial forage/grazing • Cover crops
Dairy Profitability and Enhancement Teams	Grant	http://www.mda.state.mn.us/grants/grants/diagnostics.aspx	• Perennial forage/grazing • Silvopasture • Cover crops
Financial Assistance for Conservation Practices (IA)	Cost-share	http://www.iowaagriculture.gov/FieldServices/financialAssistance.asp	• Windbreak/shelterbelt • Hedgerow • Riparian buffer • Prairie STRIPS • Grassed waterways • Silvopasture • Timber production • Fruit/nut crop • Perennial forage/grazing • Cover crops

State Revolving Loan Fund (IA)	No-interest loan	http://www.iowaagriculture.gov/FieldServices/waterQualityLoanFund.asp	• Windbreak/shelterbelt • Hedgerow • Riparian buffer • Prairie STRIPS • Grassed waterways • Silvopasture • Timber production • Fruit/nut crop • Perennial forage/grazing • Cover crops
Working Watersheds: Buffers and Beyond™	Cost-share for project planning, planting, and maintenance.	http://www.treesforever.org/Working_Watersheds	• Riparian buffer • Prairie STRIPS
Illinois Buffer Partnership™	Cost-share for demonstration site projects.	http://www.treesforever.org/Illinois_Buffer_Partnership	• Riparian buffer
Private Landowner Network	Funding search tool. Additional programs available for private landowners.	http://www.privatelandownernetwork.org/grantprograms/	• Windbreak/shelterbelt • Hedgerow • Riparian buffer • Prairie STRIPS • Grassed waterways • Silvopasture • Timber production • Fruit/nut crop • Perennial forage/grazing • Cover crops

Perennial Forage in the Crop Rotation

A crop rotation that delivers soil health, resiliency, and reduced N leakage from the cropping system is an *extended* rotation.

Extended Crop Rotation

An extended crop rotation is longer than a two-year alternation between corn and soybean.

Extended Rotation Benefits

- Reduce erosion
- Reduce N leakage
- Reduce fossil fuel use
- Break up pest cycles
- Reduce purchased N fertilizer
- Improve soil health

Examples of extended crop rotations:

- Rotation into alfalfa for a minimum of one year
- Rotation into oats + alfalfa for a year followed by alfalfa for at least one additional year
- Rotation into some other crop than corn or soybean (a "Third Crop;" see Rural Advantage, http://ruraladvantage.org/programs/third-crops/)

Perennial forage is a highly beneficial addition to a crop rotation. It puts roots in the ground that are alive all year round, although they may be dormant part of the year. Living roots in the ground anchor soil in place more effectively than any other erosion prevention practice.

Alfalfa is generally the perennial forage type with the highest market value and thus the forage that has been most studied in cropping systems trials. Other perennial forage

species or forage mixtures can be equally beneficial in terms of improving soil health, capturing nutrients, and preventing erosion.

Research at Iowa State University and the University of Minnesota has demonstrated that a 3- or 4-year extended rotation is similar in profitability to a 2-year corn/soybean cropping system. Year-to-year variations in crop prices, input costs, and weather will determine which system is more profitable in any given year.

Marsden Farm Research, Iowa State University, average of years 2006-2011			
	Cropping System		
	2-year corn/soybean	3-year corn/soybean/oat	4-year corn/soybean/oat+alfalfa/ alfalfa
Corn yield (bu/ac)	194	199	202
Soybean yield (bu/ac)	50	55	57
Return to mgmt. ($/ac)	$188	$194	$171

The Marsden Farm study included use of manure on all corn acres for the cost of hauling and spreading.

Source: *Energy and Economic Returns by Crop Rotation***.** September 2012. Ann M. Johanns, Craig Chase, and Matt Liebmann. Iowa State University Extension. www.extension.iastate.edu/agdm/crops/html/a1-90.html

Variable-Input Crop Management Study (VICMS), University of Minnesota, average of years 1993-1999		
	Cropping System on soil with high initial fertility	
	2-year Corn/soybean	4-year Corn/soybean/oat+alfalfa/ alfalfa
Corn yield (bu/ac)	139	139
Soybean yield (bu/ac)	40.7	43.1
Alfalfa yield (tons/ac)		5.11
Net Return ($/ac)	$153	$172

Sources:

Long Term Effects of Crop Management: Yield. Results from the VICMS study at the Southwest Research and Outreach Center, Lamberton, Minnesota. http://swroc.cfans.umn.edu/prod/groups/cfans/@pub/@cfans/@swroc/documents/asset/cfans_asset_236359.pdf

Long Term Effects of Crop Management: Profitability. Results from the VICMS study at the Southwest Research and Outreach Center in Lamberton, Minnesota http://swroc.cfans.umn.edu/prod/groups/cfans/@pub/@cfans/@swroc/documents/asset/cfans_asset_236361.pdf

These calculations of crop rotation profitability do not account for the less direct and long-term benefits of an extended rotation, such as reduced soil erosion leading to increased future productivity; or reduced N leakage from the system.

Placement of Crop Rotations to Reduce Soil Erosion

Research in Iowa has shown that matching length of the crop rotation to the slope of the ground is successful at reducing erosion below the "tolerable rate," T (5 tons/acre/year of soil loss).

Annual Row Cropping on slopes >15% can lead to soil loss of 80 tons/acre/year: 16 times the tolerable rate.

% Slope	Crop Selection for Soil Loss < T
< 5%	2-year corn/soybean
5% - 14%	6-year corn-soybean-corn-oat+forage-forage-forage
>14%	Permanent perennial forage

The crop rotations featured in this research were selected to represent crops that would accompany a shift toward more livestock in the region. Other crops with similar

characteristics could be chosen. For instance, wheat could be substituted for oats. A permanent agroforestry planting could take the place of permanent perennial forage on steeper slopes.

Landscape Impacts of Strategic Placement of Crop Rotations

In the same study, Iowa researchers modeled soil loss at the watershed scale for a region of 26 watersheds in western Iowa. Shifting the entire region to the cropping systems matched to slope was successful at reducing soil loss below T for the whole region; and also reduced nitrate-N leakage in all watersheds.

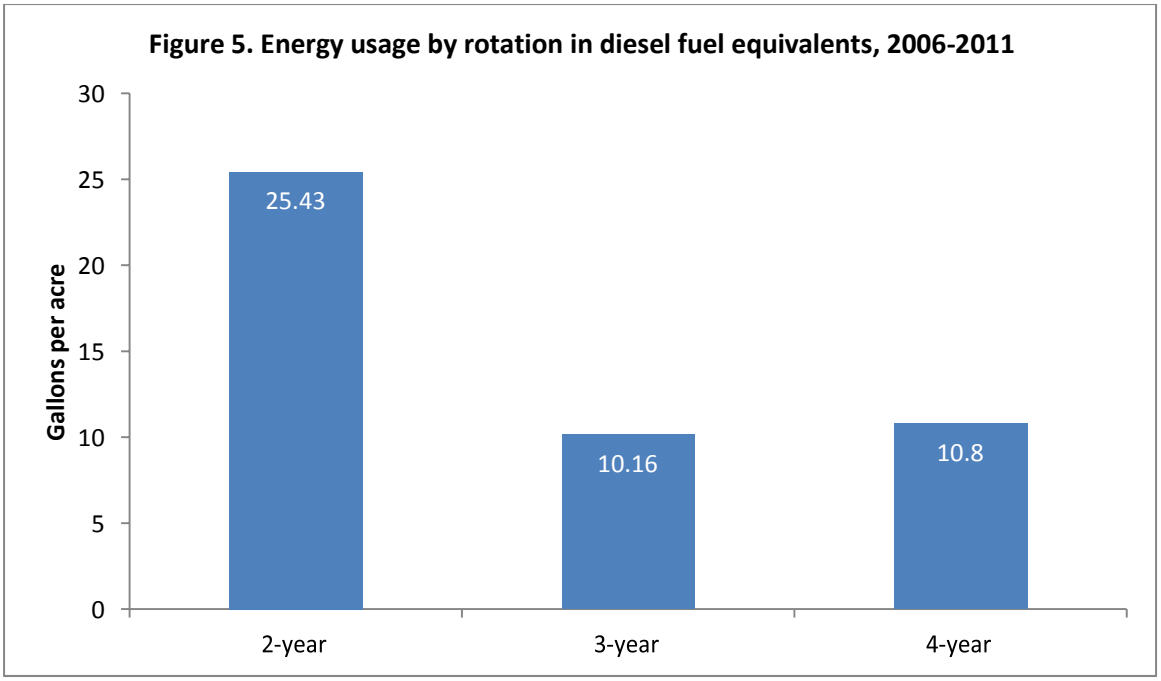
	Current system: heavily row-cropped	**Alternative system: matching cropping system to slope**
Annual soil loss range	2 to 10 tons/acre/year	0.5 to 2.5 tons/acre/year
Annual N leakage range	9 to 27 lbs./acre/year	< 9 to 18 lbs./acre/year

Reference:

Impacts of integrated crop-livestock systems on nitrogen dynamics and soil erosion in western Iowa watersheds. 2005. Burkart, M., D. James, M. Liebman, and C. Herndl. J. Geophys. Res., 110, G01009, doi:10.1029/2004JG000008.

Reduction in Purchased Inputs

The Iowa State University's Marsden Farm study showed a clear reduction in the amount of fossil fuel required for an extended rotation when compared to a two-year corn-soybean rotation. Figure 5 from the publication, "Energy and Economic Returns by Crop Rotation," is reprinted here:



The diesel fuel equivalent calculated for each rotation included the direct use of diesel fuel to run field equipment and the use of energy for grain drying; plus the energy embedded in other inputs: seed, N-P-K fertilizer, herbicides, insecticides.

Source: Energy and Economic Returns by Crop Rotation. Ann Johanns, Craig Chase, and Matt Liebman. 2012. http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2012-09-energy- and-economic-returns-crop-rotation.pdf

Nitrogen Supply from Perennial Forage

A good stand of alfalfa on medium-textured soil can provide up to 190 lbs./acre of N to the subsequent corn crop. This amount is reduced if the stand is poorer or the soil is sandy.

Because breakdown of plant matter in the soil takes place gradually over time, the plowed-down alfalfa crop will also supply nitrogen to the second year of corn after the alfalfa is plowed down. The fair stand of alfalfa on medium-textured soil could supply 50 lbs./acre of nitrogen to the second-year corn.

Other legumes besides alfalfa can also supply significant N. Red clover and birdsfoot trefoil stands can supply approximately 80% of the N supplied by a comparable alfalfa stand. Sweetclover, red clover, vetch, and peas used as a plow-down crop also supply N.

See *Using Legumes as a Nitrogen Source* (below) for more detail about calculating the N credit from legume crops.

Source: Using Legumes as a Nitrogen Source. June 1997. L.G. Bundy, K.A. Kelling and L. Ward Good. University of Wisconsin Extension, publication #A3517. http://ipcm.wisc.edu/download/pubsNM/Usinglegumes.pdf

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Soil Health

Research at the University of Minnesota's Southwest Research and Outreach Center at Lamberton, MN showed a clear advantage to a four-year crop rotation in several measures of soil health.

In either a high-input or low-input system that included moldboard plowing, merely shifting from a two-year corn-soybean rotation to a four-year corn-soybean-oat+alfalfa – alfalfa system caused an increase in each of five indicators of soil health.

A change to a four-year rotation plus reduced tillage resulted in even larger increases in percentage of stable aggregates, total carbon, and microbial carbon.

Indicators of soil health measured in this study:

• Total organic carbon

an estimate of total soil organic matter

• Mineralizable nitrogen

a measure of the amount of plant available N that can be released over time from the soil organic matter

• Particulate organic matter

an estimate of "active" organic matter

• Large stable aggregates

A measure of how well the soil holds together. Aggregate stability affects workability, root growth, and water infiltration.

• Microbial biomass carbon

an estimate of the number of microorganisms in the soil

Source: Long-Term Effects of Crop Management: Soil Quality
http://swroc.cfans.umn.edu/prod/groups/cfans/@pub/@cfans/@swroc/documents/asset/cfans_asset_236360.pdf

Cover Crops

photo from Mark Zumwinkle, Minnesota Department of Agriculture

Cover crops keep soil covered and keep living roots in the ground at times of the year when a corn, soybean, or small grain crop is not present and growing.

Late fall after harvest, winter, and early spring before planting are very high-risk times for soil loss and nutrient loss from fields. Heavy fall or spring rains, spring snowmelt, and winter winds can erode soil from fields that have little protection, causing large losses of nutrients and soil. Covering the soil year round keeps our Midwestern soil, our "black gold," in place and producing high yielding crops for the future. Reduced tillage helps reduce soil losses, but anchoring soil with the roots of a cover crop helps even more.

Know your goals for a cover crop before getting started. Determine if you want to use cover crops to reduce nitrogen loss, protect from wind erosion or provide nutrients for a cash crop. Set your cover crops up for success by determining your goals before you start, and then select species that help accomplish your goals.

Placing Cover Crops

- Use cover crops with corn-soybean rotations on slopes <5% to scavenge N and reduce N leakage
- Use cover crops on slopes <5% to reduce wind erosion
- Use cover crops with corn-soybean production on 5% to 14% slopes to reduce sheet, rill, and gully erosion

Adapted from: Impacts of integrated crop-livestock systems on nitrogen dynamics and soil erosion in western Iowa watersheds. 2005. Burkart, M., D. James, M. Liebman, and C. Herndl. J. Geophys. Res., 110, G01009, doi:10.1029/2004JG000008.

Roots in the Ground

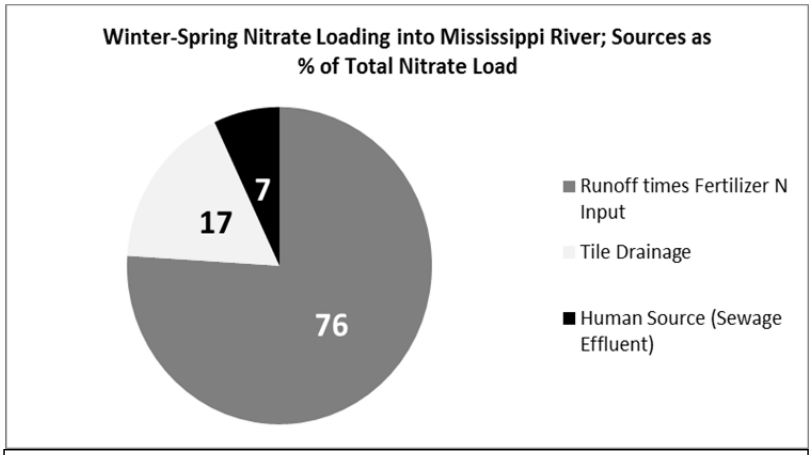
> "Always take a shovel with you. You will likely be surprised!"
>
> Dave Robison, plantcovercrops.com

Cover crops improve the soil and reduce nutrient loading to surface waters by keeping roots in the ground year-round. Living roots are key. Don't be disappointed if you only see short cover crop plants aboveground. The aboveground appearance may not show much growth, but the roots can be surprisingly well-developed below ground. Because of deep roots, the cover crop can do its jobs of capturing nitrogen before it leaches out of the soil profile; and of slowing overland flow of water, allowing water to better infiltrate into the soil.

Dave Robison, an agronomist working on cover crops in the Midwest, has found 21" roots under 4" high annual ryegrass tops. (http://plantcovercrops.com/short-cover-crops-put-down-deep-roots/)

Cover Crop Prevention of N Leakage: Scavenging

Winter cereal rye, with its fibrous roots, is a good scavenger of nitrogen. The tile drainage studies listed in the table on the next page showed a 26% to 61% reduction in nitrates in drainage water when a winter cereal rye cover crop was used. Tile drainage water accounts for 17% of the nitrate flowing into the Gulf of Mexico, as shown in the chart below; so reducing nitrates from tile drainage water has potential to make a difference in surface water quality.

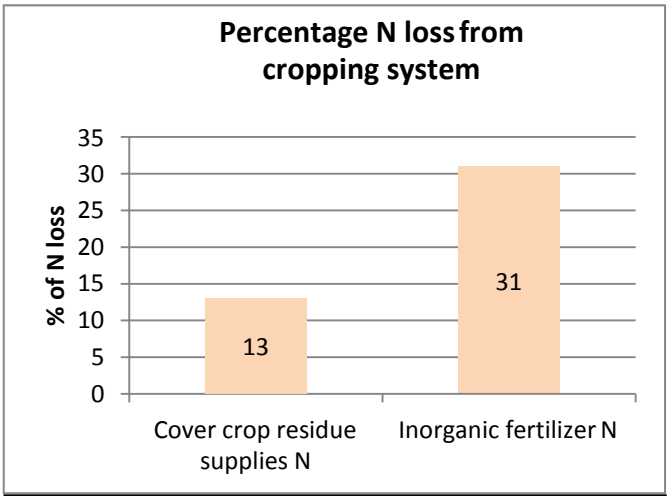


Source: *Sources of nitrate yields in the Mississippi River Basin*. 2010. Mark B. David, Laurie E. Drinkwater and Greg F. McIsaac. Journal of Environmental Quality. 39(5):1657-67.

Reduction in nitrate concentration in drainage water from corn/soybean systems with cover crops: three studies		
Study description	$N0_3$ reduction with cover crop:	Citation
Spring-applied UAN vs. Spring-applied UAN+winter cereal rye cover crop	26%	Drainage water quality impacts of current and future agricultural management practices. Leopold Center for Sustainable Agriculture Competitive Grant Report XP2011-14. http://www.leopold.iastate.edu/sites/default/files/grants/XP2011-04.pdf
Winter cereal rye cover crop Fall oat cover crop Cover crops used on both corn and soybean crops	48% 26%	Effectiveness of oat and winter cereal rye cover crops in reducing nitrate losses in drainage water. 2012. T.C. Kaspar, D.B. Jaynes, T.B. Parkin, T.B. Moorman, J.W. Singer. Agricultural Water Management 110 (2012) 25–33. http://naldc.nal.usda.gov/naldc/download.xhtml?id=54466&content=PDF
Winter cereal rye cover crop + no-till over 4 years	61%	Winter cereal rye cover crop and gamagrass strip effects on NO_3 concentrations and load in tile drainage. 2007. T.C. Kaspar, D.B. Jaynes, T.B. Parkin, T.B. Moorman. *Journal of Environmental Quality*. 36(5):1503-11 http://naldc.nal.usda.gov/download/14937/PDF

Cover Crop Prevention of N Leakage: Green Manure for Slow Release of N

Legume cover crops or mixtures of legumes with small grains and/or broadleaf plants that are plowed down as a green manure can release significant N back to a subsequent corn crop.



Source*: Using Cover Crops and Cropping Systems for Nitrogen Management*. Chapter 9 in *Advances in Nitrogen Management for Water Quality*. Edited by Jorge A. Delgado and Ronald F. Follett. 2010, 424 pages, hardcover. Soil and Water Conservation Society. ISBN 978-0-9769432-0-4. http://www.swcs.org/documents/filelibrary/advances_in_nitrogen_management_for_water_quality/ANM9_A41356AAD3B6A.pdf

Use of cover crops as green manure can also reduce N leakage from the cropping system because the slow release of N from decomposing cover crops results in greater percentage uptake of released N by the subsequent crop. Use of cover crops as a green manure may require different management practices than use of cover crops for soil protection, however. Green manures require a longer growth period to build up biomass, and then timing of cover crop termination so that the green manure crop residue is breaking down and releasing N at the same time that the subsequent crop is growing and taking up N. This slow release of N from the decomposing green manure crop, synchronized with the cash crop's uptake of N, results in very little loss of N from the system. As the chart shows, using green manures as the N source for subsequent crops results in an average loss of 13% of the N from the cropping system, compared to an average loss of 31% of the N if synthetic fertilizers are the source of N.

Estimate the N contribution from a green manure cover crop:				
	Baseline, 2000 lbs. biomass/acre	Inches over baseline * lbs./in.	% cover	% N in above-ground biomass
Legume - preflower	100% cover, 6”	(in * 150 lbs./ac)	estimate	3.5 – 4
Legume – flower	100% cover, 6”	(in * 150 lbs./ac)	estimate	3.0 – 3.5
Grasses (small grain)	100% cover, 6”	(in * 300 lbs./ac)	estimate	2.0 – 3.0
Cereal Winter cereal rye	100% cover, 8”	(in * 150 lbs./ac)	estimate	2.0 – 3.0
Brassicas & others	100% cover, 6”	(in * 300 lbs./ac)	estimate	1.5 – 2.5

Formula: [2000 lbs./acre + (inches over baseline*lbs./in.)] * (% cover/100) * (% N/100)

= Lbs./acre of N supplied by the cover crop

Source: Building Soil Fertility. In: *Managing Cover Crops Profitably*. 2007. Marianne Santiano. Sustainable Agriculture Research and Education (SARE), USDA. http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Building-Soil-Fertility

Cover Crop Plant Categories

Single-species cover crop plantings are often used in corn and soybean production. Winter cereal rye, particularly, is popular with corn and soybean producers because it can germinate and grow even if planted quite late in the season, so it allows farmers more flexibility to plant the cover crop and get stand establishment after crop harvest. The experience of Fred Abels with winter cereal rye (sidebar) is a good example of the use of winter cereal rye with corn. Multi-species mixes also have a place, and many farmers are finding that diversity of plant species confers benefits. These mixes are easier to establish and have more time to grow following shorter season crops like oats, winter wheat, vegetable crops, or corn silage.

Check with local cover crop experts, or do your own on-farm testing, to ensure that the cover crop resource you choose is appropriate for your climate, cropping system, and goals. Cropping system differences, rainfall and growing degree days can differ even from farm to farm in the same area. When looking at research results, check where the research occurred before implementing a cover crop plan for your area.

Fred Abels, farmer near Holland, IA:

In fall of 2013 we put in winter cereal rye on silage acres after the crop had been taken off. We had had no rain and this was prior hay ground with very hard-packed soil. The seeder didn't get the winter rye into the ground very well and we had a weak stand.

Spring of 2014, I was side-dressing 50 pounds of nitrogen fertilizer on four-inch corn. There was some very hard soil; I took a whole bag of shear bolts with me because they were breaking often. When I got to the field that had had the cover crops, I didn't break a single shear bolt on that field. Then we sent in some soil samples as part of hosting a field day, and could clearly see the benefit of the winter rye cover crop in the soil test report.

My cousin's husband in northern Iowa had winter rye flown on 100 acres in the fall two years ago. Last year he said the soil was so mellow in the fall, he could move one mile per hour faster through the field at harvest.

This fall, we're putting a winter rye cover crop on 100% of our corn and bean acres.

There are many ways to group cover crops into categories with different characteristics to choose from. Here's one example of a list of types:

*Cool-season summer annual grasses
* Warm-season summer annual grasses
* Winter annual grasses
* Winter annual broadleaves
* Annual Legumes
* Biennial Legumes
* Perennial Legumes
* Tap-rooted Brassicas
* Fibrous-rooted Brassicas
* Other broadleaves

Summer annual grasses sprout from seed in the spring, produce a seed crop during the summer, and die in the fall. Warm-season grasses like corn, sorghum, and sudangrass produce a greater volume of biomass than cool-season

Kent Solberg, farmer and Cover Crop Champion with the National Wildlife Federation:

"You need to understand the characteristics of the plant options that are available – the basic principles of what the crops do for you. Some are doing a 'shotgun' approach of planting whatever seed is handy, and being disappointed. We're doing better with carefully selected, complex mixtures of cover crops."

grasses like oats and annual ryegrass.

Winter annuals are planted and sprout from seed in the fall, grow until going dormant for the winter, then start growth again in the spring and produce a seed crop in the late spring or early summer if allowed to mature. Winter annual grasses include winter cereal rye, winter barley, and winter wheat. Winter annual broadleaves include pennycress.

Legumes are plants that form root nodules containing *Rhizobium* species of bacteria, which collect atmospheric nitrogen and convert it into an organic form of nitrogen within those root nodules. Annuals sprout from seed and mature and produce seed in one year. Biennials are vegetative-only for their first year of growth, and mature and produce seed in the second year. Perennials live for multiple years. Some may not produce seed in the first year.

Brassicas are plants related to mustard and turnips. Winter canola is a winter annual brassica, but most are summer annuals. They are distinguished primarily by rooting behavior: tap-rooted brassicas like oilseed radish produce a long and fleshy root, while fibrous-rooted brassicas like canola produce a dense mat of roots.

Other broadleaves include plants like chicory, buckwheat, sunflower, and sunn hemp that vary greatly in their growth habits.

Resources for Cover Crop Selection

Midwest Cover Crop Council Crop Descriptions
http://www.mccc.msu.edu/CCinfo/cropbycrop.html

Midwest Cover Crop Council's Cover Crop Selector Tool
http://mcccdev.anr.msu.edu/VertIndex.php

Cover Crop Chart. USDA-ARS Northern Great Plains Research Laboratory, Mandan, ND.
http://www.ars.usda.gov/main/docs.htm?docid=20323

SmartMix Calculator from Green Cover Seed
https://greencoverseed.com/

Managing Cover Crops Profitably, 3rd Edition. http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

Cover Crop Establishment and Cost

A 2015 publication on use of cover crops in soybean production suggests three main windows of opportunity to plant cover crops that are intended to provide cover following the fall harvest of a cash crop:

- Early-season interseeding
- Before harvest of the cash crop
- After harvest of the cash crop

Early-season interseeding is identified as an experimental practice in that publication.

Source: *Integrating Cover Crops in Soybean Rotations: Challenges and Recommendations for the North Central Region*. 2015. Midwest Cover Crops Council. www.mccc.msu.edu/documents/2015Integrating_CoverCrops_Soybeans.pdf

Before harvest of the cash crop:

In northern climates, cover crops often need to be seeded into a standing crop of corn or soybean (overseeding) in order to have enough time to establish and grow before winter. Successful cover crop establishment with this method depends on proper timing of the seeding, based on a combination of rainfall, competition with the main crop, and calendar date. Overseeding either too early or too late can result in poor establishment.
Typical overseeding methods:

- Aerial seeding into the standing crop with a plane or helicopter; many have dry boxes that can be used for cover crop seed with no modifications.
- Seeding with high-clearance equipment into the standing crop.

Equipment options for seeding cover crops are evolving rapidly. A very few years ago, "overseeding" always meant broadcasting of seed. Now, high-clearance equipment that can do some incorporation of the seed is under development.

Prototype seeding equipment under development.
Photo credit: M. Scott Wells, University of Minnesota

After harvest of the cash crop:

Good cover crop establishment typically results from good to soil-to-seed contact. Planting cover crop seed with a drill or inter-planter after the cash crop is harvested is a reliable way to achieve that. If labor is available, then drilling can be an inexpensive option.

Soybean harvest is often early enough to allow an opportunity for post-harvest planting of a cover crop. Corn silage, seed corn, small grains, and other early maturing crops also provide opportunities.

Seeding cover crops after cash-crop harvest does not always result in a better stand than overseeding into the standing cash crop. A Practical Farmers of Iowa study showed that aerial seeding into the standing crop resulted in a better fall stand and better spring stand of the cover crop than drill seeding after soybean harvest. The aerial-seeded cover crop did better because it had a longer time to establish. A key point, though, is that rainfall was adequate following the aerial seeding. Lack of rainfall can be the biggest limitation to an overseeded cover crop.

Comparison of aerial seeding vs. post-harvest drilling for establishment of a hairy vetch, cover crop radish, and rapeseed mixture		
	Aerial-seeded	Drilled post-harvest
Fall biomass (lbs./acre)	43	29
Spring biomass (lbs./acre)	527	348
Subsequent corn yield (control with no cover crop = 175 bu/ac)	179	179
Source: Aerial seeding versus drill seeding cover crops: Updated with corn yield observations. Sarah Carlson, Stephan Gailans, and McGrew Brothers' Farm. http://practicalfarmers.org/farmer-knowledge/research-reports/2013/aerial-seeding-versus-drill-seeding-cover-crops-updated-corn-yield-observations/		

Early planting of the cover crop is desirable if the goals include scavenging N. The longer time a cover crop like winter cereal rye has available to grow, the more soil N it can take up and prevent from leaching.

Cost of planting cover crops varies depending on the species selected for the cover crop mix, local rates for seed, and local rates for seeding. An example of costs from Allamakee County, Iowa in 2012:

- $20 to $35 per acre for cover crop seed blend
- $15 per acre for aerial seeding into standing corn or soybean crop
- Total: $35 to $50 per acre to establish a cover crop

Source: Aerial Seeding Cover Crops. 2012. Allamakee Soil & Water Conservation District. http://allamakeeswcd.org/aerial-seeding-cover-crops/

Cover Crop Termination and Cost

Cover crop termination may produce more farmer anxiety than cover crop establishment. Terminate too early, and you risk bare soil during spring rains as well as loss of some of the N that is held in the cover crop. Terminate too late, and you risk delayed planting of the cash crop, as well as too much N tie-up in the cover crop residue; although the early-season N tie-up can be mitigated by the addition of a starter N fertilizer when planting. Farmers terminating a cover crop too late need to make sure their planter settings are prepared for increased residue. Increased down pressure may be needed to have good soil to seed contact.

Many farmers associate their cost of termination with regular spring weed management and seed bed preparations. If there is a desire to separate the cover crop costs, the cost of termination will vary with local rates, but has been estimated at:

- $16/ac for termination by tillage
- $7/ac for ground spraying
- $10/ac for aerial spraying

Source: 2013 Iowa Farm Custom Rate Survey. March 2013. William Edwards, Ann Johanns, and Andy Chamra. In *Ag Decision Maker*, Iowa State University Extension and Outreach. www.extension.iastate.edu/agdm/crops/pdf/a3-10.pdf

Of course, cover crops that winter-kill do not need to be terminated in the spring. Many cover crops like spring cereals or brassicas do not overwinter in the upper Midwest.

Follow USDA agency guidelines on cover crop termination in order to remain eligible for crop insurance and stay in compliance with conservation programs:

Cover Crops – Iowa, Minnesota, and Wisconsin. January 2014. Risk Management Agency Fact Sheet.
http://www.rma.usda.gov/fields/mn_rso/2014/covercrops.pdf

Crop Insurance, Cover Crops and NRCS Cover Crop Termination Guidelines FAQs
http://www.rma.usda.gov/help/faq/covercrops2015.html

Cover Crops, Yield, and Drought Resiliency

Three years of survey results from farmers who use cover crops have documented consistent reports of a yield increase in the corn and soybean crops following a cover crop. In the most recent survey year, 2014, there was a statistically significant increase of 3.7 bu/ac corn yield (2.1% increase), and 2.2 bu/ac soybean yield (4.2% increase), for these crops planted after cover crops.

Source: *2014-2015 Annual Report: Cover Crop Survey*. 2015. Steve Werblow. Conservation Technology Information Center, Sustainable Agriculture Research and Education Program, and American Seed Trade Association. http://www.sare.org/Learning-Center/From-the-Field/North-Central-SARE-From-the- Field/2015-Cover-Crop-Survey-Analysis

Survey results in the Corn Belt in late 2012, a year of widespread drought, showed that fields that had cover crops in the previous season had even higher percentage yield increases than fields without cover crops. This report is suggestive of the potential of cover crops to mitigate the effects of drought on crop yields, although replicated research trials in that year did not show a similar result.

Survey results from 234 farmers reporting corn yields and 196 farmers reporting soybean yields from the 2012 crop year.		
	Corn	Soybean
	Bu/ac	Bu/ac
With cover crops	126.2	47.1
Without cover crops	115.1	42.2

Source: *2012-2013 Cover Crop Survey*. June 2013. Steve Werblow and Chad Watts. Conservation Technology Information Center (CTIC) and North Central Region SARE. www.ctic.org/media/pdf/Cover%20Crops/SARE-CTIC%20Cover%20Crop%20Survey%202013.pdf

Cover Crops and the Forage Chain

Cover crops seeded into corn (especially corn silage), soybean, or small grain fields can be a source of livestock feed in the late fall or early spring. Depending on the crop and the season, cover crops can supplement or replace stored forage at those times of year; or allow pastures to recover.

Cover crop mixtures seeded in the spring as a transition from row cropping to a perennial forage stand can be grazed in mid-summer when other forages may be growing more slowly

due to heat and dry soil. This can be useful for giving pastures a break during the "summer slump" in forage production.

Practical Farmers of Iowa has a series of reports available describing options for using cover crops as livestock feed:

Grazing Cover Crops. 2013. Margaret Dunn, Practical Farmers of Iowa. http://practicalfarmers.org/farmer-knowledge/research-reports/2013/grazing-cover-crops/

Grazing Cover Crops on Corn Ground. 2014. Margaret Dunn, Practical Farmers of Iowa. http://practicalfarmers.org/farmer-knowledge/research-reports/2014/grazing-cover-crops-corn-ground/

Kent Solberg (Verndale, MN) plans his cover crop mixes so that he can graze the cover crops and also use them to establish a perennial forage crop. Warm-season grasses like corn, millet and sorghum provide high productivity of forage for grazing during the mid-summer. Cool-season small grains are good nurse crops for establishing a perennial forage. Brassicas like turnip provide late-season forage. Legumes supply nitrogen to the soil. His current cover crop mix for pasture renovation includes 12 species.

Grazing Cover Crops for Winter Feed. 2014. Margaret Dunn, Practical Farmers of Iowa. http://practicalfarmers.org/farmer-knowledge/research-reports/2014/grazing-cover-crops-winter-feed/

Lease Considerations for Grazing Cover Crops on Non-Owned Land. 2013. Margaret Dunn, Practical Farmers of Iowa. http://practicalfarmers.org/farmer-knowledge/research-reports/2013/lease- considerations-for-grazing-cover-crops-on-non-owned-land/

Support for Cover Cropping

There's an awful lot of information available about cover crops. There are also experts available to help sort through the information; and a handy pocket-sized field guide to cover crops for times when it's hard to access a website. Directories of cover crop service providers are also available.

Cover Crop Business Directory. 2015. Practical Farmers of Iowa. http://practicalfarmers.org/wp-content/uploads/2015/05/PFI-Cover-Crop-Business- Directory-2015.pdf

Cover Crop Field Guide, pocket-sized printed booklet. 2012. The Midwest Cover Crop Council and Purdue University; available for $5 per copy: https://ag.purdue.edu/agry/dtc/Pages/CCFG.aspx

Cover Crops Resource Websites, Publications and Contact People. Green Lands Blue Waters. http://greenlandsbluewaters.net/strategies/cover-crops

Illinois Cover Crops: Directory of Businesses. 2014. Illinois Stewardship Alliance. http://www.agr.state.il.us/covercrops/businessdirectory.pdf

Minnesota Cover Crop Business Directory. 2014. University of Minnesota Extension. http://www.mccc.msu.edu/states/Minnesota/2015.MN.Cover.Crop.Business.Directory.pdf

Agroforestry

photo from National Agroforestry Laboratory

Potential value of agroforestry practices	
Direct profit potential	• Fruit, nut, or timber crop for sale (pays for itself) • Diversify farm enterprise • Improved animal productivity • Increased crop yields
Indirect benefits	• Hold nutrients • Prevent soil erosion • Carbon sequestration • Reduce energy consumption • Increase property values • Suppression of insect pest and weed populations • Greater resiliency during drought or floods • Products for use by farm family
Community and compliance benefits	• Reduce soil and nutrient load into surface waters • Proactive compliancy with potential water regulations
Quality of life benefits	• Bird, pollinator, and wildlife habitat • Fruit crop for farmers' use • Aesthetic and recreational opportunities

Read a more in-depth look at agroforestry as a strategy for resilience in the face of climate and weather related stress here:

Climate Risk Adaptation by Smallholder Farmers: The Roles of Trees and Agroforestry. Lasco, R.D., R.J.P. Delfino, D.C. Catacutan, E.S. Simelton, and D.M. Wilson. 2014. Curr. Opin. Environ. Sustain. 6: 83–88
http://www.sciencedirect.com/science/article/pii/S1877343513001619

Add the following practices to crop and livestock production in any combination:

Alley Cropping

- Two or more sets of single or multiple rows of trees or shrubs at wide spacings.
- Create alleys within which agricultural, horticultural, or forage crops are cultivated.
- Valuable hardwood species, such as nut trees, or trees desirable for wood products.
- Shrubs can provide nuts, fruit or other products.
- Sometimes called intercropping and multi-cropping.

Alley cropping; photo from "Training Manual for Applied Agroforestry Practices" Chapter 3: Alley Cropping. The Center for Agroforestry, University of Missouri

More information about Alley Cropping and how to implement this practice on the farm:

Training Manual for Applied Agroforestry Practices – 2015 Edition
http://www.centerforagroforestry.org/pubs/training/chap3_2015.pdf

Link to National Agroforestry Center alley cropping publications:
http://nac.unl.edu/alleycropping.htm

Example: Alley cropping

The two photos below show establishment of an agroforestry planting in strips through cropland. Annual row crops are planted in the spaces between woody-species rows.

Photos from Jason Fischbach, Univ. of WI-Extension

Silvopasture

- Combines trees with forage and livestock production.
- Establish trees into an existing pasture, or establish forages in the woods.
- Improved nutrient cycling.
- Diversified farm enterprise.
- Improved growth of high quality trees.
- Improved animal productivity.
- Enhanced wildlife habitat.
- Grazing can enhance tree growth.
- Economical control of weeds and brush without herbicides.
- Maintains fire breaks.
- Reduces habitat for gnawing rodents.
- Livestock manure recycles nutrients to trees and forage.
- Trees have a climate-stabilizing effect to reduce heat stress and windchill of livestock.
- Trees can cut the direct cold effect by 50% or more and reduce wind velocity by as much as 70%.
- Livestock require less feed energy, so their performance is improved and mortality is reduced.

Silvopasture; photo from "Training Manual for Applied Agroforestry Practices" Chapter 4: Silvopasture. The Center for Agroforestry, University of Missouri

More information and how to implement Silvopasture on the farm:

Training Manual for Applied Agroforestry Practices – 2013 Edition. The Center for Agroforestry, University of Missouri
http://www.centerforagroforestry.org/pubs/training/chap4_2015.pdf

Silvopasture. National Agroforestry Center.
http://nac.unl.edu/documents/workingtrees/brochures/wts.pdf

Silvopasture online course. National Agroforestry Center.
http://www.silvopasture.org/about.html

Productive Windbreaks

Properly placed rows of trees and/or shrubs of sufficient height to create a wind shadow:

- Increase production.
- Reduce wind erosion.
- Shelter livestock and crops.
- Capture water runoff and nutrients.
- Provide wildlife habitat.
- Protect structures
- Disperse snow.
- Improve aesthetics and property value.
- The USDA-NRCS estimates a 10% to 25% energy savings from having a good windbreak around your home.
- Can pay for themselves by providing a harvestable crop.

Windbreaks; photo from "Training Manual for Applied Agroforestry Practices" Chapter 6: Windbreaks. The Center for Agroforestry, University of Missouri

More information and how to implement Productive Windbreaks on the farm:

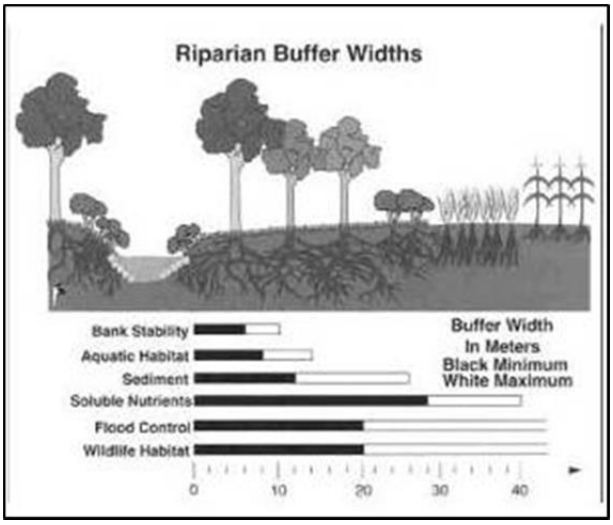
Training Manual for Applied Agroforestry Practices – 2013 Edition. The Center for Agroforestry, University of Missouri.
http://www.centerforagroforestry.org/pubs/training/chap6_2015.pdf

Living Snow Fences: Functions and Benefits. University of Minnesota | Extension
http://www.extension.umn.edu/environment/agroforestry/components/UMN-Extension-LivingSnowFences.pdf

Iowa State University – Extension and Outreach publications.
https://store.extension.iastate.edu/ProductList?Keyword=windbreaks

Forest Buffers

- Permanent strips of trees, shrubs, and grasses.
- Strategically placed on the landscape for multiple benefits.
- Riparian buffers between agricultural land and water bodies reduce runoff and non-point source pollution.



Riparian Buffer Widths; from "Training Manual for Applied Agroforestry Practices" Chapter 5: Upland & Riparian Forest Buffers. The Center for Agroforestry, University of Missouri

- Upland forest buffers are narrower and are located in areas to reduce erosion, non-point source pollution, and to prevent gully formation.
- Increase carbon storage in soils.
- Create wildlife habitat.
- Stabilize eroding stream banks.
- Provide a harvestable crop of timber, fiber, forage, or fruit.

Additional benefits include improved water infiltration rates, habitat for beneficial insects, and wind impact reduction.

More information and how to implement Forest Buffers on the farm:

Training Manual for Applied Agroforestry Practices – 2013 Edition. The Center for Agroforestry, University of Missouri. http://www.centerforagroforestry.org/pubs/training/chap5_2015.pdf

Establishment of Riparian Forest Buffers. University of Minnesota | Extension http://www.extension.umn.edu/environment/agroforestry/riparian-forest-buffers-series/establishment-of-riparian-forest-buffers/

Conservation Buffers. National Agroforestry Center. http://nac.unl.edu/buffers/index.html

Lon Strum, Story County, Iowa: "…The buffer has also added to our wildlife habitat. This is the hunting paradise of Story County right here, especially for pheasant hunting. People have come from Alaska, Michigan, and all over Iowa. The demand is very large."

Ron Risdal Grows corn and soybeans on his 1,000 acre farm in Story County, IA. Since installing a riparian buffer, he no longer loses crops during wet years and no longer gets his tractor stuck.

Source: "Training Manual for Applied Agroforestry Practices" Chapter 5: Upland & Riparian Forest Buffers. The Center for Agroforestry, University of Missouri

Incorporating STRIPS

More information about STRIPS:

http://www.leopold.iastate.edu/strips-research-team

Research at Iowa State University shows that by strategically converting as little as 10 percent of a row-cropped field to perennial prairie—in narrow patches along contours and foot slopes – farmers and landowners can:

- ✓ Reduce sediment movement off field by 95 percent
- ✓ Reduce total phosphorus loss by 90 percent
- ✓ Reduce total nitrogen loss by nearly 85 percent.

STRIPS pay for themselves by saving soil and nutrients. Make them profitable by adding a saleable woody species crop.

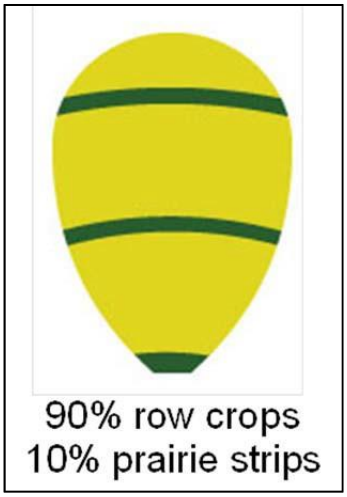


Photo from Matt Helmers, Iowa State University

Create wildlife habitat with agroforestry practices

- Increased number of pollinators
- Predatory insects and bats control pest insects
- Predators prey on seed-eating mice
- Game species to be enjoyed by farmer or income from leasing land to hunters
- Improved water quality for game fish

Agroforestry practices can be used to reduce the negative consequences of fragmentation by lessening habitat isolation through the use of plantings that are well thought out and well-connected with other habitats.

Note: the creation of habitat may attract undesirable wildlife as well as desirable. Additional management may be required to strike the right balance on the farm.

Create winter habitat for pheasant:

http://www.extension.umn.edu/environment/agroforestry/docs/winter-habitat-for-pheasants-2012.pdf

Plants that support pollinators:

http://www.xerces.org/fact-sheets/

https://plants.usda.gov/pollinators/NRCSdocuments.html

Restore an existing agroforestry practice

More information on evaluating and renovating an existing agroforestry practice:

Great Plains Windbreak Renovation and Innovation Conference. National Agroforestry Center.
http://nac.unl.edu/multimedia/conferences/Great_Plains/windbreakrenovation20120724.htm

Fruit & Nut Crops in Agroforestry Plantings

Fruits and nuts hardy to the upper Midwest:

Minnesota Hardy http://www.extension.umn.edu/garden/yard-garden/landscaping/minnesota-hardy/#look

National Arboretum hardiness zones & representative plants
http://www.usna.usda.gov/Hardzone/hrdzon4.html

USDA Hardiness Zone Map
http://planthardiness.ars.usda.gov/PHZMWeb/

Growing Fruit in the Upper Midwest http://www.upress.umn.edu/book-division/books/growing-fruit-in-the-upper-midwest

Management

Agroforestry practices require management through all phases. If that reality doesn't match the farmer's interests, there are still ways to get agroforestry practices in place:

- Consider contracting to another farmer to manage the agroforestry practices
- Apprentice a young famer with interest in agroforestry
- Bring another family member into the overall farm operation
- Lease land to an experienced agroforester

Where to start with Agroforestry:

- Steepest slopes; >14% slope should never be row-cropped.
- Toes of slopes
- Boundary of steep slope to a gentler slope
- Along in-field waterways
- Wind eroded areas
- Field edges and fencelines
- Streambanks and riparian areas
- Around houses and farm buildings

Resources:

Training Manual for Applied Agroforestry Practices – 2013 Edition. The Center for Agroforestry, University of Missouri. http://www.centerforagroforestry.org/pubs/training/

National Agroforestry Center publications. http://nac.unl.edu/publications/index.htm

University of Minnesota | Extension. Agroforestry. http://www.extension.umn.edu/environment/agroforestry/

AFTA | Association for Temperate Agroforestry. http://www.aftaweb.org/

Biomass

Photo from Steve John, Agricultural Watershed Institute

What is Biomass?

Biomass is recently living leaves, shoots, stems, stalks and flowering parts of herbaceous or woody plants. Biomass does not include grains or other starchy portions of plants. Biomass can be produced in agricultural, forestry, and agroforestry systems. Plants grown purposely for biomass, and particularly when grown under contract, are termed "dedicated bioenergy crops", or simply "dedicated crops". Agriculturally produced biomass includes annual and perennial grasses as well as residues from crops grown for food and feed, such as corn stover. However, crop residues are beyond the scope of GLBW and not further considered here. Forests provide multiple types of biomass including residues from timber harvests and timber stand improvement activities but these activities too are beyond the scope of GLBW are not further considered here. Agroforestry is a source of herbaceous and woody biomass including short-rotation woody species such as hybrid poplar (*Populus* species) and willow (*Salix* species), and perennial grasses grown as alley crops.

Biomass can be processed into bioenergy and bioproducts, including, for example:

- Space heating: combustion in small-scale and distributed heating systems such as stoves, furnaces, boilers or other unit capable of burning pelletized or shredded biomass
- Biopower and co-generated electricity: combustion is used to convert biomass alone or along with petroleum fuels (usually coal or natural gas) into power that is distributed
- Combined heat and power: biomass-burning units provide power and/or steam to a factory, hospital, or centralized heating district (e.g., a campus) while process waste heat from combustion is captured and used
- Biofuels: biomass is converted through fermentation, pyrolysis (heated in the absence of oxygen) torrefaction (a lower temperature form of pyrolysis) or gasification (heated without combustion and in the presence of oxygen) into solid, liquid or gas fuels for use in power plants, industrial processes (e.g., steel production), residential/decentralized heating, and transportation fuels (currently emerging at commercial scales)
- Biochemicals: basic and specialty chemicals, resins, paints, lubricants and solvents
- Biomaterials: engineered materials such as plastics, foams, rubber, sorbents, and dimensional products for building construction

- Livestock feed: lower-quality forage is treated to make the plant nutrition more available to ruminants
- Other materials and uses: livestock bedding, landscaping mulch, mushroom compost, and construction site stabilization materials

Plantings for biomass don't necessarily have to go to an industrial use. Biomass can be used on-farm as an energy source or livestock agriculture (e.g., bedding). Biomass is one type of CLC strategy. Some biomass plant species may have multiple CLC uses and can overlap with perennial forage or perennial grain, for example. That means biomass production is a potentially flexible practice with regard to marketing. Whether a biomass crop that is suitable as forage, for example, can be flexibly sold in different markets from year-to-year will depend on demand and whether the grower is obligated under contractual terms to deliver biomass to a specific buyer over a period of years. Also, industrial buyers may require contracts that include terms of biomass quality which may impinge on a crop's flexibility in other markets. Similarly with perennial grain crops; if a market is unavailable for the perennial grain, or weather or other conditions in a given year render the grain crop unsuitable as food or feed, then sale as a biomass crop may be an option.

Land Suitability and Placement of Biomass

Biomass plantings can be suitable for a broad range of growing locations and circumstances. Biomass crops can be established on large acreages but can also be used in buffer strip plantings or other limited configurations to address erosion and nutrient runoff. Perennial biomass crops make exceptionally good plants for filter and buffer areas and can be grown as alley crops in agroforestry systems. The extensive root systems and above-ground tissues of herbaceous and woody perennial plants will capture and hold soil and farm nutrients that may otherwise run off a cropped field. Some biomass species are very drought tolerant – such as native warm-season grasses, which makes them a good choice for drier and more erodible soils. Other biomass species are tolerant of short-term flooding – such as short-rotation willow species and some perennial grasses, which makes them a good choice for low-lying areas.

Many native perennial grasses suitable for biomass production are cold hardy and tolerant of a wide range of growing conditions, although selection of variety or cultivar is important to ensure suitability for any specific location. Native warm-season perennial grasses can succeed on land that is marginal for corn production, for example. Because of their lower value compared to cash grain crops, perennial biomass crops are not usually grown on highly productive soils. Marginality of a field can be agronomic or economic, and can take a variety of forms: high water table, frequent flooding, droughtiness, high erodibility, high level of runoff or leaching, short growing season, and other soil or climate factors that can limit productivity of commodity grain crops. Negri et al. (2014) modeled total biomass yields of 5.3 tons/acre for corn and 21.4 tons/acre for Miscanthus on the same marginal ground. Assuming 50% stover and 50% grain for the corn; a price for corn of

$3.50/bu and price for stover of $85/ton (Eric Rund, 2014); the gross income for corn on this marginal ground would be:

95 bu/ac grain* $3.50/bu = $332.50
2.67 tons/ac stover * $85/ton = $227.12

Total gross income = $559.62/ac

Assuming the same biomass price as corn stover for the Miscanthus, $85/ton (Eric Rund, 2014), the gross income for the Miscanthus crop on the same marginal acres would be:

21.4 tons * $85/ton = $1,819/ac

Perennial biomass crops can have higher income potential than corn or other commodity row crops on marginal acres, but they also provide excellent protection against soil erosion and runoff. In the Upper Midwest, on average, 31% of applied nitrogen is lost from row-cropped fields (Delgado and Follett, 2010). Negri et al. (2014) found nitrate leaching under Miscanthus was 60% to 70% less than under corn on marginal ground. Also, locating a perennial biomass crop downslope from row-cropped areas enables the biomass crop to trap nutrient-rich runoff and utilize at least a portion of the nutrients thus preventing them from entering ground and surface waters.

Biomass and conservation lands

Dedicated biomass crops such as perennial grasses and short rotation coppice trees are the only source of renewable energy that can also provide ecosystem services on a landscape scale. Nutrient loss reduction, wildlife habitat and biodiversity, and soil conservation are among the major conservation benefits that can be provided by strategic selection, placement, and management of bioenergy crops grown in monocultures or polycultures. Research and on-farm demonstrations can assess synergies and trade-offs for coproduction of harvestable biomass and ecosystem services and evaluate landscape design to integrate Multifunctional Perennial Cropping Systems into farmland dominated by annual row crops.

Iowa State University researchers are leading the innovative Science-based Trials of Rowcrops Integrated with Prairie Strips, or STRIPS project. Their research shows that strips of prairie grown on field contours are an affordable option for farmers and land owners seeking to garner multiple conservation benefits. The STRIPS protocol for reduction of soil erosion and nutrient runoff from row-cropped fields involves strategic placement of relatively small areas of native perennial grasses and flowering plants. While these diverse prairie mixtures should generally remain undisturbed during the growing season to serve as habitat for pollinators, songbirds and other wildlife, a late-fall harvest of biomass from the strips is possible. Indeed, maintenance of the prairie strips like all grasslands, requires periodic disturbance such as harvest or mowing to remain healthy. The

biomass from these "maintenance" activities potentially could be used for production of bioenergy and bioproducts. See more about Prairie STRIPS in the additional materials associated with this manual, or visit www.nrem.iastate.edu/research/STRIPs/.

Harvest and sale of biomass is possible from other types of conservation plantings as well. Riparian buffers and grassed waterways, for example, if installed under USDA/NRCS's Environmental Quality Incentive Program (EQIP) can generally be harvested occasionally to maintain the stand. Often the harvest from these areas is used for livestock forage, but the biomass market is another possibility. See more about use of the EQIP program in the "EQIP and CLC" chapter in this manual.

Biomass and agroforestry

In simple terms, agroforestry is intensive land-use management combining trees and/or shrubs with crops in integrated production systems for multiple products and benefits. Riparian buffers of permanent vegetation, grassed waterways, and alley crops (agricultural or horticultural crops cultivated in wide alleys between rows of trees or shrubs) are agroforestry practices that potentially can include biomass production. Short-rotation woody crops area received much attention as bioenergy and bioproduct feedstock, and their cultivation is well known. Perennial grasses can be grown as alley crops for biomass. Research at the University of Missouri Center for Agroforestry (www.centerforagroforestry.org) indicates that switchgrass and other warm-season grasses can be grown economically in nut tree alleys with up to 50% shade. In other geographic regions, switchgrass can be feasible as a bioenergy alley crop with loblolly pine and cottonwood.

Biomass and livestock feed

Some crops with utility as biomass can also have adequate forage quality for some classes of livestock, depending on timing of harvest. Switchgrass (*Panicum virgatum*), for instance, is a native warm-season perennial grass that has been developed as a forage. It can be grazed by cattle or harvested for hay. It is also grown as a dedicated biomass crop for biofuels at commercial scales. See for example, the Chariton Valley Biomass Project in southeastern Iowa (www.iowaswitchgrass.com/), and Abengoa Bioenergy's operation in Hugoton, Kansas (www.abengoabioenergy.com/web/en/2g_hugoton_project/). Other warm-season and even some cool-season grass forages are potentially also "dual use" crops. Reed canarygrass (*Phalaris arundinacea*), for instance, is frequently used in earlier growing stages as hay or grazing but can produce a very large tonnage per acre as a mature crop.

Major feed suppliers are now looking at biomass-type plant species with low forage quality as a potential source of livestock feed. The high lignin content of most biomass-type plants makes them

unsuitable for livestock feed in their whole form. However, processing the biomass by grinding it and chemically treating it renders the material more amenable to digestion by ruminant livestock. Thus, processing of low-quality herbaceous biomass into livestock feed represents another potentialmarketing pathway. Use of slaked lime (calcium hydroxide; CaOH) to expose more surface area of the biomass to ruminant digestion is one processing method (Cecava, 2014). Use of a combination of physical and chemical processes is an emerging technology for pretreatment of biomass for either livestock feed or bioenergy uses. See for example the Ammonia Fiber Expansion (AFEX; www.glbrc.org/news/michigan-afex-pilot-plant-provides-fodder-cattle-feed-trials.)

Small-scale and distributed heating and power systems

Biomass has low bulk density, and therefore lower energy density compared to coal, for example. Transport costs for biomass can be prohibitively high at longer distances. Also, commodity markets for biomass do not yet exist (although efforts are underway to transform diverse forms of grass biomass into consistent, quality-controlled commodity products). Some experts in the biomass field, therefore, see distributed biomass heating systems as a promising avenue for marketing and use of biomass. Localized systems can draw their biomass feedstock from a radius that makes transportation costs manageable. These localized systems can be as small-scale as a biomass-burning furnace that heats the machine shop building on a farm; and in fact, substitution of bioenergy systems for liquefied petroleum (LP) gas uses on the farm is a highly recommended way to simultaneously support putting acres into biomass and cut the farm's fuel bill. An example from east central Illinois showed a pay price of $85/ton for Miscanthus. One ton of Miscanthus would replace 170 gallons of LP gas at a cost of $364, for a savings of $279 (Eric Rund, 2014). That savings rate would allow rapid repayment of investment in a biomass-burning system.

Distributed bioenergy systems can also be larger-scale. One example is a biomass boiler system that serves a Virginia nursing home and requires 2,000 acres of dedicated biomass to supply it (Tom Canam, 2014). On a still larger, but still localized, scale; Koda Energy (www.kodaenergy.com/) is operated by the Mdewakanton Sioux in Shakopee, MN.

Profitability of biomass

Perennial biomass grown under contract to a defined user of biomass can be a stable source of farm income without the price volatility seen in commodity grain markets. Localized biomass users – businesses using biomass as their heating fuel, for instance; or factories with a CHP system – need a dedicated and nearby source of biomass for their operations, and typically pay a stable price for it. Farmers who devote acreage to biomass for these types of localized buyers can generally count on steady annual profit from those acres – especially since perennial biomass crops tend to be very hardy, without the disease or insect pressures that plague row crop monocultures, and tolerant of

temporary flooding or drought. An example in east central Illinois showed a $181/ac net income from Miscanthus in every year once the stand was established. Corn at $6.50/bu returned $364/ac net; but at $3.49/bu the corn returned a net loss of $173/ac. Those returns would give an average return from corn of $95/ac/year if corn alternated yearly between $6.50/bu and $3.49/bu, which surely cannot be depended upon. Miscanthus in that example is the crop with the more stable profit potential and could easily outperform corn financially in a 5-year average (Eric Rund, 2014).

References:

Bioenergy Landscapes for Water Quality and Greenhouse Gas Reduction. November 2014. M. Cristina Negri*, Herbert Ssegane and Patty Campbell. Energy Systems Division, U.S. Department of Energy.
http://misadocuments.info/Cristina_Negri_Argonne_2014.pdf

Harvest and Supply of Native Grass for Bioenergy. 2014. Tom Canam, Eastern Illinois University.
http://greenlandsbluewaters.net/Tom_Canam_Native_Grass_Bioenergy_2014.pdf

Multi-fuel Biomass Boilers are Key to Midwestern Biomass Markets. 2014. Eric Rund, Green Flame Energy.
http://greenlandsbluewaters.net/Eric_Rund_GreenFlameEnergy_2014.pdf

Processing Methods to Improve the Feed Value of Perennial Grasses. 2014. Michael Cecava, Director of Feed Technology Research, Archer Daniels Midland Company.
http://greenlandsbluewaters.net/Mike_Cecava_ADM_2014.pdf

Using Cover Crops and Cropping Systems for Nitrogen Management. Chapter 9 in *Advances in Nitrogen Management for Water Quality*. Edited by Jorge A. Delgado and Ronald F. Follett. 2010, 424 pages, hardcover. Soil and Water Conservation Society. ISBN 978-0-9769432-0-4.
http://www.swcs.org/documents/filelibrary/advances_in_nitrogen_management_for_water_quality/ANM9_A41356AAD3B6A.pdf

Cultivating Leadership

photo: field-edge monitor in St. Croix River watershed, Julia Olmstead

Leadership needs identified by Prairie STRIPS Project listening sessions in Iowa:

- Development of capacity of conservation agencies to provide technical assistance on Continuous Living Cover practices
- Information on ways for CLC acres to provide farm income
- Development of sources of financial support to offset establishment costs and opportunity costs of practices
- Increase understanding of and ability to articulate on- farm, off-farm, and long-term benefits of practices
- Establishment of demonstration sites to increase awareness and eventual adoption of practices

Source*: Investigating opportunities for enhancing farmer adoption of strategically targeted prairie strips in Iowa. Leopold Center for Sustainable Agriculture Competitive Grant Report P2012-08.*

Agricultural and natural resource professionals who advise farmers are leaders in their communities.

Farmers are asking for leadership from their advisors on matters of cropping system changes for soil and water protection.

Farmers are also interested in becoming leaders among their peers on these matters.

Cultivation of leadership on Continuous Living Cover needs to happen at both the farm advisor level and the farmer level.

Theory of Change: When farmers are directly involved in monitoring and they understand pollution sources, they will be able to internalize and see the need to address this on their own farms.

Farmer-Led Councils in the St. Croix River Watershed

Farmer-Led Councils have been in operation since late 2012; currently there are four councils established. The broad goal of the agencies involved is reduction of phosphorus in the St. Croix River, to attempt to meet Total Maximum Daily Loads (TMDLs) for P. Farmers' goals center around soil health and productivity. Leadership development is a central piece of the effort. The councils operate at the HUC-12 watershed level: watersheds of 8,000 to 20,000 acres. Council members meet over the winter to design the program for the next season. A menu of practices is developed and all farmers in the watershed are eligible to apply for incentives ($200 to $1,000 per farmer) on a first-come, first-served basis.

Complex Organizational Structure:

- Funding for the councils comes from McKnight Foundation, with Wisconsin Farmers Union as the fiscal agent.
- Four county land departments each contribute a ½-time conservation planner.
- Wisconsin DNR funds the project coordinator through University of Wisconsin-Extension.
- The farmers on the councils serve in an advisory role.
- The coordinator (Julia Olmstead) stitches it

Challenges:

- Lots of education, trust-building, and facilitation is needed. It requires a dedicated staff person to administer the groups.
- Funding. Farmer-led councils don't fit cleanly under NRCS practices or other conservation programs.
- Social and spatial relationships. If a large-scale farmer at the top of the watershed is not involved, soil and nutrient loss from their operation may trump the efforts of those working downstream. That creates tension among peers.
- Diversity and definition of sustainability. The types of farmers involved range from large-scale crop farmers to organic graziers; it's a challenge to get everyone on the same page.

The project has established edge-of-field monitors to track water coming off fields on several farms with different cropping systems. These are frequently used for farm tours; the differences between cropping systems are very apparent. Farmer participation has been good and leadership development is being tracked, but the project has not yet seen many changes in cropping systems. It's a slow process toward change.

Cover Crop Champions

The National Wildlife Federation established the Cover Crop Champions program to increase use of cover crops. It started with an understanding of how farmers innovate: taking in information first; then prioritizing it with higher value placed on local information from a known source. That understanding led to an emphasis on getting farmers who were already using cover crops to be the key messengers about cover crops to other farmers.

Development of leadership in these Champions is based on three core ideas:

- Communicating at the right level and using the right language
- Getting to core values
- Being a reliable resource

Interest and capacity of farmers to be Cover Crop Champions is determined through an application process and evaluation of the applicants. Criteria include the farmer's knowledge level and what their status is within their community.

Equipping is a key piece of the program. A lesson learned is that the Champions love the idea of helping their neighbors learn about cover crops, but don't generally like public speaking. A two-day media and presentation training session taught farmers how to deliver information, show statistics, tell stories, and how to do sound bites and press releases; converting them into top-notch communicators.

> "It's hard for those of us in jobs with a public relations component to really comprehend the fear of public speaking, because we do it all the time. With the Cover Crop Champions, their spirit was very willing but they sometimes had a very hard time with public speaking. I cannot overstate the value of the communications training to get the farmers the tools that they need to be effective communicators."
>
> – Ryan Stockwell, National Wildlife Federation

Continuing support and education is another key piece. A listserv and regular conference call were established to provide opportunities for Champions to network with each other, get up-to-date information on current research, and receive additional training on communication strategies from NWF staff.

Professional communications staff serve as support staff for the farmers in this program, and that has worked very well. The Cover Crop Champions program has seen tremendous success in terms of media coverage.

More about Cover Crop Champions: http://blog.nwf.org/2014/05/meet-the-cover-crop-champions/

Pollinator Habitat Project with General Mills

Linda Meschke, director of Rural Advantage (ruraladvantage.org) facilitated development of a pilot project to establish pollinator habitat on farms with financial support from General Mills. She founded the "Conservation Marketplace Midwest" (CMM) as an entity to handle and distribute these funds. The funding provides farmers with money to cover habitat establishment costs, estimated at $760/acre for herbicide treatment, site preparation, seed, and planting. The funding also provides $75 per half-acre per year to the farmers for five years to keep the habitat in place.

Pollinator Habitat Initiative

Purpose: Increase the number of acres of high quality habitat and forage for pollinators in Minnesota.

Goal: Establish 20 acres of pollinator habitat, on approximately 10 sites.

Objective: Establish a pilot project package exploring implementation requirements for pollinator habitat. Pollinator habitat site requirements can vary between targeting managed bees or native pollinators.

Four pollinator habitat practices can be funded under this initiative:

New Establishment: Plantings established on freshly tilled sites following the Pollinator Habitat Credit guidance.

Buffers: Newly planted buffers along open drainage ditches or in riparian areas, to be established following the Pollinator Habitat Credit guidance. These buffers can provide multiple benefits including sediment reduction, water quality improvement and carbon sequestration.

Enhancement: Pollinator plant species can be inter-seeded into existing native plantings to meet the criteria in the Pollinator Habitat Credit guidance. Examples of these areas include private lands, CRP, CREP, RIM and expired CRP. Any enhancements on land in a contract or easement must have the permission of the cooperating agency before approval by CMM.

Forage/ Bioenergy: Alfalfa, clover and forage mixes support managed bees. Management

would allow harvest only after the bloom period for forage or bioenergy use. This management scheme would not support dairy cattle in milk production but could be utilized by dairy beef, beef, sheep or horses.Grazing Broker

Grazing Broker

Laura Paine heads up the Managed Grazing program at Southwest Badger Resource Conservation & Development Council, and fills the position of Grazing Broker. The Grazing Broker makes connections between graziers and owners of grassland, and gets grazing agreements in place in order to use and preserve the existence of grassland.

The premise behind the Grazing Broker project:

- There is grassland in the hands of non-farming landowners
- There are graziers who would like access to that land for grazing
- The two groups do not have a good way to find each other and form grazing agreements

Non-farming landowners have control of 55% of the agricultural land in the Upper Midwest. That is an important audience for the Continuous Living Cover message, but it is also an audience that is hard to connect with. The Grazing Broker program is working on finding innovative ways to find and engage non-farming landowners. They are discovering that the non-farming landowners frequently are more interested in whole-farm management than they are specifically in grazing contracts, so Southwest Badger is moving in the direction of offering whole-farm planning services that include a grazing component.

They are also finding that many non-farming landowners are not aware of the property tax implications of their land use, and may inadvertently lose their agricultural status by failing to arrange for haying or grazing of their grassland. The Grazing Broker project is working with these landowners to educate them about the value of grazing as a conservation practice.

Laura is finding that there is considerable interest among livestock owners and graziers in finding acreage they can graze, so her challenge now is to get more landowners with grassland on board in order to satisfy the demand for grazing land.

More about the Southwest Badger Managed Grazing Program:
http://www.swbadger.org/managedgrazing.html

Laura Paine, Grazing Broker
Southwest Badger RC&D Quarterly Report: April-June 2014

Our First Big Success!

Nothing captures the essence of the Grazing Broker project better than the recently established partnership between the Andersons and the Muellers. David Anderson (white tee-shirt) is a landowner whose goal is to use managed grazing to attract grassland birds to his property near Highland. Matt (next to David) and Mike Mueller are conservation-minded beef producers from the Livingston area looking for pastures to rent. Both attended our Grazing Broker 2013-2014 winterworkshops.

Through a combination of EQIP funding, out-of-pocket investment, and 'sweat-equity', David has turned 45 acres of expired CRP pine trees into a managed grazing system. After delays getting fencing and watering installed and storm-caused power outages, it was finally ready for cattle on July 2nd.

The 30 Normande-Short Horn cross heifers stepped off the trailer into tall, rank grass and wild parsnips that took off after the pine trees were removed. Undeterred, they explored a little and then went to work grazing. Once this first rotation cycle is completed and the pastures are clipped, the parsnip will be under control (cattle eat them!) and it should be great grazing from here on out.

This is an example of how the grazing broker process works. Participants attend our workshops to learn about their options and meet others with similar interests. As broker, I help guide the formation of partnerships, provide lease templates, facilitate negotiations, and provide mentoring and advice. In this case, David wanted to manage the cattle himself and I've helped him learn the nuts-and-bolts of managing a grazing system, setting up temporary fencing and the logistics of rotating the cattle.

Women Caring for the Land℠

The Midwestern based, non-profit organization Women, Food and Agriculture Network (WFAN) discovered an untapped conservation outreach opportunity. This realization came after several years of work with women farmers and farmland owners. The opportunity lies within the growing number of women farmland owners in the Midwest. According to WFAN, about half of the farmland owners in the Midwest are women (Women, Food and Agriculture Network, 2012). The great majority of these women are non-operator farmland owners. In many cases they are widows, or have inherited the farmland and rely on a tenant farmer or farm manager to make decisions about the land. Through experience, WFAN has witnessed a strong interest in conservation among these women, but for various reasons, there is a lack of action among the group. In some cases, the women do not know or understand the language or jargon used by agency staff or tenants when discussing conservation or land management. Sometimes it is just a matter of knowing who to contact. Many wives of farmers are very much involved in the farm business but have not been the main contact person.

Of the 45 women who participated in the pilot project in eastern Iowa in 2009, half took at least one conservation action within the following year. *From: "Improving Conservation Outreach to Female Non-Operator Farmland Owners"* It should be noted that although adoption rates for trainings vary greatly, 50% is a very impressive action rate.

In the upper Midwest 32 to 53% of the land is farmed by a tenant and 61% of this leased land is owned by females (Women, Food and Agriculture Network, 2012). There are multiple factors that can cause a tenant to be hesitant to adopt conservation practices. One roadblock is lease length. An Iowa State Extension survey has shown that 80% of Iowa farm leases are year to year. Conservation practices can take many years to show return leaving a tenant hesitant to adopt them with the uncertainty of a short-term lease. Some conservation practices require certain skills and equipment that the operator may not possess, or the tenant might put the responsibility of stewardship in the hands of the landowner (Cox, 2013).

Another barrier to the conservation conversation is the tenant/landlady relationship. Not only is there a conservation language barrier, but the dynamics of the relationship can be fragile or complicated. In many cases the tenant is a family friend, relative, or life-long neighbor. Landladies are hesitant to upset this relationship by suggesting changes to the way the tenant earns his/her livelihood. This concern is not a one-way street. In some situations, the tenant would like to implement conservation

Table 1. Percentage of farmland that is rented by state.†	
Iowa	53%
Illinois	25%
Minnesota	45%
Wisconsin	32%
Missouri	35%
† Based on data collected from the USDA Census of Agriculture 2012 Table 64 for each state.	

practices but worries that the landowner will not understand.

In response to these roadblocks to conservation, WFAN developed the project Women Caring for the Land℠ (WCL). WCL is a program designed specifically for this group of non-operator landowners interested in implementing conservation practices on their farms. WCL is a unique program that has been very successful in meeting WFAN's goals of educating and empowering women landowners to implement conservation practices on their land. This prepares participants to start the conservation conversation with NRCS agency staff and farmer tenants.

Through experience, WFAN has learned that by running the meetings in a particular format, there is more success getting the women landowners talking and asking questions. Based on this observation, WFAN has developed and published an award winning curriculum called "Improving Conservation Outreach to Female Non-Operator Farmland Owners" (Women, Food and Agriculture Network, 2012). The curriculum provides detailed guidelines for holding the meeting including such things as when is the best time to hold the meetings, how to publicize, timeline, and funding. The stand-out portion of the curriculum is the methodology. This section discusses the proven methods that have made this program a success, and describes why these methods work. The curriculum closes with 12 suggested activities that are meant to educate the participants and getting them asking questions and discussing conservation.

One of the features that makes the meetings unique, and successful, is that the morning portion is women only. Recent research at Virginia Tech documented the potential negative effect of mixed-gender group dynamics on women's ability to perform tasks in small groups (Kishida et al., 2012), and this has been borne out by observations of Women Caring for the Land℠ meetings. Facilitators have found that the participants are more likely to open up and ask questions in a women-only "peer to peer" group. This has been observed even when there is only one man in the room and he is known and well-liked by all of the women present. It is important to note that some view the women-only meetings as discriminatory, and

In 2007 Iowa based outreach project Women, Land and Legacy conducted a series of "Listening Sessions". The sessions were attended by 806 women who own land or live in 22 of Iowa's 99 counties. When the input from women was compiled and analyzed, some o key highlights emerged. The highlights include "Women favor implementing conservation practices today to ensure the land can sustain future generations of tomorrow" and "Women exhibit a clear and strong consciousness about land health issues and respect nature intrinsically—not for its productive value, but because it sustains all life" (Women, Land and Legacy, 2007).

they may even be prohibited in cases where federal funding is used to support WCL activities. The WCL curriculum recognizes that the women-only format is not appropriate for every setting, and provides suggestions to meeting organizers on ways to address this issue of group composition dynamics.

Another important aspect of the meetings is that the facilitator and agency staffers present lead by not leading. The meetings are set up in a "learning circle" rather than classroom style. Facilitators and staffers scatter themselves within the circle and there is no "head". The women take turns telling their story. They are encouraged to talk about their dreams, goals, and challenges in relationship to their farmland.

The results have been very positive. Some participants report a sense of relief and others report increased self-confidence. This empowerment leads to conservation action. Since women make up about half of Midwestern farmland owners, this can mean significant change on the landscape.

Facilitator Jennifer Filipiak notes that there is a lot of interest in cover crops and conservation crop rotation. This focus leads to the natural next step, topic-specific meetings with the potential for Continuous Living Cover (CLC) specific meetings. Jennifer has seen natural leaders in the groups that she has facilitated. Her hope is that the additional topic-specific meetings will encourage these women to step-up and take a "landowner leadership role". She sees the potential for formation of organizations for non-operator women landowners.

By providing women farmland-owners with the tools they need to make the changes they desire, Women Caring for the Land℠ is a win for conservation on Midwestern farmland.

Cox, E. 2013. The Landowner's Guide to Sustainable Farm Leasing | Sustainable Farm Lease. Available at http://sustainablefarmlease.org/the-landowners-guide-to-sustainable-farm-leases/ (verified 30 July 2015).

Kishida, K.T., D. Yang, K.H. Quartz, S.R. Quartz, and P.R. Montague. 2012. Implicit signals in small group settings and their impact on the expression of cognitive capacity and associated brain responses. Philos. Trans. R. Soc. B Biol. Sci. 367(1589): 704–716Available at http://rstb.royalsocietypublishing.org/cgi/doi/10.1098/rstb.2011.0267 (verified 20 July 2015).

Women, Food and Agriculture Network. 2012. Improving Outreach to Female Non-Operator Farmland Owners. Available at http://womencaringfortheland.org/wp-content/uploads/2013/10/7thEdition_1_web.pdf

EQIP, CSP, and CLC

Overview

The **Environmental Quality Incentives Program (EQIP)** and the **Conservation Stewardship Program (CSP)** are Natural Resources Conservation Service (NRCS) programs authorized by the Agriculture Act of 2014. The focus of these programs is to improve soil, water, plant, animal, air, and related resources on privately-owned farms, ranches and forest land.

EQIP provides financial, technical, and educational assistance to agricultural producers to help plan and implement practices that address identified resource concerns on agricultural land. Producers can also utilize EQIP for assistance in meeting environmental regulations. Payment rates vary by state and payment is made when activities are complete or when the contract meets NRCS standards.

The first step in the process of receiving EQIP funding is to visit the local NRCS office for assistance in creating a whole farm Conservation Plan. With a Conservation Plan in place, an application for financial assistance can be submitted. The application is reviewed by NRCS to be sure that the applicant is eligible. After eligibility is established, EQIP applications are prioritized using screening and ranking tools that assign point values to national, state, and local priority areas. High priority applications will be ranked and funded first, followed by medium and low, as funding allows. If the application is selected for funding, a contract is signed and the conservation practices are implemented.

Photo - Cover Crops, Rick Cruse

60 percent of overall EQIP funding is ear-marked for "livestock-related practices". The USDA considers all practices implemented by livestock producers to be livestock-related practices.

EQIP is voluntary and contracts can last up to ten years.

CSP rewards producers by providing an annual payment for improving, maintaining, and managing existing conservation activities as well as for undertaking additional conservation activities.

The process of applying for funding involves working through the Conservation Measurement Tool (CMT) with a NRCS staff member. The tool determines the farmer's baseline conservation performance. If the baseline score is too low to be eligible for funding under CSP, EQIP funding can be utilized to bring the farm up to the required level. If the score is high enough and the farmer qualifies for CSP, the next step is to apply. Based on current conservation performance, and future conservation activities, the farmer receives environmental benefit payment points. Payment rate is multiplied by environmental points and number of acres. NRCS selects the highest scoring applications, based on current performance and future plans, until all acres allotted to that particular state, for a given year, are allocated. Approximately twice as many farmers apply as get approved for funding. Maximum annual payment per farm is $40,000.

CSP is a voluntary program, contracts last five years and can be renewed.

Continuous Living Cover (CLC) refers to the concept of keeping plant cover on the land all year long. Green Lands Blue Waters promotes five CLC strategies: agroforestry, cover crops, perennial forage, perennial grains, and biomass (http://greenlandsbluewaters.net/strategies/clc).

RCCRs

Because of the many benefits provided by Resource-Conserving Crop Rotations (RCCRs), the Farm Bill offers a "supplemental payment" for their adoption and improvement under CSP. RCCRs can include perennial grass, a legume, a legume-grass mixture, or a small grain grown in combination with a grass or legume that is used as a green manure. This payment is a CSP supplemental payment option and is therefore above and beyond the CSP per acre payment rate.

Photo – Alfalfa Harvest, bug_g_mebracid

This chapter was created to explore different ways Farm Bill funding might support continuous living cover strategies and systems.

Conservation Activities – The Toolbox for Increasing Continuous Living Cover

Both EQIP and CSP utilize NRCS conservation activities to meet conservation goals. EQIP uses a set of conservation activities referred to as conservation practices. CSP utilizes the same conservation practices as well as additional activities called enhancements. As of 2015, NRCS lists 35 conservation practices and 119 enhancements. **Table 1** shows a subset of NRCS conservation practices and **Table 2** shows a subset of NRCS enhancements, selected because they have the potential to support CLC strategies in the Upper Mississippi River Basin states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The tables provide an overview of the actual or potential relationship between conservation activities and CLC strategies.

Table 1: NRCS conservation practices to be used with EQIP and/or CSP and the CLC strategies that might be supported by each in the Upper Mississippi River Basin.

Practice Number	Practice Name	CLC strategies				
		Forage	Biomass	Perennial Grains	Agro-forestry	Cover Crops
311	Alley Cropping	X	X	X	X	X
327	Conservation Cover				X	
328	Conservation Crop Rotation	X	X	X		X
332	Contour Buffer Strips	X	X	X		
331	Contour Orchard & Other Perennial Crops	X	X	X	X	
340	Cover Crop					X
342	Critical Area Planting	X	X	X	X	
589c	Cross-Wind Trap Strips	X	X	X		
647	Early Successional Habitat Development/ Management	X			X	
386	Field Border	X	X	X	X	
393	Filter Strip	X		X		
512	Forage and Biomass Planting	X	X	X		
511	Forage Harvest Management	X	X	X		
412	Grassed Waterway	X	X	X		
422	Hedgerow Planting				X	
603	Herbaceous Wind Barriers	X	X	X		
595	Integrated Pest Management	X	X	X	X	X
379	Multi-Story Cropping		X	X	X	X
528	Prescribed Grazing	X		X		X
550	Range Planting	X		X		X
391	Riparian Forest Buffer				X	
390	Riparian Herbaceous Cover	X	X	X		
381	Silvopasture Establishment	X		X	X	
580	Streambank & Shoreline Protection	X	X	X	X	
612	Tree & Shrub Establishment	X	X		X	
490	Tree & Shrub Site Preparation			X	X	
645	Upland Wildlife Habitat Management	X		X	X	
739	Vegetated Subsurface Drain Outlet	X	X	X		
601	Vegetative Barriers		X			
380	Windbreak/Shelterbelt Establishment	X			X	
650	Windbreak/Shelterbelt Renovation	X			X	

Table 2: NRCS enhancements to be used with CSP and the CLC strategies that might be supported by each in the Upper Mississippi River Basin.

Activity Code	Enhancement Name	CLC Strategies				
		Forage	Biomass	Perennial Grains	Agro-forestry	Cover Crops
ANM21	Prairie Restoration for Grazing and Wildlife Habitat	X				
ANM29	On-Farm Forage Based Grazing System	X		X		
ANM32	Extend Existing Filter Strips or Riparian Herbaceous Cover for Water Quality Protection and Wildlife Habitat	X	X	X		
ANM35	Enhance Wildlife Habitat on Expired Grass/legume Covered CRP Acres or Acres with Similar Perennial Vegetated Cover Managed as Hayland	X				
ANM37	Prescriptive Grazing Management System for Grazing Lands	X		X		
ANM39	Extending Riparian Forest Buffers for Water Quality Protection and Wildlife Habitat	X			X	
ANM40	Extending Existing Field Borders for Water Quality Protection and Wildlife Habitat		X	X	X	
ANM41	Multi-Species Native Perennials and Native Self-Seeding Annuals for Biomass/wildlife Habitat	X	X			
CCR98	Improved Resource Conservation Crop Rotation	X	X	X		
CCR99	Resource-Conserving Crop Rotation	X		X		
ENR11	Improving Energy Feedstock Production Using Alley Cropping Systems with Short Rotation Woody Crops		X		X	
ENR12	Use of Legume Cover Crops as a Nitrogen Source					X
PLT06	Renovation of a Windbreak, Shelterbelt or Hedgerow for Wildlife Habitat				X	
PLT15	Establish Pollinator and/or Beneficial Insect Habitat	X				
PLT16	Intensive Rotational Grazing	X		X	X	

PLT20	High Residue Cover Crop or Mixtures of High Residue Cover Crops for Weed Suppression and Soil Health					X
SQL04	Use of Cover Crop Mixes					X
SQL05	Use of Deep Rooted Crops to Breakup Soil Compaction	X	X	X		
SQL09	Conversion of Cropped Land to Grass-Based Agriculture	X	X	X		
SQL10	Crop Management System where Crop Land Acres were Recently Converted from CRP Grass/legume Cover or Similar Perennial Vegetation					X
SQL11	Cover Cropping in Orchards, Vineyards and Other Woody Perennial Horticultural Crops					X
SQL12	Intensive Cover Cropping in Annual Crops					X
SQL14	Integrate Grazing into Crop and Forest Systems	X		X	X	
SQL16	High Species Diversity Grazing Lands	X				
SQL18	Soil Health Crop Rotation	X	X	X		X
WQL10	Plant a Cover Crop that will Scavenge Residual Nitrogen					X
WQL26	Reduce the Concentration of Nutrients Imported on Farm	X		X		

CSP offers the opportunity to increase ranking points and payments by allowing the farmer to choose "bundles" of enhancements. Bundles are groups of enhancements that are implemented together. Choosing a bundle increases ranking points and payments more than if enhancements are chosen individually from the available list of options.

CSP Bundle Example: Pasture Enhancement Bundle BPA10 (improves forage utilization) combines the following enhancements:

ANM25-	Stockpiling of forages to extend the grazing season
ANM29-	On-farm forage based grazing system
ANM64-	Managing livestock parturition to coincide with forage availability
PLT16-	Intensive rotational grazing
WQL07-	Split nitrogen applications 50% after the crops/pasture emerge/green-up

For a more in-depth description of these practices and enhancements as they relate to CLC,

please see **Table 5** and **Table 6** at the end of this chapter.

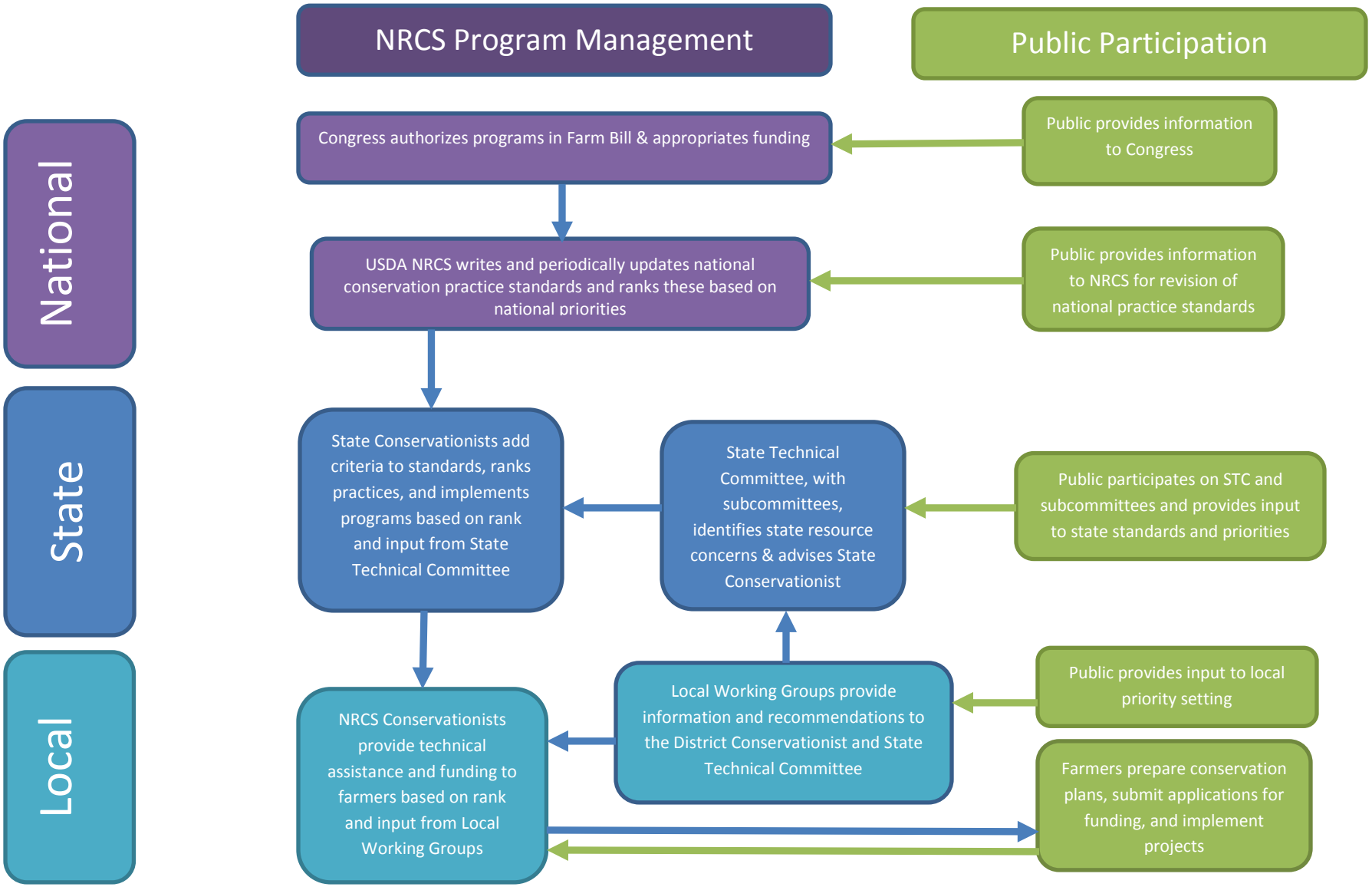
How Conservation Activities are Prioritized to Address Local Concerns

Each individual state chooses which conservation activities it will fund based on local concerns. Groups at the county and state level assist the State Conservationist in deciding which conservation activities will be funded. The State Technical Committee (STC) directly advises the State Conservationist to assist in making technical decisions. The STC listens to recommendations on the county level from Local Work Groups (LWGs). This way the State Conservationist can guide national programs that address needs on a local level (United States Department of Agriculture Natural Resource Conservation Service, 2006).

In addition to representatives from Federal and State agencies, STC and LWG membership includes "individuals with conservation expertise, agricultural producers, nonprofit organizations, persons knowledgeable about conservation techniques and programs, and representatives from agribusiness" (United States Department of Agriculture Natural Resource Conservation Service, 2006). The meetings are open to the public. Citizens are welcome to voice concerns and offer input regarding conservation as it applies to agriculture.

Figure 1 summarizes how EQIP practices and priorities are formed and implemented from the national level down to the local level.

Figure1. How the Environmental Quality Incentives Program (EQIP) is Prioritized and Approved



Prairie STRIPS - One of Many Examples of How NRCS Programs Might Fund On-Farm Conservation

In light of the concerns associated with erosion and runoff, Iowa State University and several partners formed STRIPS (Science-based Trials of Row-crops Integrated with Prairie Strips). The STRIPS project has been collecting data on the benefits of adding perennial native plants to conventional row-crop settings. The research provides hard data that shows how converting just 10% of a crop field to perennial natives, can reduce the loss of topsoil by 90% (Helmers et al., 2012).

The assistance that the STRIPS project provides is informational only and does not provide funding.

Several of the NRCS EQIP and CSP funded activities, presented in this document, allow for and fund the types of placement of perennial species on the landscape that the STRIPS project has shown to be so beneficial. In most cases, when native plants are allowed under a conservation activity, the payment rate is higher for natives than for non-natives to cover the higher cost of implementing natives. Additionally, some of the conservation activities allow for the harvest of the native perennials placed on the field. Native prairie plants can be grazed, hayed, and harvested for forage or energy biomass.

Tables 3 & **4** show NRCS activities that relate to prairie strips.

By strategically placing these conservation activities on the field and incorporating native perennials, multiple benefits can be realized. The benefits include habitat for wildlife, pollinators and beneficial insects, improved soil health and fertility, reduced loss of topsoil and nutrients, better resilience during heavy rain and drought, and improved water quality as well as potential income from harvest. These conservation activities will take up a portion of the farmer's land, but the benefits reach beyond the borders of the farm now and for future generations.

For more information on STRIPS project see the "Placement of Continuous Living Cover" chapter of this manual, the STRIPS publications included in the appendix of this manual, or visit http://www.nrem.iastate.edu/research/STRIPs/

Table 3. List of NRCS conservation *practices* that relate to prairie strips.	
Activity Code	Practice Name
311	Alley Cropping
332	Contour Buffer Strips
342	Critical Area Planting
589c	Cross-Wind Trap Strips
647	Early Successional Habitat
386	Field Border
393	Filter Strip
412	Grassed Waterway
603	Herbaceous Wind Barriers
595	Integrated Pest Management
390	Riparian Herbaceous Cover
645	Upland Wildlife Habitat
601	Vegetative Barriers

Table 4. List of NRCS *enhancements* that relate to prairie strips.	
Activity Code	Enhancement Name
ANM21	Prairie Restoration for Grazing and Wildlife Habitat
ANM32	Extend Existing Filter Strips or Riparian Herbaceous Cover for Water Quality Protection and Wildlife Habitat
ANM35	Enhance Wildlife Habitat on Expired Grass/legume Covered CRP Acres or Acres with Similar Perennial Vegetated Cover Managed as Hayland
ANM40	Extending Existing Field Borders for Water Quality Protection and Wildlife Habitat
ANM41	Multi-Species Native Perennials and Native Self-Seeding Annuals for Biomass/wildlife Habitat
PLT15	Establish Pollinator and/or Beneficial Insect Habitat
SQL09	Conversion of Cropped Land to Grass-Based Agriculture

Table 5. Descriptions of Natural Resource Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) practices† and their potential relevance to Continuous Living Cover (CLC) strategies in the US Midwest§.	
EQIP PRACTICE AND COMMONLY ASSOCIATED PRACTICES‡	PRACTICE DESCRIPTION¶ AND APPLICATION TO CLC
311 Alley Cropping Commonly Associated Practices ▪ 612 Tree and Shrub Establishment ▪ 384 Woody Residue Treatment	Alley cropping is a practice that could support multiple CLC strategies. By definition, alley cropping is the planting of a vegetative crop in areas between rows of a woody species. Because of the woody species rows, alley cropping automatically has an agroforestry component. The areas between the woody species rows could be planted to a perennial forage crop, a biomass crop, or a perennial grain. If annual row crops or small grains are planted between the woody rows, then cover crops could be used along with those annual crops. Therefore, alley cropping is a practice with potential to support CLC in each of the five CLC categories. Alley cropping will also support "stacking" of CLC strategies.
327 Conservation Cover Commonly Associated Practices ▪ 314 Brush Management ▪ 342 Critical Area Planting ▪ 612 Tree and Shrub Establishment ▪ 645 Upland Wildlife Habitat Management	Conservation Cover was developed to protect soil and water resources on lands that require permanent cover. While the NRCS states that it is not to be used for forage production, the Practice Standards do mention that "Periodic removal of some products such as high value trees, medicinal herbs, nuts, and fruits is permitted…" and therefore supports CLC in an agroforestry system. Conservation Cover has the potential to be used to support CLC for the planting of perennial forages, however it is unclear whether NRCS allows haying or grazing and it therefore may not apply to CLC.
328 Conservation Crop Rotation Commonly Associated Practices ▪ 330 Contour Farming ▪ 340 Cover Crops ▪ 329 Residue and Tillage Management, No Till ▪ 345 Residue and Tillage Management, Reduced Till ▪ 600 Terraces	Conservation Crop Rotation is defined by the NRCS as "a planned sequence of crops grown on the same ground over a period of time." This conservation practice supports the use of CLC strategies cover crops, pasture & forage, biomass as well as perennial grains.
332 Contour Buffer Strips Commonly Associated Practices ▪ 412 Grassed Waterway ▪ 595 Integrated Pest Management ▪ 329 Residue and Tillage management, No-Till ▪ 345 Residue and Tillage Management, Reduced Till	Contour Buffer Strips uses herbaceous vegetative cover to prevent erosion and improve water infiltration on hillslopes. This practice has the potential to be used as a forage crop with some restrictions on time of harvest. Additional CLC strategies include biomass and perennial grain production.

340 Cover Crop Commonly Associated Practices ▪ 328 Conservation Crop Rotation ▪ 329 Residue and Tillage management, No-Till ▪ 345 Residue and Tillage Management, Reduced Till ▪ 590 Nutrient Management ▪ 595 Integrated Pest Management	Cover Crops are grown during times of the year when no cash crop is being grown. The benefits of growing cover crops are many, including improved soil health and water infiltration. Some cover crops can be harvested for sale or provide forage for livestock.
342 Critical Area Planting Commonly Associated Practices ▪ 484 Mulching ▪ 590 Nutrient Management ▪ 315 Herbaceous Weed Control	Critical Area Planting deals with the seeding and establishment of permanent vegetation in highly erodible areas, or areas where establishing vegetation is difficult. Areas of steep slope and/or rough terrain qualify for this practice. An agroforestry crop that is hand-picked, such as fruits or nuts or grazing by sheep or goats may be opportunities to integrate a harvestable crop along with this practice.
589c Cross-Wind Trap Strips Commonly Associated Practices ▪ 328 Conservation Crop Rotation ▪ 340 Cover Crop ▪ 329 Residue and Tillage management, No-Till ▪ 345 Residue and Tillage Management, Reduced Till ▪ 645 Upland Wildlife Habitat Management ▪ 315 Herbaceous Weed Control	Cross Wind Trap Strips are herbaceous strips planted perpendicular to the prevailing winds to prevent wind erosion and protect growing crops. Potential CLC strategies to be used with Cross Wind Trap Strips include biomass, pasture & forage, and perennial grains.
647 Early Successional Habitat Development/Management Commonly Associated Practices ▪ 386 Field Borders ▪ 511 Forage Harvest Management ▪ 460 Land Clearing ▪ 595 Integrated Pest Management ▪ 612 Tree/Shrub Establishment ▪ 645 Upland Wildlife Habitat Management	The purpose of the Early Successional Habitat Development/Management practice is to create and maintain wildlife habitat and/or natural communities. Grazing can be used as a management strategy and there is potential to use this practice in an agroforestry setting.

386 Field Border Commonly Associated Practices ▪ 328 Conservation Crop Rotation ▪ 329 Residue and Tillage management, No-Till ▪ 345 Residue and Tillage Management, Reduced Till ▪ 647 Early Successional Habitat Development/Management ▪ 645 Upland Wildlife Habitat Management ▪ 644 Wetland Wildlife Habitat Management	Field Borders provide many ecosystem services and can be profitable as well. Plant field borders to prevent wind and water erosion, protect soil and water quality. Harvest perennial grains, biomass, and/or forage.
393 Filter Strip Commonly Associated Practices ▪ 590 Nutrient Management ▪ 595 Integrated pest management ▪ 633 Waste Recycling ▪ 329 Residue and Tillage management, No-Till ▪ 345 Residue and Tillage Management, Reduced Till	Filter Strips are planted to remove contaminants from overland flow. The strip should be permanent, herbaceous vegetation. It is not clear whether perennial grains for harvest are allowable. In some cases the strips can be grazed.
512 Forage and Biomass Planting Commonly Associated Practices ▪ 511 Forage and Biomass Harvest ▪ 315 Herbaceous Weed Control ▪ 590 Nutrient Management ▪ 528 Prescribed Grazing ▪ 645 Upland Wildlife Habitat Management	Forage and Biomass Planting is a multi-purpose practice. Reduce erosion while increasing livestock health and/or produce feedstock for biofuel or energy production. CLC strategies supported are biomass, pasture & forage, and perennial grains.
511 Forage Harvest Management Commonly Associated Practices ▪ 528 Prescribed Grazing ▪ 590 Nutrient Management ▪ 633 Waste Utilization	Forage Harvest Management includes timely cutting and removal of forages and biomass from the field as hay, greenchop, or insilage with the goal of optimizing the desired forage stand, plant community, and stand life. This practice can support CLC farming through the management of forages, biomass, and perennial grains.
412 Grassed Waterway Commonly Associated Practices ▪ 600 Terrace ▪ 362 Diversion ▪ 342 Critical Area Planting ▪ …"and other erosion control practices"	A Grassed Waterway is a shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity. Prescribed grazing can be practiced on the waterways. Perennial grains and biomass crops are potentially suitable vegetation for grassed waterways, but it is unclear whether or not harvest is allowable.

422 Hedgerow Planting Commonly Associated Practices ▪ 612 Tree/Shrub Establishment ▪ 645 Upland Wildlife Habitat Management	Hedgerow Planting has many purposes including, but not limited to: living fences, barriers to noise and dust, and wildlife/pollinator habitat. The CLC practice that can be supported here is agroforestry if a harvestable fruit or nut crop is planted.
603 Herbaceous Wind Barriers Commonly Associated Practices ▪ 328 Conservation Crop Rotation ▪ 340 Cover Crop ▪ 329 Residue and Tillage management, No-Till ▪ 345 Residue and Tillage Management, Reduced Till ▪ 645 Upland Wildlife Habitat Management ▪ 315 Herbaceous Weed Control	Herbaceous Wind Barriers are strips of herbaceous plants planted across prevailing winds. The purpose is to reduce wind erosion, protect crops, and to control snow deposition to increase plant-available moisture. Potential CLC strategies include perennial grain, pasture & forage, and biomass.
595 Integrated Pest Management Commonly Associated Practices ▪ 328 Conservation Crop Rotation ▪ 590 Nutrient Management ▪ 327 Conservation Cover ▪ 340 Cover Crop	Integrated Pest Management uses practices that prevent, avoid, monitor, and suppress pests. Some of these practices support CLC farming such as using cover crops, agroforestry, biomass production, pasture & forage, and perennial grains.
379 Multi-Story Cropping Commonly Associated Practices ▪ 666 Forest Stand Improvement ▪ 612 Tree/Shrub Establishment ▪ 660 Tree/Shrub Pruning ▪ 490 Tree/Shrub Site Preparation ▪ 472 Access Control	Multistory cropping requires the development and implementation of a forest management plan that incorporates the growth, management and harvest of non-timber forest products (e.g., foliage, mushrooms, berries, roots, nuts, etc.) while maintaining the option to manage the timber crop as a long-term economic investment. This practice does not apply to land that is grazed. Possible CLC strategies include agroforestry, biomass production, perennial grains, and cover crops.
528 Prescribed Grazing Commonly Associated Practices ▪ 314 Brush Management ▪ 512 Forage and Biomass Planting ▪ 550 Range Planting ▪ 382 Fence	Prescribed Grazing can be implemented to meet financial as well as conservation objectives. Prescribed grazing could be applied using cover crops, pasture & forage, and perennial grain CLC strategies.
550 Range Planting Commonly Associated Practices ▪ 314 Brush Management ▪ 548 Grazing Land Mechanical Treatment ▪ 338 Prescribed Burning ▪ 528 Prescribed Grazing	Range planting is establishment of adapted perennial vegetation on grazing land. This practice applies to rangeland, native or naturalized pasture, grazed forest, or other suitable land areas where the principle method of vegetation management is grazing. Applicable CLC strategies include perennial grain, grazing & forage, and possibly agroforestry.

391 Riparian Forest Buffer Commonly Associated Practices ▪ 390 Riparian Herbaceous Cover ▪ 395 Stream Habitat Improvement and Management ▪ 580 Streambank and Shoreline Protection ▪ 612 Tree/Shrub Establishment	A Riparian Forest Buffer is an area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies. Plant trees suitable for timber, fruit, or nut crops to add income. CLC practice agroforestry applies here and possibly biomass production.
390 Riparian Herbaceous Cover Commonly Associated Practices ▪ 327 Conservation Cover ▪ 382 Fence ▪ 472 Use Exclusion ▪ 644 Wetland Wildlife Habitat Management ▪ 528 Prescribed Grazing ▪ 580 Stream bank and Shoreline Protection ▪ 578 Stream Crossing ▪ 614 Watering Facility	Riparian Herbaceous Cover consists of grasses, sedges, rushes, ferns, legumes, and forbs tolerant of intermittent flooding or saturated soils, established or managed as the dominant vegetation in the transitional zone between upland and aquatic habitats. Perennial grains and biomass crops could be planted as CLC strategies. Additionally, the area can be grazed with limitations.
381 Silvopasture Establishment Commonly Associated Practices ▪ 666 Forest Stand Improvement ▪ 612 Tree/Shrub Establishment ▪ 660 Tree/Shrub Pruning ▪ 512 Forage and Biomass Planting ▪ 528 Prescribed Grazing	Silvopasture establishment involves establishing a combination of trees or shrubs, and compatible forages on the same acreage. Agroforestry, pasture & forage, and perennial grains could all be stacked as CLC farming under this practice.
612 Tree & Shrub Establishment Commonly Associated Practices ▪ 660 Tree/Shrub Pruning ▪ 595 Integrated Pest management ▪ 666 Forest Stand Improvement ▪ 590 Nutrient Management ▪ 472 Access Control	Tree and Shrub Establishment is establishing woody plants by planting or seeding. One could apply this practice in an agroforestry setting, woody biomass production, or pasture & forage (silvopasture).
490 Tree & Shrub Site Preparation Commonly Associated Practices ▪ 612 Tree/Shrub Establishment ▪ 384 Woody Residue Treatment ▪ 645 Upland Wildlife Habitat Management ▪ 380 Windbreak/Shelterbelt Establishment	Tree/shrub site preparation involves the treatment of areas to improve site conditions for establishing trees and/or shrubs. This practice could be used in conjunction with Tree & Shrub Establishment (612) and would therefore apply to the same CLC strategies: agroforestry, biomass, and pasture & forage (silvopasture).

645 Upland Wildlife Habitat Management Commonly Associated Practices ▪ 614 Watering Facility ▪ 643 Restoration, Management of Rare or Declining Habitats ▪ 472 Use Exclusion ▪ …"and many more"	Upland wildlife habitat management offers guidance on establishing and managing upland habitats and connectivity within the landscape for wildlife. A farmer could put together a plan that includes woody-species corridors for wildlife movement, perennial forage areas, vegetative strips harvestable as biomass after the nesting season, and could also use cover cropping as part of a plan to create a season-long food supply for wildlife.
739 Vegetated Subsurface Drain Outlet Commonly Associated Practices ▪ 554 Drainage Water Management ▪ 590 Nutrient Management ▪ 340 Cover Crop	A Vegetated Subsurface Drain Outlet diverts drainage outlets to distribute the drainage discharge. The purpose is to reduce nitrate loading and to restore or maintain soil saturation levels. These structures must be covered with permanent vegetation such as perennial grain, biomass crop, or native prairie plants. This area can be harvested as forage, biomass, perennial grain, or grazed with some limitations. These structures support CLC strategies pasture & forage, biomass, and perennial grains.
601 Vegetative Barriers Commonly Associated Practices ▪ 595 Integrated Pest Management ▪ 590 Nutrient Management ▪ 328 Crop Rotation ▪ 329 Residue and Tillage management, No-Till ▪ 345 Residue and Tillage Management, Reduced Till	A vegetative barrier is a permanent strip of stiff, dense vegetation established along the general contour of slopes or across concentrated flow areas. Due to the types of vegetation required for this practice, it is not suitable for grazing or woody plants. However, a non-woody biomass crop might be a good option for this practice.
380 Windbreak/Shelterbelt Establishment Commonly Associated Practices ▪ 328 Conservation Crop Rotation ▪ 340 Cover Crop ▪ 344 Residue Management ▪ 490 Tree/Shrub Site Preparation ▪ 612 Tree/Shrub Establishment ▪ 660 Tree/Shrub Pruning ▪ 645 Upland Wildlife Management	Windbreaks or shelterbelts are single to multiple rows of trees and possibly shrubs planted in a linear fashion. Use this practice to protect grazing livestock and/or consider using species that provide additional income such as fruit and nut trees and shrubs. In this way, windbreaks and shelterbelts support the agroforestry and silvopasture components of CLC.
650 Windbreak/Shelterbelt Renovation Commonly Associated Practices ▪ 328 Conservation Crop Rotation ▪ 340 Cover Crop ▪ 344 Residue Management ▪ 490 Tree/Shrub Site Preparation ▪ 612 Tree/Shrub Establishment ▪ 660 Tree/Shrub Pruning ▪ 645 Upland Wildlife Management	When renovating windbreaks or shelterbelts, incorporate species that diversify and create added income such as fruit and nut species of shrubs or trees. Like Windbreak/Shelterbelt Establishment (380) this practice can support agroforestry and silvopasture CLC strategies.

†NRCS headquarters has a comprehensive list of approved conservation practices. Each state chooses which practices it will fund based on state conservation priorities.
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

‡ Associated practices were found on the NRCS "Info Sheet/Practice Overview" documents for each EQIP practice. Documents can be found here:
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/references/?cid=nrcs143_026849

§ CLC is the practice of integrating summer row crops, winter annual crops, and perennial crops with the goal of keeping farm fields covered and rooted in place continuously throughout the year.
http://greenlandsbluewaters.net/

¶ More information and details regarding NRCS conservation practices can be found in the Conservation Standards on the NRCS web site.
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/references/?cid=nrcs143_026849

("Conservation Practices" | NRCS)
("Field Office Technical Guide (FOTG)" | NRCS)

Table 6. Descriptions of Natural Resource Conservation Service (NRCS) conservation ***enhancements***† and their potential relevance to Continuous Living Cover (CLC)‡ strategies in the US Midwest.

ACTIVITY CODE	NRCS ENHANCEMENT NAME	ENHANCEMENT DESCRIPTION AND APPLICATION TO CLC
ANM21	Prairie Restoration for Grazing and Wildlife Habitat	This enhancement includes the implementation of a grazing management plan and therefore applies to permanent pasture. Potential for use with STRIPS.
ANM29	On-Farm Forage Based Grazing System	Applies to the implementation and management of a perennial-based pasture system.
ANM32	Extend Existing Filter Strips or Riparian Herbaceous Cover for Water Quality Protection and Wildlife Habitat	Applies to the extension/widening of existing perennial buffers. Grazing is allowed with this enhancement if a grazing management plan is in effect.
ANM35	Enhance Wildlife Habitat on Expired Grass/legume Covered CRP Acres or Acres with Similar Perennial Vegetated Cover Managed as Hayland	This enhancement applies to perennial grass/legume hayland managed for both wildlife and forage production.
ANM37	Prescriptive Grazing Management System for Grazing Lands	For the implementation of a prescriptive grazing management system. Also applies to silvopasture.
ANM39	Extending Riparian Forest Buffers for Water Quality Protection and Wildlife Habitat	Applies to the widening of existing forest buffers only. May be grazed if a grazing management plan is in place.

ANM40	Extending Existing Field Borders for Water Quality Protection and Wildlife Habitat	This enhancement applies to the extension or widening of existing field borders using perennial forbs and/or shrubs. Vegetation can be harvested for bio-energy.
ANM41	Multi-Species Native Perennials and Native Self-Seeding Annuals for Biomass/wildlife Habitat	This enhancement consists of establishing native perennial and native self-seeding annual vegetation for biomass production and wildlife habitat. The biomass may be harvested for renewable energy or forage, grazed, or left in place.
CCR98	Improved Resource Conservation Crop Rotation	This enhancement applies to existing resource-conserving crop rotation. Improvements include adding a growing year for perennial crops, a perennial crop substituted for a row crop, and changing a perennial legume to a perennial grass or grass/legume.
CCR99	Resource-Conserving Crop Rotation	Applicable crops include perennial grass, legume as forage or green manure, legume-grass mixture, and other mixtures. This is a potential fit for pasture/forage systems.
ENR11	Improving Energy Feedstock Production Using Alley Cropping Systems with Short Rotation Woody Crops	Short rotations woody crops grown for energy feedstock directly support the CLC strategies of biomass and agroforestry.
ENR12	Use of Legume Cover Crops as a Nitrogen Source	This enhancement directly supports the CLC strategy of using cover crops to keep living plants on the land when row crops are not currently growing.
PLT06	Renovation of a Windbreak, Shelterbelt or Hedgerow for Wildlife Habitat	Harvest of wood products is allowed under this enhancement that supports renovation of existing windbreaks, shelterbelts, or hedgerows. This enhancement has the potential to support the CLC strategy of agroforestry.
PLT15	Establish Pollinator and/or Beneficial Insect Habitat	Haying and grazing may be used as maintenance practices with some restrictions therefore this enhancement has the potential to support forage/grazing.
PLT16	Intensive Rotational Grazing	This enhancement is for the harvest efficiency of grazing livestock to increase forage harvest, and to improve forage quality and livestock health. It directly supports perennial forage/grazing systems.
PLT20	High Residue Cover Crop or Mixtures of High Residue Cover Crops for Weed Suppression and Soil Health	By utilizing biomass from a cover crop or cover crop mixture as a living or killed mulch to suppress weed seed germination and to add carbon to the terrestrial carbon pool, this enhancement supports the CLC strategy of cover crops.
SQL04	Use of Cover Crop Mixes	This enhancement is for the use of cover crop mixes that contain two (2) or more different species of cover crops or cultivars of a single species.
SQL05	Use of Deep Rooted Crops to Breakup Soil Compaction	Deep rooted crops that are supported by this enhancement include perennials and annuals that have the potential to align with CLC strategies forage and perennial grains.

SQL09	Conversion of Cropped Land to Grass-Based Agriculture	Grass-based agriculture aligns with CLC practices forage, biomass, and perennial grains.
SQL10	Crop Management System where Crop Land Acres were Recently Converted from CRP Grass/legume Cover or Similar Perennial Vegetation	This enhancement supports the use of high residue cover crops to stabilize or increase carbon sinks in croplands recently converted from perennial vegetation to annually planted crops. The CLC strategy of cover crops has the potential to be supported by this enhancement.
SQL11	Cover Cropping in Orchards, Vineyards and Other Woody Perennial Horticultural Crops	This enhancement has the potential to support the CLC strategy of cover crops in an agroforestry operation.
SQL12	Intensive Cover Cropping in Annual Crops	This enhancement directly supports the CLC strategy of using cover crops. Under this particular enhancement, the cover crop is not to be harvested or grazed.
SQL14	Integrate Grazing into Crop and Forest Systems	Because this enhancement supports grazing in crop as well as forest systems, it potentially aligns with forage, perennial grain, and agroforestry CLC strategies.
SQL16	High Species Diversity Grazing Lands	With this enhancement, warm-season perennial grazing lands will be overseeded with a multi-species diverse mixture of annual grasses, clovers, and broadleaf species. This has the potential to support the forage CLC strategy.
SQL18	Soil Health Crop Rotation	This enhancement supports the implementation of a crop rotation that addresses the four principle components of a soil health: adds diversity to the cropping system; maintains residue throughout the year; keeps a living root; and minimizes soil chemical, physical and biological disturbance. There is potential for this enhancement to align with CLC strategies, perennial grain, forage, and biomass. This enhancement does not apply to permanent hayland, orchards, or vineyards.
WQL10	Plant a Cover Crop that will Scavenge Residual Nitrogen	This enhancement has the potential to support the CLC strategy of cover crops when crops with at least a “very good” rating for scavenging nitrogen as documented in “*Managing Cover Crops Profitably, 3rd Edition*” (Sarrantonio, 1998), Chart 2 Performance & Roles, pg. 67, are planted.
WQL26	Reduce the Concentration of Nutrients Imported on Farm	By growing the majority of feed for livestock on the farm and properly accounting for the nutrients in the manure when applying it to crop land, better nutrient cycling is achieved. Nutrients are not concentrated on the farm and a more sustainable operation is possible. This enhancement has to potential to support CLC strategies forage and perennial grain.

	† More information and details regarding NRCS enhancements can be found in the Enhancement Activity Job Sheets on the NRCS web site. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/csp/?cid=nrcseprd421806 ‡ CLC is the practice of integrating summer row crops, winter annual crops, and perennial crops with the goal of keeping farm fields covered and rooted in place continuously throughout the year. http://greenlandsbluewaters.net/

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Integrating Livestock

"First day of spring;" photo from Laura Paine

A shift to Continuous Living Cover – especially the perennial forages – carries with it an assumption that there will be more livestock on the land to utilize the forages.

Livestock = stacked enterprise in a cash grain operation

Besides the soil health, reduced erosion, and reduced nutrient loss benefits of perennial forages …

Addition of a livestock enterprise also contributes to resiliency in the case of market fluctuations: downturns in commodity crop prices can be buffered by livestock production and sales, and vice versa.

Livestock are a potential entry point for the next generation in a farming operation.

Management of a livestock and grazing system can be contracted out to a farmer who specializes in grazing management (a grazier); or the land for managed grazing can be leased to a grazier.

Integrating Livestock into the Farm

Integration of livestock, or of perennial forages for livestock feed, into a farming system can take many forms. It doesn't have to involve year-round presence of animals on the farm. A few examples:

- Permanent pasture on marginal land or slopes > 14%; contract grazing of a neighbor's dry dairy cows by a beginning grazier whose sole investment is in temporary fencing.
- Expanded grassed waterway system; grazing and hay production on the grassed waterways to support a cow/calf herd
- Highly erodible (HEL) areas seeded into a perennial grass/legume mixture and managed grazing of:
    - Beef cow/calf pairs
    - Stocker cattle
    - Dairy replacement heifers
- Oats + two years of grass hay in the crop rotation and marketing to the horse industry
- Late-fall grazing of cover crops and cornstalks by a beef cow/calf herd

- Two years of alfalfa in the crop rotation + feedlot beef production using alfalfa hay or haylage and corn produced on the farm
- Two years of alfalfa in the crop rotation + collaboration with a neighboring farm to supply alfalfa hay or haylage to their feedlot or dairy operation

Beginning Farmers

It has been a fairly common practice in the past for beginning farmers to get started in farming either by renting and growing crops on marginal land, or by expanding acreage within a family's farm operation. Sometimes that expanded acreage involves returning grassland to row cropping.

First, before considering cropping on marginal land or grassland, beginning farmers should take a look at a livestock-based enterprise.

Livestock and forages as an entry point offer several advantages:

- Potentially low capital investment for entry. Contract grazing arrangements can allow entry into grazing management without investment in either land or cattle; the capital investment can be solely the fencing materials. In some arrangements, even the fencing expenditure is minimal and the grazier is paid for the management of the cattle on existing pastures.

- Adding livestock to an existing family operation can be low-cost: forage can be utilized

Beginning Grazier Programs and Grazing Networks

- Greenhorn Grazing, Iowa Beef Center http://www.iowabeefcenter.org/events/GHgrazingflyer2014.pdf
- Grazing information and support from Iowa Beef Center http://www.iowabeefcenter.org/news/grazingevents2014.html
- Wisconsin School for Beginning Dairy Farmers http://www.cias.wisc.edu/dairysch.html
- GrassWorks Grazing Networks (Wisconsin) http://grassworks.org/?110500
- Livestock Program, Practical Farmers of Iowa http://practicalfarmers.org/member-priorities/livestock/
- Keep Cattle in Minnesota, Sustainable Farming Association of MN http://www.sfa-mn.org/keep-cattle-in-minnesota/
- MN Grazing Lands Conservation Association http://www.mnglca.org/

from grassed waterways and other grassed areas established to control erosion. Grazing of cornstalks and other crop residue can reduce feed costs in the fall and winter; and the animals help cycle the nutrients out of residue back into soil.

- Custom-harvesting of forage is another potential entry point for a beginning farmer.
  There is potential for farm-to-farm cooperation here: if several farmers in an area agree to add perennial forage to their crop rotation, that opens an opportunity for someone to do the forage harvesting on all of those farms.

- Grass-based dairy is a potential farming entry point in areas where dairy infrastructure exists and where equipped former dairy barns may be available to rent. A great advantage of dairy production for a beginning farmer is the regular milk check. Using forage to the greatest extent possible reduces feed input costs and often veterinarian bills as well.

- There are established apprenticeship and training programs for beginning graziers, and an extensive network of grazing groups that support learning and mentoring in Minnesota, Wisconsin, and Iowa.

Economics of Livestock Enterprises

Livestock Enterprise Budgets for Iowa
http://www.extension.iastate.edu/agdm/livestock/html/b1-21.html

Decision Tools and Software, Wisconsin Beef Information Center
http://fyi.uwex.edu/wbic/decision-tools-and-software/

Grass-fed beef

Grass-fed beef is a specialty product that can command a premium price. If a farm's situation or farmer interest bends in the direction of permanent pasture and grazing, then marketing of grass-fed beef could be a profitable option.

Agricultural Marketing Service (USDA-AMS) report on grass-fed beef prices:
http://www.ams.usda.gov/mnreports/nw_ls110.txt

Resources for Livestock Production Information

Illinois Livestock Trail
http://livestocktrail.illinois.edu/

Iowa Beef Center
http://www.iowabeefcenter.org/

University of Minnesota Extension Beef Team
http://www.extension.umn.edu/agriculture/beef/

University of Minnesota Extension Dairy Team
http://www.extension.umn.edu/agriculture/dairy/

Wisconsin Beef Information Center
http://fyi.uwex.edu/wbic/

University of Wisconsin Extension Dairy Team
http://www.uwex.edu/ces/ag/teams/dairy/

More Grass-fed Beef

There are several aggregator businesses active in IA, MN, and WI that buy grass-fed cattle and market the beef:

Thousand Hills Cattle Company (source cattle in IA, MN, and WI)
http://www.thousandhillscattleco.com/

Wisconsin Grass-Fed Beef Cooperative
http://wisconsingrassfed.coop/

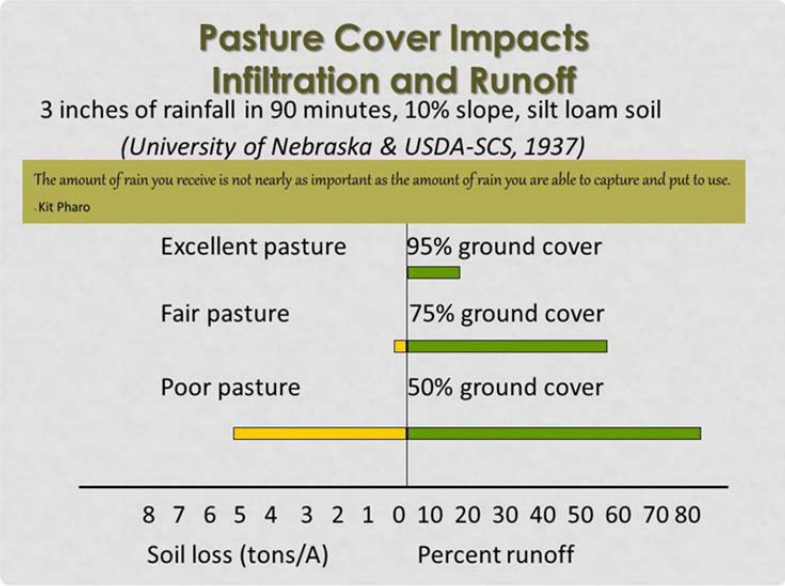
Tallgrass Beef
http://www.tallgrassbeef.com/

Managed Grazing

Having well-managed pastures is important both for livestock productivity and profitability; but also for preventing water and nutrient runoff. A continuously-grazed pasture is worse than a cornfield in terms of water infiltration rate:

60-minute water infiltration rate (inches) under six different plant species types; average of measurements in June, August, and October/November.					
Silver maple	Switchgrass	Cool-season grass mixture	Corn	Soybean	Continuously grazed pasture
15	10	9	2	4	< 2

Source: Soil-water infiltration under crops, pasture, and established riparian buffer in Midwestern USA. 2002. L. Bharati, K.-H. Lee, T.M. Isenhart, and R.C. Schultz. Agroforestry Systems 56: 249–257.



Pasture Cover Impacts slide courtesy of Allen Williams

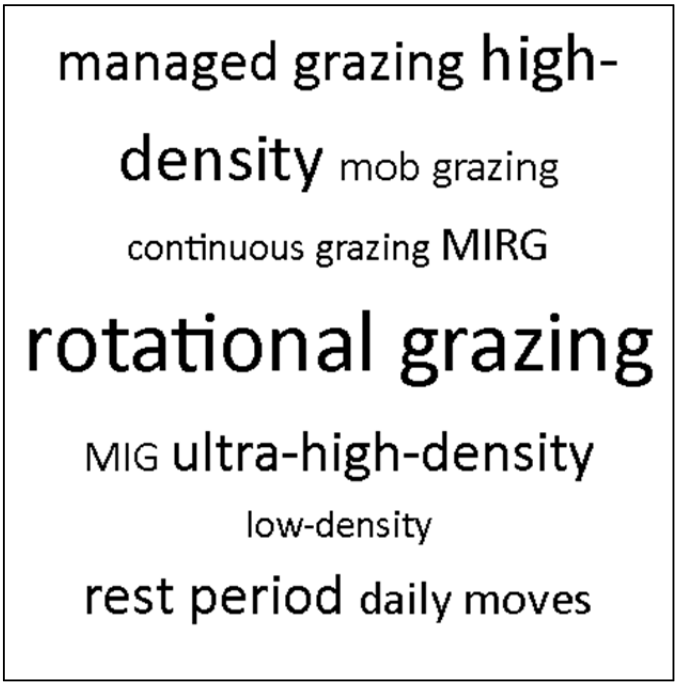
Characteristics of well-managed pastures include:

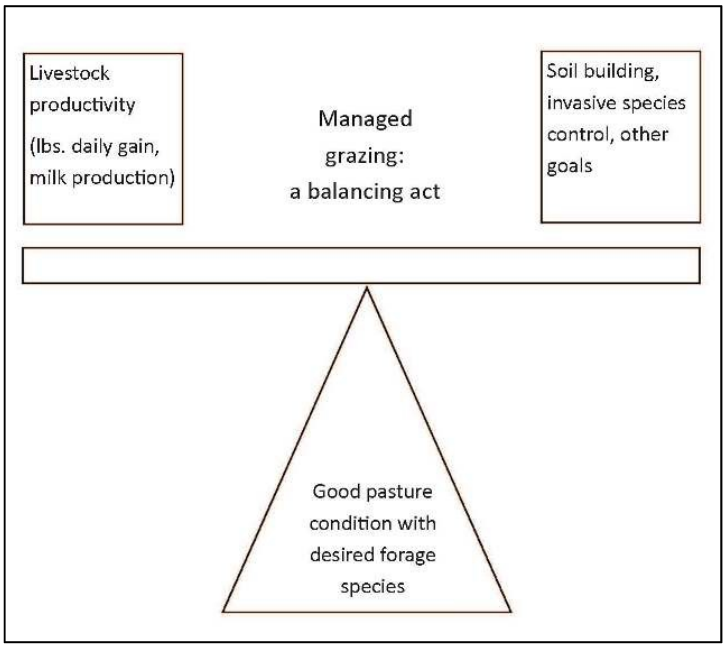
- High level of forage productivity and quality
- Sufficient residual forage mass left after grazing to support rapid regrowth
- Diversity of plant species to provide resilience in varying environmental conditions
- Gradual accumulation of soil organic matter
- Maintenance of protective plant cover over the soil surface.

Source: Well-managed grazing systems: a forgotten hero of conservation. 2012. Alan J. Franzluebbers, Laura K. Paine, Jonathan R. Winsten, Margaret Krome, Matt A. Sanderson, Kevin Ogles, and Dennis Thompson. Journal of Soil and Water Conservation 67(4):100A-104A. http://www.jswconline.org/content/67/4/100A.full.pdf+html

There have been a lot of words and phrases applied to various grazing schemes. The take-away message from all the diversity of grazing methods and ways to describe them is that **grazing is a highly flexible and adaptable tool for management of forage, soil health and herd health**.

The basic principle of managed grazing: balance the needs of the





animals, the goals of the producer or land manager, and the condition of the pasture.

There are lots of "right ways" to do managed grazing. Grazing systems can be adjusted to a farm's particular:

- Layout – how the fields lie in relation to buildings and a water source
- Infrastructure – what's in place or do-able in terms of perimeter fence, watering system, loading/unloading pens, etc.
- Goals – maximum productivity for dairy cattle, less intensive needs for beef cow/calf or dry dairy cows

Find key resources about grazing and pasture forage management on the website of the Midwest Perennial Forage Working Group:
http://greenlandsbluewaters.net/Perennial_Forage/resources.html

Contract Grazing

Contract grazing is an arrangement for the grazing of livestock on land, in which the same individual need not manage the grazing, own the livestock, and own the land.

Contract grazing is an opportunity for beginning farmers to get into agriculture with a small capital investment – they can supply the management of grazing and do not have to invest in either cattle or land ownership. Contract grazing is also an opportunity for farmers to add perennial forages to their cash grain operation but not have to either own livestock or manage a grazing system.

The Midwest Perennial Forage Working Group has developed a series of fact sheets on contract grazing:

The Basics of Contract Grazing
http://greenlandsbluewaters.net/Perennial_Forage/CG_Basics_final_0313.pdf

Evaluating Land Suitability for Grazing Cattle
http://greenlandsbluewaters.net/Perennial_Forage/CG_Evaluating%20Land_final_0313.pdf

Pasture Rental and Lease Agreements
http://greenlandsbluewaters.net/Perennial_Forage/CG_ContractLeases_final_0313.pdf

Rates Charged for Contract Grazing Agreements
http://greenlandsbluewaters.net/Perennial_Forage/CG_Rates_final_0313.pdf

Additional contract grazing information:
http://greenlandsbluewaters.net/Perennial_Forage/contract.html

Integrating Livestock with Agroforestry

Livestock benefit from access to shade in summer and access to shelter in winter. Both of these benefits can be provided by agroforestry practices.

Silvopasture is the combined production of trees for timber, fruit, or nut production; and the grazing of livestock on forage planted under the tree canopy.

Windbreaks or shelterbelts can provide significant reductions in windspeed on the downwind side, and are a useful enhancement for livestock on a farm.

These agroforestry practices can be located in strategic areas to solve a water or wind erosion problem or a water and nutrient runoff problem, or to put a productive use on marginal land that is difficult in some way for row-crop agriculture.

More information about how to install and use these practices:

Importance of Shade for Livestock

Following a day of extreme heat + high humidity in Iowa in 1995, feedlot producers were surveyed about death losses due to the heat.

Feedlots with shade: 0.2% loss

Feedlots without shade: 4.8% loss

Source: Heat Stress In Feedlot Cattle: Producer Survey Results. A.S. Leaflet R1348. Darrell Busby and Dan Loy. http://www.iowabeefcenter.org/Cattlemen'sConference/heat%20stress%20study.pdf

Extreme weather events including deadly heat + humidity are becoming more common. Integrating livestock production with agroforestry practices for shade is good insurance for the livestock, as well as providing reduction of soil erosion and runoff.

Chapter 4: Silvopasture. In Training Manual for Applied Agroforestry Practices - 2013 Edition. Center for Agroforestry, University of Missouri.
http://www.centerforagroforestry.org/pubs/training/chap4.pdf

Chapter 6: Windbreaks. In Training Manual for Applied Agroforestry Practices – 2013 Edition. Center for Agroforestry, University of Missouri.
http://www.centerforagroforestry.org/pubs/training/chap6.pdf

Integrating Livestock with Cover Crops

Cover crops that have significant above-ground fall or spring growth are a potential source of forage for grazing cattle. Even a few days of grazing on a cover crop in the fall can improve the profitability of livestock production by delaying or reducing the amount of stored feed that must be fed.

Cover crops on large corn and soybean acreage can be grazed using portable, temporary fencing technology. This can be an opportunity for contract grazing as well. Grazing of cover crops is allowed after November 1 on preventive planting acres. On other acres with cover crops, grazing is allowed for crop insurance purposes; but may be restricted by other programs if program dollars paid for establishment of the cover crop. Rules are changing between 2013 and 2014 crop years to allow haying or ensiling of cover crops as well. Which rules apply depends on contract date; see the FAQs link, below.

References:

NRCS Cover Crop Termination Guidelines: Non-irrigated Cropland. June 2013.
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167871.pdf

NRCS Cover Crop Termination Guidelines: Non-irrigated Cropland. December 2013.
http://efotg.sc.egov.usda.gov/references/public/MN/340TerminationGuideline.pdf

Cover Crops – Iowa, Minnesota, and Wisconsin. January 2014. Risk Management Agency Fact Sheet.
http://www.rma.usda.gov/fields/mn_rso/2014/covercrops.pdf

Crop Insurance, Cover Crops and NRCS Cover Crop Termination Guidelines FAQs
http://www.rma.usda.gov/help/faq/covercrops2014.html

Placement of Continuous Living Cover

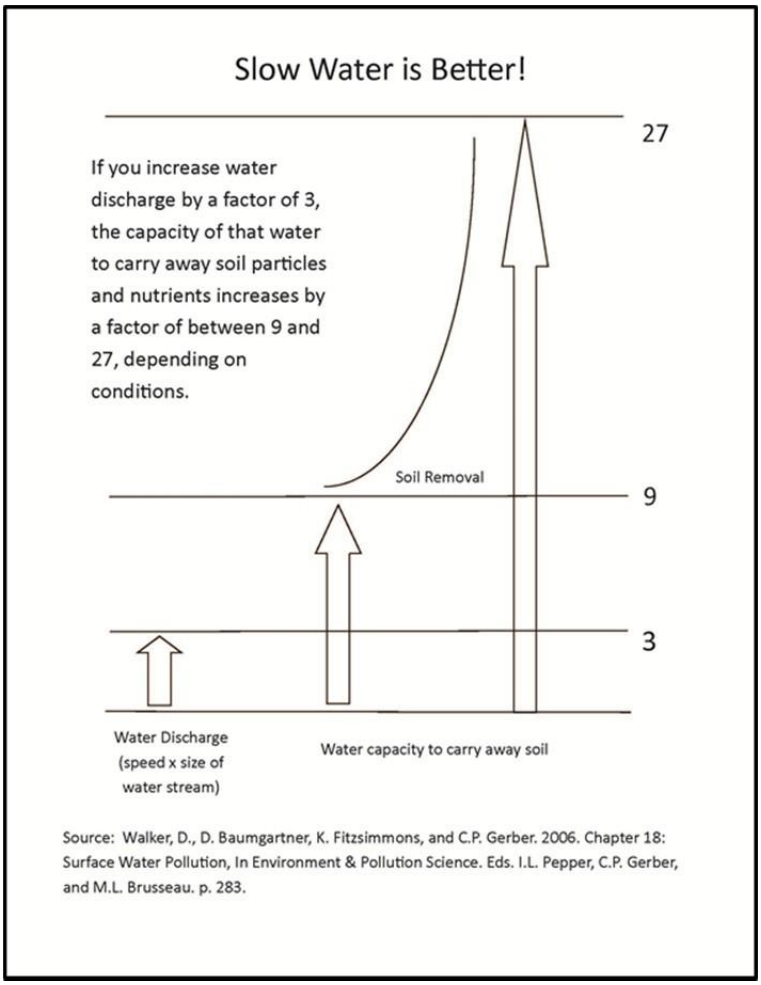
Photo: Elm Creek Watershed, Linda Meschke, Rural Advantage

Almost all of the research and recommendations around placement of Continuous Living Cover (CLC) practices has one or both of these objectives:

1. Slow down water
2. Slow down wind

The goal of these objectives is to reduce soil and nutrient loss from agricultural fields. Continuous Living Cover practices that slow down water and wind:

- Prairie strips within fields
- Windbreaks
- Grassed waterways
- Riparian buffers
- Perennial forage
- Cover crops



Fast Water = Soil Erosion

Fast water carries soil away, and the amount of soil carried is in a squared-to-cubed ratio to the speed of

the water and the size of the channel. If even a small channel or gully gets started in bare soil in a heavy rain, it can quickly expand and be responsible for significant soil losses.

Continuous Living Cover practices, strategically placed, slow water down and give it a chance to infiltrate the soil. CLC practices also improve the water infiltration rate of soil - the capacity of the soil to rapidly take in water into the soil profile. Rapid water infiltration into soil is desirable both for retention of soil-borne nutrients in the soil, and for ensuring adequate soil moisture for crop growth.

60-minute water infiltration rate (inches) under six different plant species types; average of measurements in June, August, and October/November.					
Silver maple	Switchgrass	Cool-season grass mixture	Corn	Soybean	Continuously grazed pasture
15	10	9	2	4	< 2

Source: Soil-water infiltration under crops, pasture, and established riparian buffer in Midwestern USA. 2002. L. Bharati, K.-H. Lee, T.M. Isenhart, and R.C. Schultz. Agroforestry Systems 56: 249–257.

Fast Wind = Soil Erosion

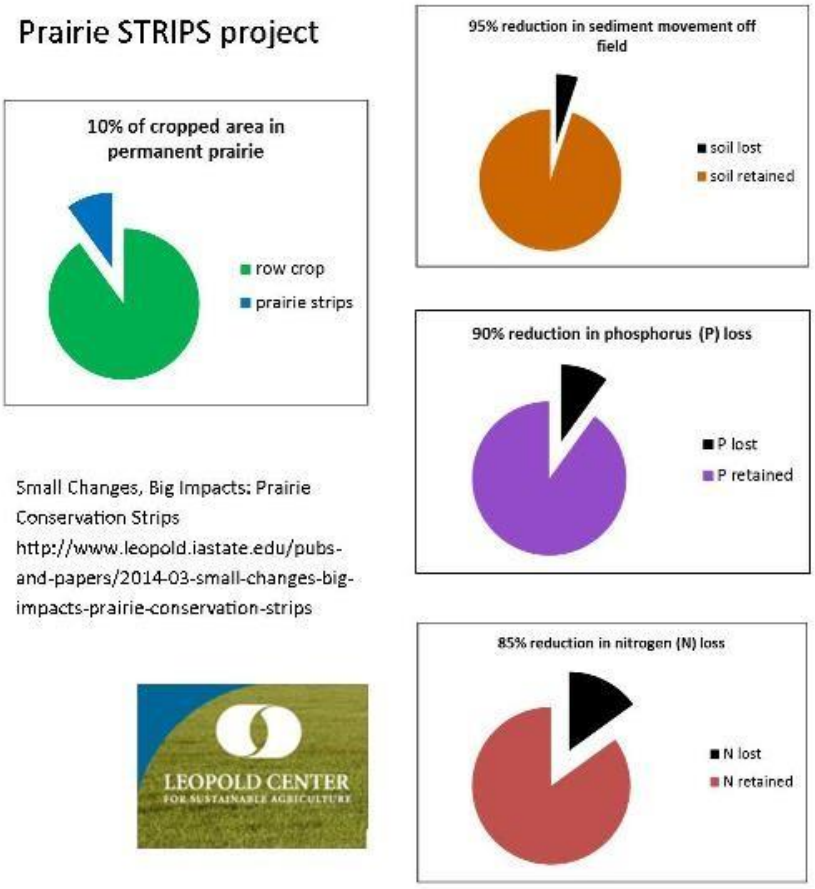
Wind speed, similar to water speed, has a non-linear relationship with amount of soil lost. Simulation studies showed a four-fold increase in soil erosion for a 20% increase in wind speed. Conversely, there was a 10-fold reduction in soil erosion with a 20% decrease in wind speed.

Source: Sensitivity of the US corn belt to climate change and elevated CO2: II. Soil erosion and organic carbon. 1996. Jeffrey J. Lee, Donald L. Phillips, Rusty F. Dodson. Agricultural Systems Volume 52, Issue 4, December 1996, Pages 503–521.

Perennial prairie plants + strategic placement on 10% of cropped land = large reductions in loss of soil, P, and N.

Prairie Strips to Reduce Soil and Nutrient Loss

The Prairie STRIPS Project (Science-based Trials of Rowcrops Integrated with Prairie Strips) is based at Iowa State University and involves a number of researchers. The

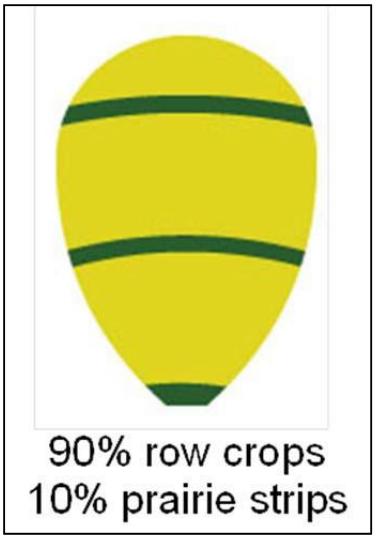


project overall has been finding greater-than-expected benefits from the establishment of relatively small, permanent strips of perennial plants strategically located within crop fields.

In fields with 6% to 10% slopes, narrow strips of prairie along field contours and a strip at the foot slope reduced soil loss by 95%, P loss by 90% and N loss by 85% when compared to fields in corn with no prairie strips.

Besides the reduction in soil and nutrient losses, researchers found more positive benefits to the strips:

- Four-fold increase in number of plant species that support pollinators and other beneficial insects
- Double the number of bird species, triple the abundance of birds



Cost of implementing prairie strips in a field: $24 to $35 per acre per year, which includes the opportunity cost of the lost crop acres.

Source: *Small Changes, Big Impacts: Prairie Conservation Strips*. http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2014-03-small-changes-big-impacts-prairie-conservation-strips.pdf

Resource:

Photo courtesy of Matt Helmers, Iowa State University

STRIPS Research Team. http://www.leopold.iastate.edu/strips- research-team

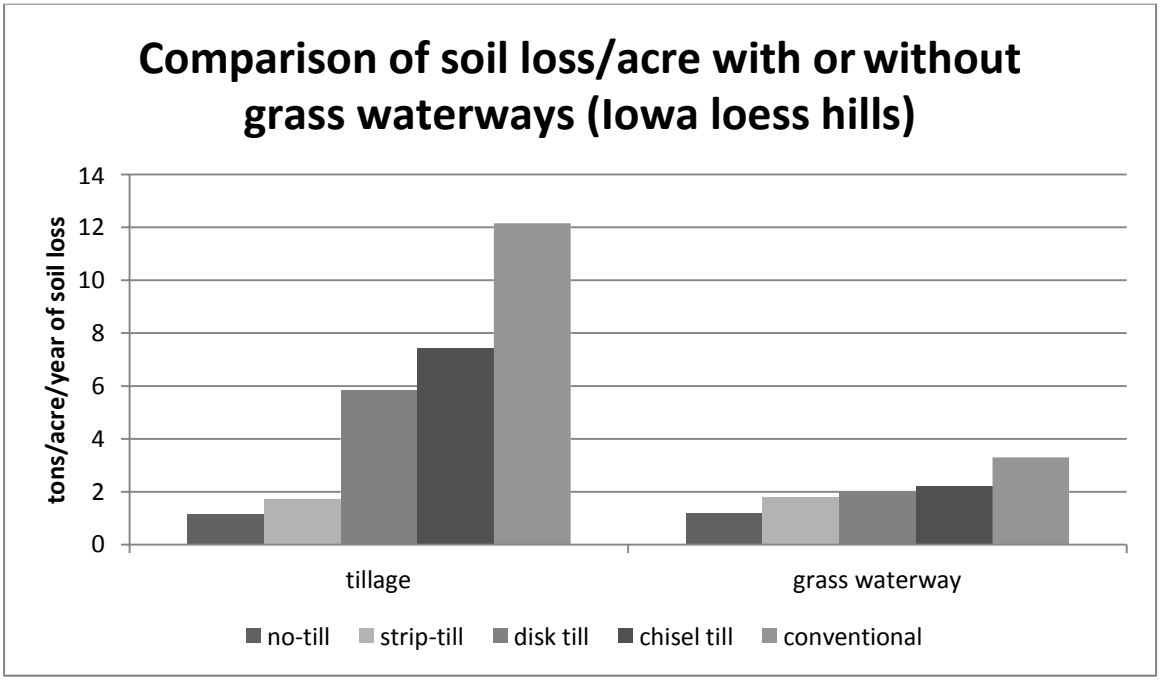
Grassed Waterways

Similar to prairie strips on contours within crop fields, grassed waterways can dramatically reduce the amount of soil lost from fields. Rainwater running through grassed waterways is slowed down by the presence of the grass and is less able to carry away soil into streams and rivers. On conventional-tilled fields in western Iowa's loess hills, the presence of grassed waterways reduced soil loss from 12 tons/acre/year (more than twice the tolerable rate, T), down to about 2.5 tons/acre/year (half the tolerable rate).

Fred Abels, farmer near Holland, IA:

When I started with beef cattle, I had NRCS funding to establish grazing paddocks but I didn't have any hay ground. A friend was custom-farming big acreage and didn't want to take care of the grassed waterways, so I hayed them. There were about 25 to 30 acres of grassed waterways, and I mowed it twice and got all my winter feed.

Federal and state funds are available to support construction of grassed waterways, and there are detailed agency standards for their construction (see resources below). Grassed waterways can also be a resource for livestock production. Hay made from them can provide a significant portion of the winter feed for a farm's cattle herd. Periodic grazing is also permitted to maintain the grass stand.



Source: Impact of Conservation Practices on Soil Erosion in Iowa's Loess Hills https://www.extension.iastate.edu/NR/rdonlyres/26DC3619-5E13-4992-9F38-C104F60E6DBE/135600/Conservation_Practices_on_Soil_Erosion_Loess_Hills.pdf

Resources:

Grassed Waterways. Conservation Practices: Minnesota Conservation Funding Guide. http://www.mda.state.mn.us/protecting/conservation/practices/waterway.aspx

Grassed Waterway: Iowa Fact Sheet. Natural Resources Conservation Service, USDA. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_007306.pdf

Design of Grassed Waterways: Illinois Drainage Guide. University of Illinois, Urbana-Champaign. http://www.wq.uiuc.edu/dg/grass.htm

Windbreaks for Wind Speed Reduction

Planted windbreaks (or shelterbelts; the terms are interchangeable) are highly effective at slowing down wind and reducing soil erosion – surprisingly, on both the upwind and downwind sides of the windbreak.

The percentage reduction in wind speed on the downwind side is related to the density of the windbreak planting. At 5H, a multi-row conifer planting can reduce wind speed by 75%. A more open deciduous tree planting can reduce wind speed by 50%.

Detailed information on windbreak height, width, length, and density for maximum effectiveness can be found in the Chapter 6: Windbreaks reference shown in the box to the right.

Wind Speed Reduction from Windbreaks, Shelterbelts

H = height of the tallest trees in the windbreak

Area of wind speed reduction on upwind side = 2H to 5H out from windbreak

Area of wind speed reduction on downwind side = up to 30H out from windbreak

Source: Chapter 6: Windbreaks. In Training Manual for Applied Agroforestry Practices - 2015 Edition. Center for Agroforestry, University of Missouri. http://www.centerforagroforestry.org/pubs/training/

Riparian Buffers and Riparian Corridors

Riparian buffers slow water down before it gets to a river or stream, and trap and hold nutrients that may have escaped from cropped fields or pastures in runoff water. They are a critically important last line of defense against N, P, and soil loading into surface waters.

Riparian buffers can also be a way to connect individual farms to each other and to the larger landscape. Establishment of riparian buffers on multiple properties along an entire waterway produces a riparian corridor, which can be an important refuge for wildlife as well as protecting the entire waterway.

Many farmers who are committed to conservation practices lament the fact that a neighbor's poor practices can negate their efforts to protect surface and groundwater. On a larger landscape scale, promoting riparian corridors are a way for landowners to begin to work together to address water protection issues – and riparian buffers are a very fundable conservation practice.

From the Bear Creek Riparian Buffer Project, supported by the Leopold Center for Sustainable Agriculture, Iowa State University
http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2013-06-funding-impact-brief-bear-creek-riparian-buffer-project.pdf

What did we learn?

Riparian buffers:

1. Cut sediment in surface runoff as much as 90 percent
2. Cut nitrogen and phosphorus in runoff by 80 percent
3. Entice and support 5 times as many bird species as row cropped or heavily grazed land
4. Allow water to infiltrate 5 times faster than row cropped or heavily grazed land
5. Remove up to 90 percent of groundwater nitrate
6. Cut stream bank erosion by as much as 80 percent from row cropped or heavily grazed land
7. Reach maximum efficiency for sediment removal in as little as 5 years
8. Reach maximum nutrient removal efficiency in 10-15 years
9. Increase soil organic carbon up to 66 percent
10. Are most effective at upper reaches of a watershed

Resources:

Connecting landscape fragments through riparian zones. 2012. Bentrup, G., M. Dosskey, G. Wells, and M. Schoeneberger**.** p. 93–109. In *Forest Landscape Restoration*. Springer. link.springer.com/chapter/10.1007/978-94-007-5326-6_5

Riparian Management System. Iowa State University. http://www.buffer.forestry.iastate.edu/HTML/buffer.html

Agroforesty Practices: Riparian Forest Buffers. The Center for Agroforestry, University of Missouri. http://www.centerforagroforestry.org/practices/rb.php

Perennial Forage

Research in Iowa has shown that matching length of the crop rotation and the location of permanent perennial cover to the slope of the ground is successful at reducing erosion below the "tolerable rate," T (5 tons/acre/year of soil loss).

% Slope	Crop Selection for Soil Loss < T
< 5%	2-year corn/soybean
5% - 14%	6-year corn-soybean-corn-oat+forage-forage-forage
>14%	Permanent perennial forage

At a slope less than 5%, a two-year corn-soybean rotation would keep soil losses from water erosion below T; although soil losses approached T at slopes approaching 5%. An extended rotation with perennial forage would drop average soil losses well below T on even modest slopes.

At slopes of 5% to 14%, the very low soil loss during years in perennial forage would balance the higher soil loss in the corn-soybean years.

At slopes higher than 14%, the low soil loss during years in perennial forage was not enough to balance the extreme soil losses seen in the corn-soybean years. These slopes should be in permanent perennials.

This study did not look at wind erosion. On flat ground where water erosion may be less of a concern, there could still be wind erosion that would make an extended rotation or use of cover crops, or both, desirable to hold soil in place.

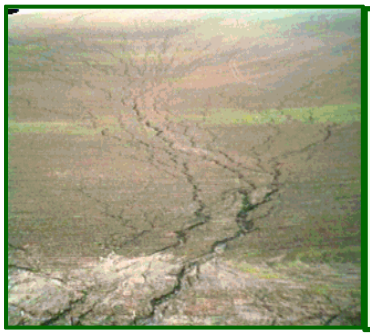
Source: Impacts of integrated crop-livestock systems on nitrogen dynamics and soil erosion in western Iowa watersheds. 2005. Burkart, M., D. James, M. Liebman, and C. Herndl. J. Geophys. Res., 110, G01009, doi:10.1029/2004JG000008.

Cover Crops

Cover crops to keep roots in the ground at all times of the year can help reduce both water and wind erosion on the low slopes or flat ground where a two-year corn-soybean rotation may be practiced. Cover crops on higher % slopes, combined with an extended rotation, can help reduce soil loss to below T.

On low slopes or flat ground where a two-year corn-soybean system may be used, cover crops can scavenge N and reduce N leakage from the cropped fields; reducing NO3 levels in drainage water by as much as 61% in one study.

Reduction in nitrate concentration in drainage water from corn/soybean systems with cover crops: 3 studies		
Study description	N03 reduction with cover crop:	Citation
Spring-applied UAN vs. Spring-applied UAN+rye cover crop	26%	Drainage water quality impacts of current and future agricultural management practices. Leopold Center for Sustainable Agriculture Competitive Grant Report XP2011-14. http://www.leopold.iastate.edu/sites/default/files/grants/XP2011-04.pdf
Winter cereal rye cover crop Fall oat cover crop Cover crops used on both corn and soybean crops	48% 26%	Effectiveness of oat and rye cover crops in reducing nitrate losses in drainage water. 2012. T.C. Kaspar, D.B. Jaynes, T.B. Parkin, T.B. Moorman, J.W. Singer. Agricultural Water Management 110 (2012) 25–33. http://naldc.nal.usda.gov/naldc/download.xhtml?id=54466&content=PDF
Winter rye cover crop + no-till over 4 years	61%	Rye cover crop and gamagrass strip effects on NO3 concentrations and load in tile drainage. 2007. T.C. Kaspar, D.B. Jaynes, T.B. Parkin, T.B. Moorman. *Journal of Environmental Quality*. 36(5):1503-11



Prevent Gully Erosion

Photo from National Soil Erosion Research Laboratory

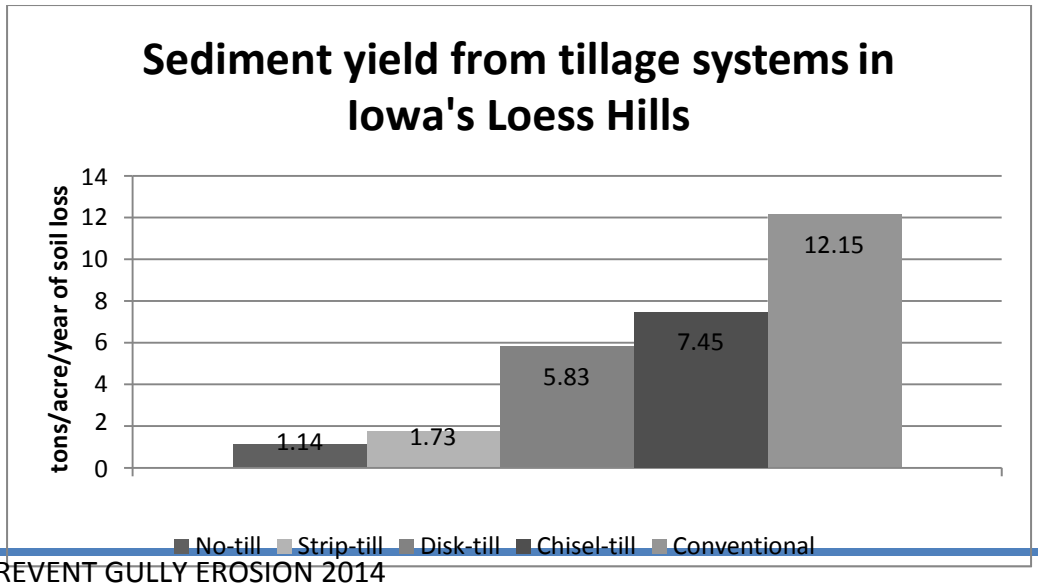
"The soil loss tolerance rate (T) is the maximum rate of annual soil loss that will permit crop productivity to be sustained economically and indefinitely on a given soil. Erosion is considered to be greater than T if either the water (sheet & rill) erosion or the wind erosion rate exceeds the soil loss tolerance rate."

-- Natural Resources Conservation Service, NRCS http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/nri/?cid=stelprdb1041925

Gully erosion means higher-than-expected soil losses

Research in Iowa is showing that gully erosion is sometimes under-accounted for by soil erosion estimates, and is a significant contributor to soil loss in cropped fields.

Simulations on test sites under several tillage systems in Iowa's Loess Hills showed soil loss rates higher or much higher than the Iowa state average of 5.42 tons/acre/year, which is already higher than the average T value of 5.0 tons/acre/year:



The Iowa Daily Erosion Project has been mapping daily rainfall and associated soil erosion for more than 10 years. Heavy rainfall events are becoming more common, and this project is demonstrating that some areas in Iowa have experienced 7 tons/acre in soil losses in a single day – well over the average annual soil loss per acre.

NRCS estimate of average soil loss on cultivated cropland as of 2010 (sheet and rill erosion):

Illinois – 4.00 tons/acre/year

Iowa – 5.42 tons/acre/year

Minnesota – 2.04 tons/acre/year

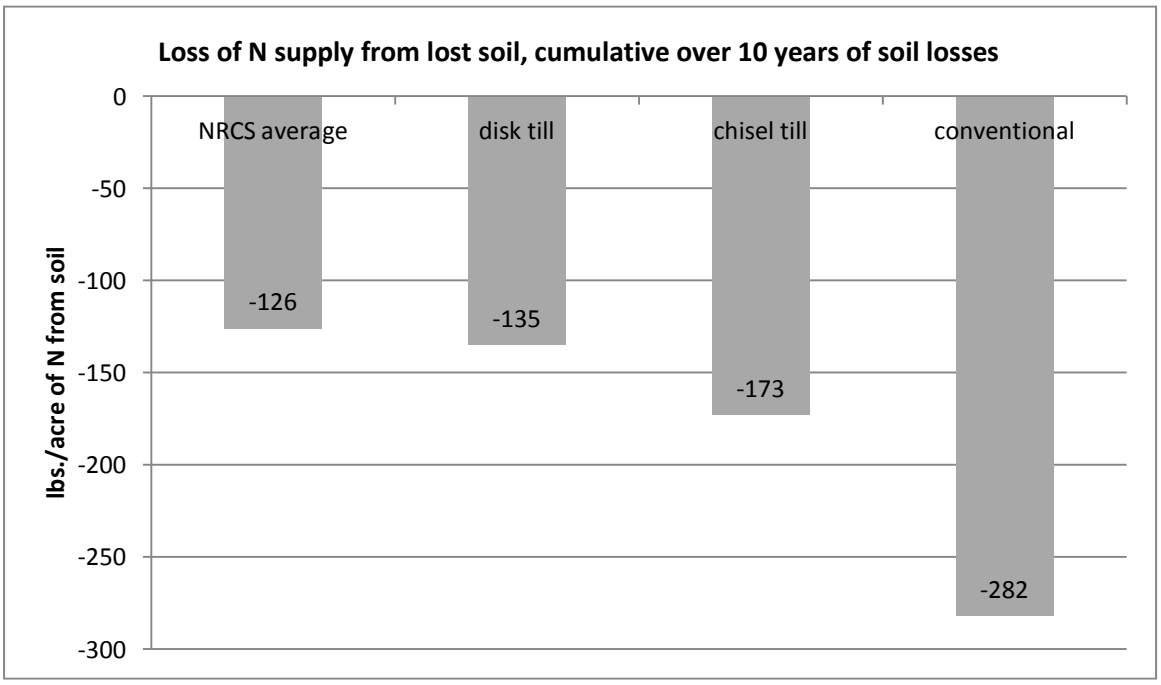
Wisconsin – 5.07 tons/acre/year

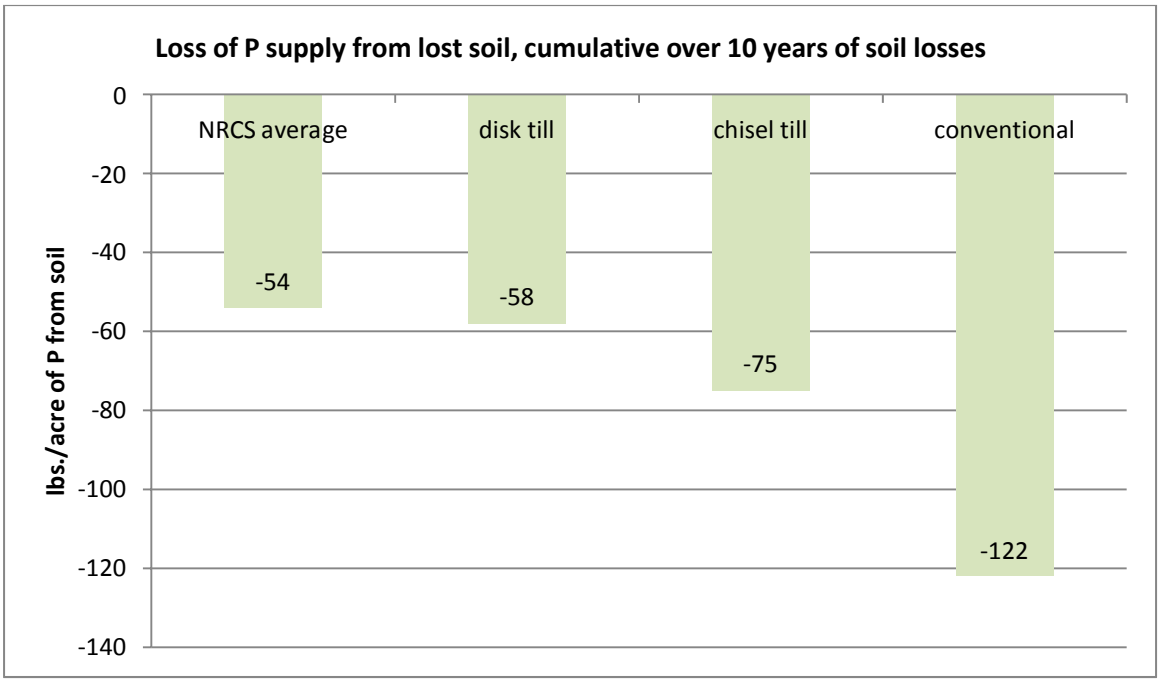
Dr. Rick Cruse at the Iowa Water Center estimates that soil loss due to gully erosion results in an annual loss of $1 billion in Iowa, including crop yield losses and flooding cleanup costs.

Fertilizer value of lost topsoil:

Soil characteristic	Amount available per ton of soil per year
N	2.32
P	1

Losses of fertilizer value are cumulative, because once you lose the soil in one year, you lose the N and P that would have been available from it in every future year. This loss of soil-supplied N and P to the crop has to be made up by manure or purchased fertilizer inputs, or by the formation of new soil.





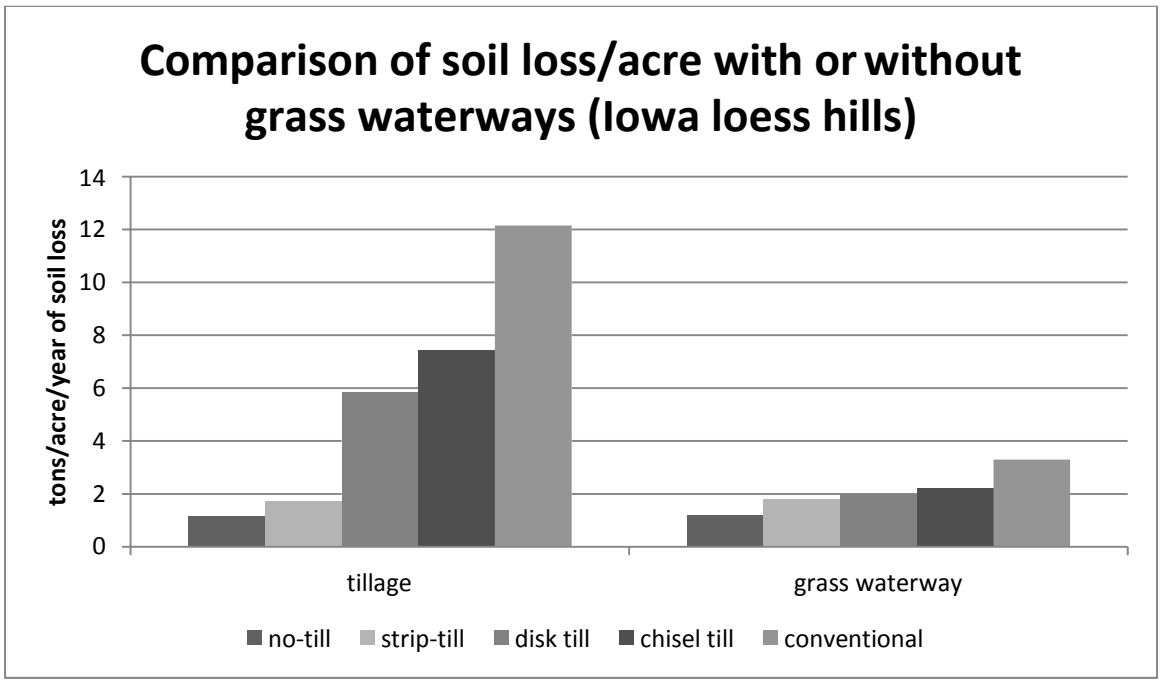
Reduced tillage clearly reduces soil erosion. However, reduced tillage alone may not be enough to prevent gully erosion in extreme rainfall events. Reduced tillage combined with Continuous Living Cover practices is needed to prevent erosion from the extreme rainfall events that are becoming more frequent.

Continuous Living Cover Practices to Help Prevent Gully Erosion:

- Cover crops on the ground in spring and fall, when heavy rains are common and row crops are not at full growth.
- Perennial forage in the crop rotation. A perennial forage stand can reduce erosion to near-zero in the years it is in place; and the residual root system in place after the crop is terminated can still help anchor the soil.
- Grassed waterways.
- Prairie strips in the crop fields.

The research in Iowa's loess hills showed that addition of grassed waterways could greatly reduce the soil loss from even the more intensively tilled fields. The prairie STRIPS research also shows large reductions in soil loss from fields due to the addition of relatively small strips of perennial vegetation, even if the crop fields are tilled. Farmers can balance tillage practices with Continuous Living Cover practices to achieve reduced

erosion in a way that works on their farm. Combining Continuous Living Cover practices with reduced tillage can reduce soil erosion to very low levels.



References:

The Cost of Soil Erosion. 2013.
http://www.extension.iastate.edu/ilf/sites/www.extension.iastate.edu/files/ilf/Cost_of_Ero ded_Soil.pdf

Summary Report: 2010 National Resources Inventory.
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167354.pdf

Impact of Conservation Practices on Soil Erosion in Iowa's Loess Hills
https://www.extension.iastate.edu/NR/rdonlyres/26DC3619-5E13-4992-9F38-C104F60E6DBE/135600/Conservation_Practices_on_Soil_Erosion_Loess_Hills.pdf

Iowa Daily Erosion Project
http://wepp.mesonet.agron.iastate.edu/GIS/erosion.phtml

Strategies for Transforming Sensitive Lands and Marginally Productive Row Crops to Pasture or Other Perennial Crops

Update Spring 2017
Continuous Living Cover Series

Introduction

Some croplands are poorly suited for annual row crops due to ecological sensitivity or marginal productivity. These areas offer opportunities for more diversified farm income and greater ecological services from perennial crops.

Perennial cropping systems include perennial grain, forage and hay, pasture, biomass energy crops, fruit and nut crops, and timber. These systems yield a harvestable crop or pasture and keep living roots in the ground year-round.

Ecologically sensitive areas that can benefit from the conversion of row crops to perennial crops or pasture include: buffers along streams and other aquatic features, wellhead recharge areas, and karst sinkholes.

Some farmlands consistently produce at or below the cost of production. The low profitability of these lands may be related to soil type, poor soil health from past management, or site hydrology. Planted with perennial crops or as livestock pasture, these areas could result in the same or more income, with more ecological benefits.

This chapter describes perennial cropping or pasture systems that might replace annual crops on ecological sensitivity and marginal productivity lands.

Buffers Along Streams, Lakes, and Wetlands

Adding a perennial crop buffer between waterways and farm fields planted with annual row crops can reduce surface water that carries topsoil and nutrients off farm fields. Other benefits include improved soil health, expanded wildlife and pollinator habitat, increased water infiltration, stream bank preservation, and more carbon sequestration in soil.

Designing Buffers with Perennial Cropping Systems

Buffers designed with perennial cropping systems must meet environmental and farming objectives at the same time. Buffer shape and width, constructed features (e.g., to address areas of concentrated water flow), and plant selection must meet minimum requirements to address surface water management objectives. These same factors—shape, width, constructed features, and plant selection—must meet the objectives of the farming operation. To meet the needs of farming operations, the buffer shape and width need to be wide enough to match equipment width, for example, and to accommodate the optimal number of tractor passes.

Equipment width and harvestability are important factors to think about early on. Ease of management will be critical to the success of the perennial buffer system. Another point to consider is that perennial cropping systems may increase the area that can be cropped. Perennial vegetation often allows farmers to drive equipment onto areas that in the past were too wet to drive on.

Minnesota Buffer Law

In 2015 Minnesota Governor Mark Dayton signed into law a new buffer initiative to protect Minnesota's waters. The law calls for perennial vegetation buffers up to 50 feet along public waters and at least 16.5 feet along ditches. Landowners can also use other water quality practices with comparable water quality benefits.

A Buffer Map is at www.dnr.state.mn.us/buffers.

Another benefit of installing riparian or stream buffers is the opportunity to start the talking about riparian corridors with neighbors. On a landscape scale, continuous riparian buffers increase water quality and offer crucial refuge for wildlife, including beneficial insects.

Resources for Technical and Financial Assistance

- Federal Farm Bill resources: Conservation Reserve Program, Continuous Conservation Reserve Program, and the Environmental Quality Incentives Program.

- Minnesota state resources: Reinvest in Minnesota easement program, Conservation Cost-Share, and the Minnesota Agricultural Water Quality Certification Program.

- See the chapter on "EQIP, CSP and CLC" to identify NRCS programs that can fund perennial cropping systems.

Wellhead Management Areas and Karst Sinkholes

Areas around wellheads, the places where springs come out of the ground, can be targets for water quality improvement. When managed/planted with summer annual crops, wellhead management areas and areas around sinkholes can act as conduits to groundwater and nearby streams.

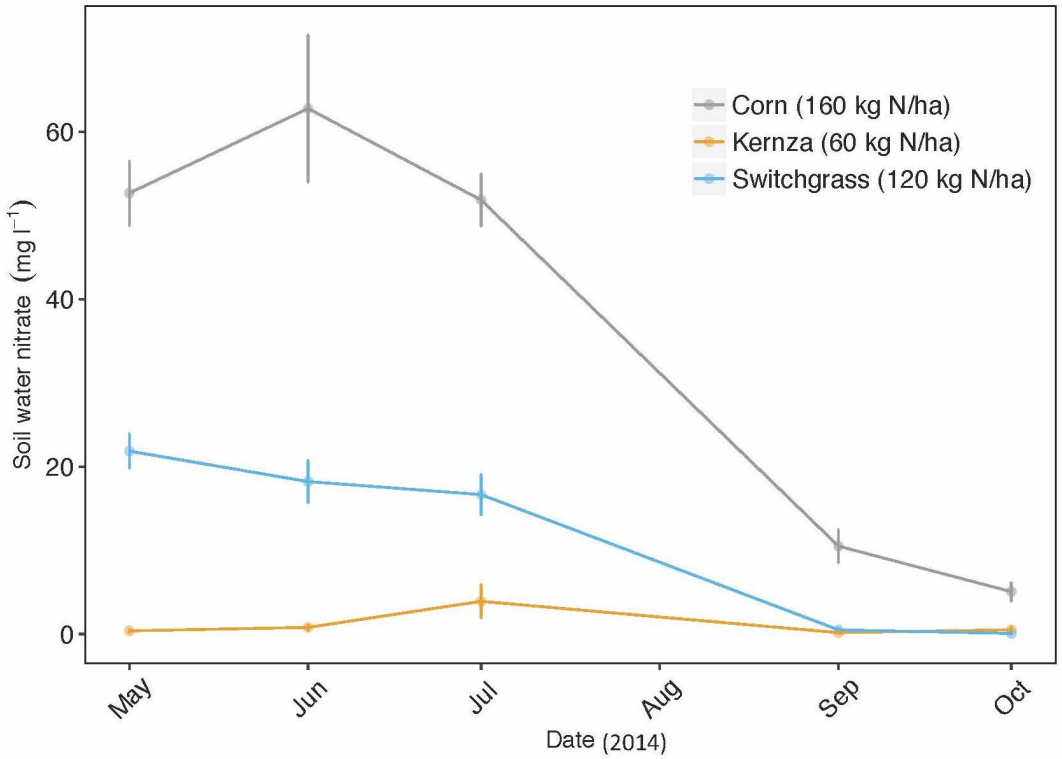
Sinkholes occur in karst areas where water-soluble bedrock exists. Water dissolves the rock and as the resulting sediment moves away into cracks and voids, the ground above collapses and creates a sinkhole. Sinkholes can serve as direct conduits from field to groundwater or nearby streams. When this occurs, debris, topsoil, agricultural inputs, and other contaminants flow freely into the groundwater.

Nitrates, pesticides, and fecal bacteria have contaminated groundwater in hundreds of wells across the Midwest. When treatment becomes a necessity, communities and private landowners bear the cost. By contrast, when these areas are managed/planted with perennial crops, soluble nutrients are reduced before they reach groundwater and surface waters. Groundwater quality can be protected by planting a perennial buffer around the sinkhole. Studies show that converting row crops to perennial systems in well recharge areas can significantly decrease contamination by nitrates and other pollutants.

The Natural Resource Conservation Service recommends a minimum width of 25 feet.

Figure 1. Soil water nitrate comparison with annual and perennial plantings.

Annual row crop (corn), perennial grass (switchgrass) and Kernza® perennial grain crop.



From Jacob M. Jungers, Department of Agronomy and Plant Genetics, University of Minnesota.

Agencies Responsible for Wells and Groundwater Protection

Illinois - Environmental Protection Agency

Iowa - Department of Natural Resources

Minnesota - Minnesota Department of Health

Missouri - Missouri Department of Natural Resources

Wisconsin - Wisconsin Department of Natural Resources

Marginally Productive Land

Some farms have areas that are less productive and therefore less profitable than others. This "marginality" can be due to a high water table, frequent flooding, droughtiness, high erodibility, high levels of runoff or leaching, and other soil or climate factors that can limit productivity. These areas are good candidates for conversion from row crops to perennial cropping systems or pastures. The large root systems of perennial crops are better at holding soil in place, tolerating periods of low moisture, and allowing large amounts of moisture to infiltrate. Because of this, perennial crops on less productive plots have the potential to out-perform annual row crops.

Identifying Marginally Productive Areas on the Farm

In situations where "marginality" is not easily identified on the land, there are a variety of tools that may help landowners determine the best areas to plant perennials. Some of the tools available include the following:

- **Whole Farm Conservation Planning**
  The U.S. Department of Agriculture (USDA)'s Natural Resource Conservation Service helps landowners create individual conservation plans at no charge. The plan can help landowners evaluate opportunities, mitigate loss, and comply with regulations. A conservation plan can identify areas with production potential and conservation improvements. Once areas for improvement have been identified, NRCS program dollars may be available—but participation is not required.

Prairie STRIPS Research

Research from the **Science-based Trials of Rowcrops Integrated with Prairie Strips** or **STRIPS** project in Iowa shows that converting 10% of cropland to diverse prairie forbs resulted in a 95% reduction in soil loss and 85% to 90% reduction in nutrient loss.

Key to the success of Prairie Strips is the correct placement on the land. In fields with 6% to 10% slopes, narrow strips of prairie should be placed along field contours and at the foot slope (also known as the toe slope) for best results.

For more information go to www.nrem.iastate.edu/research/STRIPs/content/about-strips

- **Profit Zone Manager**

  AgSolver's Profit Zone Manager (now owned by EFC Systems) is an online product designed to help landowners test field profitability for a variety of management scenarios. The product can project how conservation management decisions will impact producer's bottom lines, and it allows users to assess these projections before they commit to making changes.

- **Cropping Systems Calculator**

  The Chippewa 10% Project's Cropping Systems Calculator is an Excel-based tool that helps farmers determine the financial viability of planting annual crops versus planting pasture and grazing. Farmers plug in a variety of management scenarios to see how each scenario would impact their bottom line. The calculator even includes a soil loss feature.

Perennial Solutions

- **Agroforestry**

  Adding forest production to farm enterprises is a good way to diversify income while adding ecological benefits. Agroforestry can mean many different practices and there is plenty of room to customize for each unique situation.

  For more information, please see the Green Lands Blue Waters publication "Agroforestry" from the *Continuous Living Cover Manual*.

  Agroforestry includes growing woody trees and shrubs that produce fruits or nuts, and high-value lumber integrated into another enterprise. One example of agroforestry is the use of a fruit-bearing species as a windbreak to protect crops, livestock, or to improve energy efficiency in buildings. Another example is the use of fruit, nut, or lumber trees in a riparian buffer.

Alley cropping is great example of how to integrate forest products into farm enterprises. For more information, see the "Alley Cropping" sidebar.

- **Biomass**

  In this document biomass refers to recently living leaves, shoots, stems, stalks, and flowering parts of herbaceous or woody plants. These parts of the plant can be used on-farm as an energy source or bedding or sold to industries for processing into bioenergy or bioproducts. Biomass plant sources include perennial grasses or woody species such as hybrid poplar or willow. For more information and additional resources, see the Green Lands Blue Waters publication "Biomass" from the *Continuous Living Cover Manual*.

- **Integrating Livestock**

  The integration of livestock into a farm system can mean using perennial forage for on-farm use or sale. Areas planted to perennial pasture can be grazed, hayed to support on-farm cattle, hayed and sold off-farm, or contract grazed by a beginning grazier's cattle. The Minnesota Buffer Law does not restrict haying and grazing buffer strips. Landowners can hay or graze these areas as long as they maintain perennial vegetation.

  Grazing requires thoughtful management to successfully balance animal needs, the goals of the producer, and the condition of the pasture. However, the growing popularity of premium-price grass-fed beef can make it a profitable option. See the Green Lands Blue Waters document "Integrating Livestock" from the *Continuous Living Cover Manual* for more detail and additional resources.

Alley Cropping

Alley cropping refers to the use of two or more rows of woody tree or shrub species planted to form a wide alley for crops to be grown in.

Integrating woody species that provide income such as fruit, nut, or lumber products has many benefits. Deep-rooted, wind-blocking trees and shrubs can:

Reach deep nutrients and cycle them to the surface by shedding litter.

Protect valuable crops from wind and sand particle damage.

Reduce evapotranspiration.

Increase soil moisture in the tillage layer.

Increase crop yield.

Provide economic diversity.

Increase soil carbon.

- **Kernza®**

  Over the past two decades, the Land Institute and the University of Minnesota have worked to breed a marketable perennial grain from intermediate wheatgrass, which is related to wild wheat. While still in development, the result is Kernza®, a promising plant with the potential to be a profitable perennial crop that lessens the environmental impacts associated with U.S. agriculture. Because the crop is still in development, there are risks associated with it, and much more research and market development are needed. However, Kernza® is already used in commercial beer, bread, crackers and spirits.

Stacking Continuous Living Cover Strategies

The stacking of Continuous Living Cover (CLC) strategies means using more than one strategy in the same vicinity at the same time. "In the same vicinity" can mean within a single field or portion of a field, or on a whole-farm basis. Stacking of CLC strategies can even be done on a larger landscape scale, such as on a series of neighboring farms or within a watershed.

Trying to envision all of those interactions and placement decisions ahead of time could seem intimidating, but the experience of many farmers is that once they started adding CLC strategies, the interactions among them flowed naturally and contributed to the stability of their whole farming system. Please see the Green Lands Blue Waters document "Stacking of Continuous Living Cover Strategies" from the *Continuous Living Cover Manual* for more information and summaries of how 10 farmers stacked Continuous Living Cover on their farms.

Intermediate Wheatgrass/Kernza®

Intermediate wheatgrass (*Thinopyrum intermedium*) (IWG) is a perennial grass genetically related to common wheat that is being bred and marketed as the perennial grain Kernza®.

IWG produces large biomass and is among the most productive cool-season forage species in the western United States (Harmoney, 2015). As a perennial species, it provides substantial environmental services relative to annual grain crops, including **reduced soil and water erosion**, **reduced soil nitrate leaching**, **increased carbon sequestration**, and **reduced input of seed, tillage, energy, and pesticides** (Culman et al., 2013; Glover et al., 2010; Robertson et al., 2000). IWG has a more extensive root system, **can capture more applied fertilizer**, and **reduce total nitrate leaching by 86% or more** relative to annual wheat (Culman et al., 2013).

Please see the Green Lands Blue Waters document titled "**EQIP, CSP, and CLC**" from the ***Continuous Living Cover Manual*** for details on the use of Farm Bill program funding to implement conservation practices on working lands.

Stacking of Continuous Living Cover Strategies

Stacking of Continuous Living Cover (CLC) strategies means using more than one strategy in the same vicinity at the same time. “In the same vicinity” can mean within a single field or portion of a field, or on a whole-farm basis. Stacking of CLC strategies can even be done on a larger landscape scale, such as on a series of neighboring farms or within a watershed.

Agroforestry, biomass, cover cropping, perennial forage, and perennial grain strategies can be linked together and coordinated with each other in many potential combinations of two, three, four, or all five strategies to achieve goals for farm income, soil health, water quality, species diversity, wildlife habitat, aesthetics, etc. For more information about how continuous living cover strategies can reinforce each other on a farm or larger landscape and create multiple benefits, see Asbjornsen et al. (2013).

Stacking and placement of CLC strategies can go hand-in-hand. When considering implementation of a single CLC strategy, it is desirable to look at choosing the planting location in order to gain maximum benefit from the strategy. The “Placement of Continuous Living Cover” chapter in this manual goes into greater detail about decision-making for siting CLC strategies. Once you stack a second CLC strategy onto the first, you need to also think about how those two strategies interact with each other in addition to where to place them both for maximum benefit. Stacking additional CLC strategies, of course, increases those interactions.

Trying to envision all of those interactions and placement decisions ahead of time could seem intimidating, but the experience of many farmers is that once they started adding CLC strategies, the interactions among them flowed naturally and contributed to the stability of their whole farming system. See below for summaries of how ten farmers stacked CLC on their farms; and then visit their case studies in this manual for more detail about how it works for them.

Kent and Linda Solberg, Verndale, MN.
The Solbergs started restoring a degraded soil through managed grazing and “outwintering” of cattle (feeding hay in the paddocks during the winter.) Adding the technique of short-duration grazing with a high rate of trampling of forage helped them

make progress in soil health and forage production. Their next step was using complex cover crop mixtures to facilitate renovation of pastures. These cover crops are typically grazed, and Kent plans cover crop mixtures that include annual warm-season grasses to use as cattle forage during the hot and dry part of summer. Now they are working on designing site-specific mixtures of perennials for their pastures, in addition to maintaining and improving their other strategies.

Fred Abels, Holland, IA.
Fred Abels added livestock to his operation, established permanent pastures, and started a rotational grazing system in 2003. He also uses a pasture that had existed on his farm since the 1930s. His winter cattle feed originally came from baling a friend's grassed waterways, but he added hayfields gradually from 2008 to 2010. He does some rotating of row-crop acres with hay. After experimenting with cover crops for several years, he became convinced of their value for improving soil health on his row-cropped acres; and planned to use them on 100% of cropped acres in 2014.

Brad, Sue, and Andrew Johnson farm; Osceola, WI.
The Johnsons started down the soil conservation path with reduced tillage, going fully to no-till in 1981. Then they withdrew some areas from cropping entirely, putting sensitive streambank areas into CRP. Now they are experimenting with cover cropping on their corn and soybean ground to protect soil and improve their efficiency of nitrogen use. Andrew is interested in multi-species mixtures of both cover crops and grain crops. They are looking towards Kernza ™ perennial grain as a way to further protect sensitive soils and adapt to climate change.

Tony Thompson and Sonya Buller, Windom, MN.
Willow Lake Farm
No-till production was adopted in the 1980s. Tony pays careful attention to placement of cropping and conservation strategies. Wide buffers around wetlands and river headwaters were established with CRP contracts, and raises corn and soybeans on his flat lands. Cover crop experimentation is ongoing, and Tony is particularly interested in developing "prescription" treatments of cover crops for problem areas within fields.

Ted and Gretchen Johnson, Star Prairie, WI.
Grassed waterways were established by Ted's father in the 1950s under a contract with the Soil Conservation Service, the predecessor to today's NRCS. Those waterways are still in place. Strip cropping was discontinued because of a need to consolidate fields for custom harvest. Wide buffer areas protect the stream and those are not in a contract; they are cut for hay or haylage twice per year. Steep hillsides are in permanent cover. Most of the fields have some slope and are on a long rotation of alfalfa for four years and corn for two or three years. Cover crops are used in the alfalfa establishment year

on sloping fields, to protect soil. A winter cereal rye cover crop is used following corn silage. Experimentation with cover crops continues to try to find an optimum seeding strategy for their farm.

Gene Schriefer, Dodgeville, WI.
Gene started out with grazing, primarily of sheep but gradually shifted to beef cattle. He uses a rotational grazing system with permanent pastures on his sloping areas, and short-duration grazing with a high stocking rate has improved his pastures. He employs an agroforestry strategy of using wooded areas as shade for livestock during hot spells in summer. Cropland on the ridge-tops has been converted to hay and pasture with a seven- to eight-year reseeding schedule. He uses a cover crop mixture of three to seven species along with a small grain crop in the reseeding year, and the cover crop is grazed after small grain harvest. He is experimenting with an improved big bluestem variety on 12 acres with an eye toward winter grazing for the cattle as well as a forage that can withstand a summer drought.

Tom and Irene Frantzen, New Hampton, IA.
Agroforesty is an important strategy for the Frantzen farm. It has been certified organic since 1995 and a key piece of their system is the 66'-wide shelterbelt that surrounds the majority of the property. It serves as their required buffer for organic production, but also provides species diversity, wildlife habitat, and protection against extreme weather. It proved its worth in the flooding of 2008, slowing down rushing floodwater and giving it a chance to spread out and deposit sediment on their fields. They use a five-year crop rotation on their 355 tillable acres, with two of those years in perennial forage. A winter cereal rye cover crop is routinely used on corn stubble following silage harvest and then tilled in prior to soybean planting the following May. Cover crops are also used as a weapon against specific weed problems; for instance, sorghum-sudangrass followed by two years in hay to combat giant ragweed.

John and Beverly Gilbert, Buckeye, IA.
Gibralter Farms
John Gilbert says there are a lot of things they just never stopped doing: crop rotation, small grains in rotation, grassed waterways, and annual and perennial forage mixtures. Those strategies form their baseline of continuous living cover. In addition they have expanded their grassed waterway system, added some permanent pasture and a rotational grazing scheme for their cattle, and established grassed headlands for their cropped areas. The grassed headlands where equipment turns are connected to the grassed waterway system, and all are harvested for cattle feed. Wetland establishment with a buffer area near the stream was established more recently. Wooded areas are used by the cattle for shelter, but future plans include more intensive management of the woodlots for income. Currently they are experimenting with cover crops, and host some cover crop test plots for Iowa State University.

Jim and LeeAnn VanDerPol, Kerkhoven, MN.
Pastures A'Plenty Farm
The VanDerPols got started in continuous living cover by establishing a pasture mix on a low-lying field where tillage and harvest equipment frequently got stuck. They gradually expanded the pasture system up to 30 paddocks and do managed rotational grazing of beef cattle. Their sow herd also has access to some paddocks. Next they implemented a six-year rotation on their cropland, which includes three years in hay. They added an agroforestry strategy in the form of windbreaks, which help reduce winter wind erosion on cropped areas and allow them to expand areas where cattle can be wintered. Future goals include increasing the species diversity of their pastures and adding a winter annual grain to their crop rotation to increase winter cover on their fields.

Mary Jo and Luverne Forbord, Starbuck, MN.
Prairie Horizons Farm
The Forbords started out with preservation of prairie remnants and re-establishment of prairie areas on their farm. They converted cropped fields to perennial forage, and established a managed rotational grazing system for beef cattle. Some of their land is available to researchers for testing biomass crops, monitoring species diversity, and studying prairie establishment. They have agroforestry components in the form of windbreaks and an orchard featuring native fruits. Their goal is to continually move toward perennialization, putting more fields in perennials and adding more strategies that build on and reinforce each other. Maintaining the profitability and ecology of the system as a whole is important to their vision for their farm.

Reference:

Targeting perennial vegetation in agricultural landscapes for enhancing ecosystem services. 2014. Heidi Asbjornsen, V. Hernandez-Santana, Matthew Z. Liebman, J. Bayala, and J. Chen. *Renewable Agriculture and Food Systems*. 29(02):101-125.

Tools of the Trade

photo: Lowery Creek, Richard Cates

The "Trade" is planning and implementing farming systems that:

DELIVER yields of commodity crop

DELIVER on-farm and off-farm benefits to soil health and water quality

SECURE long-term stability of the farm and its resources

Continuous Living Cover practices are tools that can be used in combination with each other and other tools to:

- Deal with nutrient loading concerns
- Deal with soil erosion concerns
- Deal with N leakage concerns
- Achieve improved soil health on the farm
- Improve resilience and robustness of the farm
- Maintain profitability, short-term and long-term

Goal	**Continuous Living Cover Practices**
Reduce nutrient (N and P) loading into surface waters	• Extended crop rotation with perennial forage • Strategic placement of perennial strips within fields • Riparian buffers • Grassed waterways
Reduce water erosion	• Extended crop rotation with perennial forage on slopes above 5% • Permanent perennial forage or agroforestry planting on slopes above 14% • Strategic placement of perennial strips within fields • Cover crops on the ground in spring & fall

Goal	Continuous Living Cover Practices
Reduce wind erosion	• Windbreaks /Shelterbelts • Hedgerows • Cover crops • Winter grain and perennial forages in rotation
Reduce N leakage to surface or ground waters	• Cover crop used as “catch crop” • Extended crop rotation with perennials and small grains
Improve soil health	• Extended crop rotation with perennial forage • Integration of livestock • Cover crops • Complex cover crop mixtures
Improve farm resilience	• Stacking of multiple CLC practices • Consistent use of CLC practices
Maintain profitability	• Use the shortest rotations on the flattest land • Add agroforestry plantings that produce a cash crop • Use extended rotations verified as profitable by University research • Integration of livestock

Continuous Living Cover practices are effective for meeting the above goals, but their effectiveness is even greater when multiple CLC practices are stacked on a single farm; and when stacked with other types of practices to control soil erosion, N leakage, and nutrient loading into surface waters. These may include:

- Reduced tillage
- Drainage management
- Terracing and contouring
- Bioreactors

Farmer Profile Library

photo: Cates Farm, Richard Cates

Cover Crop farmer profiles

Cover crops in small grains

Carmen Fernholz – Cover crops: Carmen has been using cover crops on his Madison, MN farm for almost 30 years. Most of his covers are used in conjunction with small grain management. All of his small grains which include wheat, oats, barley, flax and dried field peas are all underseeded with either a red clover or an alfalfa. These underseedings are then used as covers late into the fall or as cash forage crops for ensuing years. Alfalfa as a three year perennial and cash crop also is a big part of his crop rotation system. http://www.mccc.msu.edu/states/MN_farmers.html#CarmenFernholz

Cover crops in corn/soybean

Jerry and Nancy Ackermann farm – Cover Crops: ~1050 acres of corn, soybeans and alfalfa in Lakefield, MN. Purple-topped turnips, cover crop radish and cereal rye cover crops on standing corn and soybeans. Farm is being studied by Andy Nesseth, of Extended Ag Service in Lakefield. http://www.agweek.com/event/article/id/22104/ http://www.pipestonestar.com/Stories/Story.cfm?SID=13986

Dan DeSutter – Cover crops: Dan grows continuous, no-till corn on his 4,300 acres near Attica, IN. In the 10 years he has been growing cereal rye, oilseedradish, and crimson clover as cover crops, his organic matter has increased 2%.

http://magissues.farmprogress.com/MOR/MR01Jan12/mor031.pdf

Tim Smith – Cover Crops: Eagle Grove, IA farmer Tim Smith honored by the National Corn Growers Association as the inaugural recipient of its Good Steward Recognition Program
http://www.nature.org/newsfeatures/pressreleases/the-nature-conservancy-congratulates-iowa-farmer-tim-smith-for-winning-natio.xml

Danny & Kevin Harms –Cover Crops: The Harms family farms about 3,250 acres in Livingston, McLean and Ford counties, Illinois. They had a dairy operation until 2007 and now focus on corn and soybeans. "We wanted something to pull nutrients up from deep down and bring them closer to the surface," said Danny. With its thick, fibrous roots, annual ryegrass does that and more, helping with compaction, water infiltration and nitrogen sequestration.

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?cid=stelprdb1083051

http://www.heartlandoutdoors.com/malone/story/partnership_equals_successf ul_watershed_project/

Daniel Steidinger – Cover Crops: Daniel read about cover crops and decided to give them a try on his Illinois farm. He planted radishes to increase water infiltration where water used to run across the field. The deep roots of the radish aerated the area enough to pull water further down into the soil profile. Daniel said "There was a 100-bushel difference in my field with cover crops, and in a drought like we had, that just speaks for itself".

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?cid=stelprdb1083051

Cover crops in corn/soybean/small grain rotation

Gary Sommers – Cover Crops: Gary grows corn, soybeans, and winter wheat on 1,475 of his 1,500 acres in Clinton, Wisconsin. The remaining 25 acres are
enrolled in CRP. Gary uses cover crops on his steeper fields.

http://www.cias.wisc.edu/wp-content/uploads/2012/01/sommerscovercroplowres011912.pdf

Ralph Upton Jr. – Cover Crops: Ralph's farm is 1,800 acres of no-till corn, soybeans, and wheat located in Hamilton County, Illinois. Ralph has implemented cover crops for several reasons. His primary goal was improving crop access to sub-soil moisture and building fertility, he also wanted to protect his soil from erosion, provide nitrogen for subsequent crops, and manage weeds.
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/il/home/?cid=stelprdb1143 59 4

Dave Brandt – Cover crops: When soybean farmer Dave Brandt started using cover crops in 1978, his soil was yellowish clay. Today his soil is black and organic matter has gone from 0.5% to 5.5%. He uses ryegrass and hairy vetch for cover crops on his 900 acres in Carroll, OH.
http://magissues.farmprogress.com/MOR/MR01Jan12/mor031.pdf

Steve Berger – Cover crops: Steve Berger became a convert when he noticed a yield boost on ground where there used to be a fencerow. The corn yield has increased on his 2,200 acre farm near Wellman, Iowa since he started using cereal rye as a cover crop.
http://www.extension.iastate.edu/ilf/page/steve-berger
http://magissues.farmprogress.com/MOR/MR01Jan12/mor031.pdf

Cover crops & grazing

The Anderson Farm – Silvopasture + Grazing + Cover Crops + Field Crops + Perennial Forage: 22 head of beef cattle graze on 65 acres of pasture in Cherokee, IA. Burr oak on part of the farm creates a savannah-like area for grazing. http://practicalfarmers.org/blog/2013/08/19/perennial-pasture-management-a- beginners-perspective/

Torray Wilson – Cover Crops + Perennial Forage. Torray and family farm about 640 acres organically near Paullina, IA. He grows organic corn (maize), soybeans and oats and these are sold off the farm for cash. He also has a

burgeoning sheep, cattle and pig enterprise.
http://willoutwest.blogspot.com/2009/11/beginning-farmer.html
http://practicalfarmers.org/farmer-knowledge/research-reports/2013/grazing-cover-crops-fact-sheet/

Dana Foster – Cover Crops + Grazing: Dana is a sheep and cattle farmer in Springdale, IA who planted cover crops on the fallow area of the garden. Dana got 3 grazes off of the cover crops the first year.
http://practicalfarmers.org/farmer-knowledge/research-reports/2013/grazing-cover-crops-fact-sheet/

Seth Watkins – Cover Crops + Pasture + Native Grasses: Seth grows corn, soybeans and alfalfa and runs a cow-calf operation on hilly pastureland in Taylor County, Iowa. The 2,800 acres of land in southwest Iowa that he owns, rents or manages include crop fields, pasture and natural habitat. He rotates 600 head of cattle through 2,300 acres of pasture to keep the land healthy and produce high- quality beef. He plants a diverse array of cover crops in his corn-soybean fields and has about 30 acres enrolled in the Conservation Reserve Program. In the summer of 2013, Seth seeded a 50-acre field with about eight acres of prairie in an effort to reduce soil loss, slow runoff and create vital patches of native habitat among his row crops. Watkins also preserves habitat for hunters, who keep the deer herds at a manageable level and provide an additional source of revenue for the farm—more than he could make by putting the same land in crops.
http://www.leopold.iastate.edu/news/leopold-letter/2013/summer/prairie-conservation-strips

Cover crops in corn/soybean + grazing

Jim O'Hara – Cover Crops + Forage: Jim aerial seeded 60 acres of rye and radish cover crops in September. His 25-head Shenandoah, Iowa cow herd grazed on the cover crops during the winter. Iowa Soybean Association member. http://www.iasoybeans.com/stories/2014/05/08/cover-crops-and-coffee

Gabe Brown - Cover Crops + Perennial Forage: Gabe, along with his wife, Shelly, and son, Paul, own and operate a diversified 5,400-acre farm and ranch near Bismarck, N.D. The Browns holistically integrate their grazing and no-till cropping system, which includes a wide variety of cash crops along with multi-species cover crops and all-natural, grass-fed beef, poultry and sheep. http://agriculturalinsights.com/episode-035-gabe-brown-on-cover-crops-no-till-and-livestock/ http://www.sare.org/Events/National-Conference-on-Cover-Crops-and-Soil- Health/Cover-Crop-Innovators-Video-Series/Gabe-Brown-Bismarck-North- Dakota

Cover crops in commercial vegetable production

JenEhr Family Farm – Paul Ehrhardt and Kay Jensen CSA farm on 50 of their 110 acres. They rotate cover crops on sloping land. Turkeys and chickens are pastured on the cover crop portions. On his bottomland, Paul rotates annual grass cover crops – winter wheat, rye, oats and barley – with his vegetables. These small grains add carbon and biomass to the soil and slow erosion. He has experimented with Sudangrass and soybeans with mixed success. He is interested in trying field peas, likely planting them with barley and triticale. http://www.cias.wisc.edu/wp-content/uploads/2011/11/jenehrcovercrops111011lowres-2.pdf

Cover crops instead of irrigation

Kent Solberg, Seven Pines Farm. Profile yet to be written – about his decision to pursue cover crops rather than invest in irrigation equipment. http://blog.nwf.org/2014/05/meet-the-cover-crop-champions/

Cover crops & weed control

Ryan Stockwell has been coupling no-till with cover crops on the ground he farms. He drills in a cover crop of radish following harvest of winter wheat and then plants to soybean the following year. The radish out-competed winter annual weeds, and broke up some plow pan as well. “It was amazing. It made my weed control really easy,” he remarked. http://www.agriview.com/news/regional/stockwell-cover-

crops-benefit-farmers-and-wildlife/article_bc9a5776-1583-54e8-8f44-6351364ff55e.html

Agroforestry farmer profiles

Woody-species windbreaks

* For livestock protection
* For crop protection
* For reduction of wind erosion

Jim and Kari Miller farm southwest of Hoisington, KS – Windbreaks: Experienced increased yields of wheat and milo after installing windbreaks. http://www.hpj.com/archives/2009/mar09/mar23/Fieldwindbreakplantingsincr. cfm#.U5Chmfm-1cY

Paul Huenfeld – Agroforestry: Paul is a Nebraska organic farmer that installed windbreaks because he needed buffers around the farm. He also values the importance of habitat for the insects and predators. http://www.centerforagroforestry.org/pubs/training/chap6.pdf

Riparian buffers

Ron Risdal – Riparian buffer: In 1990 corn, soybean, and alfalfa farmer Ron Risdal planted a riparian buffer on his farm in Story County Iowa. Ron says "I don't think we've lost hardly any stream bank since 1993, where before, we were moving the fences about every year. When it floods, the water stops at the buffer strip now instead of washing all over the bank. We don't have to move fences every year, and we don't have to haul rocks in the gullies like we used to do years ago." http://www.centerforagroforestry.org/practices/rb.php http://www.buffer.forestry.iastate.edu/Demosites/HTMl/risdal.html

Ron Strum – Agroforestry: Ron grows corn and soybeans on his 1,000 acre farm in Story County, IA. Since installing a riparian buffer, he no longer loses crops during wet years and he no longer gets his tractor stuck. http://www.centerforagroforestry.org/pubs/training/chap5.pdf

Andreas Farms – Cover Crops + riparian buffer: Dan Andreas' dairy farm is a milking operation with more than 1,500 dairy cows. Nearly 4,000 acres are used to grow forage for the cows. Dan uses cover crops on the active fields to improve soil health and to prevent soil erosion and nutrient runoff. He also installed a buffer to improve water quality.
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/
?cid=stelprdb1253957

Silvopasture

WE Farm –Silvopasture: Josh Egenolf and wife Laura Beth Wayne raise cattle, pigs, and poultry using high-density grazing patterns on a farm in Owen County, Indiana. Forested parts of the property provide acorns, paw paws, beechnuts, and walnuts for the pigs. Egenolf says that chefs appreciate nut-finished pigs. The farm is leased from Lisa Harris of Indianapolis. Harris is a big fan of leasing to farmers that are stewards to the land.
http://issuu.com/screamingeaglemedia/docs/farm_e6f4925560a44a/18

Early Boots Farm – Silvopasture: Grass-fed and finished beef farm, Tyler Carlson and Kate Droske. Oak and pine saplings on 20 acres of old crop fields in Sauk Centre, MN. Trees are planted to optimize the pasture microclimate, to reduce livestock stress, and for future timber sales.
http://maawg.files.wordpress.com/2013/08/maawg_case-studies-earlyboots_2013-final.pdf

Timber production

East Grove Farm – Agroforestry: Timber covers almost half of the southeast Iowa farm's 800 total acres. Kurt Garretson has 5 acres planted in Elderberries with plans to expand and become certified organic. Also in the works are plans for a winery with a focus on farm-related ecotourism.
http://midamericanagroforestry.net/agroforestry-case-studies/elderberry-eastgrove/

Fruit/Nut Crop

Red Fern Farm – Tom Wahl – Agroforestry: Fruit, berry, nuts, container-grown seedlings and medicinal planting roots near Wapello, Iowa. Chestnuts are one of the farm's most profitable crops. Tom is also a chestnut broker for other growers in the area.
http://midamericanagroforestry.net/agroforestry-case-studies/redfernfarm-chestnuts/

New Forest Farm – Mark Shepard's 106-acre perennial permaculture farm in the Driftless Area of Southwestern Wisconsin. Produce includes chestnuts, hazelnuts, pine nuts, apples, asparagus, and many other perennial fruits and nuts. Cattle, pigs, chickens, and turkeys are also raised on the farm.
http://www.newforestfarm.net/in-the-news.html

Larry and Nancy Turner – Agroforestry: Larry and Nancy Turner have more than 1700 aronia bushes on their farm, Winding Creek, in Blemond, IA. In 2013 they harvested 14,400 pounds of berries. Sold wholesale, the aronia berries can bring annual gross revenue of $2300 - $6500 per acre, and even more when marketed directly.
http://greenlandsbluewaters.net/Aronia%20Case%20Study%20FINAL%20(1).pdf

Bill and Geri Hanson – Agroforestry: Bill and Geri Hanson have been growing black walnuts on their Centerville, IA farm since the early 1980's. They harvest 1500 to 2000lbs per acre during full production years.
http://greenlandsbluewaters.net/Black%20Walnut%20Case%20Study%20FINAL%20(1).pdf

John and Betty Wittrig – Agroforestry: John and Betty Wittrig grow up to 6000 pounds of organic chestnuts on their 4.5 acre Winfield, IA farm every year. The nuts are sold for $6/lb and they sell the entire crop every year.
http://greenlandsbluewaters.net/Chinese%20Chestnut%20Case%20Study,%20FINAL.pdf

Mark Fisher – Agroforestry: Mark Fisher of Clear Lake, IA grows Christmas trees on his 20 acres that he originally purchased for hunting.

http://greenlandsbluewaters.net/Christmas%20Tree%20Farm%20FINAL.pdf

Natura Farms – Agroforestry: Paul Otten grows Elderberries at Natura Farms in Scanidia, MN. He sells the berries direct or to wine and supplement manufacturers. He also sells plant plugs to growers. http://greenlandsbluewaters.net/Elderberry%20Case%20Study%20-%20Final.pdf

Hazel Acres – agroforestry: Roger and Jeff Hanson grow and study hazelnuts on their farm, Hazel Acres, in Fenton, IA. Hazelnuts can be sold direct in the shell or roasted. Hazelnut oil is almost identical to olive oil and makes a superior biodiesel. http://greenlandsbluewaters.net/Hazelnut%20Case%20Study%20FINAL.pdf

Perennial forage/grazing farmer profiles

Mob grazing for building soil organic matter, vegetation management

Breitkreutz Farm – Perennial Forage: 125 cow-calf pairs mob grazing in Redwood County, Minnesota. The family has a "cooperative farming agreement" with the DNR where they help manage the state land by grazing their cattle herd there periodically. http://www.redwoodfallsgazette.com/article/20101122/NEWS/311229972 http://www.tcdailyplanet.net/blog/brian-devore/making-diversity-farm-pay-its-own-way

Managed grazing

Altfrid and Sue Krusenbaum – Managed grazing: Altfrid and Sue of Elkhorn, WI started farming in 1990 with a leased conventional dairy/cash grain operation. Over the years they have transitioned to an organic grass-based farm. Conversion studied and assisted by the UW-Madison Center for Integrated Agricultural Systems. http://www.cias.wisc.edu/an-organic-dairying-overview-from-the-krusenbaum- farm-studies/

Full Circle Farm - Rick Adamski and Valerie Dantoin – Managed grazing: Managed grazing dairy farmers in Seymour, WI. Rick and Valerie hosted the first public demonstration of managed grazing in Wisconsin. From 2002 to 2004, Rick

worked for the Glacierland Resource Conservation and Development Program, Inc. as a grazing assistant, consulting with farmers in 13 counties and the Oneida Nation.
From 1996-2000, as a watershed education specialist with the Oneida Nation, Valerie introduced the tribe to managed grazing and organic farming, establishing a demonstration farm on the Tsyunhehkwa farm. Rick and Valerie have held annual pasture walks on their farm for nearly 20 years, hosting more than 1,000 farmers and ag educators. In 1998, Full Circle Farm was named the Shawano County Conservation Farm of the Year.
http://www.rurdev.usda.gov/rbs/pub/jul02/rising.html
http://www.cias.wisc.edu/rick-adamski-and-valerie-dantoin-receive-cals-award/

Green Acres Dairy – Managed grazing: Matt and Tabitha Hartwig and son Ben operate a 160-cow dairy grazing operation in Marathon County, Wisconsin. The Hartwigs' purchased their 180 acres farm in 2009 and lease another 315 acres, with 265 acres of the total land available in improved pastures and the remainder in crops. Matt is a current board member of GrassWorks, Inc., a statewide grazing producer organization.
http://www.progressivedairy.com/index.php/index.php?option=com_content&view
=article&id=5606:young-grazing-producer-profiles&catid=72:producers&Itemid=115

Enchanted Meadows Organic Dairy Farm – Managed grazing: Art and Jean Thicke own the 477 acre dairy farm and run it with the help of Chad and Melissa Crowley. The farm consists of 90 rotationally grazed milking cows, located in La Crescent, Minnesota.
http://www.westbycreamery.com/patron-profile-crowley.html
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?&cid=nrcs143_023449

Dairy grazing – beginning farmer

Joe and Christy Tomandl – Grazing: Joe and Christy own a 320-acre grass-based dairy near Medford, WI. In 2010 they purchased a 200-acre satellite grass-based dairy 3 miles away. The satellite dairy is managed by young farmers Clem and Melinda Miller. Clem is a 2013 graduate of the Dairy Grazing Apprenticeship

(DGA) http://www.dairygrazingapprenticeship.org/pressroom/a-satellite-farm-grows-new- opportunities

Nate Weisenfeld – Perennial forage + grazing: Nate is beginning farmer with an 80- acre grass farm near Merrill, WI with additional pasture and milking facilities leased from a neighboring farm
http://www.dairygrazingapprenticeship.org/pressroom/a-mentor-s-help-lays-the- groundwork-for-success-in-dairying

Gabby and Julio Rojas – Grazing: Young farmers that own a herd of dairy cattle and lease dairy facilities with 60-acres of pasture near Wausua, WI.
http://www.dairygrazingapprenticeship.org/pressroom/living-the-dream-the-start-of-a-family-dairy

Conversion of cropland to perennial forage

Hans Breitenmoser – Perennial forage + grazing: As a project for his employee Nate Weisenfeld (see above), Merrill, WI dairy farmer Hans Breitenmoser rented a 78- acre farm nearby that had grown row crops. They no-till planted the farm to meadow fescue, red clover and sweet clover for grazing.
http://www.dairygrazingapprenticeship.org/pressroom/a-mentor-s-help-lays-the- groundwork-for-success-in-dairying

Hay production in rotation with corn/soybean

Wallace Farms – Perennial Forage: 160 acres in Keystone, IA. Long crop rotation of small grains, some organic corn, and forages for hay or grazing. Forage grazed by cattle followed by pastured chickens.
http://practicalfarmers.org/blog/2012/08/23/high-value-rotations-on-a-grass-based-system/

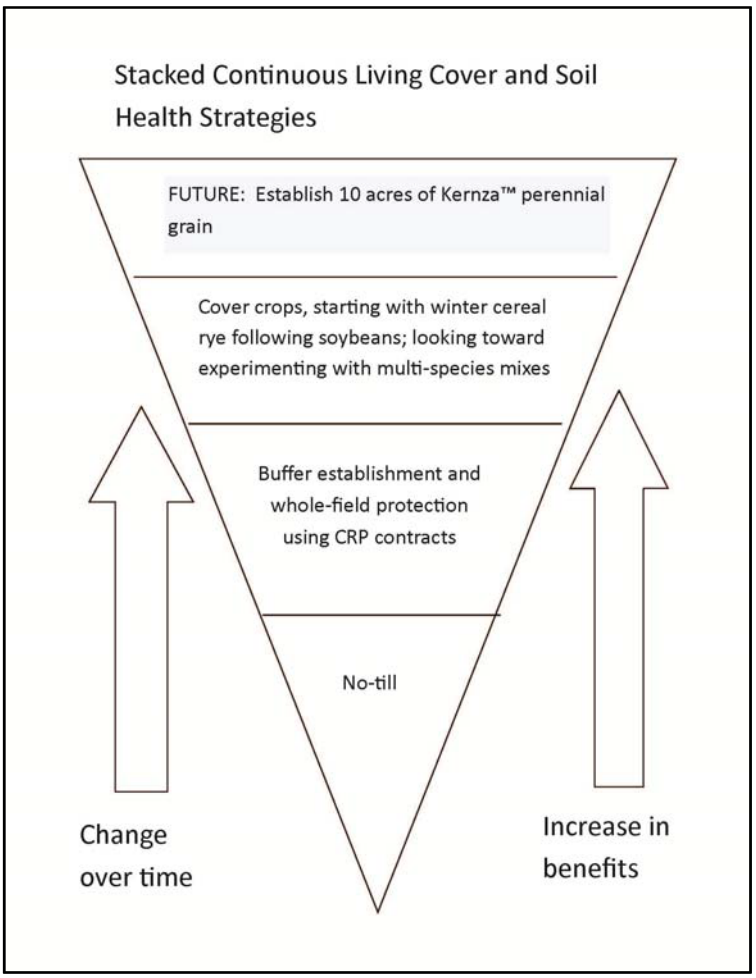
Forage production for hay or grazing on HEL or marginal cropland

Native grasses

Shepherd Farms - Agroforestry + Perennial Forage + Grazing: 2300-acre operation

in Chariton, MO produces bison, pecans, native grass seed, corn & soybeans; emphasis on direct marketing.
http://maawg.files.wordpress.com/2012/07/shepherd-case-study-1.pdf

Brad, Sue, and Andrew Johnson



The Johnson farm near Star Prairie, Wisconsin has been in the family since 1878. Brad and Sue began farming it in 1974, with Brad's parents. At the time it was a dairy farm and Brad's father had registered Holsteins. The cows were sold in 1997.

Andrew served in the Air Force Reserve. He was in civil engineering and gained experience in facility construction and facility maintenance, including HVAC and boiler licensing, and then worked in those trades after leaving the military. He currently lives on the home farm, and is the 4th generation to live there. Brad looks to Andrew to carry the farm forward and develop new directions for it. Andrew, for his part, says he wants to move the farm in a more sustainable

Stacking of multiple soil conservation and continuous living cover practices: the Johnsons started with reduced tillage, going fully to no-till in 1981. Then they withdrew some areas from cropping entirely, putting sensitive streambank areas into CRP. Now they are experimenting with cover cropping on their corn and soybean ground to protect soil and improve their efficiency of nitrogen use, and are looking towards Kernza ™ perennial grain as a way to further protect sensitive soils and adapt to climate change.

direction and reduce purchased inputs. He is interested in taking an ecological approach, inspired by the work of The Land Institute in Salina, KS. He's especially intrigued by the possibility of growing multi-crop mixtures and having the different grains sorted out after harvest.

The total farming operation includes more than 800 acres. About 560 acres are tillable, split approximately evenly between corn and soybeans. Much of the remaining acreage is in CRP buffers and in perennial wildflowers and native grasses. The streambank buffers are quite wide; Brad estimates that the narrowest one is 100'. "We used to farm those acres," said Sue, "but it wasn't worth the agony." They say that the CRP program has been hugely beneficial to their farm, but Andrew adds that he would continue to keep those areas permanently out of crops even if the CRP program ended. The whole family clearly shares a conservation ethic, and in fact were named State of Wisconsin Conservation Farmers of the Year in 1998. They take pride in the amount and diversity of wildlife that passes through their farm, and benefit from it financially through sale of hunting leases on their property.

The Johnson's farm lies close to Cedar Lake, an 1100-acre lake designated as an impaired water by the State of Wisconsin. The lake, which drains into the Apple River, a tributary of the St. Croix, has had a seemingly intractable phosphorus problem for decades. Brad notes that the local farmer-led council has been encouraging farmers to do a better job of keeping phosphorus out of the lake and river, and farmers have been responding. Brad and Sue's land has hosted an edge-of-field water quality monitor for the past three years. They are looking forward to seeing the results of that monitoring.

For more about the farmer-led councils in the St. Croix River watershed, see the "Cultivating Leadership" chapter.

No-till production of corn and soybeans has been their practice since 1981. Brad says it was a decision that came out of a desire stop picking rocks. They had tried reduced tillage and using a chisel plow, but constantly broke plow shovels on the limestone "square rocks" in their fields. No-till turned out to be the right answer. They can get into their fields earlier after a rain event than their neighbors due to the surface residue; and Brad said he has never seen a sacrifice in yield from no-till planting of soybeans. Local farm educators have taken soil cores from their fields to use as the "healthy soil" example in comparative water infiltration demonstrations. They still have neighbors who moldboard plow. The three Johnsons slowly shake their heads over that thought, and point out a nearby steep field that they say should probably not be cropped at all, let alone moldboard plowed.

The Johnsons have no livestock on the farm at present. It is a topic of discussion. They recognize the value of livestock for enabling the addition of perennial forage to the crop

Andrew is paying attention to the cover cropping experiences of other farmers, and is planning to try out some five- or six-species cover crop mixes. Most of the cover cropping in their area is done after harvest of the cash crop, but Andrew wants to try other options like planting cover crops into standing corn.

rotation. Brad reminisces about the beauty of planting no-till corn into burned-down alfalfa. Andrew, though, is concerned about managing livestock and especially the water for them in the winter. Setting up and managing a rotational grazing system would add another layer of complexity. He doesn't foresee it happening on their farm within the next 10 years.

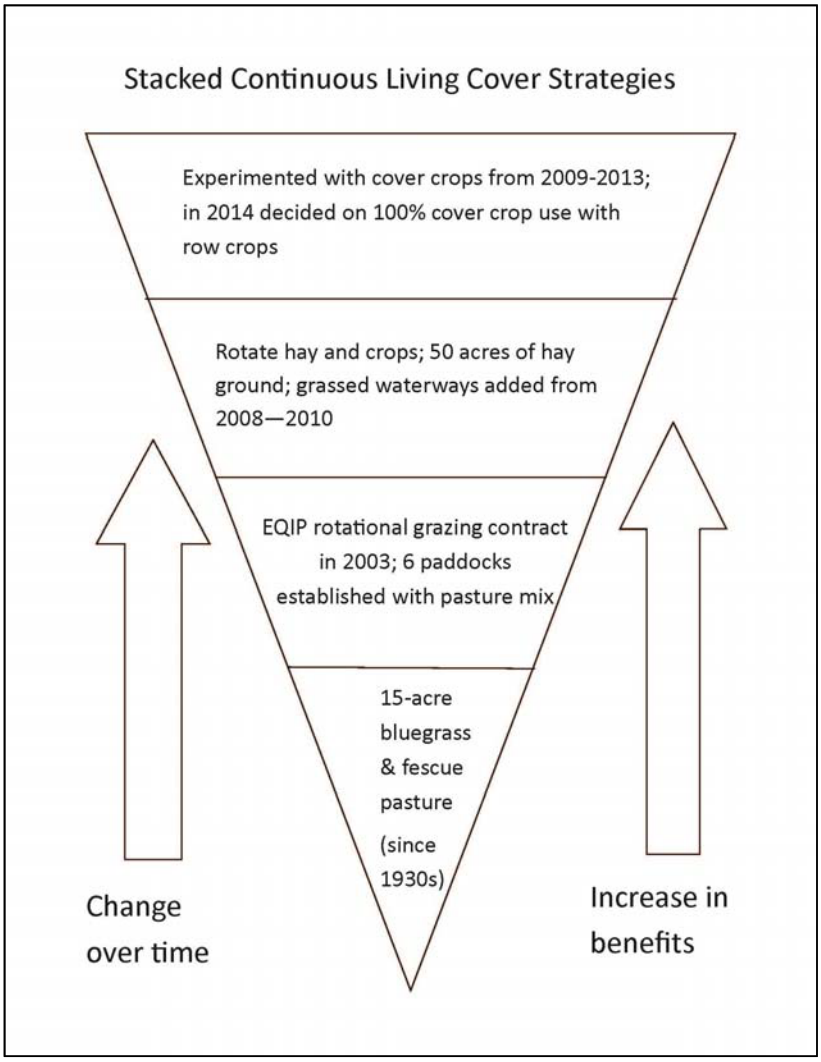
The Johnsons see change and adaptation as essential for the long-term future of their farm. They are looking to crops other than corn and soybeans as a possible future direction, and have recently been trying out a winter cereal rye cover crop following soybeans. Incentive payments from the local Land and Water Office helped them decide to do that experimenting, and Brad says those incentive payments are important to take the risk out of trying something new. Now that they have tried it and have seen the benefits, they will continue using cover crops without the incentive funding. They do have some fields with considerable slopes. The cover crop benefits they have seen include retaining moisture and holding the soil in place.

Brad suspects that cycling of N may be an important benefit of cover crops as well. He notes the erratic price and sometimes erratic supply of propane, and sees that as a symptom of over-reliance on imports and a harbinger of increased volatility of price and supply of other inputs. Legume covers would be a more stable source of N, and might help with effective timing of delivery of N to the corn crop as well. Brad calls N the most frustrating part of corn production due to the difficulty of timing applications to precisely feed the corn crop without either wasting N or failing to have sufficient N for the corn at critical times.

Climate change is another concern. The whole family has noted a change in rainfall patterns in the Midwest. They are looking to Kernza™ as a potential adaptation for their farm: with its deeper and year-round root system, it can help the soil hold moisture better. "We have to evolve along with our crops," says Brad

Fred Abels

Holland, IA; July 2014



Up until 2003, Fred Abels was driving a semi-truck and farming. When that truck-driving job ended, he wanted to be fully employed on the farm, so added cows to his operation. He discussed rotational grazing with an NRCS staff person, then signed up for EQIP (Environmental Quality Incentives Program) and got grazing paddocks and hay ground established. Fred's acreage is divided into 1/3 corn, 1/3 soybean, and 1/3 forage for cows. His rotational grazing system includes 6 paddocks, each 9 acres. He also uses a 15-acre bluegrass and fescue pasture, which has not been tilled since the 1930s. His hay ground is hayed for the first cutting and usually grazed for the second and third harvest.

Stacking of multiple soil conservation and continuous living cover practices: Fred Abels added livestock to his operation and started a rotational grazing system in 2003, also using a pasture that had existed on his farm since the 1930s. His winter cattle feed originally came from baling a friend's grassed waterways, but he added hayfields gradually from 2008 to 2010. After experimenting with cover crops for several years, he became convinced of their value and planned to use them on 100% of cropped acres in 2014.

The hayfields were added gradually from 2008 to 2010. Back in 2003 when starting out, he got his winter feed by harvesting about 20 to 25 acres of grassed waterways on land custom-farmed by a friend. The friend didn't want to do the mowing and was willing to let Fred take the hay if he would mow it, so Fred got the forage for just the cost of harvesting.

He chose the land for the hay and pasture ground based on their location close to his buildings; the livestock handling facilities were on the home place, and it would have been more difficult to use neighboring land to run cattle. Fencing requirements were also a consideration that resulted in cows being on his home place. The cows have to walk up to the buildings for water. EQIP funding was used to install a "jug" waterer at the buildings. Although there are two access points to the creek where cows could get water, they walk home to drink from the jug. Fred can tell in the farthest-away edges of the paddocks that they aren't grazed as hard because of their distance from the water source.

His first seeding in 2004 was red clover, birdsfoot trefoil (BFT), and endophyte-free fescue. The BFT stuck around in the drought of 2012 when other forage species didn't make it. He's now trying to manage the BFT to let it go to seed, so that it will reseed and maintain the stand. When cows harvest his 2nd and 3rd hay cutting, he can accomplish the natural reseeding. He has had really good luck with frost-seeding, too. He has frost-seeded a bluegrass pasture with red clover and BFT. He'll let it get it grazed pretty far down in the fall and then seed before first graze in the spring.

Cows spend 5 days on a 9-acre paddock. He hasn't changed from that rotation in 10 years. The paddocks are seeded in a mixture of reed canarygrass and Kura clover. It took four years to establish the Kura clover, which was done through an Iowa State University on-farm trial. He loves the Kura clover; it spread through runners, always regrows, and he hasn't grazed it out in 10 years. An application of 64 oz. of Roundup knocked it back for two weeks, but then it recovered He has 55 acres of Kura clover and reed canary that he would not return to row crops, because he wants to keep the Kura. It just keeps going and supplies N to the reed canarygrass.

Fred's average herd size is 85 cows. He buys in cows from southern Iowa as replacements, and his culls go to the local sale barn. Calving is from August 15 through early October. He weans in March, holds until May, and sells weaned and backgrounded calves at the sale barn. Net returns have been good on the cattle. The price of replacement cows has been going up, though. In 2013 it was $1200/head, in 2014 it was $1775/head, and he anticipated a price of $2200/head in fall of 2014. His cows have a calf nursing them all winter and need good feed. Usually he grazes cattle through the cornfields after harvest, but the last couple of years have been hard with cold and snow. Feeding his own hay and corn silage means he doesn't have to buy feed; and with the grazing he has been able to hold his feeding costs to less than $1/head/day.

After the drought of 2012 and then in 2013 a wet spring followed by drought, Fred put about half of his hay ground back into crops. On June 26, 2013 he had 8" to 10" of rain in the afternoon. That was the last rain he had in the 2013 season. He switched to feeding corn silage instead of hay in 2013,

because corn silage growers in the area were seeing increased yields in 2012. He was very disappointed in the hay yields in the spring of 2014; especially the poor performance of the endophyte-free fescue. He had it on some of his best ground and even so, wasn't seeing good production. In the drought of 2012 he harvested a grassed waterway three times that was in reed canarygrass. That kept going when other things didn't, and got him thinking about using reed canarygrass instead of fescue for hay when he rotates crop ground back into hay. His plan as of summer of 2014 was to sign up for an EQIP contract to put the crop acres that used to be in hay back into bromegrass, reed canarygrass and alfalfa.

Evolution of Fred's experience with cover crops:

- 2009 –Sarah Carlson talked him into trying cover crops. He seeded turnips on a Friday into standing corn. That Sunday a hailstorm knocked the corn down to waist-high. Then it was too shady for the turnips and they didn't establish.
- 2010 – Skipped cover crops.
- 2011 – Aerial-seeded 50 acres of annual ryegrass and oats. Then there was no rain except for a little shower the week of seeding, and no growth.
- 2012 – Skipped cover crops.
- 2013 – In the fall, seeded winter cereal rye on corn silage acres after the crop was removed. There was no rain afterwards, and this was on prior hay ground with very hard-packed soil. The seeder didn't get the rye into the ground very well and there was a weak stand.
- 2014 – Hosted a field day; sent soil sampled in from cover-cropped and non-cover-cropped ground; had the Haney soil test applied by Ward Labs. It clearly showed the benefit of cover crops. This fall, cover crops are going on every corn and soybean acre due to the benefit on cycling of nutrients. The savings on avoided P & K inputs alone will pay for the cover crop.

The winter cereal rye cover crop planted in fall of 2013 had an additional, unexpected benefit. Fred puts down 100 lbs. of N before planting corn, and then side-dresses another 50 lbs. N into 4" corn. In the spring of 2014 when he headed out to side-dress N by knifing it in, he found very hard soil and kept breaking shear bolts on the applicator. He took a whole bag of bolts with him to get the job done. When he got to the field that had the rye cover crop, the soil was softer and he didn't break a single shear bolt. His cousin's husband had a similar experience. He strip-tills and applies P and K in the fall, and aerial seeded 100 acres with winter cereal rye. In the following fall, the soil was so mellow on those acres that he could move one mile per hour faster through that field during harvest. After those experiences, both Fred and his cousin are planning to plant cover crops on 100% of their acres.

Fred is intending to use winter cereal rye. He likes the longer fall window for planting it: he's looked through the Midwest Cover Crop Council's selector tool and found a Sept. 1 cutoff date for planting just about everything except winter cereal rye, which can go into October for seeding. A neighbor two miles away has five crop-duster planes, so he has access to aerial

seeding. It will cost him $15 to $18 /ac for the seeding and about $18/ac for purchasing the seed. He is thinking about growing his own rye for cover crop seed. He needs about 500 lbs. of seed to treat his acreage. If he could get a good stand of cover crop rye seeded around Labor Day and get a good stand, he would consider letting it go and combining it for his cover crop seed. He is also considering winter cereal rye as a potential forage crop that he could bale in early spring and then plant soybeans. Some of his neighbors are getting 1.5 to 3 round bales per acre from baling a winter cereal rye cover crop.

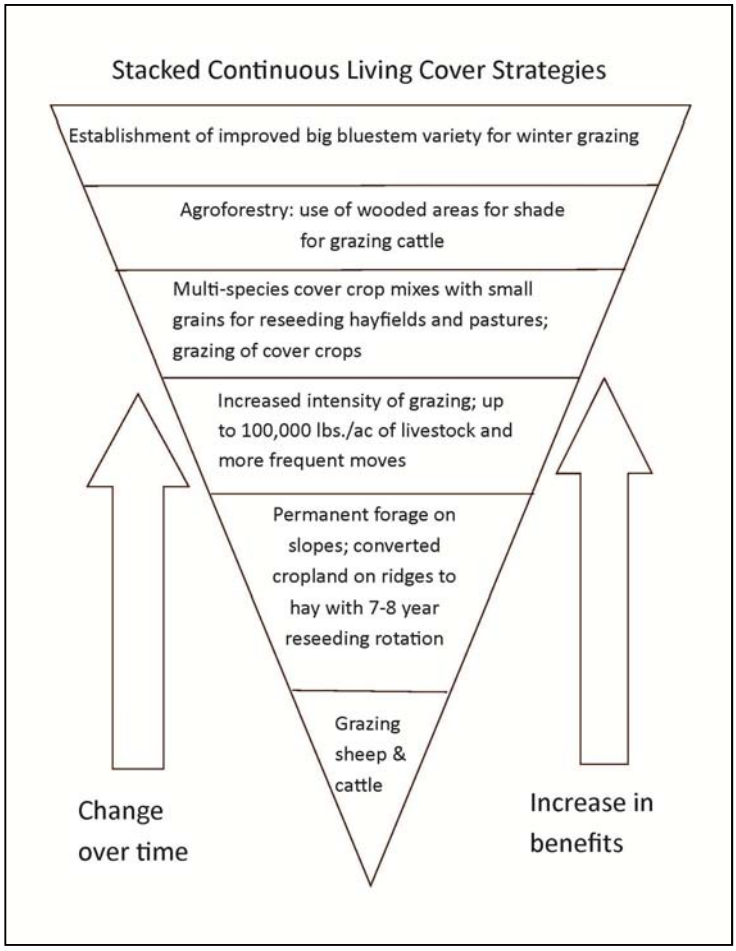
The fibrous roots of winter rye help to increase soil organic matter and decrease the fertilizer requirement for his corn crop. The Haney test that he had done through Ward Labs recommended no P and K, and 150 lbs. of N for 200 bu/acre corn. Fred knows he can reduce P and K application, but isn't sure yet about N. This is a big change from the old days when the recommendation was 1.1 to 1.2 lbs. of N applied for every bu/acre of corn yield goal. The loss of N from those applications was previously thought to be no big deal, but now we know it is causing problems downstream, so he's interested in the reduced N application.

The Haney soil test was very eye-opening. A new field they acquired that hasn't been under no-till management does not have as healthy of a soil as their no-till acres. He was also surprised that their pasture paddocks have a soil health index of 13 (20=best); he thought it would be higher. A neighbor has been applying swine manure to the paddocks and Fred thinks maybe they need even more manure on the paddocks.

He noted the contrast between his operation and that of a neighbor with fields uphill of Fred's. The neighbor uses maximum tillage, and makes 4 trips across the field to Fred's one. He piles up dirt along the fencerow to build a sort of dam at the edge of his field, and in 2014 the result of that was a 4' high waterfall pouring into Fred's field. When the soil dam washes away, the neighbor just re-builds the dam. Fred shakes his head at this method of land management. Fred's farm had 17.7" of rain from the last ½ of June through first ½ of July of 2014. With grassed waterways and no-tilling of everything, he thinks his farm is not too bad off in terms of soil loss.

There are more birds around his farm now because of all the grass. Actually, they keep him up at night with all the chirping. When he was out spraying for thistles after the cows had just left a paddock, he found a nest in the reed canarygrass that wasn't disturbed after 5 days ofgrazing. He is satisfied with knowing that he can protect his soil, balance crops and livestock, make a living from his land, and see the benefits to wildlife on his property.

Gene Schriefer



Dodgeville, WI; July 2015

Gene Schriefer's farm is 260 acres, of which 105 are steeply sloping and in permanent pasture and 135 are tillable. The remainder is wooded or under buildings. The farm was purchased by his parents in 1983. They still live on the farm, but Gene has managed it for most of that time. The Schriefers are originally from New Jersey and Gene grew up with fruit, vegetable, and small-scale livestock production. After moving to the Wisconsin farm, he began grazing sheep and cattle with the main emphasis on sheep. He eventually built the flock up to 420 ewes. More recently he has shifted more

Stacking of continuous living cover: Gene started out with grazing, primarily of sheep but gradually shifted to beef cattle. He uses a rotational grazing system with permanent pastures on his sloping areas. Short-duration grazing with a high stocking rate has improved his pastures. He employs an agroforestry strategy of using wooded areas as shade for livestock during hot spells in summer. Cropland on the ridge-tops has been converted to hay and pasture with a seven- to eight-year reseeding schedule. He uses a cover crop mixture of three to seven species along with a small grain crop in the reseeding year, and the cover crop is grazed after small grain harvest. He is experimenting with improved big bluestem and indiangrass varieties with an eye toward winter grazing for the cattle as well as a forage that can withstand a summer drought.

toward beef cattle. The current operation includes 45 cows plus their calves and youngstock, and 80 ewes. Currently he strives to graze at least until the end of November, and usually makes it to mid-December before feeding hay. The end of his grazing season is dictated by onset of winter weather rather than by lack of forage. He thinks he would be better off with an increased stocking rate to use all of the available grazing and then buying more hay – but also notes that the market landscape is constantly changing, and increased hay prices in the future could change his mind. He is experimenting with some stockpiling of forage for winter grazing.

Calf Management & Marketing

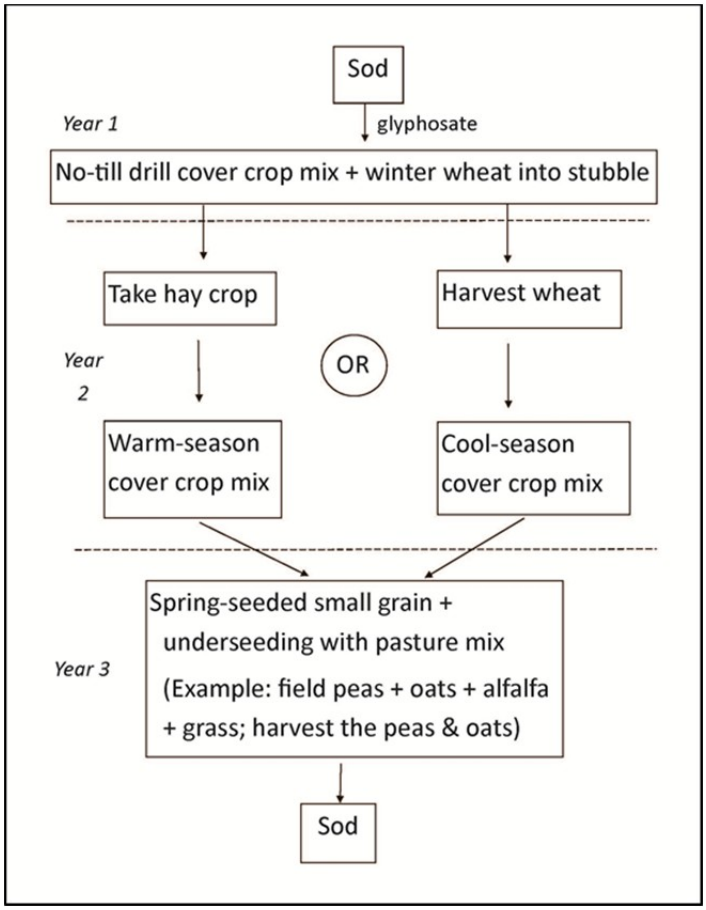
Calving is from early May to the end of June. Calves are weaned in November or December. This is earlier weaning than in a typical grass-fed beef system, but Gene has had better luck with this system than with keeping calves on the cows through the winter. Weaned calves have shelter in a shed and are fed high-quality forage, but no grain since some are marketed as grass-fed beef. Gene markets beef through several channels. A few are sold locally to individual customers. About one-third of his steers are sold as grass-fed beef to the Wisconsin Meadows Co-op. The remainder are sold through a local livestock auction. Lambs are mostly sold through the livestock auction, with a couple per year sold locally to customers.

Gene says that his farm is better at growing forage than it is at growing corn. Corn crops on his place have yielded 150 bu/ac, which is below the county average. Hay, on the other hand, averages 4.5 tons/ac with 5 tons/ac in a good year, which is good in his area. Tillable acres on the ridgetops include a 50-acre field that is rented to a neighboring dairy farm. This field is in alfalfa hay for three to four years, put into a row crop for one year, and then back to hay. The remaining tillable acres are in a hay-graze system: one to three cuttings of hay and/or rounds of grazing before Labor Day, depending on forage demand and growth; then delaying further grazing until November and December to the extent possible. This harvest and grazing schedule matches the plant dormancy cycle: pasture plants are allowed to grow and build their root reserves in September and October, and then are grazed after going dormant for the winter but with care to leave 3” to 4” of stubble to protect crown buds and tillers that will grow the following spring. Gene notes that he always needs to think ahead to the next season: grazing before dormancy in the fall would cause the plants to use their root reserves and set them back for the following spring.

His permanent pastures on the steep slopes are never tilled. He interseeds them with a no-till drill as needed. He uses managed rotational grazing, with permanent fencelines

following the contour of the hillside and then cross-fencing moved every two to three days for cows or every one to one and a half days for youngstock. A gravity-fed watering system includes a reservoir on the ridgetop and water lines down to every paddock. He began investing in watering infrastructure 15 years ago and can now get water to virtually every point on the farm, which facilitates the managed grazing system. He needs to finish installing high-tensile perimeter fence in a few places but can graze on virtually the entire farm. He has been gradually increasing his stocking density on pastures and began to see positive impacts on the pasture sward and soil health at 50,000 lbs. liveweight/acre. He is now up to 100,000 lbs. liveweight/acre. Soil test results from 25 years ago show 2% organic matter. Soil samples from those same fields now show 4 to 5% organic matter. Gene would like to get the organic matter percentage higher, but seems to have reached a plateau in the progress he can make with managed grazing.

The cattle are outwintered (fed hay outdoors on the fields during the winter), and the paddock where outwintering takes place rotates on a 12-year cycle. The outwintering results in waste hay and manure being applied to the paddock, giving it a boost in soil fertility. He feeds hay daily to minimize waste, and unrolls round bales to ensure that all animals have access to the hay. The sheep also outwinter unless hay is high-priced; then they are fed in a shed where Gene can control their hay consumption better and minimize waste.



Reseeding Pastures

Pasture mixes always include a legume, a grass, and a forb. He uses birdsfoot trefoil, alfalfa, and/or clover in combination with a grass. He likes birdsfoot trefoil because it maintains production and quality during the hottest part of summer. He always adds two to three pounds of chicory seed into the pasture mix. Chicory has a deep taproot; he has found chicory roots at the bottom of a four foot deep posthole. The

chicory tends to disappear from the pasture mix after about four years, but in the first years of a new seeding it is pulling up nutrients from deep in the soil profile. Gene doesn't have a set schedule for reseeding of pastures: pasture stands are renovated depending on the stand density and weediness. Generally reseeding takes place every seven or eight years. Reseeding is done with a no-till system (see graphic). Gene has seen good yields from the cover crop in his reseeding system: about 1 ton/ac in a drought year, and up to 2.5 tons/ac when moisture was adequate.

Gene finds that he can raise beef cattle very inexpensively on pasture up to 800 to 900 lbs. of liveweight. Finishing on grass is more difficult. He reserves the cover crops and the higher-quality forage growing on his tillable acres for his finishing steers and heifers and finishing lambs. The cows graze the permanent pastures on the non-tillable acres and generally get a more mature, less leafy forage than the youngstock. He estimates that the cows take 14" forage down to 5", and the steers and heifers take 10" forage down to 5".

Gene strives to have comfortable conditions for his livestock. Summer heat is becoming a concern and he expects to see more 90^{o} to 100^{o} days in the future. He has two paddocks near wooded areas that he reserves for hot spells: the cattle can graze in the cooler mornings and evenings and stay in the shade during the day. If the hot spell lasts longer than three weeks, though, those paddocks run out of forage and he needs to adapt by letting the cows go back to shade during the day from more distant paddocks. He is experimenting with a portable shade structure for the cattle.

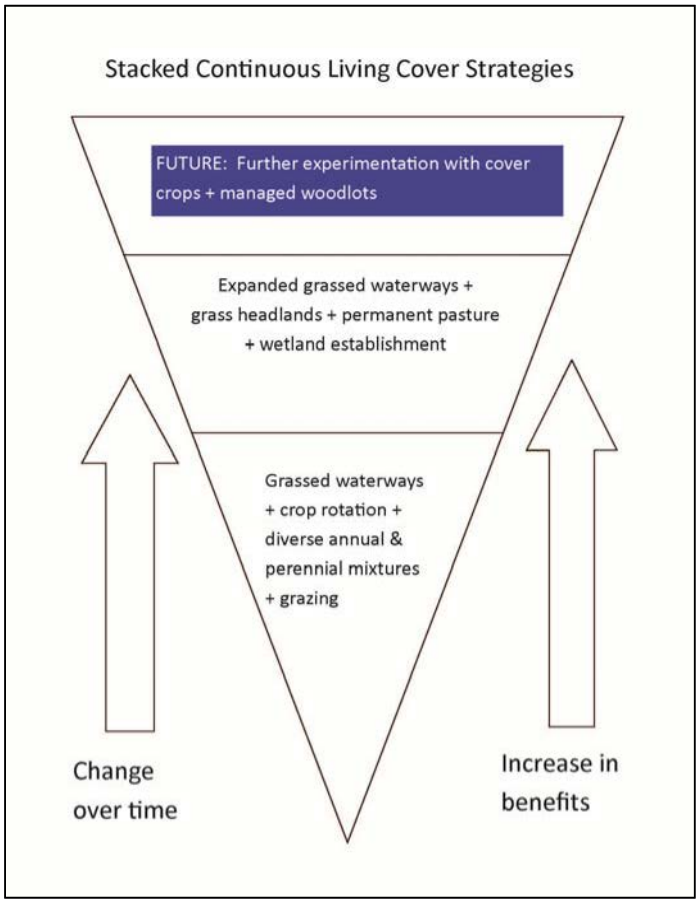
More frequent droughts are also something he expects to see in the future. The drought of 2012 required him to take the drastic measure of selling all of his youngstock in order to keep his breeding herd intact. He thinks that if he had had some areas in warm-season native grass, he could have had a better outcome. In 2013 he planted 12 acres of ridgetop field into an improved big bluestem variety out of a Nebraska breeding program. Native warm-season grasses take some time to establish and he's still seeing an uneven stand, but is hopeful that the stand will be good in its third year. He planted more native warm-season grasses in 2014. Gene is looking to these grasses to hold winter snow cover, improve water infiltration, and to withstand drought. He notes that they have a four to five times larger root system than cool-season grasses. Besides looking to the native grasses as a hedge against climate change, he's also interested in seeing if the cattle will graze the dormant grasses in mid-winter, which might allow him to eventually reduce or eliminate his hay feeding.

John & Beverly Gilbert Farm

photo: Brown Swiss heifers on the Gilbert farm; John Gilbert

John and Beverly Gilbert Farm
Buckeye, Iowa
July 2014

There are a lot of things that the Gilberts just never stopped doing – like crop rotations, grassed waterways, small grains, and forage mixtures, both annual and perennial.



There are three features of the farm which are key to land use choices: the family structure involved; the reliance on farmer-owned livestock; and Southfork, a tributary of the Iowa River which the farm straddles.

Matching Cropping System to the Land

It's worth noting that the majority of the Gilbert's land is classified as NHEL (non-highly erodible land). Even so, they are taking great care to match cropping systems to the topography and soil conditions:

- Steep slopes near the farmstead – seeded for long term hay and mostly grazed by sows and dry cows
- Steep slopes farther away –

long term hay, or occasional two years into row crops and then back to hay

- Wet ground – seeded as hay and mostly grazed by dry cows and heifers
- 50 acres of mixed topography and mild slopes; 7-year rotation: oats – hay-hay-corn-beans-corn-beans
- Other mixed topography with some steeper slopes – 4 years in hay, 10 to 12 years in corn-soybean, then oats and back to hay

Our farm is run by family members doing our best to work together (along with some hired help). But what really defines the family aspect is the realization that we have the opportunity to farm because of decisions and efforts of our ancestors (dating back to great-great grandfather Gilbert here in Hardin County.) We feel an obligation to make choices our great grandchildren can live with.

"Mixing things together – that's what you're supposed to do. We never quit seeding a whole mixture along with alfalfa. … Just corn by itself isn't silage. "

John uses a corn/forage sorghum/group 5 soybean blend for silage. The soybean stays green late into the season, allowing them to take the corn to greater maturity and still have enough moisture in the mix to ensile.

After the floods of 2008, John seeded a mix of leftover corn, bean, sudangrass, other odds and ends, and rape in early August after ponds finally dried enough. Although everything else was frosted the rape was still green in early November, so they chopped and ensiled the mix. The cows ate it!

"Seed's pretty cheap – we have no problem throwing things together."

- Headlands are in permanent grass where feasible
- Extensive grassed waterway and terrace systems.

The farm in total is about 770 deeded acres, with 640 tillable (originally four separate tracts). The operation is two corporations: one with John, Beverly, their eldest son John and his wife Sarah; the other is primarily brother Greg and his wife Barb. , as well as minor interests with John Sr. and Greg's four other brothers. The first corporation raises the livestock and farms most of the south two tracts (on either side of Southfork). The second farms the home farm (where the dairy is located) as well as a shared 160 immediately to the east. Although harvests, costs and marketing are separate, farming is essentially done as one operation. An estimated 100 acres are either wooded, wetland, grass waterway or the Southfork riparian area, of which some is grazed.

All of the crops grown are non-GMO. Most are fed to the dairy herd and pigs. The farm farrows and finishes about 250 to 300 head of hogs per year, most of which are sold to Niman Ranch. Extra corn, about 5,000 bushels per year, is sold. John is not getting a non-GMO premium on corn, primarily because of high prices in recent years and a strong local basis. He sells soybeans for a non-GMO premium; which generates the dollars to buy back soybean meal for their rations. He estimates one acre of beans should buy a ton of soymeal. Feed is ground on the farm.

"Dick Thompson had a system down. Three six-inch rows of rye on top of the ridge, terminated by the sweep on his planter leaving a natural herbicidal band. That first cover crop trial was in 1982. The new generation of farmers coming up doesn't know about some of these practices."
-- John Gilbert

[Note: Dick Thompson was one of the founder of Practical Farmers of Iowa, and very dedicated to both sustainable agriculture and on-farm research. He died in August of 2013. More about his farm and philosophy: http://www.sare.org/Learning-Center/Books/The-New-American-Farmer-2nd-Edition/Text-Version/North-Central-Region/Dick-and-Sharon-Thompson-Boone-IA]

The dry dairy cows and heifers are grazed year-round. The cattle are rotated among pastures, based on growth available. In the fall after crops are harvested, cattle can range over the south two farms. Wooded areas provide winter shelter.

Cover Crops

John has been trying some cover crops and has research plots in cooperation with Practical Farmers of Iowa (see attached description). He is hesitant about cover crops in corn and soybean production, for both himself and other farmers, for several reasons:

- There's a skill to their use that needs to be learned.
- There's too much emphasis on paying people to use them, and that's not the best mechanism for long-term adoption.
- Rye is heavily promoted, but it has explosive spring growth that can tie-up nitrogen ahead of corn, plus the problem of allelopathy if tilled. He's concerned that disappointment over rye will turn people away from cover crops in general.

John's tillage system:

"We're using a hybrid of ridges, strip- till, and no-till; and violating the rules of all three."

- Herbicide carryover may kill cover crops.
- There are some unreasonable expectations: people expect to see a lot of top growth from their cover crop, and really it's about the roots.
- There can be trouble with terminating the cover crop, especially when wet spring weather creates large amounts of biomass before termination, interfering with planting; or using too much moisture in a dry year.

7-year Crop Rotation: oats – hay – hay – corn – soybean – corn – soybean

Corn following hay receives no fertilizer other than manure plowed down with the alfalfa. He uses N fertilizer (knifed-in MAP, plus 32% UAN spring and side dress) on all other corn. The first soybean crop the second year after alfalfa provides the opportunity to work with specialty varieties (like the low trypsin-inhibitor variety for direct feeding he's trying this year) because alfalfa helps break disease cycle. The seven year ground also offers the potential of identity-preserved specialty crops, as well as soil building.

Permanent Pasture

A lowland area was formerly pasture until John's father installed tile and tried growing crops, despite frequently getting equipment stuck and periodic flooding. It's adjacent to a wooded area along the river so raccoons and deer would invade the crop. The farm got EQIP money for fencing and returned the area to perennial forage, which is used for summer grazing of dry cows, bred heifers, and larger calves. It is wet, cold ground and doesn't hold clover well. John is still trying to raise corn and soybeans on some adjacent acres but is considering using those for raising winter wheat or triticale for cover crop seed.

The dairy has about 26 of the 152 tillable acres seeded to a pasture mix and intensively grazed with a paddock system.

Wetland and Woods

The Gilberts have established a shallow water wetland area near the Southfork, close to the low-ground pastures. That was part of their Conservation Stewardship Program (CSP) contract enhancement.

John would like to see more value coming out of the woodlands. The cows use it for shelter and neighbors hunt deer, but he doesn't have the time or the knowledge to manage it as productive woodland. He is open to an interested party to enter a cooperative arrangement to sustainably manage the tree resources and add value to what is harvested.

Grass Headlands & Waterways, and Terraces

When John was ridge-tilling, he was planting from one end of the field to the other. He saw a lot of water moving down the rows used for permanent traffic, particularly on long slopes. The change to grass headlands for equipment turning and to break up the slope led to better access for more complex rotations (like the seven-year) and to grassed waterways for haying.

The cropping patterns and farming practices evolve as problems are identified and low cost solutions sought. One example is a hillside planted across the slope so the rows parallel the grass waterway, which also helps slow down water. That waterway is part of the break between upland and lowland. The lowland soil south of the creek is highly productive, but prone to flooding and washout. It is tiled, and John has established a sculpted grassed areas around one tile intake to direct water into the grassed drainage ways.

Some of the grassed waterways have been around for as long as he can remember. The system was improved in 2008, and again in 2011 to better handle water and soil movement from a neighbor's field. The newer grassed waterways are 50' to 60' wide and built to NRCS specifications. Older waterways are 30' to 35' wide. There is also a grass buffer along the Southfork that is not in a program. It is variable widths to make the corn rows come out even, and is used for haying, grazing and to provide year-round access to the creek.

There are 13 terraces that were established in 1980 and replaced 3 to 4 acres of grassed waterways. John prefers the terraces to the waterways because they are easier to maintain and control water movement better. John estimates the waterways and grassed headlands at 10-12 acres and terraces at less than one acre total. Grassed waterways are hayed twice per year to supply winter feed for the dry cows.

Cover Crop Trials with Practical Farmers of Iowa

Cover crops need to become a seamless part of many farms if they are to make the significant difference envisioned in Iowa's voluntary nutrient reduction plan. We're barely in cover crop kindergarten in the knowledge and skills needed. Working with Stefan Gailans of Practical Farmers of Iowa, a shotgun approach was developed to determine if cover crop seeding could be timed with other possible field trips.

Four cover crop scenarios were identified: fall green manure in both corn and beans; forage production in corn for fall and spring grazing; nitrogen production in beans; and over-wintering options for spring growth in both. Mixes for each were designed to look at the potential of several crops. The idea is to spread seed in small replicated plots (15 by 15

feet) at two week intervals, starting with the last normal field trip (which for us is usually ridging). Originally it was hoped to get a late June/early July for the first seeding to correspond with ridging in corn, but the late June rains in 2014 delayed the first planting in corn until mid-July and in beans until late July. Last seeding will be early September, which is fairly late but prior research has been done with even later planting dates.

Each plot is replicated twice with about 15 feet between plots in the row, hopefully forming a checkerboard pattern. Evaluation will be made at harvest with stand evaluation on both number of plants and amount of growth (hopefully pre-frost). Seed is being spread on the soil surface using a hand crank seeder. Issues to consider include difference in seed viability when exposed to the elements, and seed predation. No attempt to measure crop yield is possible because of plot size and the scope of this project.

Cover crop mixes for the plots:

- Fall green manure; a commercially available mix of annual ryegrass, crimson clover and radishes
- Planted in corn for forage are oats, rye rape and mammoth red clover (winter wheat was preferred but unavailable when seed was purchased)
- Spring cover in corn going into soybeans includes rye, hairy vetch and alsike clover
- Spring cover in soybeans going into corn includes oats, hairy vetch and alsike cover (oats will replace the rye in beans going to corn, reflecting our concern about grass cover crops before corn creating N tie-up)
- Nitrogen production crops seeded in soybeans going to corn are mammoth red clover, hairy vetch, alsike clover and a few oats.

Problematic practices on neighboring properties are a frustration.

- Baling and selling of cornstalks leads to too little residue on a field and huge gullies.
- Gullies on a neighbor's soybean ground are getting worse; there isn't enough cover left on the ground to prevent gully formation.
- Grassed waterways on adjacent property are too narrow and silt is washing into John's waterway.

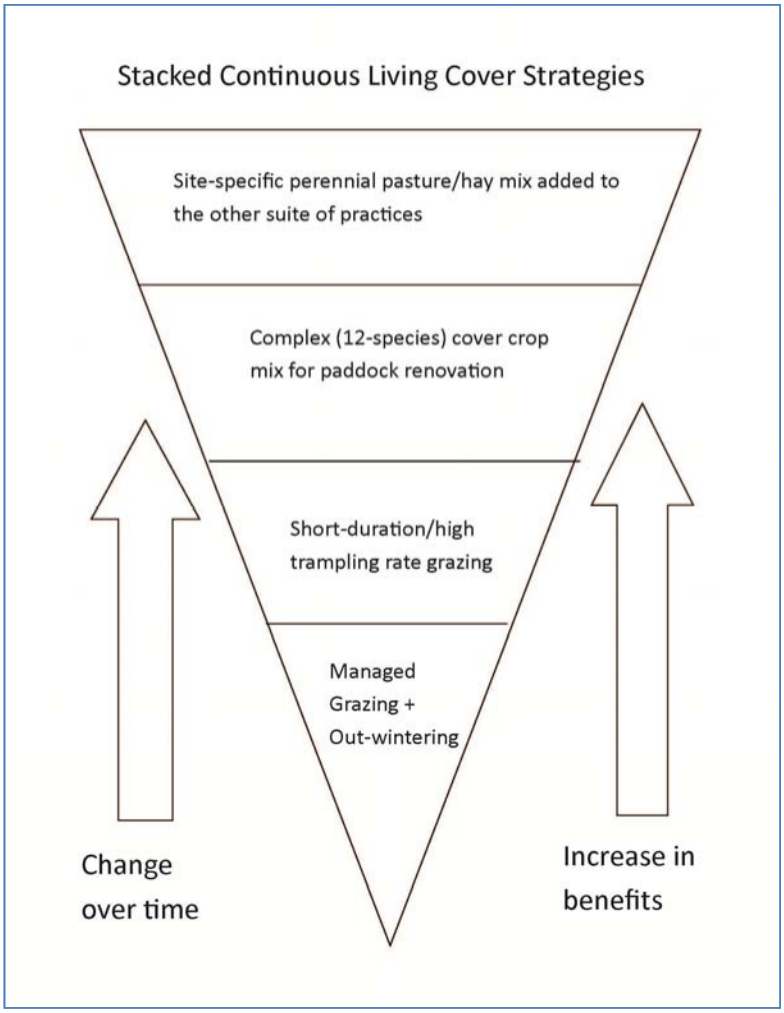
A frequently heard question from visitors is "Why don't your neighbors do what you do?"

That is the question.

Kent and Linda Solberg

Kent & Linda Solberg Profile
Verndale, MN -- July 7, 2014

When Kent & Linda Solberg moved to their farm in 2003, they found thistles and sandburs and a sandy topsoil that was essentially dead. Six-year-old cornstalks lying on the soil surface had not decomposed. There were no worms or dung beetles. The Solbergs started out with a conventional dairy. They used inexpensive and locally-available byproduct feeds as about 30% to 40% of the cows' ration. They grazed the cattle in the summer on every patch of forage they could find: fields, road ditches, woodlot. They relied on rented ground for



Stacked continuous living cover strategies: The Solbergs started restoring a degraded soil through managed grazing and outwintering of cattle. Adding the technique of short-duration grazing with a high rate of trampling of forage helped them make progress in soil health and forage production. Their next step was using complex cover crop mixtures to facilitate renovation of pastures. Now they are working on designing site-specific mixtures of perennials for their pastures, in addition to maintaining and improving their other strategies.

Use All of the Soil Health Tools

Kent and Linda emphasize the importance using all of the available tools for improvement of the soil. Kent's top four tools to achieve soil health:

- Diversity of species
- Representatives from each of the four crop groups in the pasture and cover crop mix rotation: cool-season broadleaves, cool-season grasses, warm-season broadleaves, warm-season grasses
- Integration of livestock
- Minimize (not necessarily eliminate) tillage

summer forage for youngstock. Managed grazing along with manure via outwintering, and compost application to the paddocks, was the Solbergs' start at restoring soil health and improving the yield capacity of their farm.

A crisis came in 2007. They went for 17 weeks with no rain that summer. Every forage plant dried up. Purchased forage got them through, but it was very expensive. It did help add some fertility to the soil; they systematically fed hay out in the pastures, similar to the outwintering feeding method, to add fertility to the soil.

They knew they needed more organic matter in their sandy soil, but it was difficult to make progress in a drought situation. They looked into installing irrigation. A neighbor had a central pivot irrigation system on his organic dairy farm and was able to make substantial progress at building soil organic matter due to the availability of moisture for forage production and soil microbes. The Solbergs looked into an irrigation system of "pods" every 50' that would work with their odd-shaped fields. Kent's requirement was that they had to be able to water every five days to keep things growing during hot, dry weather. When the quote for the irrigation installation came back, it was for $1700 per acre and Kent couldn't cash-flow that investment. They had to look for another way to grow forage.

Kent felt that he had hit a ceiling with management-intensive grazing, application of compost, and outwintering. Productivity of the forage stands was increasing, but not enough. The forage stands were a near-monoculture of quackgrass with some Kentucky bluegrass and smooth bromegrass. The sod formed by the roots of those cool-season grasses only reached down about 9" into the soil, and were susceptible to drought.

The Solbergs took another hard look at their land, what assets they had, and what they could do to take advantage of those assets. Their topsoil was sandy and dried out quickly. Two weeks of no rain and 80^{o} daytime temperatures would dry up their forage. Yet, the

Diverse Cover Crop Mix

Kent is a strong promoter of diverse cover crop mixes. He acknowledges that some farmers have had disappointing results with cover crops, and suggests that better success could be achieved by understanding what each cover crop species can do, and blending cover crop mixes to achieve specific goals within the context of the farm's resources.

In his case, he wants to graze the cover crops and also use them to establish a perennial forage crop. Warm-season grasses provide high productivity of forage for grazing during the mid-summer. Cool-season small grains are good nurse crops for establishing a perennial forage. Brassicas like turnip provide late-season forage. Legumes supply nitrogen to the soil. He does have a plow pan, and deep-rooted crops like forage radish help to break that up. His current cover crop mix for pasture renovation includes 14 species.

A favorite source of cover crop information: greencoverseed.com

water table was only 8' below the soil surface and did not drop lower during dry years. Kent started looking for a way to get roots down to the level of the water. He identified deep tap-rooted plants like alfalfa, yellow sweetclover, and chicory; and deep fibrous-rooted plants like intermediate wheatgrass; and planted those as part of his pasture mixes. He also experimented with annual warm-season grasses that had a much lower water and nutrient requirement than corn: sorghum/sudangrass and pearl millet.

Next, they began a different approach to grazing. Rather than careful timing of the graze to keep everything in a vegetative state, Kent began letting the forage grow to a taller and more mature state, and then letting cattle trample some of it back into the soil as they grazed. Kent allowed the cows to select 40 to 50% of the available forage and trample the rest. They did three daily moves of the cows to keep good forage in front of them.

Another crisis came in 2011. They lost access to the rented ground for youngstock, and also some sources of cheap byproduct feed. They felt like they were just beginning to make real progress on improving their soil and forage production, but now things needed to change, and fast.

The conventional dairy model had worked financially – they had paid down their farm debt in seven years – but it couldn't hold up to the loss of the byproduct feed. They sold all but a

few cows and a handful of youngstock and focused on improving their soil, with a goal of seeing how much forage they could produce without irrigation.

They turned to complex mixes of cover crops to renovate pastures. Kent uses tillage to establish cover crops for pasture renovation. He is aware of and admires the no-till cover cropping of the farmers in Burleigh County, ND – but on his farm, he sees so much mounding and tunneling from badgers and pocket gophers that he feels the tillage and leveling is necessary on ground that he intends to both hay and graze. He also experimented with no-tilling and with frost-seeding of legumes into his grass sod, and had zero legume establishment; another reason he now relies on tillage. He currently has about ¼ of his acres in annuals for forage and ¾ in perennials. He's planning to shift that to 1/8 to 1/10 of acreage in annuals and the remainder in perennials, with a long rotation of tillage and renovation on a field every 8 to 10 years. He estimates a cost of seed cost of $40/acre to establish his cover crop mixes, and thinks he's gaining more than that back in forage for the cattle plus soil health improvements.

Grazing cattle with frequent moves, outwintering and bale grazing, and use of complex cover crop mixes in the rotation has enabled the Solbergs to make great strides in their soil health and farm productivity. In 2013 they experienced 6 weeks of no rain, and their forage stands remained green. Also in 2013, they were able to take a hay crop of about 2.5 tons/acre (65% DM equivalent) in June following early-season grazing. When they first began their soil improvement efforts they barely got a hay crop of around 1.1 tons/acre with no grazing. Kent estimates that 2/3 of their hay acreage is grazed early, before haying; and will be grazed again one or two times after haying. There has been more than a three-fold increase in their forage productivity since they began on the soil improvement path.

Next steps for the Solbergs include the

<u>Perennial pasture & hay forage mix for the Solberg farm:</u>

Sandy topsoil, acidic, drought-prone

Intermediate wheatgrass
soft-leaf endophyte-free tall fescue
orchardgrass
alfalfa red
clover
birdsfoot trefoil
yellow sweetclover
chicory

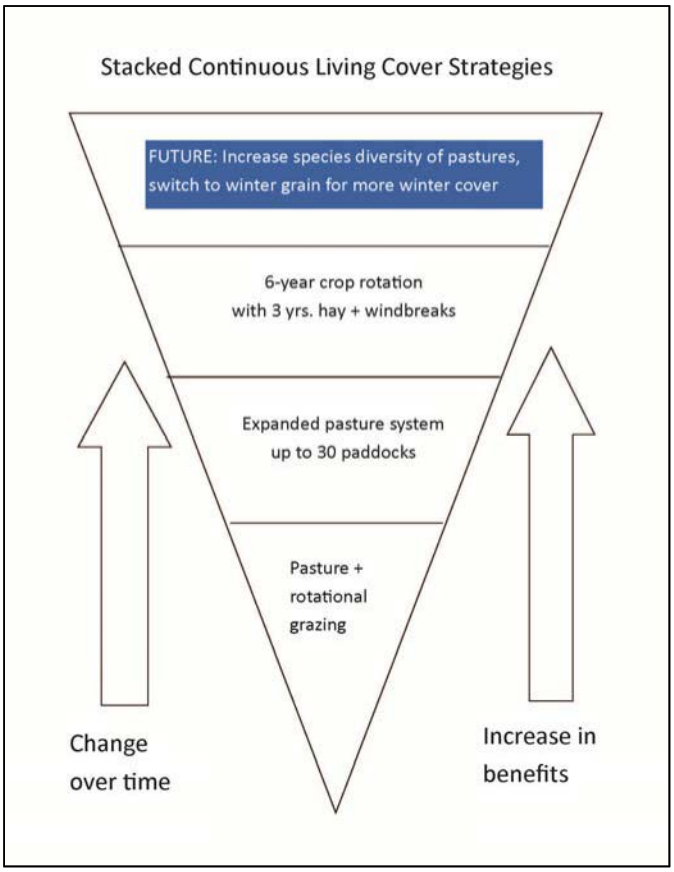
Kent notes that the yellow sweetclover, birdsfoot trefoil and chicory can dominate the first year or two of pasture establishment. Those three species will be mostly gone by year four as the other species establish.

gradual renovation of all their pastures to a perennial pasture and hay mix, custom-designed for their site. Kent has found it beneficial to apply 2 tons/acre of lime prior to seeding perennial pastures, and to apply poultry litter at a rate of 3 tons/acre every other year on hay ground.

The Solbergs are currently grazing and milking a small herd of cows and are working on a crossbreeding program to rebuild their herd, with a goal of being back into the full swing of dairy production and supplying at least 80% of the feed for their herd within three years. Kent emphasizes the degraded state of their soil when they bought their farm. With managed high-trampling grazing, outwintering, and cover crop use, he says, “There is the potential to take poor ground and make it productive in five to seven years.

Pastures A'Plenty Farm
Jim and LeeAnn VanDerPol
Josh and Cindy VanDerPol

Clara City, MN; July 21, 2014



Farm History

The VanDerPols have 320 acres, with about 100 of those in permanent grass/legume forage. The farm is low and wet as a whole, especially the area that fronts the road. They were originally a conventional corn and soybean farm, and there was always a problem with getting equipment stuck in certain fields, so those were the first to go into a permanent perennial forage. The pastured area grew in pieces from the early 1990s through 2004. It was driven originally by a small flock of 4-H and FFA sheep, and was expanded as that flock grew to 160 ewes by 1996. A farrow-to-finish hog operation was a large part of the farm, and Jim started putting gestating sows out to graze.

The VanDerPols changed their operation in 1999 and started raising dairy replacement heifers for Cedar Summit Dairy, an organic grass-based dairy in New Prague, MN. The need to have organic feed for those heifers spurred the VanDerPols to get organic certification for their farm. They transitioned the fields to organic status a piece at a time, beginning in 2002 and completing the process in 2007. Raising dairy heifers lasted from 1999 to 2013,

when the Cedar Summit Dairy changed its operations. The farm had built up a beef herd during the dairy heifer years, so grass-fed beef is now the main focus of the grazing portion of the farm. Jim estimates that the herd still needs to grow by about 25% to fully stock the pastures. Jim and LeeAnn, their son Josh, and his wife Cindy are all fully employed by the farm operation. Josh and Cindy's three children – two high-school student and a college student -- are employed part-time.

Agroforestry

Having trees on this farm is difficult. It is a prairie area, and a limited number of tree species work with his soil. Nut, fruit, and high-value trees don't do well. Jim recognizes the value of windbreaks, but laments just a bit that he has to settle for value, but no cash crop from the agroforestry plantings. Wind erosion is clearly a problem that they have seen, though, and windbreaks help address it. They also want windbreaks to be able to expand the areas where they can overwinter cattle. A windbreak planting of cedar, ash, and red osier dogwood to the north of the buildings has now grown up enough that they can winter cattle on the north side of the farm.

Six-Year Crop Rotation and Cover Crops

The remainder of the farm, 200 acres, is in a six-year rotation with some variation due to weather: hay – hay – hay – corn – small grain – corn. About 90 of the 200 cropped acres is in hay at any given time. The hay is a mixture of about 60% legumes (alfalfa and red clover) and 40% grasses (tall fescue and orchardgrass). When they were transitioning the farm to organic status, the six-year rotation made it very easy: three years of hay satisfied the organic transition period, so they simply certified each field as it came out of hay. They use hog manure as fertilizer, and underseed the small grain crop with a cover crop (red clover under oats in 2014). They have not yet figured out how to use cover crops with corn. Yields of organic corn have ranged from 140 to 170 bu/ac, compared to neighbors' 200 bushels, but Jim notes that his input costs are much lower. He is using no purchased N fertilizer; hog manure and the preceding hay crop or green manure cover crop are taking care of the N requirement.

Each of the six fields in the rotation is close to 30 acres in size. Jim acknowledges that this is much smaller than the field size many farmers in his area deal with, but believes there is a beneficial result of a smaller field size – wind erosion is less from a smaller field.

The main cause of lower yields in the organic corn is weed pressure. Over the past few wet springs, they haven't been able to do mechanical weed control in a timely fashion. They are

planning a change from spring grain to winter grain. The main driver of that change is because they can't get the spring grain planted early enough and are seeing too many weeds; but control of wind erosion is another reason. Jim says, "If we can make winter grain work, plus the 90 acres of hay, we will have 120 acres [out of 200] covered over winter."

Grazing and Hay

Forages are essential for the beef cattle but very useful in the farm's hog operation as well. The three years of hay in rotation on the crop fields supplies enough hay to winter the cattle and feed the hogs. They use hay in their grower/finisher ration, and hay is also a signification percentage of the sows' winter ration.

Jim uses a planned rotational grazing system with 30 paddocks for the cattle, currently 50 youngstock. He hasn't used a very heavy stocking rate, and he matches the rate of cattle movement to the condition of the pasture, with a goal of grazing a 7" to 14" sward. The cattle take half and leave half of the available forage. When bare spots showed up in some pastures in 2011 and 2012, he slowed down the rotation and let pasture plants go to seed. Heavier grazing in early spring is helping to get more grasses into the pastures. Jim also has a 15-year plan with the paddocks: he tries to give two out of the 30 paddocks an extended rest period every year, delaying the first graze until August. The two paddocks thus treated change every year.

The pastures are never tilled but get occasional reseeding. This is done either via frost-seeding or by spinning on clover seed just ahead of the cattle during a rainy spell, and keeping the cattle on the pasture just a bit longer than usual. They have seen good clover establishment with either method. Jim strives for plant diversity in the pastures. He wants to keep an alfalfa component because of its deep taproot, and is trying altered grazing schedules to get birdsfoot trefoil to reseed itself. Pastures get a topdress of manure every 5 to 6 years. This is solid manure; they use the residue from their own crops as bedding for pigs and cattle and build up a pack that is periodically removed, composted, and applied to fields.

The farm's 90 head of sows are on pasture when pasture is available. The pasture fences are set up so that the cattle are rotated and confined to one paddock at a time, but the sows can go wherever they want within the whole pasture. The sows are housed in a building a short distance from the pasture area, and walk down a lane to access the pasture. The sows perform multiple duties on pasture. They harvest some of their own feed. They break up cow patties and spread the manure around, which helps reduce fly pressure. They

also allow Jim to use a fairly high percentage of legumes in his pasture with reduced risk of bloat in the cattle. Early in their pasturing days, they did see some problems with bloat because they were converting hayfields with a high percentage of legumes into pastures. Now, the sows preferentially graze the succulent tops of alfalfa and clover; and that plus the grasses in the mix has greatly reduced the incidence of bloat.

Jim's sister Terry's brood cows spend the winter at his farm. There is perimeter fence around the entire farm, and in winter the cattle can range all over and graze crop residue.

Marketing

The beef cattle and hogs supply the Pastures A'Plenty meat business. Beef and pork is marketed directly to individual customers, and also wholesaled to grocery stores, food co-ops, and restaurants in the Twin Cities Metro Area primarily. Although the farm fields are certified organic, the livestock are not. VanDerPols sell their organic corn for the organic price premium and buy back non-GMO corn to feed the hogs. They have a group of farmers who raise non-GMO corn for them, and a cooperative arrangement with the consolidated elevator business in the area to rent bins and get custom feed mixes blended at a local, decommissioned feed mill.

Resilience

The pastures handle weather extremes that row crops can't. Jim points out a drowned-out portion of a neighbor's cornfield adjacent to his pasture. On the Pastures A'Plenty side of the property line, that low ground is in reed canarygrass, which handles wet conditions very well.

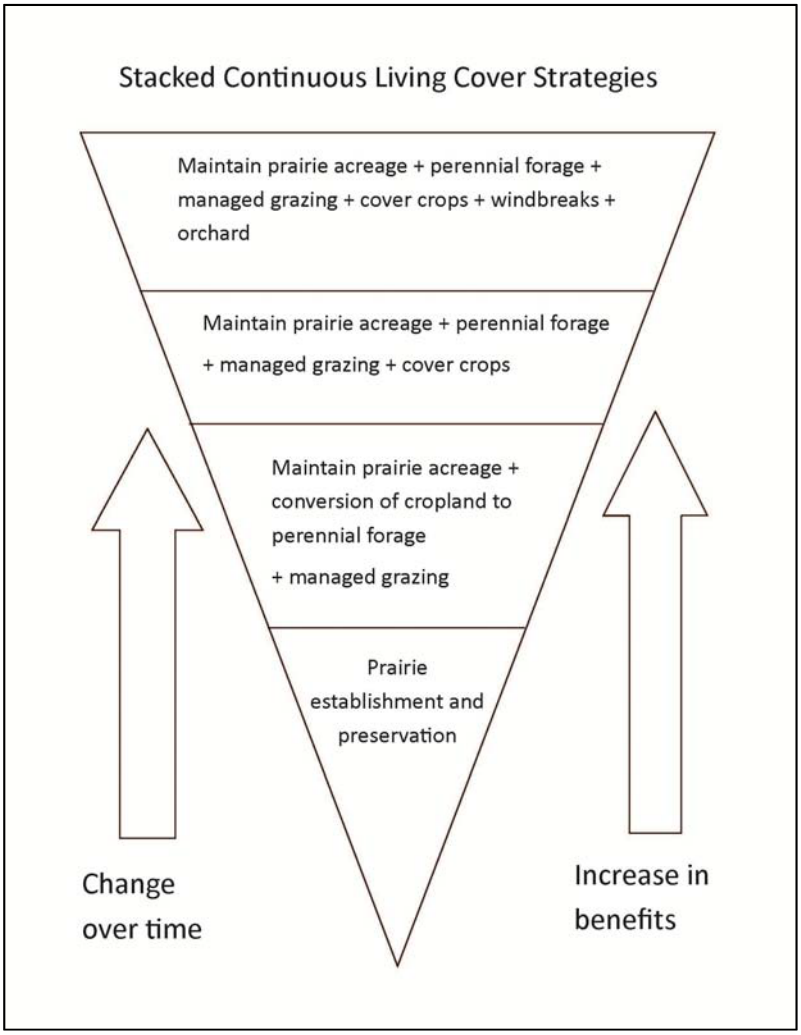
The strong emphasis on perennial forages, the integration of crops with livestock, and the marketing of those livestock contributes to the stability and profitability of the whole farm operation, and its ability to fully support two families on 320 acres.

> "This 320-acre farm keeps four adults and three teenagers very busy. The livestock are the reason - you couldn't support that many employees with a grain farm of this size. Livestock need to be integrated with grain. Our markets allow us to do what we do. The land is connected with livestock, and the livestock are connected with markets."
>
> – Jim VanDerPol

Prairie Horizons Farm

Mary Jo and
Luverne Forbord
July, 2014

The area now occupied by Prairie Horizons farm was first surveyed in 1868, and the surveyors' notes say that it was tallgrass prairie with scattering oak. They are in an area of undulating hills that are the beaches of ancient Glacial Lake Benson, a forerunner to the more famous Glacial Lake Agassiz. There are many rocky hilltops that are not ideal for plowing, which has helped to preserve some patches of native prairie.



Stacked continuous living cover strategies: The Forbords started out with preservation of prairie remnants and re-establishment of prairie areas on their farm. Their goal is to continually move toward perennialization, putting more fields in perennials and adding more strategies that build on and reinforce each other. Maintaining the system as a whole is important.

Farm History

> "We have heard people say that the reason we have so much grassland on our farm is because it's all marginal ground, but that's not true. We are surrounded by conventional crops. We ourselves used to get more than 200 bushel per acre corn yields, using injected dairy manure as fertilizer. Our shift to perennials was a choice, and not one forced upon us by poor yields or marginal land."
>
> – Mary Jo Forbord

Both Mary Jo and Luverne grew up on West Central Minnesota farms that included diversified crop and livestock production. When they purchased the Forbord family farm from Luverne's parents in 1985, they also inherited the pressure to produce more by purchasing more inputs, but didn't truly become a high-input dairy operation until 1998. "We were selling commodity milk and grain, with very little control over the price we received. To stay profitable, we had to produce more milk and more commodity grains for sale. We started using a total mixed ration, more supplements, antibiotics, and rBST for the dairy cows to obtain a high rolling herd average, but the work to get it done was killing us," says Mary Jo. "We had to change." They decommissioned the dairy in 2002, and began the process of transitioning to certified organic production, converting their land to perennials and producing grass-fed beef.

> Luverne Forbord bought his first 160 acres of land at the age of 19, and it is still part of his and Mary Jo's holdings. They farm in the place farmed by Luverne's family. A brother recently sold his property to the west of theirs. Their son Jaiden bought his grandparents' farm, visible from the hillside just to the west of the Forbord's current home.

Perennialization

Prairie Horizons Farm features about 100 of its 480 acres in original native prairie vegetation, and has restored native prairie, perennial forage mixtures or trees planted on most of the remaining acreage except for 55 acres that are annually cropped. There are 250 acres set up as rotationally-grazed pasture with water lines. All winter feed and grazing for 150 Lowline Angus beef cattle is supplied by that 250 acres, with occasional grazing or haying of the native prairie areas.

Luverne and Mary Jo have made Prairie Horizons Farm available to researchers, and have some acreage dedicated to research plots. Research on perennial biomass production for biofuels has been studied at their farm since 2008, looking at biomass production under several fertilizer treatments, including commercial fertilizers and manure. The Nature

Conservancy has a transect on 40 acres of grazed land, and those researchers are finding a wide variety of bird species.

The farm is enrolled in the Conservation Stewardship Program (CSP). There are also conservation easements protecting prairie potholes on the west side of the farm. They do "flash-grazing" of those areas to keep brushy growth down and maintain the perimeters of the ponds in a classic prairie pothole condition. They are seeing a lot of bird use of those areas.

Resilience

The Forbords are constantly observing all aspects of their land: the plant species, flowering times of native plants, bird species, soil condition, pasture condition, health of the cows. Part of that observing involves the performance of their perennial polycultures in weather extremes. Their perennial pastures and hayfields are planted to a diverse mix of species, modeled after the prairie diversity. That system barely missed a beat in 2014's spring of unprecedented rainfalls. In contrast, their 55 acres of row-crop ground was not workable at all due to wetness.

Foregoing a cash crop is a difficult thing financially, but it is possible for them because the productivity of the perennial acres can carry the whole farm through that rough patch. Productivity of the remainder of the farm also allows them to maintain the native prairie acreage. The majority of those prairie acres are not set-aside acres in any program; maintaining them is a choice and a commitment that the Forbords have made.

55 crop acres with no 2014 crop

Luverne had planted a rye cover crop in fall of 2013, then turned it under as a green manure in spring of 2014. Then the rains began. The Forbords gave up an oats contract because they couldn't get onto the field. Now they are looking at planting another cover crop in that field in preparation for a future cash crop, but are also considering converting that field to perennial forage.

Agroforestry

A windbreak of conifers runs along the south edge of the 55-acre crop field, and windbreaks around their house consist of conifers and ash trees. Mary Jo points out that these are not native species to the area. Despite the region's history as a tallgrass prairie and the remnants of prairie on the hilltops and hillsides, she was mostly unaware of "prairie" as a concept until the 1990s, when she started learning about the diversity of prairie plants and how they function together to form a resilient ecosystem. Burr oak trees are native – part of that original "tallgrass prairie with scattering oak" – so the Forbords are working on renovating windbreaks on their property with plantings of burr oak.

They have also added a diverse fruit orchard near the farmstead of the former dairy operation. In the spirit of the Forbords, it is not merely for fruit production but also for testing, observing, and conserving the genetics of native fruit species. They intend that this will be a profitable venture once the trees and vines are fully established, and have plans to add a fruit marketing and processing enterprise to the farm to handle the orchard's output. Their farm is certified organic, and they maintain that certification now primarily in order to have some legal protection against spray drift affecting the orchard.

Joraan's Orchard

Multiple varieties of berries, plums, cherries, grapes, apples, pears, and even some peaches and apricots grace "Joraan's Orchard," planted in memory of their eldest son who died from sarcoma at the age of 22. That loss was not only of a beloved child, but also of their farm succession plan: Joraan had intended to take over the farm and live on the dairy farmstead. The Forbords are exploring innovative ways to pass on the farm that will satisfy their commitment to continued stewardship of the land and help more young people start farming.

Cultural Preservation

The Forbords are attuned to the rich cultural heritage of their area, pre-European settlement. They find evidence of Native American presence on those hilltops on their farm, and local historians believe that there are graves on one of the hills nearby. Mary Jo has studied the medicinal properties of the native plants that they find in their prairie areas – knowledge that people there before her and Luverne's ancestors had and used. The Forbords are seeing a recent shift in their area toward removal of the hilltop rocks for use in home landscaping and tilling of the native grassland areas, and are distressed at the possibility of losing an important piece of the area's culture and history. "The native

seedbeds are still there on those hills," said Mary Jo. "If you stop tilling, the prairie plants can come back." She believes that we ignore the wisdom of earlier cultures at our peril.

Part of Mary Jo's commitment to preserving cultural heritage on her farm has been to use a tilled field edge to grow out a Native American squash. She received nine of the rare seeds as a gift from Winona LaDuke a few years ago, and has since increased the seed, gifted seed back to Native American gardeners, and is growing a quarter-mile-long row of squash (1,000 plants) this summer. That will supply additional seed for giving away, plus a large amount of squash with which she intends to test the potential of the aggregation and distribution market to handle her crop.

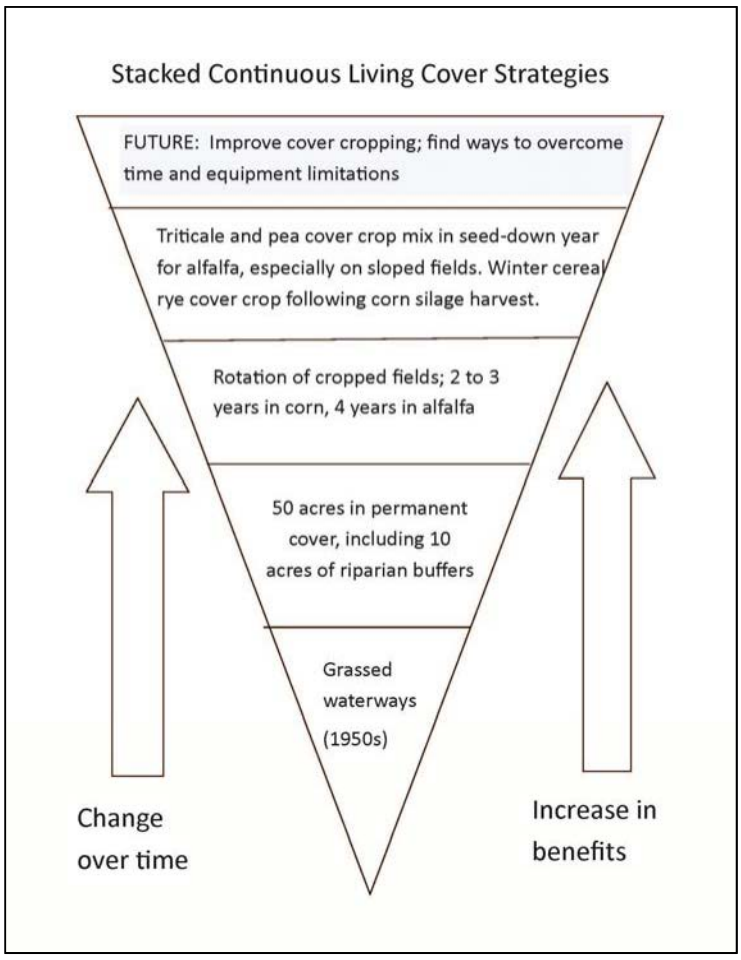
Barriers and Rewards to Perennialization

The Forbords' perennial system is not a commodity-product system. They are raising beef, not dairy; so they are not getting a milk check, and there is a considerable lag time between investing in the cattle and getting a return on that investment. Barriers that they see to other farms doing what they have done:

- Lag time for cash flow
- Lack of incentives (either program or market incentives)
- Management intensive
- Challenging to pull all of the pieces into a whole system
- Technical assistance for agricultural production using perennial polycultures is extremely scarce.

It is also rewarding for them to meet those challenges and see their whole farming system work in a way that is beneficial to themselves, their immediate surroundings, and the larger community.

Ted and Gretchen Johnson



Ted and Gretchen Johnson have a 310-cow dairy operation on 900 acres near Star Prairie, WI. A stream runs through their property and they are very conscious of the importance of their role in minimizing runoff from their sloping fields. About 200 to 250 acres of their flattest land is in continuous corn. They practice a six- or seven-year rotation on their moderately sloping fields: four years in alfalfa, then two to three years in corn. They do not raise any soybeans because corn and alfalfa are what they need for their dairy herd.

The cows do not graze. The Johnsons use some of the areas that are in permanent cover as a dry lot for the cows, but their focus is on corn and hay production to support their milking herd.

Stacked continuous living cover practices: Grassed waterways were established by Ted's father in the 1950s under a contract with the Soil Conservation Service, the predecessor to today's NRCS. Those waterways are still in place. Strip cropping was discontinued because of a need to consolidate fields for custom harvest. Wide buffer areas protect the stream and those are not in a contract; they are cut for hay. Steep hillsides are in permanent cover. Most of the fields have some slope and are on a long rotation of alfalfa for four years and corn for two or three years. Cover crops are used in the alfalfa establishment year on sloping fields, to protect soil. A winter cereal rye cover crop is used following corn silage.

Fifty of their acres are in permanent cover. These include their steepest slopes, some small and odd-shaped fields that are difficult to farm with their equipment, and their streambank (riparian) buffers. Ted estimates that they have 10 acres in those riparian buffers. The buffers are quite wide. Fifty feet is the minimum width at any point, and many of the buffer areas are closer to 200 feet. Ted thinks that 50 feet is barely sufficient as a riparian buffer. His buffers are not under a CRP, EQIP, or other program contract. He cuts them twice a year for hay or haylage. He notes that they also benefit the ease of his farming operation; he uses the buffer areas in some cases to square off fields for easier equipment travel and turning.

Conservation Planning and Implementation

Ted and Gretchen use NRCS programs occasionally, but they also do a lot of the conservation work on their own. Ted says that they see the need to take care of the creek and the nearby lake, and they strive to make their stewardship practices sustainable on their farm without requiring NRCS funds. His hope is that the NRCS money that they don't will be used to incentivize someone else to get started in conservation practices.

The Johnsons worked with their local NRCS office to develop a Comprehensive Nutrient Management Plan (CNMP). This is a massive, 100-page document that serves as their reference guide for their yearly planning. They work with an independent agronomist to develop their yearly crop rotation management plan and yearly implementation of their Nutrient Management Plan, which they have under NRCS Practice 590. Their agronomist also keeps them on a routine of soil sampling so that they are testing every field at least once every three years. The local watershed organization has recently offered some funds to support that sampling in an effort to establish baseline phosphorus levels in the area, as part of efforts to reduce phosphorus loading into nearby Cedar Lake.

Ted notes the influence of the farmer-led council in his area, part of a larger effort to establish local farmer-led councils in the St. Croix River watershed. The farmer-led councils have credibility that state and federal agencies may not have in pushing for new practices, because farmers tend to pay attention when other farmers are promoting something. He has noticed way more acres in winter cereal rye cover crops in his area within the past four years, and thinks that is because seeding of fall cover crops was a priority of the farmer-led council. Ted was in a leadership role on that council initially, but had to step back over the past couple of years due to a family health issue. He still follows their work and approves of their efforts.

Farmer-Led Councils

For more information about the effort to establish farmer-led councils in sub-watersheds of the St. Croix River, see the Farmer-Led Councils segment in the Cultivating Leadership chapter of this manual.

Cover cropping is something that Ted does routinely on any highly erodible land (HEL) that is going

back into alfalfa after corn. He uses a triticale and pea mixture seeded down with the alfalfa, then takes the triticale and peas off for hay. He has gotten some very good tonnage yields of hay from that cover crop. On the non-HEL land, he prefers to go directly into alfalfa from corn without using the cover crop because the alfalfa gets a little more growth in its first year without the competition.

The Challenges of Cover Cropping

Ted would like to use cover crops more, especially fall-seeded winter cereal rye following corn, but finds it very challenging to match the workload on the farm to the planting windows for the rye. Right now he's using the winter rye primarily after corn chopped for silage, because he can get out there and spread manure and then seed the rye with enough time for it to germinate and get some growth before winter. He doesn't have enough window of growing time to do that after harvesting corn for grain.

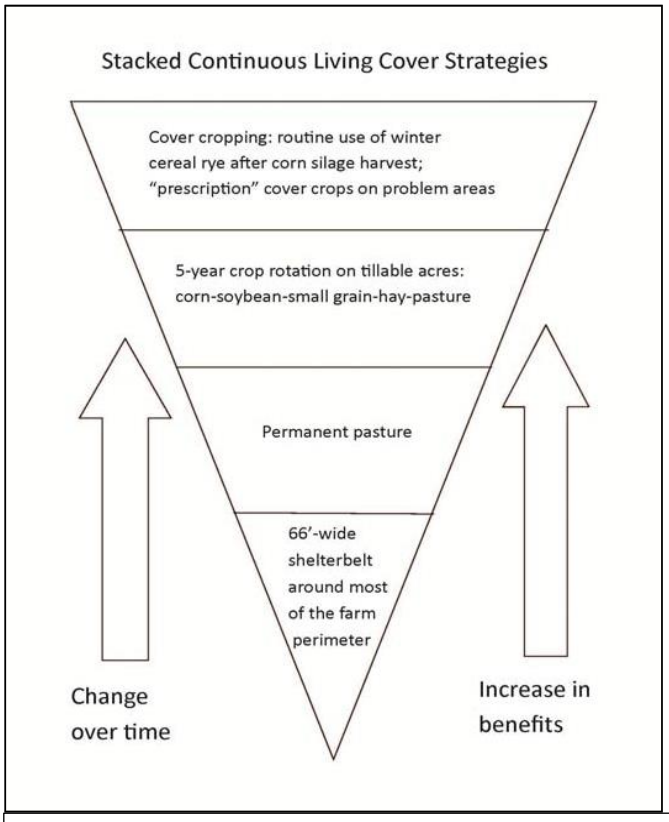
Broadcasting of the seed with his manure spreader is the cheapest and easiest way for him to apply the winter cereal rye cover crop, but the falls lately have been dry, and he hasn't had good soil to seed contact when broadcasting rye over corn stubble. He has been putting down 60 lbs./acre of rye seed, and seeing very poor stands. Broadcasting of the seed into standing corn before harvest might be an option, but he isn't sure how the rye would hold up to the equipment traffic and manure that gets applied after corn harvest.

Managing Manure

Manure management is an important component of Ted and Gretchen's operation. They have 310 to 315 cows, and limited manure storage facilities, so they have to do multiple applications of manure each year. They have a number of parcels of cropland in three townships, all within a 10-mile radius of their farm, and have been working at getting manure moved out to fields within that entire radius. They have to do some spreading of manure in the spring, and township road restrictions in spring make that challenging. They spread manure each year on about 120 acres alfalfa that will be plowed down prior to planting corn. They also put manure on about 40 to 50 acres of a neighbor's field that is in a grassy hay mixture. Manure is always spread on corn stubble after harvest for either silage or grain.

He is considering drilling in the seed, but notes that any time you look at a more specialized seeding option, the costs go up, and cost-sharing for cover cropping doesn't cover all of the costs of doing it. With fluctuating milk prices, he has to be sure that the cover crop will pay for itself. He is feeling the need for better planting options, but is hopeful that his continued experimentation and that of other farmers in his area will lead to good cover cropping solutions. Again, he points to the farmer-led councils as an important source of support for farmers in his area to work towards improved stewardship of their soil and water resources, and would like to take up a more active role in that council again in the future.

Tom and Irene Frantzen



North Hampton, IA; July 2015

Tom Frantzen grew up on this farm and started farming it himself in 1974. The farm lies almost at the origin of the upper east fork of the Wapsipinicon River. There are 400 -acres with 355 tillable, and all of it certified organic since 1995. Their organic transition in the 1990s included the creation of a 66-foot wide shelterbelt around the majority of the farm. That amounts to 25 acres that was established under CRP contract and has since been re-enrolled in CRP. It consists of native prairie plants, hand-planted conifers, and direct-seeded hardwoods. Tom views this shelterbelt as the most

Stacking continuous living cover: Agroforestry is an important strategy for the Frantzen farm. It has been certified organic since 1995 and a key piece of their system is a the 66'-wide shelterbelt that surrounds the majority of the property. It serves as their required buffer for organic production, but also provides species diversity, wildlife habitat, and protection against extreme weather. It proved its worth in the flooding of 2008, slowing down rushing floodwater and giving it a chance to spread out and deposit sediment on their fields. They use a five-year crop rotation on their 355 tillable acres, with two of those years in perennial forage. A winter cereal rye cover crop is routinely used on corn stubble following silage harvest and then tilled in prior to soybean planting the following May. Cover crops are also used as a weapon against specific weed problems; for instance, sorghum-sudangrass followed by two years in hay to combat giant ragweed.

distinctive and most critical aspect of his farm, valuable for multiple reasons. One reason is that it serves as their buffer zone as required for organic certification. When he first pursued certification he was told he needed a 25' buffer, but he believes that would have been inadequate. He views 50 feet as a minimum buffer width and is very pleased with his 66 feet of buffer. A biologist present on a farm tour many years ago explained that an area that wildlife use for shelter need to be wide enough to accommodate normal predator/prey interactions; in other words, the prey species need to have enough room to be able to get away and hide. Tom took that explanation to heart. He also believes that species diversity is important for the long-term stability of the farm, and views the wide buffer zone as a stabilizing force. He notes that there are benefits to it that may not even be understood yet, but he is learning some of them as new research comes forward. For example, research on weed seed predation is relatively recent, and he has learned that the shelterbelt serves as habitat for species that eat weed seeds. Every little bit of weed reduction helps, he says. Another benefit of the shelterbelt is aesthetic: it just looks nice to have trees around the place, says Tom. The 355 tillable acres on the Frantzen farm are in a five-year rotation of corn-soybean-small grain-hay-pasture. The small grain in the rotation is usually a mixture of wheat, barley and oats, which is commonly called "succotash." Tom notes that row crops account for 40% of the years of the rotation, or two years out of five. He says that percentage is a basic principle of successful organic farming: you never want more than 50% of your rotation in a row crop. He has a 50-cow Angus x Gelbveih beef herd and finishes out the calves as organic beef, which requires him to have the animals on pasture during the growing season. Drought in 2012 set back his availability of forage for the cattle because a new seeding of hay didn't survive. It took him several years to restore the crop rotation after that crop failure.

Cover cropping is something that Tom continues to study. He regularly plants a winter cereal rye cover crop after harvesting corn silage in the fall. The rye gets tilled down in May before planting soybean. He's happy with that system because he gets a very clean stand of soybean. He hasn't been able to make it work to plant winter cereal rye following corn grain harvest, however. His grain harvest is just too late in the year to allow establishment of the winter rye crop.

Tom has used cover cropping to address specific problems on his farm. One example is combating giant ragweed. He says that giant ragweed is an increasing problem for him, and one that he believes is climate change-related. He has had pretty good success in controlling it by planting a sorghum-sudangrass cover crop followed by two years of hay.

Another example of "prescription" cover crop use was his treatment of a degraded field purchased from a neighboring farm in 1995. Tom worked at restoring productivity to that

field through manure application and crop rotation for 10 years with little progress. Finally, he found the winning combination of a small grain underseeded with sweet clover, a biennial legume. The small grain was harvested in the fall and the sweet clover left on the field. It grew explosively in the second year. He plowed it down in late June and planted a cover crop of oilseed radish; then plowed that down before planting into a row crop the following spring – and was finally able to harvest a good crop from that field.

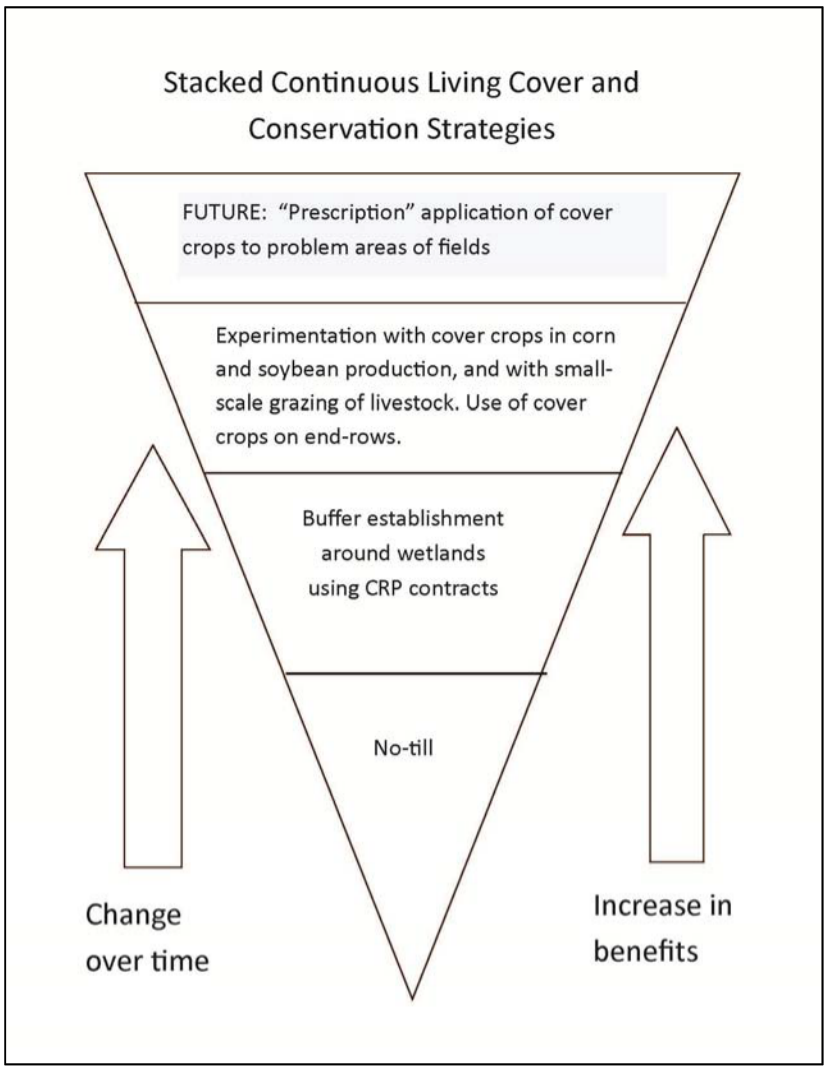
The forages in Tom's rotation feed the cattle, which he can sell at a premium price as organic beef. Tom is adamant that he will never sell hay or other forage from his farm; it has to run through an animal first. He believes that selling forages from a farm will deplete soil nutrients faster than selling grain; and in many cases faster than an organic farmer's ability to replace them. Feeding the forages to cattle and returning their manure to the soil stabilizes the soil fertility and biology. Achieving stability through diversity is what the Frantzen farm is all about.

Coping with Climate Change

There's no debate that we're seeing climate change, Tom says – the question is how to abate the effects. He thinks his shelterbelt and the continuous living in other parts of the farm do a pretty good job. The flood of 2008 is an example. June of that year was wet to start with. Tom was edgy one day for no apparent reason, and decided to move the cows out of a riparian area to higher ground. They got 9" of rain the next night. The floodwaters were moving very fast when they hit his shelterbelt, which performed just as it should. The shelterbelt held the water, slowed the rampage of the flood down and made it less violent, and caused the waters to spread out. The slowed, spread-out water deposited a lot of sediment on his fields. He could see the different responses to flooding on various parts of his diversified farm. The hay ground held and absorbed water. The pasture and small grain areas also held onto water. Water ran off of the tilled fields, but those were a small percentage of the total farm. He believes that if he had all tilled fields, the flooding would have been far worse for those downstream of his farm.

Tom expects to see more flooding, drought, and other weather extremes in the future. He's seen evidence that his diverse system is resilient, but isn't sure just how far it can be pushed. The summer of 2014 included multiple shifts between extremely wet and extremely dry conditions, followed by an early frost. That was their hardest year ever, with lower grain yields even than in the drought of 2012.

Tony Thompson and Sonya Buller



Windom, MN; July 2014

Tony Thompson is quick to note the successes of what one hears variously termed the large-scale, industrial, conventional, or high-input model of agriculture. He gives the example of heavy early-summer rains of 2014, with one 17.7" rainfall event in Rock County, MN in June, noting that the large hog barns were properly sited – all on high enough ground that there weren't any pigs in the water, and the manure remained safely stored in lagoons so that the nutrients in it remained available as a resource. He has the highest respect for organic farmers and for

Stacking of multiple soil conservation and continuous living cover practices: No-till production was adopted in the 1980s. Wide buffers around wetlands and river headwaters were established with CRP contracts. Cover crop experimentation is ongoing, and Tony is interested in developing "prescription" treatments of cover crops for problem areas within fields.

those using pasture-based models of livestock production, but thinks it is important to recognize the challenges and limitations of those systems, and to acknowledge the things that large-scale agriculture gets right.

Tony is a conventional corn and soybean farmer, but yet he's an unconventional ecologist and amateur archeologist, hosting an "Acroecology Summit" at his farm every other August; and finding, collecting, and archiving evidence of the presence of earlier peoples on his property. He defies pigeon-holing. He's forthright about growing corn and beans for a global market that is always ready to buy. He is experimenting with organic production and is intrigued by the possibility of grain polycultures; but his land is flat, fertile, and really good at growing corn and beans – and for now at least, that's what he believes it should grow. He uses GPS and precision agriculture technology to gain the maximum yield from each square foot of his cropland.

Yet, Tony is utterly committed to conservation and wise use of water and soil resources. He explains the priorities laid down when his brother Mark joined the operation in the 1980s. At the time, there were egregious problems on their family farm. The high-tillage model of the 1960s and 70s had wreaked havoc on the soil. They experimented with organic agriculture and worked to understand concepts like economic thresholds for fertilizer and integrated pest management. The number one priority, though, was to reduce tillage; and that goal was most practically achieved with the integrated pest management practices that were available in a conventional ridge-till system.

Tony's priority list:

1. Reduce tillage
2. Close all open intakes in drainage
3. Enroll in CRP to buffer wetlands and streams
4. Cover cropping
5. Install bioreactors
6. Install controlled drainage
7. Strategic cover cropping

Keep the soil in place and hold on to every drop of water.

These priorities have evolved over time. Tony has had 30 years of praxis – observing and manipulating the interplay between theory and practice – in which to develop a keen understanding of the capabilities of his land.

Early on, Tony and his brother Mark switched to ridge tillage, and tried to understand the thresholds at which reduced tillage would make a difference in reducing sediment loading

into surface waters. According to some on-farm research led by Mark Zumwinkle in the Minnesota Department of Agriculture, there is a flex-point in tillage reduction where you see a dramatic reduction in soil loss.

The majority of Tony's cropped fields are tiled. He has tight control of the drainage outlets, and can hold water for gradual release. He greatly prefers that every drop of water that falls on his ground be transpired through a crop plant before it escapes his property: losing water out of the drainage system is not desirable. Bioreactors at various outlets filter nitrogen out of drainage water that does have to be let go.

The farm as he knew it growing up was more diversified and included the grazing of dairy and beef cattle as well as production of hogs and sheep. Livestock left the farm in the 1970s. That is something that Tony speaks of with a hint of regret; but it was a decision he made to focus on the corn and soybean crops that have been financially rewarding and that have allowed him the financial freedom to set aside 400 acres of grassland out of his total of 3200 acres. The remaining 2800 acres are nearly half in corn, half in soybean; with a small area in alfalfa. The grassland acres are managed for plant diversity and wildlife, primarily using fire and hand-weeding to maintain desirable plant species and eliminate non-natives. He takes pride in the fact that there is no Japanese honeysuckle, mulberry, or buckthorn on his property; it has all been removed by hand-weeding. Tony experimented in 2014 with allowing a tenant to graze sheep on part of the grassland, but was concerned about the impact on nesting birds. The sheep defoliated sumac bushes and exposed blackbird nests. The grazing was useful for cleaning out non-native understory brush under native oak trees, however.

Tony used the Conservation Reserve Program in what he considers an optimal fashion, to establish wide buffers around wetlands and to protect a portion of the headwaters of the south fork of the Watonwan River that originates on his property. These buffer areas are under contract and can't be hayed or grazed. He has contemplated the possibility of buying out the contract to allow sheep grazing, but isn't convinced that there is enough money in sheep to justify that.

Cover cropping is a practice that Tony continues to study and experiment with. He tried broadcasting rye and radish with a spinner into soybean, but didn't get good soil-seed contact and had poor germination. That was an expensive experiment. He needs to figure out a cheaper way to apply seed, but also isn't convinced that cover crops are the right answer for all of his crop production fields. He has fields with 0 to 2% slopes with no erosion, and can't justify the $50/acre cost of cover cropping on the whole field when he is

seeing no erosion issues. What does interest him is the possibility of spot-treating problem areas with a "prescription" cover crop; for example, a crop that would build organic matter on sandy areas. He envisions precision technology that would allow the tractor to turn cover crop seeding on or off as it moves across the field during planting or harvest of the main crop. He does use cover cropping regularly on the end rows, where equipment turns. Those areas get scuffed up and abused.

Tony's farm is a frequent subject of articles and media reports, but he says that one important message that doesn't often come through about his operation is that he's mostly just following the lead of other farmers and of researchers. He says that he's not particularly innovative. What he *is*, is observant and attentive to recommendations and the conditions on his farm, and quick to adopt good practices. One example is his nitrogen fertilizer application method. He side-dresses all N in late May or June. This is the best- practice recommendation of University researchers, and 2014 was the perfect example of why: most fall-applied N was probably lost in the big rains in early June, because the crop was not growing fast enough yet then to use all of the N available from a fall application. He side-dresses with ammonia in the V6 stage of corn growth, when the plant is poised to grow rapidly and use that applied N.

Tony and Sonya recently welcomed a son, Reuben, to their family. The wealth of their soil and Tony's careful study and careful stewardship of the farm's resources are legacies that it's good to know will be passed on. Another part of that legacy is connectedness to the local community. Tony commented on the importance of "rolling the cob" – local vernacular for spending time chatting with neighboring farmers after some errand brought them to his place. He wants it known that his success is not his alone, but helped along by that connectedness with "… a supportive family, community, and professional colleagues -- Fairland Management Company, crop consultant Steve Sodeman and excellent employees!"

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Appendices

Basics of Contract Grazing
Pasture Rental and Lease Agreements
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Small Changes, Big Impacts: Prairie STRIPS
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Midwest Perennial Forage & Grazing Working Group

The Basics of Contract Grazing

Spring 2013
Factsheet 1 of 4 in the Contract Grazing Series

What is Contract Grazing?

Contract Grazing (also known as Custom Grazing) is a livestock production system in which land ownership, livestock ownership, and management of the system may be de-coupled. This arrangement can involve as many as three separate entities carrying out three distinct roles: a land owner, a livestock owner, and a *grazier* (the grazing manager) who provides the grazing management expertise and oversees the grazing activities. Some common scenarios include:

- A grazier who owns pasture land and facilities contracting to manage another farmer's livestock.
- A livestock owner leasing pasture land from a land-owner and managing his or her own livestock on that land.
- A farmer contracting with a grazier to manage the farmer's livestock on the farmer's own land or on another party's land.

Is Contract Grazing a good fit for me?

Well-managed pastures offer environmental benefits, such as reduced potential for soil erosion and nutrient runoff from agricultural areas for improved water quality, high quality grassland wildlife habitat, and many others. Becoming a contract grazier may be a good fit for someone who has a farming operation and is looking for ways to either expand grazing (if they already own livestock) or start grazing (if they would like to incorporate grazing on their farm, and may or may not already own livestock). Since contracting as a grazier can be done without owning land, it can also be a good way for beginning farmers to start a grazing operation. For land-owners, contract grazing can be used to diversify their farming operation with livestock, without having to be responsible for livestock care. For absentee or non-farming land owners, renting one's land for contract grazing is an alternative to renting the land for annual row crop production. Renting or leasing to a contract grazier qualifies land owners to maintain agricultural use tax benefits while achieving conservation goals.

Grazing Considerations

Contract grazing can be done with almost any species of livestock (e.g. cattle, sheep, goats, or bison) or any class of livestock (breeding, growing, meat or dairy). Usually the arrangement only includes summer grazing, but, with appropriate facilities, a year-round arrangement is possible. For all grazing operations, it is crucial to have a continuous supply of good-quality forage. Because of this, a custom grazier should know the carrying capacity of the land being grazed. Knowing the land's actual production capacity will make it possible to fine-tune the system to ensure successful grazing. Graziers should also be aware of the production goals for the livestock

being grazed. Different livestock classes may require different quality forage. For example, dairy heifers or stocker cattle generally require higher quality forage than beef cow-calf pairs in order to meet production goals.

Payment Rates

The production goals and livestock class being grazed also can affect the payment rate charged by the grazier. For example, when weight gain is the goal, the payment plan may be based on weight gain over a period of time ($/lb. of gain). In other instances, it may be more practical to charge a fee on a flat-rate, daily basis ($/day), or to charge on a sliding scale based on the weight of the animal grazing (lbs. of animal/acre). Before grazing begins, it is important to define the payment rate and payment plans in a written contract.

Contracts

Written contracts allow for documentation of the payment scheme, as well as other considerations. A written contract should clearly define the responsibilities of each party, how payments should be made, and how the parties will handle any problems or disagreements that arise. For the grazier, these responsibilities typically will include decisions about cattle rotation and movement during the grazing season, providing a continuous supply of water, and ensuring that pasture quality is maintained. Animal owners are usually in charge of vaccination and other health costs, cattle insurance policies, etc. The land owner is typically provides effective perimeter fence, and initial soil fertility inputs. Decisions about who is responsible for facility maintenance, marketing, and animal transportation should also be addressed. (For more information about what to expect in a contract, please refer to the companion publication "Pasture rental and lease agreements).

Facilities and Equipment

Contract grazing arrangements can be a good way for farmers to be profitable without a large capital investment. However, there are some facility and equipment costs that must be considered. Fence and water development are two important infrastructure costs to consider. Contract grazing also requires livestock handling facilities that minimize stress on the animal and ensure worker safety. Livestock scales will be necessary if payment will be made based on the animals' weight gain.

Further Information

- *Grazing Contracts for Livestock* https://attra.ncat.org/attra-pub/summaries/summary.php?pub=243
- *Custom grazing contracts: Successful models to grow profit, avoid pitfalls* http://www.leopold.iastate.edu/grants/e2007-11

Other fact-sheets in this series include:

- Evaluating Land Suitability for Grazing Cattle
- Pasture Rental and Lease Agreements
- Rates Charged for Contract Grazing Arrangements

Factsheet Series produced by the Midwest Perennial Forage & Grazing Working Group:
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Midwest Perennial Forage & Grazing Working Group

Pasture Rental and Lease Agreements

Spring 2013
Factsheet 3 of 4 in the Contract Grazing Series

Contract grazing arrangements typically follow one of three potential scenarios:

1) A grazier who owns pasture land and facilities who contracts to manage another farmer's livestock
2) A livestock owner leasing pasture land from a land-owner and managing his or her own livestock on that land
3) A farmer contracting with a grazier to manage the farmer's livestock on the farmer's own land or on another party's land

This factsheet addresses pasture and lease agreements pertaining to the second situation: when a livestock owner plans on managing their own cattle on land leased or rented from another person. Raising cattle on rented or leased land offers livestock producers the opportunity to affordably start or expand their operations and limit financial risk. With the high price of grains and the growing interest in grass-fed beef and dairy, managed productive pastures offer an alternate and affordable way to feed cattle. Sheep and goats have traditionally been fed a mostly forage diet but managing their pasture can lead to greater profitability. Additionally, land owners without livestock can consider leasing out their land to realize some income while giving a beginning farmer the chance to get established.

What is the difference between a rental agreement and a lease for a pasture rental?

When you rent out a property, you will need to decide if you wish to offer your tenants a lease or a rental agreement. Although these terms are often used interchangeably, they are not the same.

Rental agreements are month to month, with no set period of residence. At the end of each 30-day period, both you and your tenant are free to change the rental agreement (subject to any rent control laws). These changes may include raising the rent, changing the terms of the initial agreement, or asking the tenant to vacate the property. However, in most states, both landlord and tenant are required to give 30 days' notice before any changes can be made. If your state doesn't require notice, you can change any part of the rental agreement at your discretion. A rental agreement typically renews automatically after each 30-day period has elapsed. There's no need to give notice about this automatic renewal, as long as neither you nor your tenant has stated that the tenant will vacate the premises.

A **lease** has a set term, such as six months or a year, during which the tenant agrees to rent the property. During that time (also known as the duration of the lease), the tenant and the landlord must adhere to the agreement. For example, tenants agree to make monthly rent payments and follow any code of conduct or other stipulations in the lease.

Neither party can change any terms of the agreement until the lease expires, unless both parties agree to the change. A tenant can't vacate the property without breaking their lease, in which case they can be held liable for the rest of the rent due under the lease, or can be required to find someone else to take over the lease.

Amount to pay or charge:

Both land owners (lessors) and graziers (lessees or renters) need to determine a fair rental or lease rate. What is a fair amount to charge for rent? The answer is always: "It depends". The devil is in the details and there can be many details to work out. You as a renter need to determine what kind of gain you can expect on livestock or how many animal units an acre can support. How you manage the pasture can make a big difference on the stocking rate and rate of gain on the livestock. If you manage the pasture as a continuously grazed system, the stocking rate and rate of gain could be different than if you rotationally graze in smaller paddocks or mob graze in a high density grazing system. The more gain you can achieve, the more you may be willing to pay or the less your risk might be.

Typically, most pastures are rented by the month on a per-acre or per-head basis. An alternative is to consider rental rates based on an amount of gain in a season. Two very important items that must be clear and agreed upon are the maximum number of animals allowed on a unit of land and the weight of the animals. These will greatly affect the impact on the pasture stand life and soil health. If you rent on an acre basis, you may overstock to reduce cost per head. If you rent on a per head basis, you may want to lower your stocking rate to improve rate of gain. These decisions might be in conflict with the landowner's expectations of how they want their land managed, so it's important to deal with these questions upfront in a written agreement.

Consider some different scenarios

A few potential scenarios illustrate the different ways of determining a whether a rental or lease rate is "fair."

Scenario 1: You have a 75-cow beef herd and expect you will have 75 cow/calf pairs to put on pasture May 1. You hear of a pasture available to lease for the year for $15,000 for 100 acres. Is this a fair price? In the past you have paid $1/cow/calf unit per day for pasture rental. If we can expect 180 days of pasture growth adequate to support the 75 cow/calf units; our math would tell us that would equal $75/day in pasture costs for 180 days which would equal $13,500. If you pay the $15,000, the cost comes out to $83.33/day or $1.11per cow/calf unit per day.

Scenario 2: As a second example, say you are looking at the same pasture as in Scenario 1, but you have 75 bred Holstein heifers that you want to gain at least 1.75lbs/head/day by calving time in the fall. In order to achieve this rate of gain, it will be necessary to divide the pasture into 30 paddocks with movable electric fencing which you will have to provide. It will also require you to move fences and animals daily. In this scenario, the fencing costs, and time and labor costs will be significant.

Someone who doesn't have the available time, or doesn't have the necessary fencing supplies on-hand, may decide that it makes more sense to pay someone else to raise the heifers for them. As an alternative to raising them yourself, the landowner offers to raise the heifers for a fee of $2.50/head/day (without offering a guaranteed rate of gain). This cost includes the land rental and the grazing management—the land rental fee equals $1.11 per day (from scenario 1) so the grazing management would be $1.39/head/day. As the owner of the heifers, you'd need to consider whether this is a grazing management cost you can beat by supplying your own subdividing fence materials and labor for daily moves.

These scenarios serve to illustrate things that need to be considered in negotiating a pasture lease, including:

- What is the forage production potential of the pasture; is it composed of diverse and productive grasses and forbs or weedy Kentucky Blue grass?
- What is the fertility status of the ground and who will be responsible for the additional fertilizer needed?
- What is the soil type? Is it good loam, or sandy and rocky with little water holding capacity?
- Who will pay for supplemental feed if required in time of drought?
- What is the water supply and quality in the pasture and the location of the water source? Will different fencing plans work with the water available?
- What happens if the water supply dries up in late summer? Who is responsible to provide water?

The landowner is usually responsible for providing effective perimeter fences. The fencing for subdividing the pasture into multiple paddocks in a more intensive system is usually the renter's option and responsibility.

Whether it is a rental agreement or a true lease, the agreement should be put in writing with the guidance of legal counsel. The agreement should include the names of the parties involved, legal description of the land involved, length of the agreement, pay provisions and all of the other the items agreed upon. It should then be signed and dated before livestock take occupancy.

Other fact-sheets in this series include:

- The Basics of Contract Grazing
- Evaluating Land Suitability for Grazing Cattle
- Rates Charged for Contract Grazing Arrangements

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Midwest Perennial Forage & Grazing Working Group

Evaluating Land Suitability for Grazing Cattle

Spring 2013
Factsheet 2 of 4 in the Contract Grazing Series

When evaluating the suitability of pasture acreage, here are some important features to consider:

- Pasture composition (what species are present)
- Condition of the pasture
- Water sources and availability
- Fencing condition and configuration
- Land base: soil type, slope, and aspect

Pasture Composition

Good pasture land should have a diversity of perennial plants, including both grasses and legumes, and species of each that contribute to extending the grazing season. There should be little or no bare ground, and few annual plants. There will likely be broadleaved plants, and it is important to identify what species of these are present—some species of broadleaf plants can be good cattle forage and some can be harmful, even fatal. Each plant group (grasses, legumes and broadleafs) that may be present in the pasture has a different seasonal pattern of growth. When considering an unfamiliar pasture, if your timeline allows, visit the pasture site over several seasons prior to grazing.

Cool season grasses

Cool season grasses have the most prolific growth in the spring and fall, when temperatures are mild. These grasses, when they are leafy and have not yet produced a seed head, are highly palatable to cattle. They are desirable pasture species. The drawback of this class of pasture species is they tend to shut down growth in hot summer weather. This is known as the "summer slump," and it is important to have a plan for supplemental feeding if this situation arises, such as during periods of drought.

More Information:

- *Cool-season grasses. Illinois Natural Resources Conservation Service (NRCS). http://www.il.nrcs.usda.gov/technical/grazing/coolgrass.html*
- *Identifying pasture grasses. UW Extension. http://learningstore.uwex.edu/Identifying-Pasture-Grasses-P176.aspx*

Legumes

Legumes (nitrogen-fixing plants such as clover, alfalfa, and birdsfoot trefoil) tend to have their most active growth in early to mid- summer. Generally, legume content of 30 to 50% of the total forage in a pasture is ideal. Legumes have higher protein content than grasses, making them an important part of a cattle's diet. Keep

in mind that most legumes—with the exception of birdsfoot trefoil—can cause bloat in cattle.

More information:

- *Identifying Pasture Legumes. Dennis Cosgrove and Dan Undersander. 2003. University of Wisconsin Extension. http://learningstore.uwex.edu/Identifying-Pasture-Legumes-P179.aspx*

Warm Season Grasses

Warm season grasses have active growth in the heat of mid to late summer. Most pastures will have either warm season or cool season grasses and need to be managed to benefit the dominant grass type. Warm-season grass pastures often are not established with a legume component, and they tend to be lower in nutritive value for cattle than cool season grasses. Never the less, they are still desirable forage, especially for the "summer slump" when the growth of cool season grasses slows.

More Information:

- *Warm Season Grasses. Illinois Natural Resources Conservation Service (NRCS). http://www.il.nrcs.usda.gov/technical/grazing/warmgrass.html*
- *Warm Season Grasses for Hay and Pasture. Stephen K. Barnhardt. Iowa State University Extension. http://www.extension.iastate.edu/Publications/PM569.pdf*

Forbs (Broadleaf plants, other than legumes)

Though a diversity of plants in the pasture is good, pay close attention to the number and species of forbs present. Many forbs that are considered weeds in row crops are highly nutritious and palatable in pasture settings. These include dandelions, chicory, and lambs quarter, among others. Other species such as burdock and thistle species are problematic because they are unpalatable to cattle (though they may be preferred by small ruminants like sheep or goats). Some other forbs, like goldenrod or buttercup, may cause animal health problems if consumed.

With forbs, remember that "the dose makes the poison." Many forbs have the potential to be harmful if cattle eat too much of them, which is more likely is the pasture being grazed is overly weedy. However, consumed as a small percentage of total daily intake, the same forb may not be harmful and may even be beneficial.

More information:

- *Plants Poisonous to Livestock. Fred Fischel. University of Missouri Extension. http://extension.missouri.edu/publications/DisplayPub.aspx?P=G4970#poison*
- *Plants Poisonous to Livestock. Lisa Axtel and Beverly Durgan. University of Minnesota Extension. http://www.extension.umn.edu/distribution/livestocksystems/DI5655.html*
- *The dirty dozen and beyond. UW Extension. http://learningstore.uwex.edu/Dirty-Dozen-and-Beyond-Identifying-and-Managing-25-Pasture-Weeds-of-Wisconsin-The-P165.aspx*

Pasture Condition

Livestock will do best if offered high quality feed, and the highest quality forage is available in well-rested, well-managed pastures. There should not be erosion in the pasture, indicated by areas of bare soil, mud holes, or gullies. If you're evaluating pasture that is currently being grazed, look for signs of overgrazing. The stubble height of the plants just after grazing should be no shorter than 3-4 inches tall for most plant species found in pastures. A pasture that has been overgrazed—a pasture that looks like a golf course for example—can often be

restored with proper grazing management. In more degraded pastures, full restoration may require additional inputs, such as fertilizer application. The need for these inputs should be a factor to consider in the rental price for the land.

Water Sources

Cattle and other livestock need access to fresh, clean water. This is particularly important for animals with the highest energy and nutritional demands, such as milk cows and growing steers and heifers. A general rule of thumb is that cattle will consume one gallon of water per 100 lbs. of body weight each day in the winter and two gallons per 100 lbs. of body weight each day in hot weather or when grazing dry forage or feed.

Table 1: Estimates of the water required for cattle in pasture.

	Water per Day
1 Beef Cow	15-20 gallons
1 Dairy Cow	20-30 gallons
1 Yearling Cattle	10-15 gallons

When you evaluate a potential pasture, note the available water sources and ask the following questions:

- If the water source is a shallow well or small stream, what is the possibility of that source drying up? You may need to plan for alternative water sources.
- If water must be hauled in, how much storage is available? How far must water be hauled? Hauling is an additional expense that can influence how much you are willing to pay for pasture rental.
- How amenable is the topography and ground cover of the pasture to a paddock design and water system that will bring water close to the cows? The paddock design should ideally offer water within 800 ft of the grazing animals. Cattle tend to congregate around water sources if they are more distant from grazing areas. Shorter distance to water (less than 800ft) encourages the animals to go individually to drink, reducing the concentration of manure and urine nutrients around the water source. Lanes can be used to access a central watering site, but better forage utilization will be achieved when water is available in every paddock (figure 1).

More Information:

- *Pumps and Watering Systems for Managed Beef Grazing. Donald Pfost, James Gerrish, Maurice Davis and Mark Kennedy. 2007. University of Missouri Extension and Missouri Natural Resources Conservation Service.* *http://extension.missouri.edu/p/EQ380*
- *The ABCs of pasture watering systems. Ben Bartlett.* *http://www.extension.org/mediawiki/files/d/d2/9_Watering.pdf*

Fencing

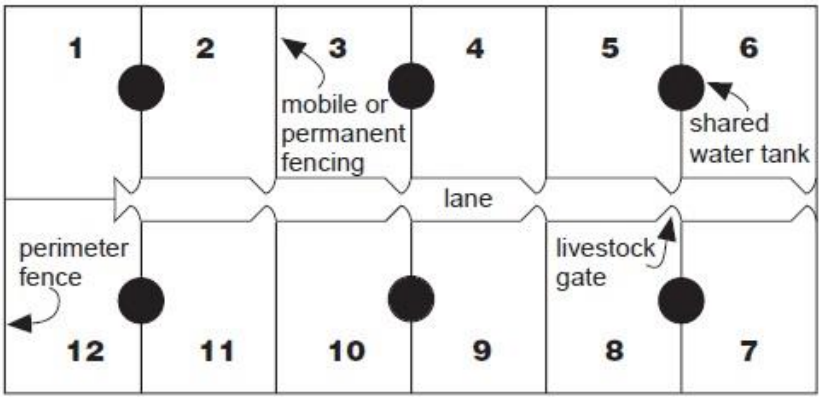
Using a rotational grazing system which follows a grazing plan means that the grazier can move the cattle based on forage growth. This allows for the highest quality of forage to be available on the pasture and better utilization of available plant growth, which can extend the length of the grazing season and result in the highest environmental performance of the pasture. Appropriate fencing is important to keep the livestock in the designated grazing area, without injury to the animal. Look at the condition and location of existing fences:

- There should be a perimeter fence around the outside of the entire grazing area, sufficient to keep livestock in the pasture. High tensile wire, woven wire and barbed wire fences are all common for perimeter fencing. Barbed wire fences should never be electrified due to risk for animal or human injury.
- Notice logical fence-line routes to divide a larger pasture into smaller paddocks, and convenient points where a temporary divider fence could be tied in to the perimeter fence. Temporary fences are commonly constructed out of light-weight, moveable materials, including fiberglass or plastic step-in posts and soft-wire or polyethylene wire and tapes embedded with steel strands called "polywire."
- You will need a source of electricity to power an electric fence charger (energizer) for the temporary divider fences and the perimeter fence if that is designed to be electrified. Fence chargers that plug into the grid are generally the least expensive option. If access to the grid is not available, 12-volt energizers are a relatively inexpensive option. These can be run by a deep-cycle marine or RV-type battery with or without a solar charging panel—these batteries can also be recharged using a common 12-volt battery charger.

More Information:

- *Grazing Systems Planning Guide. Kevin Blanchet, Howard Moechnig, Jodi DeJong-Hughes. 2003. University of Minnesota Extension and Minnesota Natural Resources Conservation Service. PDF, 3.8 Mb. http://www.extension.umn.edu/distribution/livestocksystems/components/DI7606.pdf*
- *Fencing Materials for Livestock Systems. Susan Wood Gay and Rick D. Heidel. 2009. Virginia Cooperative Extension. http://pubs.ext.vt.edu/442/442-131/442-131.html*
- *Managed Grazing Systems and Fencing for Distribution of Beef Manure. Donald Pfost, James Gerrish, Maurice Davis and Mark Kennedy. 2000. University of Missouri Extension and Missouri Natural Resources Conservation Service. http://extension.missouri.edu/p/EQ379*
- *Pastures for Profit. UW Extension. http://learningstore.uwex.edu/Pastures-for-Profit-A-Guide-to-Rotational-Grazing-P96.aspx*
- *Lanes that keep animals high and dry. UW Extension. http://learningstore.uwex.edu/Lanes-That-Keep-Dairy-Animals-High-and-Dry-P1390.aspx*
- *Fencing for managed grazing. UW Extension. http://www2.uwrf.edu/grazing/#Fencing*

Figure 1*:* Square or rectangular paddock layout uses a central lane with shared water source. Paddocks are separated by mobile or permanent fencing.



Source: University of Wisconsin Cooperative Extension and University of Minnesota Extension Service publication Pastures for Profit: A Guide to Rotational Grazing (A3529)

Other fact-sheets in this series include:

- The Basics of Contract Grazing
- Pasture and Lease Agreements
- Rates Charged for Contract Grazing Arrangements

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Midwest Perennial Forage & Grazing Working Group

Rates Charged for Contract Grazing Arrangements

Spring 2013
Factsheet 4 of 4 in the Contract Grazing Series

Contract grazing arrangements typically follow one of three potential scenarios:

1) A grazier who owns pasture land and facilities who contracts to manage another farmer's livestock
2) A livestock owner leasing pasture land from a land-owner and managing his or her own livestock on that land
3) A farmer contracting with a grazier to manage the farmer's livestock on the farmer's own land or on another party's land

This factsheet addresses rates charged for contract grazing arrangements similar to the first situation: when a grazier is hired to manage someone else's livestock on the grazier's own land. There are two common ways to determine payment rates charged by the grazier: flat rates, or incentive pay.

Flat Rates

One of the most common strategies for determining payments for contract grazing is to charge a *flat rate* per animal per day. Rates charged per day vary over a range of prices. The tables shown below give examples of possible price ranges for a two-party contract grazing system (a livestock owner and a land-owner/grazier) for cattle grazed in Wisconsin and Southern Iowa as of Spring 2013 (tables 1 and 2, respectively). The values shown in the tables are meant only as ballpark figures. Actual rates charged are influenced by several factors, including:

- Estimated value of the land being grazed
- Level of labor and number of services provided by the grazier
- Type of cattle operation (dairy, cow-calf, yearling beef, etc)
- In-weights of the cattle
- Reputation of the grazier

Chief among the factors influencing the rate charged is the reputation of the grazier, and the relationship between the grazier and livestock owner. An experienced and knowledgeable grazier will command higher charges, because they are expected to show high performance (high weight gain, milk production, etc) with the cattle they are grazing. An experienced grazier with a good reputation is also expected to maintain this level of production given variability in climate and the pasture growing season (for example, they should be able to maintain high animal performance in all but the worst of droughts).

The receiving weights, or "in-weights", of cattle can also affect which end of the price range the charge will be; animals that are lower in weight may be at the lower end of the range, whereas heavy animals may be at the high end. As an example, a grazier with a good reputation may charge $1.15/head for developing replacement dairy heifers with an in-weight of 500-550lbs, but increase that rate to $1.50/head for heifers that have an in-weight of 650-700lbs. Fees charged for contract grazing cattle can also depend on the services to be provided by the grazier that are included in the contract. Many contracts assume the cattle owner will take on the cost of services such as veterinary care, liability insurance, and trucking to market. Those that expect the grazier to cover those costs are likely to see a grazing fee that is on the upper end or even higher than the rates estimates show in tables 1 and 2. Additionally, cattle raised as organic-certified may incur fee charges that are $0.25-0.50 higher than the highest values in the ranges given.

Incentive Pay

Contract grazing fees can also be scheduled as *incentive pay*, meaning that the payments are based on production of the animal. In such cases, a base grazing fee per head per day is established (such as those values shown in tables 1 and 2), but as goals—such as increased average daily gain or milk production—are met, an additional fee is paid on top of that base.

Another version of incentive pay for beef finishing operations is to not utilize the base fee, but rather split the price earned at market for that weight put on while under the care of the custom grazier.

Table 1: Expected price ranges for various contract grazing operations in Wisconsin. Prices reflect the amount that the livestock owner would pay to the grazier. (Note: rates are approximations for spring 2013.)

Livestock Class	Typical Price Range (cost per head per day)
Heifers	
Dairy	$1.00-1.60
Beef	$0.60-1.00
Pregnant cows	
Dairy	$1.50-2.00 +
Beef	$0.75-1.10

Table 2: Expected price ranges for various contract grazing beef cattle operations in south-central Iowa. These fees include labor and mineral provided by the grazier. Prices reflect the amount that the livestock owner would pay to the grazier. (Note: rates are estimations for spring 2013).

Livestock Class	**Typical Price Range** (cost per head per day)	**Average Cost** (per head per day**)**
Cows-calf pairs (beef)	$1.20-1.50	$1.35
Yearlings and developing heifers (beef)	$0.90-100	$0.95
Dry, pregnant cows (beef)	$0.90-1.10	$1.00

Other fact-sheets in this series include:

- The Basics of Contract Grazing
- Evaluating Land Suitability for Grazing
- Pasture and Lease Agreements

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Practices to Improve Water Quality

Leopold Center for Sustainable Agriculture

LEOPOLD CENTER

Here's a snapshot of on-the-ground practices that farmers and landowners can use to improve Iowa's water quality. The Leopold Center for Sustainable Agriculture supports research to learn more about these practices.

Prairie Strips

Remove pollutants from subsurface and overland flow. Research started in 2007 at the Neal Smith National Wildlife Refuge demonstrates the benefits of strategically placed native prairie buffer and filter strips in row-cropped fields. Sediment loss has been reduced by as much as 90 percent where 10 – 20 percent of the watershed is planted in prairie strips. Nitrate and phosphorus movement also have been substantially reduced in watersheds with prairie strips, both in runoff and in subsurface flow.

Learn more: **www.leopold.iastate.edu/STRIPs-research-team**

Riparian Buffers

Remove pollutants from subsurface and overland flow. Long-term research at Bear Creek has shown that diverse plantings, 60 to 80 feet wide, of trees, shrubs and grasses along streams can reduce sediment in surface runoff by 90 percent, and cut nitrogen and phosphorus in surface runoff by 80 percent. Nitrate in shallow groundwater also can be reduced by as much as 90 percent depending on site geology. Atrazine concentrations were found to be 70 percent lower in the rooting zone below the buffer.

Learn more: **www.leopold.iastate.edu/agroecology-research-team**

Saturated Buffers

Remove pollutants from tile drainage. Saturated buffers, unlike ordinary riparian buffers, capture and treat water from tile drainage. A shallow lateral line redirects flow from a main tile line into the buffer, where it percolates into the soil or gets taken up by vegetation. A 1,000-foot saturated buffer at Bear Creek removed 100 percent of the nitrate from 60 percent of the tile flow during its first year of operation. No data has been collected yet for phosphorus or pesticide removal. The demonstration buffer has an estimated lifespan of 20 years and treats water draining from 50 acres.

Learn more: **www.leopold.iastate.edu/grants/e2010-01**

Woodchip Bioreactors

Remove nitrate from tile drainage. A bioreactor works by rerouting tile drainage through a buried trench filled with woodchips, where naturally occurring denitrifying bacteria will convert nitrate to harmless nitrogen gas. Most bioreactors remove 15 - 80 percent of the nitrate load annually. They have an estimated lifespan of 15 - 20 years and treat water draining from 30 - 80 acres.

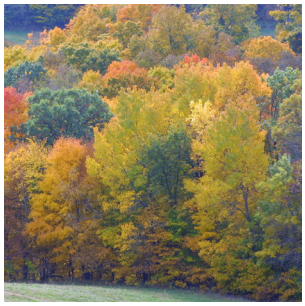
Learn more: **www.leopold.iastate.edu/grants/e2009-11**

Cover Crops

Remove nitrate from subsurface and overland flow. Cover crops like rye, oat, wheat and red clover accumulate nitrate and recycle it into the soil. Rye is the most studied in Iowa. It significantly reduces nitrogen losses at widely variable rates depending on field conditions, fertilization rates, weather conditions and when the cover crop was planted. Legumes such as red clover make atmospheric nitrogen available for subsequent crops, reducing the need to apply synthetic nitrogen fertilizer.

Learn more: **www.leopold.iastate.edu/iowa-cover-crops-working-group**

June 2012



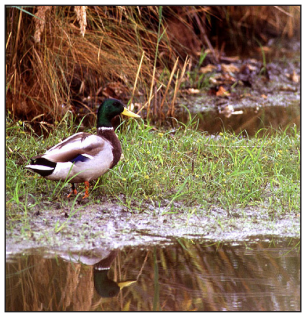


Photo credits: 4 - Laura Christianson, 6 - Iowa DNR, 7 - Scott Bauer/USDA, 8 - Anna MacDonald, 10 - Stefan Gailans

Forest Understories

Remove pollutants from subsurface and overland flow. This research looks at how forest understories capture nutrients and slow soil erosion to protect small headwater streams. The restoration or preservation of key spring-growing species has the potential to improve nutrient capture. Ongoing work investigates any differences between intact, healthy forest ecosystems and degraded ones.
Learn more: **www.leopold.iastate.edu/grants/e2011-05**

Wetlands

Remove pollutants from subsurface and overland flow and/or tile drainage. Wetlands are a proven and long-lasting practice for improving water quality. Research at Iowa State University has shown that wetlands can remove 40 to 90 percent of nitrates and over 70 percent of herbicides. Nitrate removal is variable depending on the volume of inflow and watershed size. Wetlands treat drainage from watersheds that are 500 to 4,000 acres, and can be designed to treat drainage from tile flow.
Learn more: **www.leopold.iastate.edu/grants/1995-48**

Rain Gardens

Remove pollutants from urban runoff. Rain gardens, shallow depressions filled with native plants, capture and filter pollutants from runoff by increasing soil filtration. Properly designed rain gardens can effectively trap and retain up to 99 percent of the common pollutants found in urban storm runoff. A special Leopold Center project installed two demonstration gardens in Ames and developed an outreach program to educate landowners about native landscaping.
Learn more: **www.leopold.iastate.edu/grants/esp2007-02**

Diverse Crop Rotations

Reduce inputs and transport of pollutants. Diverse crop rotations allow farmers to apply less synthetic fertilizer, herbicides and pesticides. A project at Iowa State University's Marsden Farm compares the conventional corn-soybean system with a three-year rotation (corn-soybean-small grain/red clover) and a four-year rotation (corn-soybean-small grain/alfalfa-alfalfa). The diverse rotations, which received composted cattle manure and clover and alfalfa residues, required 80 and 86 percent less synthetic nitrogen, respectively. After nine years, herbicide inputs were 7 to 10 times lower and herbicide-related freshwater toxicity 200 times lower. On average, corn yields were four percent greater, soybean yields nine percent greater, and net returns similar, compared to the conventional system.
Learn more: **www.leopold.iastate.edu/grants/e2010-02**

Reduce inputs and transport of pollutants. Another option for diverse crop rotations is adding a "third" annual crop to the conventional corn-soybean rotation.This project evaluates spring and winter varieties of canola as a potential third crop for Iowa. The canola is double-cropped with spring or winter varieties of wheat and interseeded with red clover. Because canola actively takes up nutrients and water during times of year when corn and soybean aren't growing, the three-year rotation has a smaller risk of runoff. Winter crops also interrupt the life cycles of summer annual weeds.
Learn more: **www.leopold.iastate.edu/grants/e2009-21**

Reduce nitrate loss. An on-farm project in western Iowa is looking specifically at reducing nitrate leaching into shallow groundwater with perennial crops and cover crops. The project tests five different rotations, ranging from continuous corn, to continuous grass, to various combinations of corn, soybean, oat, alfalfa and winter wheat. The cover crops used are red clover, oat or winter rye. Initial results show that perennial crops like alfalfa, with living root systems in the ground all year long, are the most effective way to reduce nitrate loss.
Learn more: **www.leopold.iastate.edu/grants/e2009-22**

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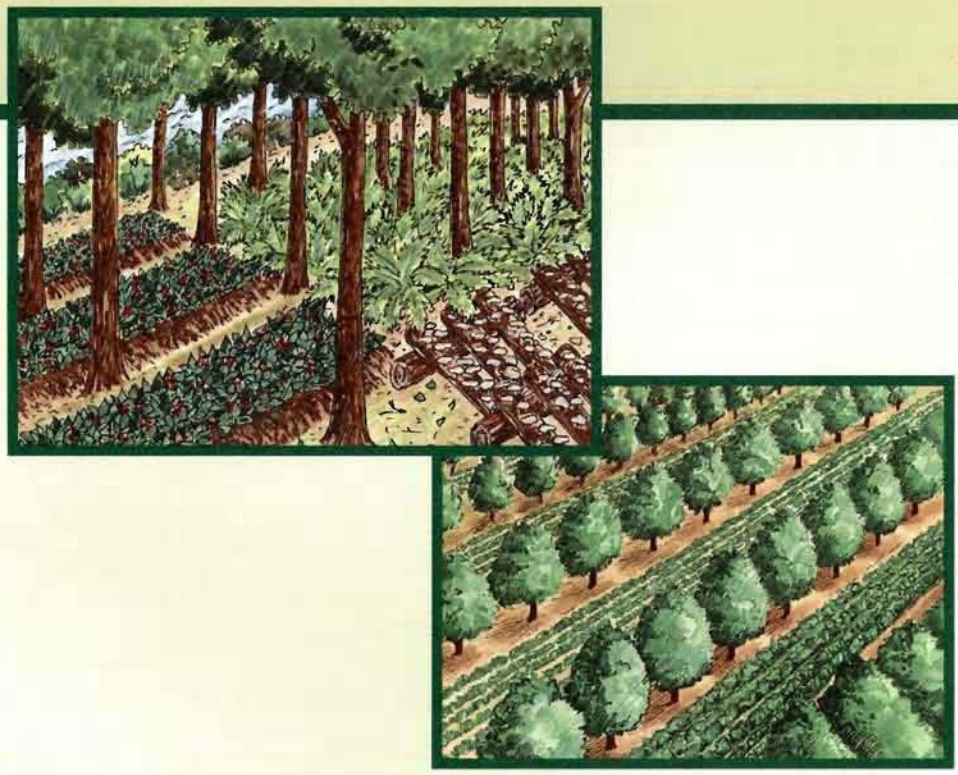
Discovering Profits in Unlikely Places:

Agroforestry Opportunities for Added Income



by Scott J. Josiah

Acknowledgments

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Searching for Profit Niches On Your Farm

Let's take an armchair tour of your land. Let your mind wander over the fields, woods, creeks, and ditches around the farm. Are any of these areas underutilized? Can field borders, center pivot irrigation corners, and other areas less suitable for row crops be planted to trees or shrubs which can provide income and improve conservation? This publication highlights opportunities for Midwestern farmers to introduce agroforestry practices on their farms, outlines some of the benefits associated with agroforestry, describes six different agroforestry practices, and provides a list of resources for additional information.

Let's start by taking a closer look at your land.

Does your farm have...

...unsheltered farmsteads and livestock areas, fencelines, roads, and degraded windbreaks?

Profit Opportunities:

Wood fiber, lumber, and specialty forest products

Agroforestry Practice: Multipurpose windbreak

Multiple row windbreaks can be used to produce marketable products like hybrid poplar, black walnut wood and nuts, hazelnuts, and woody floral products from shrubs (such as curly, pussy, and basket willows, and red-and yellow-stem dogwoods). Evergreens such as spruce, pine, and firs add color in winter, protect birds and other wildlife, can provide boughs for the seasonal floral industry, or can be sold as Christmas trees or landscaping stock.

Searching for Profit Niches On Your Farm

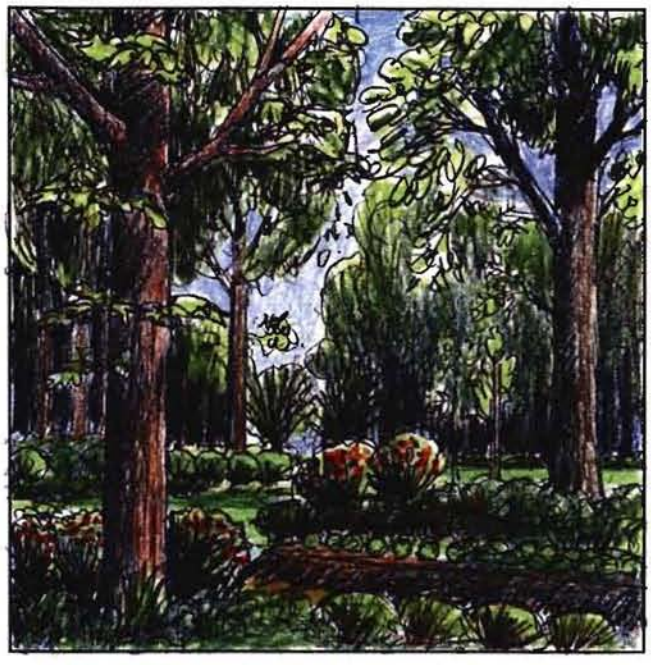
Does your farm have...
...neglected or grazed woodlots?

Profit Opportunities:

Timber and specialty forest products

Agroforestry Practice: Forest farming

Improved woodlot management can produce higher quality timber and firewood. Woodlots also can be managed to produce valuable specialty forest products like ginseng and other medicinal plants, which are grown under shade. While prices fluctuate considerably, high-quality, woods-cultivated ginseng roots can sell for $370/pound or more.[1] Producing seed of oak-savanna prairie plants in more open forests is also a potentially profitable option.

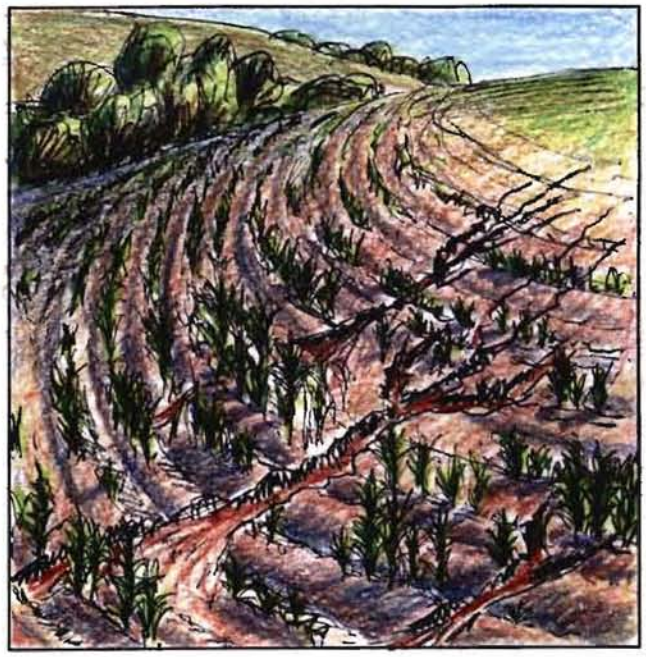


[1]Persons, W.S., "Growing American Ginseng in its Native Woodland Habitat," *Proceedings of the North American Conference on Enterprise Development through Agroforestry: Farming the Agroforest for Specialty Products, October 1998* (Center for Integrated Natural Resources and Agricultural Management, University of Minnesota. St. Paul, Minnesota).

Searching for Profit Niches On Your Farm

Does your farm have...

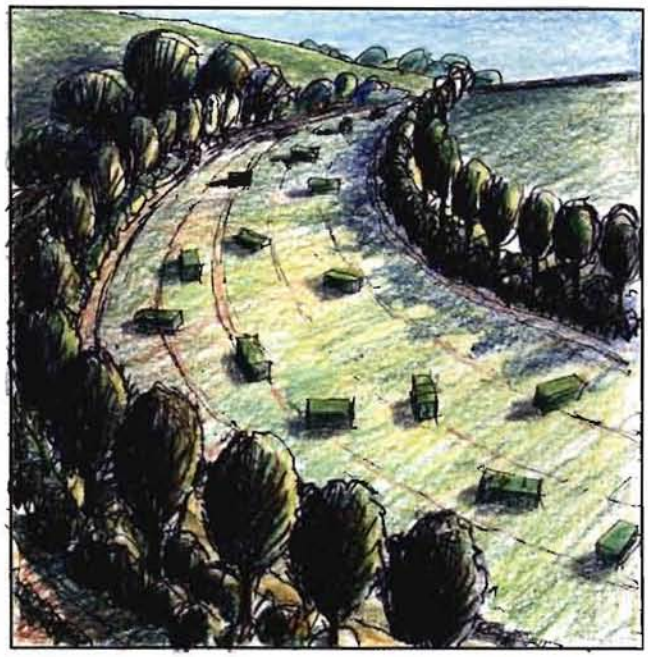
...marginally-productive upland fields?



Profit Opportunities:

Fruit and nut crops

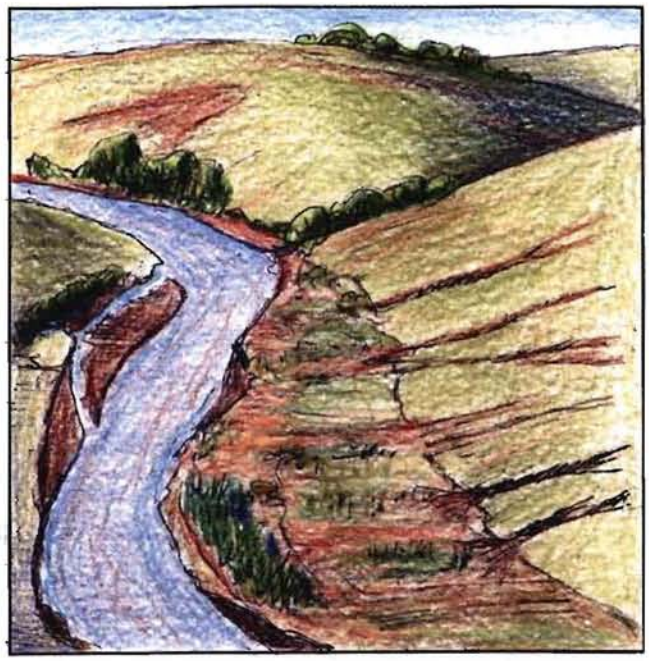
Agroforestry Practice: Alley cropping



Blueberries, chokecherries, highbush cranberries, sand cherries, elderberries, currants, gooseberries, and many others have great potential when marketed as locally-grown products, and with processors who produce high-end jams, preserves, and wines. In north central Minnesota, one producer has established alley cropping with chokecherries, highbush cranberries, and blueberries. The taller shrubs and trees redirect snow onto the blueberries, insulating them from winter weather. These shrubs and small trees can also be part of windbreaks, living snow fences and forested riparian buffers, producing products while protecting the land.

Searching for Profit Niches On Your Farm

Does your farm have...
...areas along streams?



Profit Opportunities:

High-value hardwoods and specialty forest products

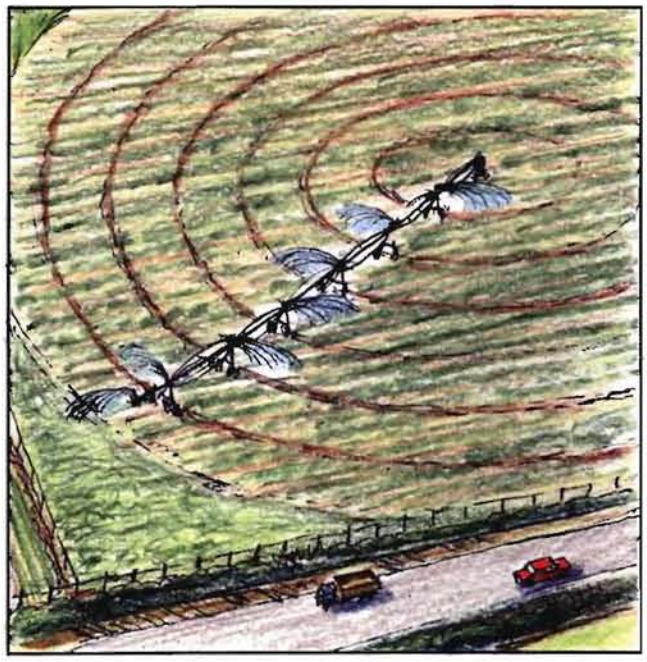
Agroforestry Practice:
Riparian forest buffer

A wooded riparian buffer strip along a stream can combine trees, shrubs, herbaceous plants, and grasses to produce a variety of products. These can include wood from high-value hardwood species such as walnut, oak, maple, and ash, plants used for medicinal and botanical purposes, food products (berries, nuts, and mushrooms), specialty woods, woody floral products, and prairie grass seeds. The buffer also protects the stream, particularly in upland areas, intercepting chemicals and nutrients from adjacent agricultural lands and improving water quality.

Searching for Profit Niches On Your Farm

Does your farm have...

...corners not reached by pivot irrigation, or inconvenient, out-of-the-way or small parcels?

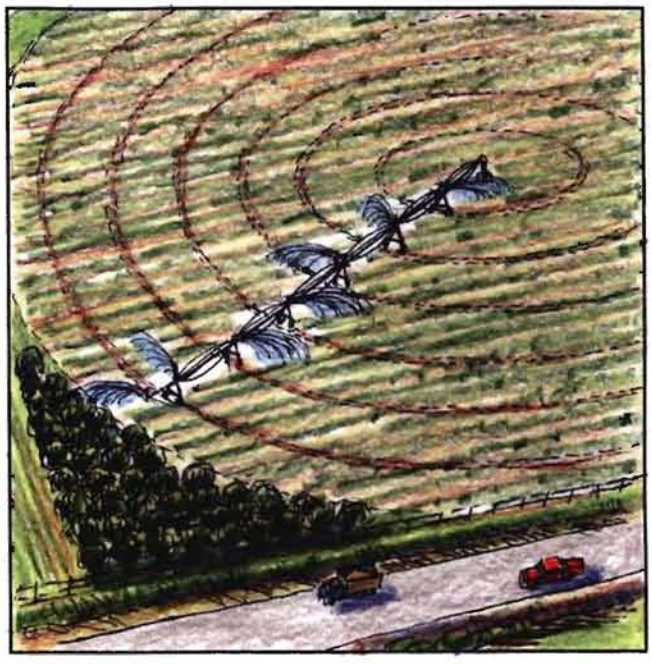


Profit Opportunities:

Hazelnuts, fruit, prairie seed

Agroforestry Practice: Woody crop plantation

Hybrid hazelnut, a new woody crop currently under development, shows good potential across the central and upper Midwest. Experimental plantings at Badgersett Research Farm in southeastern Minnesota suggest potential yields from clonally-produced selected lines of hazels ranging from 800 to 2,000 pounds per acre per year (dry pounds of whole nuts including shell) depending on spacing, variety, and weather.[2] As new cultivars are developed, higher yields may be possible. In 1998, the wholesale price for inshell hazelnuts was $0.49 per pound.[3]

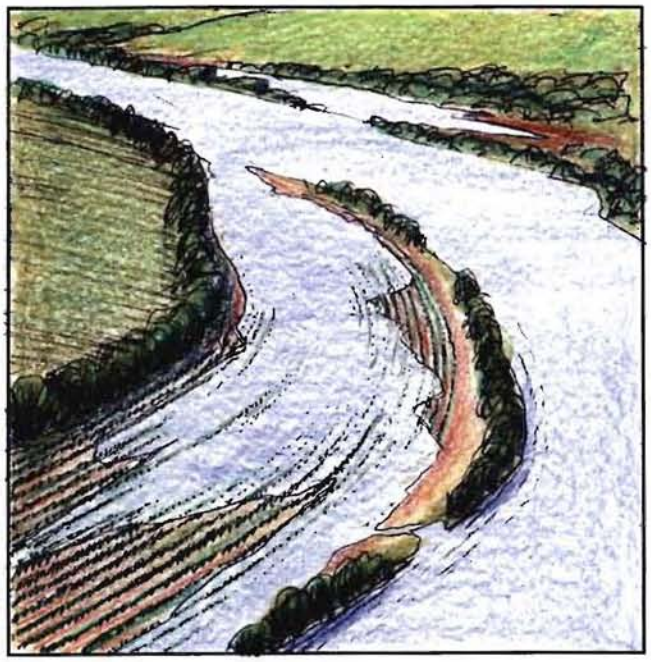


[2]Rutter, Phil., *Badgersett Research Farm,* July 1996, Personal communication. Canton, Minnesota.
[3]Crop Values, National Agricultural Statistics Service, Agricultural Statistics Board, USDA. Feb. 2000.

Searching for Profit Niches On Your Farm

Does your farm have...

...river bottomland fields where crops are frequently flooded?



Profit Opportunities:

Hybrid poplar or hybrid cottonwood wood fiber, or lumber

Agroforestry Practice: Woody crop plantation

On bottomland susceptible to flooding, a plantation of hybrid poplar or cottonwood may provide a more reliable crop over the years than corn or soybeans, whose yields can suffer from delayed planting or flooding. Fast growing trees like hybrid poplar or hybrid cottonwood can be harvested and sold for pulpwood and other wood products every 10 to 15 years in Minnesota. The market for hybrid poplar pulpwood is still developing, but it is expected to sell for prices similar to aspen (about $60/cord in 1997 delivered to the mill).[4] On average, most land can produce 30 to 40 cords/acre or more during a ten-year period.[5] Some forest product companies have advanced purchase or lease agreements that can provide annual payments before the trees are harvested. And because these plantings can attract wildlife, hunting leases are also a possible income source.

[4]"The Market Place Newsletter," Summer 1998, *Minnesota Department of Natural Resources Forestry Division*, St. Paul, Minnesota.
[5]Teynor, T.M., and Edberg, K.L. "Market Opportunities for Hybrid Poplar in Minnesota," March 1996, *Minnesota Department of Agriculture*, St. Paul, Minnesota.

Profits in Your Pocket: The Potential of Agroforestry

Agroforestry is an approach to land use that incorporates trees and shrubs into agricultural systems, and allows for the production of trees and crops and/or livestock from the same piece of land. It offers ways to take advantage of new and profitable product markets while at the same time improving your land and the environment.

Agroforestry Can Help Increase Farm Profitability

Matching woody crops to your own unique conditions offers several ways to increase farm profitability:

- **Increased total production from your land.** The total output per unit area of tree/crop/livestock combinations can be greater than any single component alone. The addition of forest products and specialty crops to your existing agricultural enterprises means more sources of income from your existing resource base. Wood, wildlife, specialty forest products, Christmas trees and products, landscape plants, herbs, nuts, seeds, fresh and dried fruit, and honey are just some of the many alternatives.

- **Greater financial diversity and flexibility.** More sources of income means greater financial diversity and flexibility of the farming enterprise, thus reducing risk.

- **Higher productivity of existing crops and livestock.** Plantings of trees and shrubs provide cover and protection from wind and sun, and can help manage soil moisture by trapping snow. This can mean higher crop values, increased crop yields, and better livestock production and survival.

- **Reduced costs.** Providing wind protection can also have money-saving results, such as reduced ditch cleaning and snow removal costs, lower farmstead heating and cooling bills, and reduced irrigation and energy costs.

Agroforestry Can Protect and Enhance Your Resources

Agroforestry practices combine economic production and environmental protection to a greater extent than can agriculture or forestry alone. Agroforestry can help conserve natural resources and create more pleasant places to live and work, through:

- **Improved air quality** with less blowing soil, dust, and odors, and reduced noise

- **Improved water quality** - vegetation acts as a natural filter and reduces streambank erosion, sediment, and chemical/nutrient inputs

- **Increased recreational and hunting opportunities** with improved game and non-game wildlife habitat

- **More diverse and visually-appealing landscapes.**

The combined increases in income and cost savings from agroforestry can make a big difference in a poor crop year and can be a financial bonus in a good one... all while enhancing your resources.

Agroforestry Practices for Profit

The following are descriptions of six agroforestry practices that can be used to produce income and conserve natural resources. All use trees, shrubs, grasses, and herbaceous plants to produce commercially valuable products, helping to improve your bottom line.

Windbreaks

- Windbreaks are agroforestry systems in which trees and/or shrubs are planted in widely spaced rows to minimize negative impacts from excessive wind.
- Field windbreaks are used to protect row crops and livestock from damaging wind and to control wind erosion.
- They can also function as living snow fences to disperse snow more evenly across cropland, increase soil moisture in dry areas, and prevent drifting over roads and driveways.
- Multiple row windbreaks of hybrid poplar or cottonwood (known as timberbelts), can protect crops from wind until mature trees can be harvested for wood products (10-15 years). Other fruit, nut or decorative floral-producing plants can be used in windbreaks to provide income.
- Farmstead and community shelterbelts protect homes from wind. They can help save household heating energy, manage snow drifts, provide products for use by the community, and create a more pleasant place to live.

Forest Farming

- Forest farming is producing specialty crops under a tree canopy.
- Forest farming can provide annual or periodic income either before, or as an alternative to, harvesting the trees for wood products.
- Potential understory crops are those that grow naturally under forest conditions or are adapted to shade, and that can be sold for medicinal, ornamental, handicraft, or culinary uses.
- Shade-tolerant crops such as ginseng, decorative ferns, goldenseal, black or blue cohosh, or shiitake mushrooms can be intensively cultivated under a forest cover that has been modified to provide the correct level of shade.

Alley Cropping

- This practice mixes trees, planted in single or grouped rows, with agricultural, horticultural, or forage crops that are cultivated in the wide alleys between tree rows.
- Alley cropping can be a way to convert marginal cropland to a high value woodland while continuing to earn income from annual crops during the early years of the project, or to protect sensitive crops such as vegetables and fruits from wind.
- Annual crops (row crops, forages, vegetables) cultivated between rows of trees provide extra income before nut or fruit trees bear or early in the long-term timber rotation.
- High-value hardwoods (oak, walnut, ash), fruit and nut trees, fast-growing trees (hybrid poplar and cottonwood), or fruit, nut, or floral producing shrubs are potential species for alley cropping.

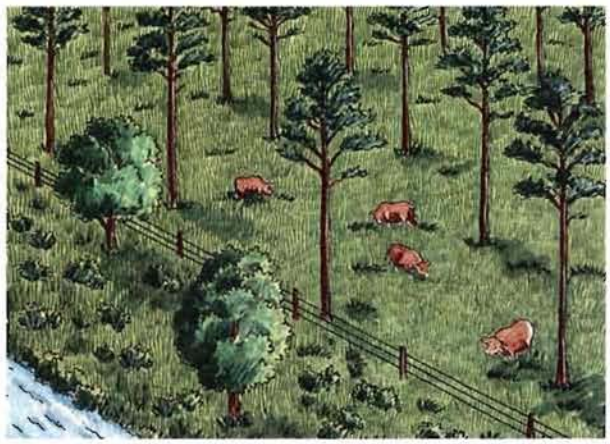
Riparian Forest Buffers

- Riparian buffers are strips of perennial vegetation (trees/shrubs/grass) planted between cropland or pastures and streams, lakes, wetlands, ponds, or drainage ditches.
- They reduce runoff and non-point source pollution from agricultural activities on adjacent lands by trapping sediment, filtering excess nutrients, and degrading pesticides.
- They can also stabilize streambanks, protect floodplains and enhance wildlife habitat. Buffer strips can be planted with trees, shrubs, grass and herbaceous plants that produce harvestable products such as pulpwood, fruits, nuts, seed, or floral products.

Woody Crop Plantations

- Woody crop plantations are larger areas of trees or shrubs often planted in a block.
- Plantations of woody crops can be added to the farm enterprise to increase income and biological diversity, and to help address special concerns such as disposal of animal wastes and filtering irrigation runoff (recycled from ditches).
- Plantings can be designed for conditions and needs of a specific piece of land.
- While woody crop plantations are not considered agroforestry in the traditional sense (because they do not provide tree/annual crop interactions), they can provide a mix of tree-based conservation and production benefits when used as part of a whole farm diversification strategy.
- Possibilities for woody crop plantations include short rotation woody crops, nut and fruit groves, and Christmas trees.

Silvopasture



- This practice combines trees with forage (pasture or hay) and livestock production.
- The overstory trees provide shade and wind shelter for grazing livestock, and yield additional income when the trees or tree products are harvested.
- Silvopasture is different from traditional forest or pasture/range management systems because it is intentionally created and intensively managed.
- Branches and leaves of some trees can be pruned from the trees and fed directly to livestock.
- Some nut and fruit orchards may be carefully grazed to produce income before and while trees are bearing.

Trees, Shrubs, and Herbs used in Agroforestry Practices

The following is a short list of tree, shrub, and herbaceous plant species that produce valuable products and that can be used in agroforestry systems. This list is far from complete, but it will give you an idea of the wide range of plant species appropriate for the Midwest and Eastern Great Plains. We know that some species work better than others in particular agroforestry practices, but there is still a lot to learn about how to best use and combine species for maximum benefit. Each species or cultivar has specific climate zones and growing conditions where it will do best. You will want to investigate the suitability of the species you are interested in for your farm's climate and particular conditions.

Fast Growing Trees	
Eastern Cottonwood *(Populus deltoides)* **Hybrid Poplar** *(Populus hybrids)* **Hybrid Willow** *(Salix hybrids)*	**Products:** Wood fiber for pulp and oriented strand board (OSB), lumber production, biomass for energy
High Value Hardwoods	
Basswood *(Tilia americana)* **Black Walnut** *(Juglans nigra)* **Butternut** *(Juglans cinerea)* **Green Ash** *(Fraxinus pennsylvanica)* **Maples: Red, Sugar** *(Acer rubrum, Acer saccharum)* **Oaks: Bur, Red and White** *(Quercus macrocarpa Quercus rubra, Quercus alba)* **Russian-olive** *(Elaeagnus angustifolia)* **Smooth Sumac** *(Rhus glabra)*	**Products:** High value lumber, pulpwood, fuelwood and biomass, specialty wood products for artisans
High Value Conifers (Softwoods)	
Black Hills Spruce *(Picea glauca* var. *densata)* **Colorado (Blue) Spruce** *(Picea pungens)* **White Spruce** *(Picea glauca)* **Douglas Fir** *(Pseudotsuga menziesii)* "Glauca" **Eastern Red Cedar** *(Juniperus virginia)* **Limber Pine** *(Pinus flexilis)* **Rocky Mountain Juniper** *(Juniperus scopulorum)* **Pine, Austrian** *(Pinus nigra)* **Pine, Ponderosa** *(Pinus ponderosa)* **Pine, Red** *(Pinus resinosa)* **Pine, Scotch** *(Pinus sylvestris)* **Pine, White** *(Pinus strobus)* **Balsam Fir** *(Abies balsamea)* **Concolor Fir** *(Abies concolor)*	**Products:** Fence posts, specialty wood products for use by artisans, furniture, distilled oils, lumber, Christmas trees, alcohol products, edible pine nuts
Nut Trees and Shrubs	
Black Walnut *(Juglans nigra)* **Butternut or White Walnut** *(Juglans cinerea)* **Hybrid Chestnut** *(Castanea hybrids)* **Chinese Chestnut** *(Castanea mollissima)* **Hybrid Hazelnut** *(Corylus americana hybrids)* **Northern Pecan** *(Carya illinoensis)*	**Products:** Nut meat and shell products

Fruit Trees & Shrubs

American Cranberrybush or Highbush Cranberry *(Viburnum trilobum)* "Wentworth," "Redwing," **American (wild) Plum** *(Prunus americana)* **Black or Clove Currant** *(Ribes odoratum)* many cultivars **White Currant** *(Ribes sativum)* many cultivars **Red Currant** *(Ribes rubrum)* many cultivars **Chokecherry** *(Prunus virginiana)* "Boughens Yellow," "Boughens Chokeless," "Garrington," "Goertz," "Robert," "Lee Red" **Crab Apple** *(Malus* species*)* **Elderberry or American Elder** *(Sambucus canadensis)* "Adams," "York" **Gooseberry** *(Ribes uva-crispa, Ribes hirtellum)* "Pixwell," "Welcome" **Hawthorn** *(Crataegus* species*)* **Juneberry or Saskatoon** *(Amelanchier alnifolia)* "Pembina," "Honeywood," "Northline," "Smokey," "Regent," "Martin," "Thiessen" **Nanking Cherry** *(Prunus tomentosa)* **Pawpaw** *(Asimina triloba)* many cultivars **Red Mulberry** *(Morus rubra)* "Johnson," "Travis," "Wiseman," "Cooke" **Western Sand Cherry** *(Prunus besseyi)* "Black Beauty," "Hansen's" **White Mulberry** *(Morus alba)* "New American," "Wellington"	**Products:** Berries and fruits for jellies, jams, syrups, pies, and other food products

Woody Decorative Floral Shrubs

Cherries, Apples, Plums *(Malus and Prunus)* **Basket Willow** *(Salix purpurea)* **Corkscrew Willow** *(Salix matsudana hybrids)* "Tortuosa," "Golden Curls," "Scarlet Curls" **Goat or Pussy Willow** *(Salix caprea* or *Salix discolor)* several cultivars **Holly** *(Ilex opaca)* "Winter Red" **Red Stemmed Dogwoods** *(Cornus sericea)* "Cardinal," "Bailey" *(Cornus coloradensis)* "Cheyenne" *(Cornus sanguinea var. atrosanguinea)* "Bloodtwig"	**Products:** Woody decorative floral products

Herbs

Black Cohosh *(Cimicifuga racemosa)* **Blue Cohosh** *(Caulophyllum thalictroides)* **Dandelion** (root) *(Taraxacum officinale)* **Ginseng** *(Panex quinquefolius)* **Goldenseal** *(Hydrastis canadensis)*	**Products:** Medicinal products, health foods and many others

Getting Started in Agroforestry

1. **Identify places on your land where trees and woody crops can be planted.**
   Think about how each practice described might fit into your overall farming operation, which species might work, and whether the production requirements are appropriate for your climate zone.

2. **Visit and learn from farmers using agroforestry techniques.**
   To help locate farmers, see #5.

3. **Learn about the costs, benefits, markets and production requirements of each species and/or cultivar you are considering using (seedlings, equipment, establishment and maintenance concerns, etc.).**
   Before implementing any of the practices outlined in this publication, investigate the markets that are available to you, keeping in mind geographical location and prices. Remember that income from agroforestry depends on the availability of markets for the products it yields, and on your ability to identify and meet market needs. *No one makes money from growing trees—they make money from selling them.*

4. **Visit your local Soil and Water Conservation District, University of Minnesota Extension Service, or Natural Resources Conservation Service office** for information on the species that are best suited for your land, and to learn about agroforestry cost-share and technical assistance programs, such as the:

   Conservation Reserve Program (CRP)
   Land enrolled in CRP and planted with windbreaks or riparian forest buffers can receive up to 90% cost-share for establishment, sign-up bonus plus maintenance payments, and earn a 20% bonus on annual land rental payments.

   The Forestry Incentive Program (FIP) and Environmental Quality Incentives Program (EQIP) are other programs that support agroforestry efforts.

5. **See *Agroforestry in Minnesota: A Guide to Resources and Demonstration Sites,* a statewide directory of resources for people interested in learning more about agroforestry.**
   This directory provides a comprehensive list of agroforestry resources in Minnesota. It includes demonstration sites (listed by agroforestry practice), individuals with agroforestry knowledge to share, organizations, nurseries that supply planting stock, and agroforestry-related publications. You can find the directory at your local Extension, Soil and Water Conservation District, Natural Resources Conservation Service, or Department of Natural Resources office. Or, you can order your own copy from the University of Minnesota Extension Service Distribution Center. See the Additional Resources section for order information.

Additional Resources

Organizations

Appropriate Technology Transfer for Rural Areas (ATTRA). P.O. Box 3657, Fayetteville, AR 72702. 800-346-9140, Fax 501-442-9842 www.attra.org

Association for Temperate Agroforestry (AFTA). 203 ABNR Bldg., University of Missouri, Columbia, MO 65211. http://web.missouri.edu/~afta/

Center for Integrated Natural Resource and Agricultural Management (CINRAM). 115 Green Hall, 1530 N. Cleveland Ave., St. Paul, MN 55108-1027. 612-624-4296, Fax 612-625-5212 www.cnr.umn.edu/FR/cinram

Minnesota Institute for Sustainable Agriculture (MISA). 411 Borlaug Hall, 1991 Buford Circle, St. Paul, MN 55108-1013. 612-625-8235 or 800-909-MISA, Fax 612-625-1268 misamail@umn.edu, www.misa.umn.edu

Native Fruit Development Program. Dr. Richard St-Pierre, Department of Plant Sciences, University of Saskatchewan, 51 Campus Drive, Saskatoon, Saskatchewan, CANADA, S7N 5A8. www.ag.usask.ca/departments/plsc/nfdp/index.html

USDA National Agroforestry Center (NAC). East Campus, UNL, Lincoln, NE 68583-0822 402-437-5178. Fax 402-437-5178 nhammond@fs.fed.us, www.unl.edu/nac

Publications

The following publications are from CINRAM and the University of Minnesota Extension Service, and can by ordered by calling 800-876-8636. They can also be ordered or viewed in full text on CINRAM's web site.

Agroforestry in Minnesota: A Guide to Resources and Demonstration Sites. S. Josiah, L. Gordon, E. Streed, J. Joannides. 1999. BU-7275. Provides a detailed look at agroforestry practices around the state and lists demonstration sites for a variety of practices.

Catching the Snow with Living Snow Fences. 1999. MI-7311. A comprehensive national award winning technical resource about living snow fences, produced by Minnesota's Interagency Task Force on Living Snow Fences.

Commercial Hazelnuts in Minnesota. S. Josiah. 1998. FO-7280. A summary of the potential to produce hybrid hazels in the Midwest. Provides a review of planting and maintenance information.

Hybrid Poplar Profits. E. Streed. 1998. FO-7279. Detailed information on the financial aspects of growing hybrid poplar as a crop in Minnesota.

Living Snow Fences. S. Josiah, M. Majeski. 1999. FO-7277. Discusses the benefits and the technical aspects of establishing living snow fences.

Marketing Specialty Forest Products. C. Vollmers, E. Streed. 1999. FO-7278. Discusses products that can be grown in a forest farming system, the role of value added processing, and recommendations for marketing plans.

The following publications are available directly from CINRAM (see Organizations for contact information).

Agroforestry Advantage Newsletter. Free quarterly newsletter. (Subscribe/view on web site).

Growing Trees as a Crop. Spring, 1999. Agroforestry Advantage Newsletter, Vol. 2 No. 1. Presents the "how to" of growing hybrid poplar. (Available on web site).

Proceedings from the 1998 Specialty Forest Products/Forest Farming Conference. A complete collection of papers presented at the 1998 conference held in Minneapolis, MN. A terrific source of up-to-date research information on specialty forest products (medicinals, foods, decorative florals, handicrafts. (Table of Contents available on CINRAM's web site).

The following publications can be obtained from the USDA National Agroforestry Center (NAC) (see Organizations for contact information). The publications are also available in full text on their web page.

NAC Brochures:

Working Trees for Agriculture. Undated. Explains rural agroforestry practices and benefits.

Working Trees for Carbon Cycle Balance. Undated. Using trees and shrubs to produce social, economic, and conservation benefits.

Working Trees for Communities. Undated. The application of agroforestry technologies in community conservation.

Working Trees for Livestock. Undated. The application of agroforestry technologies for livestock protection and silvopasture operations.

Working Trees for Wildlife. Undated. The application of agroforestry technologies designed specifically for wildlife habitat.

Working Trees for Treating Waste. A natural alternative for using nutrients from livestock and farm operations, municipalities, and industries.

NAC Agroforestry Notes:

These brochures provide agroforestry information in a useful "how-to" format:

Agroforestry in the United States. B. Rietveld, K.Irwin. 1996. AF Note-1.

Alley Cropping: An Agroforestry Practice. S. Hodge, H. Garrett, J. Bratton. 1999. AF Note-12.

American Ginseng Production in Woodlots. R. Beyfuss. 1999. AF Note-14.

The Biology of Silvopasturalism. S. Sharrow. 1997. AF Note-9.

Economics and Marketing of Ginseng. R. Beyfuss. 1999. AF Note-15.

Establishment and Cultural Guidelines for Using Hybrid Tree Species in Agroforestry Plantings. G. Kuhn, W. Rietveld, D. Riemenschneider. 1998. AF Note-11.

Farming Exotic Mushrooms in the Forest. D. Hill. 1999. AF Note-13.

Forest Farming: An Agroforestry Practice. M. Dix, D. Hill, L. Buck, W. Rietveld. 1997. AF Note-7.

Forest Production of Goldenseal. J. Davis. 1999. AF Note-16.

From Pine Forest to a Silvopasture System. T. Clason, J. Robinson. 2000. AF Note-18.

Guide to a Successful Agroforestry Demonstration Project. K. Irwin. 1997. AF Note-6.

How to Design a Riparian Buffer for Agricultural Land. M. Dosskey, D. Schultz, T. Isenhart. 1997. AF Note-4.

Opportunities for Growing Short-Rotation Woody Crops in Agroforestry Practices. G. Kuhn, W. Rietveld. 1998. AF Note-10.

Outdoor Living Barn: A Specialized Windbreak. K. Irwin, J. Bratton. 1996. AF Note-2.

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Riparian Buffers for an Agricultural Land. M. Dosskey, D. Schultz, T. Isenhart. 1997. AF Note-3.

Silvopasture: An Agroforestry Practice. N. Klopfenstein, W. Rietveld, R. Carman, T. Clason, S. Sharrow, G. Garrett, B. Anderson. 1997. AF Note-8.

Wastewater Management Using Hybrid Poplar. G. Kuhn, J. Nuss. 2000. AF Note-17.

Waterbreaks: Managed Trees for the Floodplain. D. Wallace, W. Geyer, J. Dwyer. 2000. AF Note-19.

The following materials can be obtained from ATTRA (see organizations for contact information). The publications are available in full text on their web page.

Agroforestry Overview. A. Beetz. 1999.

Black Walnut Agroforestry. A. Beetz. 1999. ATTRA. Not available on web site—call 800 number for copy.

Ginseng, Goldenseal & Other Native Roots. K. Adams. 1998.

Mushroom Cultivation & Marketing. A. Beetz, L. Greer. 1997.

The following materials can be found at your local library or can be ordered or accessed from their respective sources

Badgersett Research Farm Web Site. Phil Rutter. RR 1, Box 141, Canton MN 55922, 507-743-8570, www.badgersett.com

Conservation Trees for Your Farm, Family, and Future. Undated. National Arbor Day Foundation. Nebraska City, NE.

Forest Farming: Towards a Solution to Problems of World Hunger and Conservation. 1984. J. Sholto Douglas and Robert A de J. Hart. 207 pages. Intermediary Technology Publications. 103-105 Southampton Row, London WC1B4HH, United Kingdom.

Growing Hybrid Poplars as a Crop. Agricultural Utilization Research Institution (AURI). 2000. www.auri.org/poplars/poplars.htm. Information on hybrid poplar production and contacts for more information and sources of nursery stock. Ed Wene; Agricultural Utilization Research Institute, PO Box 599, Owen Hall Annex, University of Minnesota-Crookston, Crookston, MN 56716, ewene@auri.org. 218-281-9014. Fax: 218-281-3759.

Heavenly Hazelnuts. Craig Cramer. Feb. 1994. The New Farm. Rodale Institute. Emmaus, Pennsylvania. pp. 36-39. Check your local library or contact the MISA office to borrow a copy.

Income Opportunities in Special Forest Products: Self-Help Suggestions for Rural Entrepreneurs. USDA Forest Service, Agricultural Information Bulletin 666, May 1993. USFS, Washington, DC.

Minnesota-Grown Opportunities: Hybrid Poplar. E. Streed. 2000. Center for Alternative Plant and Animal Products (CAPAP-U of MN). 352 Alderman Hall, St. Paul, MN 55108.

Minnesota-Grown Opportunities: Hazel. S. Josiah & E. Streed. 2000. Center for Alternative Plant and Animal Products (CAPAP-U of MN). 352 Alderman Hall, St. Paul, MN 55108.

Permaculture: A Practical Guide to a Sustainable Future. B. Mollison. 1997. Ten Speed Press, Berkeley, CA.

Tree Crops: A Permanent Agriculture. R.J. Smith. 1950. Island Press, Washington, DC.

Windbreak Technology: Economics of Windbreaks. 1997. Natural Resources Conservation Service, USDA. Suite 600, 375 Jackson Street, St. Paul, MN 55101. 651-602-7900.

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Energy and Economic Returns by Crop Rotation*

With rising energy costs, input costs and variable grain prices, adjusting crop rotations could be profitable for some farm operations. Using research from the ISU Extension and Outreach Marsden Research Farm, the rotational effects on energy usage and economic returns were compared by two, three and four-year rotations. The two-year rotation included GMO corn and soybeans (C-Sb); the three and four-year rotations included non-GMO corn, soybeans and oats, and added a fourth year alfalfa crop in the four-year rotation. (C-Sb-O and C-SB-O/A-A). The energy analysis focuses on uses of energy that have a price associated with them. To successfully compare across rotations, a line was drawn to keep energy use contained to producing the crop. It does not take into account solar energy or energy consumption outside the "farm gate." Storage, hauling and handling past initial removal of the crop are not considered. These have an impact on overall energy usage and economic returns but can vary widely and would not make equal comparisons across the three rotations.

This study looks at the period from 2006-2011. A previous study by Cruse, Liebman, Raman and Wiedenhoeft takes a similar approach for 2003-2008. One major change was a switch from triticale to oats for the small-grain rotation. Figure 1 shows average yields for corn and soybeans for the three rotations. Yield gains were present for the three and four-year rotations that can be associated with the agronomic benefits of crop rotations and management practices used.

Energy Study

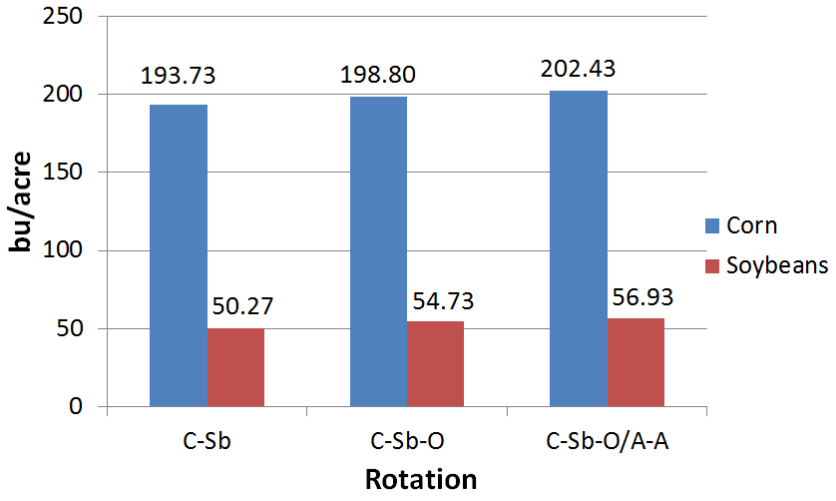
Energy use was split into five categories. Within each category, the BTU/units were applied to the actual inputs and field operations from the research farm field notes. The five categories included: seed, grain drying, field operations, pesticides and fertilizer.

There is limited information on the energy production of seeds for clover, oats and alfalfa. Previous research (Shapouri, Cruse) uses one factor for corn seed production and another for all other seeds. A similar method was used in this study as well. Factors used were 6,320 BTU/lb for corn and 1,333 BTU/lb for other seeds.

Field operations were categorized into preharvest and harvest operations, including hauling grain.

This study looks at the energy usage for grain drying in a category of its own to show the high energy requirements that drying can capture. The average reduction in moisture was 3.9 percent across the span of the study. This was multiplied by the factor of 1,620 BTU/point/bushel dried, giving a total of 6,320 BTU per bushel. This was then applied to the average yield for each rotation.

Figure 1. Average Yields by Crop and Rotation, 2006-2011



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Fuel usage for every field operation came from the publication, "Fuel Required by Field Operation," (www.extension.iastate.edu/agdm/crops/pdf/a3-27.pdf). For operations not specifically listed, the closest equivalent was used as a substitute. The energy values and sources are listed in Table 1.

Table 1. Energy Values Used

Input	Energy Value	Units	Source
Seed – Corn	6,320	BTU/lb	Grabowski
All other seed	1,333	BTU/lb	Sheehan
N	24,500	BTU/lb	Shapouri et al. (2004)
P	4,000	BTU/lb	Shapouri et al. (2004)
K	3,000	BTU/lb	Shapouri et al. (2004)
Herbicides	101,034	BTU/lb	Bhat et al.
Insecticides	113,932	BTU/lb	Bhat et al.
Grain Drying	6,320	BTU/bu	Grabowski
Diesel	138,690	BTU/gallon	EIA

Fertilizer applied was averaged across all years to give a long-term picture of energy use. Application, based on need, varied year to year. Amounts used were taken from the provided field notes. Though minor, nitrogen as an adjuvant was included in the fertilizer category.

The energy usage of herbicide and insecticide applications were based on active ingredients in the amounts applied. On the three and four-year rotations, application was done by banding, thus reducing the overall rates.

Results

The rotational results were similar to previous studies (Cruse, et. al), though at a slightly lower rate. This can be attributed to several adjustments done in the later years of the study, including reduced fertilizer application and improved pesticide efficiencies, both in the product and method of application. Another change was the switch to oats from triticale.

Figure 2 shows average energy inputs over the six-year period, with the two-year rotation clearly demanding the most energy. From 2006-2011, the three-year rotation showed the least amount of energy usage based on the parameters of the study. Figure 3 illustrates in more detail where energy is expended. The highest category for energy usage was fertilizer for the two-year rotation, whereas the three and four-year rotations show the most energy usage in field operations. Table 2 illustrates the details of percent of energy usage by category as indicated in Figures 2 and 3. In the two-year rotation, just over 60 percent of energy expenditures came from fertilizer. In the three and four-year rotations, the leading category of field operations carried 44 and 47 percent, respectively, of the energy demands.

Figure 2. Average Energy Inputs by Rotation, 2006-2011

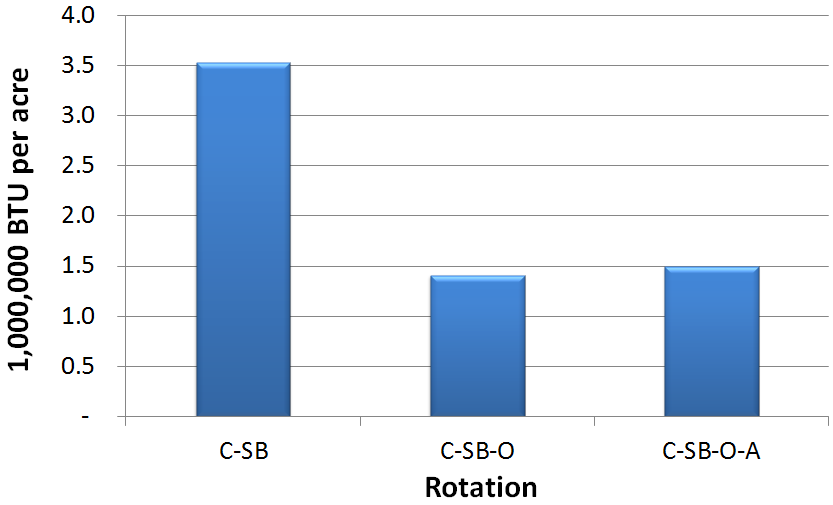
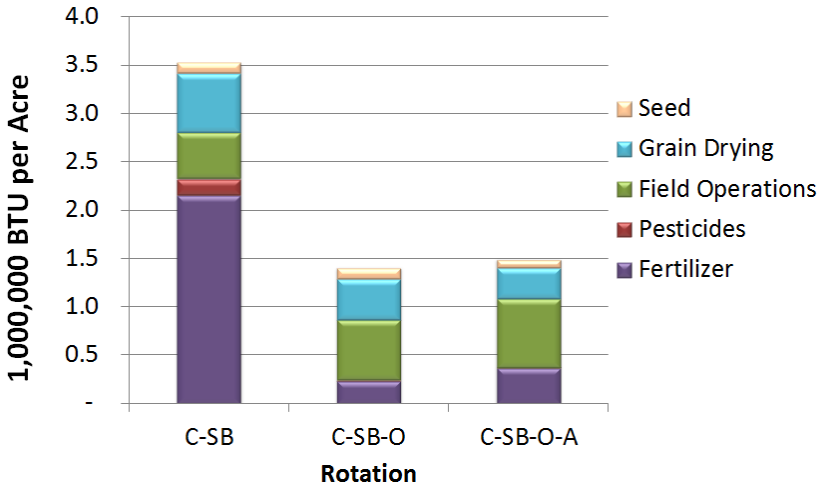


Figure 3. Distribution of Energy Inputs by Selected Energy Categories, 2006-2011



Energy use was looked at by crop as well as by rotation. In Figure 4, the two-year corn crop leads as the most energy demanding, much higher than any other crop. The two-year corn crop utilized more than twice the energy of any other crop at 5.83 million BTU, primarily due to increased herbicide and fertilizer usage. Table 3 shows the three and four-year corn rotations come fairly close to one another at 2.45 and 2.63 million BTU each. The reason for the difference in those rotations can mostly be attributed to the drying costs associated with the slightly higher corn yields in the four-year rotation.

Table 2. Percent of Energy Use by Category

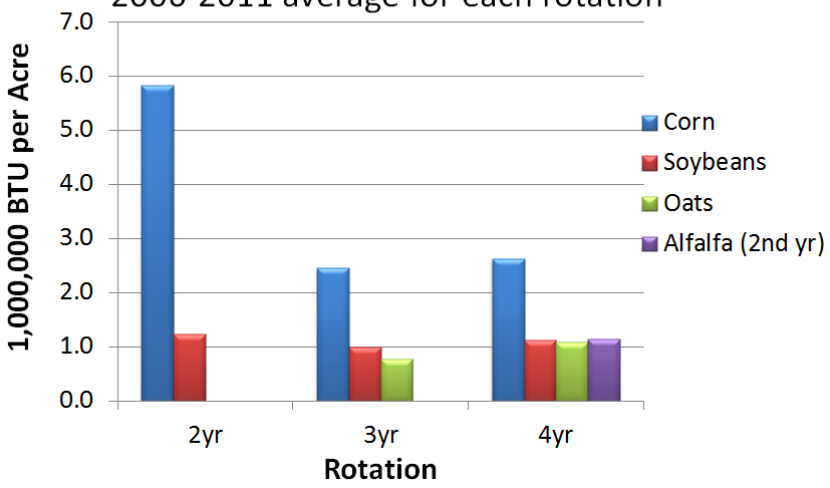
	GMO	Non-GMO	
	C-SB	C-SB-O	C-SB-O-A
Seed	3%	8%	6%
Grain Drying	17%	30%	21%
Field Operations	14%	44%	47%
Pesticides	5%	1%	1%
Fertilizer	61%	17%	25%

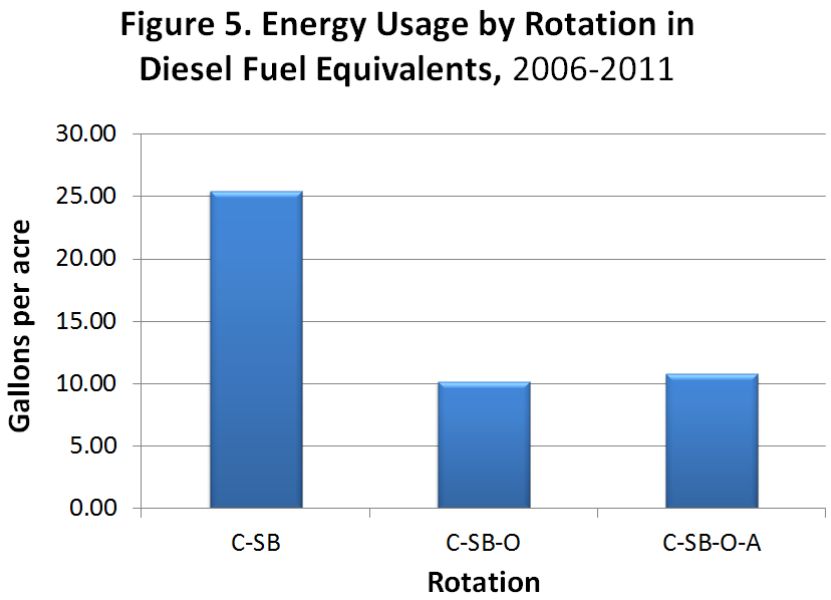
Table 3. Total BTU by Crop

	2yr	3yr	4yr
Corn	5.83	2.45	2.63
Soybeans	1.23	1.00	1.13
Oats		0.77	1.09
Alfalfa (2nd yr)			1.14
Total Average BTU by Rotation	3.53	1.41	1.50

Figure 4. Energy Input per Crop for Individual Rotations

2006-2011 average for each rotation





Another way to look at energy usage is in diesel fuel equivalents. This is shown in Figure 5. Diesel fuel equivalents were found by taking the total BTU/rotation divided by the BTU/gallon of diesel fuel. This represents the energy consumption in an easily recognizable form, even though not all energy usage was associated with diesel fuel. The two-year rotation uses the equivalent of 25.43 gallons of diesel fuel per acre. The three and four-year rotations are both just over 10 gallons per acre.

Economic Returns

Along with energy usage, this study also compares economic returns for the three rotations. Using data from the annual publication for estimated costs of crop production for that year, the costs for production were applied to the various cost components (Duffy, et. al). Herbicide and Insecticide prices were taken from annual reports from North Dakota State University and the University of Nebraska. Annual grain prices came from the USDA National Ag Statistics Services, Iowa office. No government payments or other income were included in the study. With differences in field operations, fertilizer, and reduced pesticides, the three and four year rotations have the ability to compete with the two-year rotation in profitability as well as energy requirements.

Energy Usage by Rotation in Diesel Fuel Equivalents

	2yr	3yr	4yr
Diesel Fuel Equivalents (gal/acre)	25.43	10.16	10.80

Figure 6 shows the average return to management by crop and rotation. Figure 7 shows the average returns for the three rotations to land, labor and management, land and management, and management. The first of these categories shows the returns if the costs for land, labor and management are not included. The second takes into account the cost for labor, and the last includes all costs; what remains are the returns to management. Rotational effects of increased yields and lower input costs for the non-GMO crops make the three-year rotation result in the highest returns for this study. Table 4 gives a detailed summary of the cost and returns by crop and rotation and shows the three-year rotation having an average Return to Management of $194.03; the two-year and four-year rotations have positive returns of $187.92 and $170.97, respectively.

Figure 6. Average Return to Management by Crop and Rotation, 2006-2011

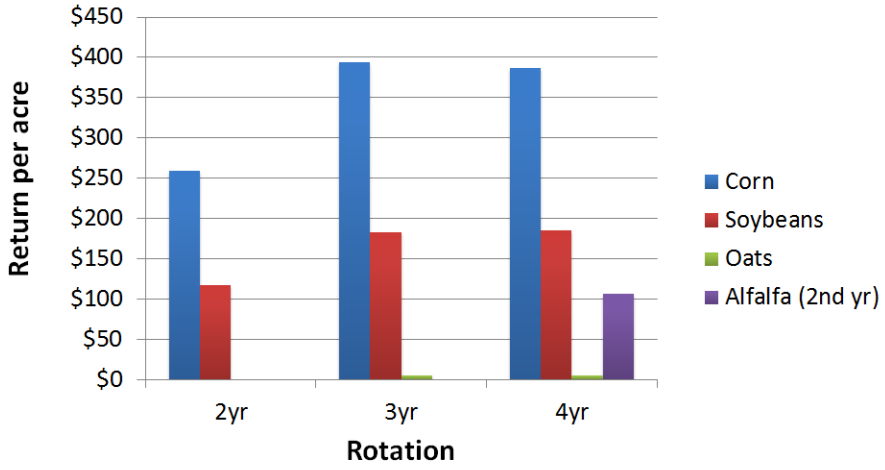


Figure 7. Average Returns to Land, Labor, and Management by Crop Rotation 2006-2011

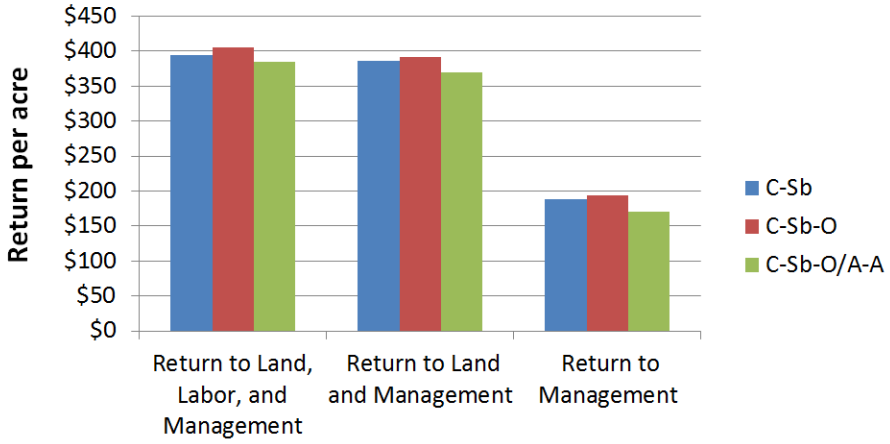


Table 4. Revenue and Returns by Crop and Rotation

	Yields	Prices	Gross Revenue	Production Cost	Return LL&M	Return L&M	Return Mgmt
C-Sb							
Corn	193.73	$4.35	$841.60	$377.27	$464.33	$457.25	$259.09
Soybeans	50.27	9.95	503.82	180.76	323.06	314.92	116.75
					$393.70	$386.08	$187.92
C-Sb-O							
Corn	198.80	$4.35	$865.19	$255.22	$609.97	$592.73	$394.57
Soybeans	54.73	9.95	549.31	158.01	392.00	380.72	182.56
Oats	97.92	2.69	256.35	129.54	212.04	203.13	4.97
Oat Straw	1.07	79.17	85.23				
					$404.67	$392.20	$194.03
C-Sb-O/A-A							
Corn	202.43	$4.35	$878.09	$275.72	$602.37	$584.75	$386.59
Soybeans	56.93	9.95	571.12	175.97	395.15	383.91	185.74
Oats	101.58	2.69	267.15	215.37	218.05	203.72	5.55
Oat Straw	1.00	79.17	79.74				
Alfalfa (1st yr)	0.74	119.47	86.52				
Alfalfa (2nd yr)	3.97	119.47	470.21	145.08	325.13	304.16	106.00
					$385.17	$369.14	$170.97

Nutrient Pricing

A portion of the cost savings in the three and four-year rotations was due to applying manure from an available livestock operation to all corn acres in the rotation. In the initial study, the only cost associated with the manure is the cost to apply. Another way to phrase this is that manure was viewed as a "waste product" that needs to be disposed of in a feasible manner.

Another second method was also applied to see how it would affect the profitability of the rotations. This involved valuing the manure based on its nutrient value. The concept behind this method was to show the cost that would have occurred had an equivalent amount of fertilizer been purchased commercially.

Manure was analyzed each year for nutrient content and these rates were used along with the cost that would have been assessed had those nutrients been purchased. Nutrient prices used were from the ISU publication for Estimated Costs of Crop Production. A third option in comparing the rotations might be to put a flat rate per ton or load on the manure rather than breaking the cost down for each nutrient. The energy usage of the animals in producing the manure is not considered. This could also be taken into consideration as far as number of animals, manure nutrient content, etc.

Figures 8 and 9 show the returns to land, labor and management by crop and rotation. Table 5 gives the economic data with manure priced at its nutrient value. Applying this process shows the benefits of having manure readily available and that it is a major factor in the profitability of the non-GMO rotations in this study.

Summary

This publication has focused on the energy use and economic returns of three different crop rotations. The choice of which rotation to choose is dependent on many factors. When considering profitability and energy consumption, including a third or fourth crop may be a viable option for some operations. Other benefits might include an outlet for excess manure, reduced erosion, increased soil health and pest management.

Table 5. Revenue and Returns by Crop and Rotation, with manure priced by nutrient value

	Yields	Prices	Gross Revenue	Production Cost	Return LL&M	Return L&M	Return Mgmt
C-Sb							
Corn	193.73	4.35	$841.60	377.27	464.33	$457.34	$259.18
Soybeans	50.27	9.95	$503.82	180.76	323.06	$314.92	$116.75
					393.70	386.13	187.96
C-Sb-O							
Corn	198.80	4.35	$865.19	336.72	528.47	$511.24	$313.07
Soybeans	54.73	9.95	$549.31	157.32	392.00	$380.72	$182.56
Oats	97.92	2.69	$256.35	128.56	213.01	$204.42	$6.26
Oat Straw	1.07	79.17	$85.23				
					377.83	365.46	167.29
C-Sb-O/A-A							
Corn	202.43	4.35	$878.09	357.22	520.87	$503.26	$305.09
Soybeans	56.93	9.95	$571.12	175.97	395.15	$383.91	$185.74
Oats	101.58	2.69	$267.15	215.12	218.30	$203.97	$5.80
Oat Straw	1.00	79.17	$79.74				
Alfalfa (1st yr)	0.74	119.47	$86.52				
Alfalfa (2nd yr)	3.97	119.47	$470.21	144.11	326.10	305.22	107.06
					365.11	349.09	150.92

Figure 8. Average Return to Management by Crop and Rotation

2006-2011, manure priced at nutrient value

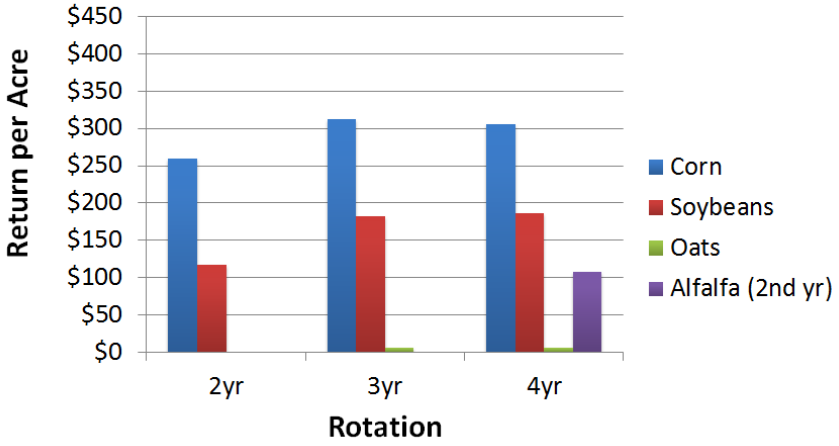
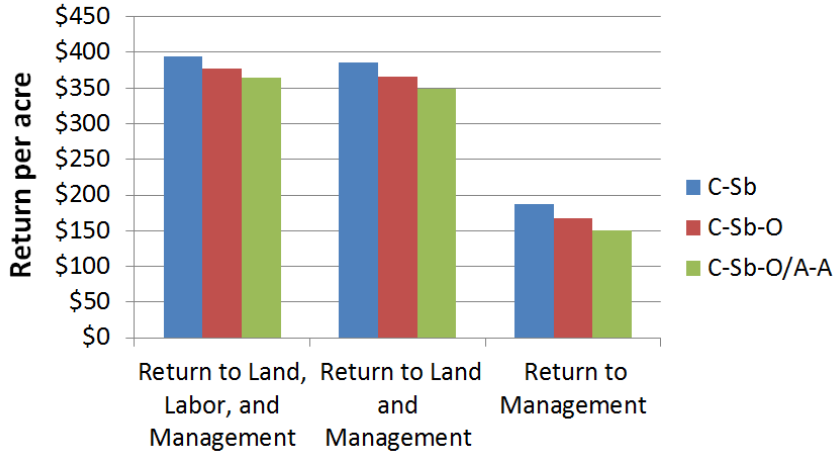


Figure 9. Average Returns to Land, Labor, and Management by Crop Rotation

2006-2011, manure priced at nutrient value



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* Funds for this project were provided by the Leopold Center for Sustainable Agriculture and Practical Farmers of Iowa.

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The College of Agricultural, Food and Environmental Sciences

Long Term Effects of Crop Management:
Profitability

Results from the VICMS study at the Southwest Research and Outreach Center in Lamberton, Minnesota

Paul Mahoney, Kent Olson, and Paul Porter
University of Minnesota, Departments of Applied Economics, and Agronomy and Plant Genetics

The bottom line

Organic production systems in southwest Minnesota are more profitable than conventional systems because of the lower cost of inputs and the organic price premium. If there were no price premium, profits from organic systems would be similar to those from conventional operations. Variability of net returns is similar in both systems.

Background: Why consider organic production systems?

By most measures, crop production systems are more efficient and productive today than at any time in the past. This is largely due to improved crop varieties, improved farm equipment, better management skills, synthetic pesticides, and chemically processed fertilizers. While synthetic pesticides and chemically processed fertilizers have contributed to gains in productivity, some people have become concerned about their effects on food safety and environmental quality and are interested in buying organically grown food. In addition, the current price and income situation has increased farmers' interest in organic production methods.

Farmers' reasons for not changing from traditional cropping systems are as diverse as the farmers themselves. Some of the reasons include uncertainty about the profitability of organic systems, increased labor that may be required by an organic system, lower yields compared to other systems, the cost in money and time to learn other systems, and the difficulty of finding markets for organic products.

The VICMS trials

The University of Minnesota started the Variable Input Crop Management Systems (VICMS) trials in 1989 at the Southwest Research and Outreach Center in Lamberton, MN to compare the agronomic and economic impacts of conventional and organic production methods in southwest Minnesota. The VICMS1 plots were set up on land with depleted fertility and heavy weed pressure. The VICMS2 plots were established on a field that had been cropped according to University recommendations since 1959, resulting in high soil fertility levels and low weed populations. These conditions are typical of those of many producers interested in the transition from conventional to organic production practices. The value of this study comes from the use of long-term data (10 years) in which each crop in each management strategy and each crop rotation was grown in replicated treatments each year. This report uses data from 1990-1999 from the VICMS2 plots to compare the profitability and riskiness of three different management strategies, two crop rotations, and three organic price scenarios.

The study

Our primary objective was to test the hypothesis that conventional systems were more profitable and/or had less risk than organic systems.

The three management strategies analyzed in this study included conventional production practices (**high inputs, HI**), a reduced level of purchased inputs (**reduced inputs, RI**), and organic production practices (**organic inputs, OI**). Conventional practices used by farmers in the region were similar to the HI treatment in 1989. By 1999, the regions' farmers were commonly using practices that were more similar to the RI system.

The two crop rotations were a two-year corn-soybean rotation and a four-year corn-soybean-oat/alfalfa-alfalfa rotation.

The three organic price scenarios were 1) the OI strategy received the full historical average organic premium starting in 1992 (when organic premium could start according to the national standards), 2) the OI strategy received only half of the historical average organic premiums, and 3) no organic premiums even for certified organic production.

Net return was calculated for each year based on actual yields, input and operational costs, market prices, and organic premiums.

Risk is the variation in net return. To estimate risk, we analyzed the variation in yields, market prices, and input costs, and we analyzed the correlation among crop yields and between crop yield and market price. From these analyses, we calculated all possible net returns, and estimated the probability of each possible net return. By comparing these probablities, we evaluated the level of risk of each management system.

Results and conclusions

- Yields and costs were lower for the 4-yr OI strategy than for the 2-yr conventional strategies.
- Without organic premiums, the 4-yr OI strategy had net returns equal to the 2-yr conventional strategies.
- With organic premiums, the 4-yr OI strategy had net returns higher than the 2-yr conventional strategies.
- Even with half the organic premiums, the 4-yr OI strategy had net returns higher than the 2-yr conventional strategies.
- The net return of the 4-year OI strategy was not more variable than the net return of the conventional strategies.
- The finding that conventional agriculture was not obviously more profitable or less variable on a per acre basis supports the continuance of programs supporting organic farming such as production research (including crop insurance coverage), market information and development, and policies at the federal and state levels. Policies that include subsidizing farmers for the environmental benefits of organic production methods warrant further development and refinement.
- This study can give farmers and their advisors more confidence in the potential benefits of investing the time and costs to learn the skills needed to grow and market certified organic products and to control potential problems.

Net returns, 1990-1999

Annual return per acre averaged over either two or four crops.

Management system	2-yr rotation	4-yr rotation
HI	$153 (44) [b]	$172 (36) [b]
RI	$137 (49) [bc]	$173 (37) [b]
OI, ave. org. premium	NA	$270 (76) [a]
OI, half org. premium	NA	$223 (53) [a]
OI, no org. premium	$92 (49) [c]	$175 (34) [b]

NA = not applicable.
Standard deviations are in parentheses.
Different letters indicate net returns are significantly different (P=0.5).

Production costs, 1990-1999

Average annual costs per acre.

Crop and rotation length	Management strategy		
	HI	RI	OI
Corn, 2-yr	$145 (16)	$118 (12)	$98 (7)
Soybean, 2-yr	$82 (7)	$77 (7)	$73 (10)
Corn, 4-yr	$142 (19)	$119 (12)	$106 (6)
Soybean, 4-yr	$88 (11)	$77 (7)	$75 (6)
Oats, 4-yr	$90 (14)	$83 (13)	$69 (7)
Alfalfa, 4-yr	$104 (22)	$100 (17)	$91 (14)

Standard deviations are in parentheses.

For additional information about these results contact Kent Olson (612-625-7723) at the University of Minnesota, or see the full article published as:
Mahoney, P.R., K.D. Olson, P.M. Porter, D.R. Huggins, C.A. Perillo, and R.K. Crookston. “Profitability of organic cropping systems in Southwestern Minnesota.” *Renewable Agriculture and Food Systems*, 19(1):35-46, 2004.

April 2004

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Long Term Effects of Crop Management:
Soil Quality

Results from VICMS study at the Southwest Research and Outreach Center in Lamberton, Minnesota

Maya Kuratomi, Deborah Allan, and Elizabeth Dyck
University of Minnesota, Department of Soil, Water, and Climate, and Department of Agronomy and Plant Genetics

The study

The Variable Input Crop Management Systems (VICMS) research plots were established in 1989 in southwestern Minnesota to study the effects of four management systems under 2-year and 4-year crop rotations. This fact sheet summarizes soil quality measurements made in 2000 and 2001 on the VICMS1 plots. The results represent the effects of more than 10 years of crop management systems.

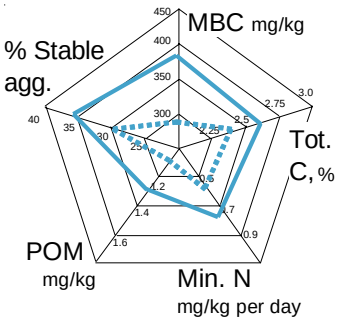
Results

The diagrams below represent the soil quality under each of the four management systems. The spokes of each wheel represent five soil quality indicators. The thick colored lines mark the measured values for each of the indicators. Values toward the outside of the wheel are associated with higher soil quality, so the greater the area outlined by the colored line, the better the overall soil quality for the system examined.

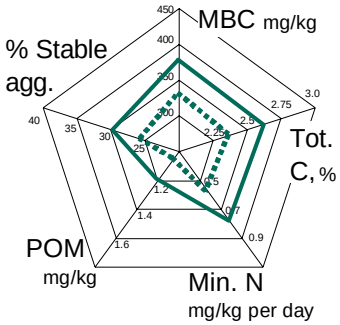
2-yr rotation = corn-soybean

4-yr rotation = corn-soybean-oat/alfalfa-alfalfa

No inputs (NI) = No fertilizers or herbicides. The only inputs are seed and tillage.



High input (HI) = Broadcast fertilizer and herbicides. Moldboard plowed most years.

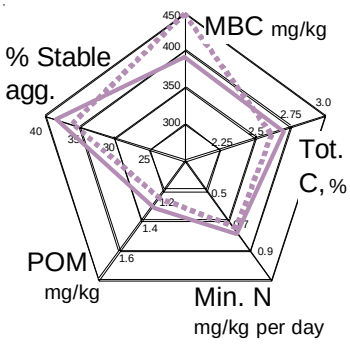


The NI and HI systems have the lowest soil quality, as shown by the smaller area encompassed by the colored lines.The areas encompassed by solid lines (4-yr rotations) are much larger than those of the dashed line (2-yr rotations), showing that the NI and HI systems had greater positive responses to the extended rotations than did the RI and OI systems.

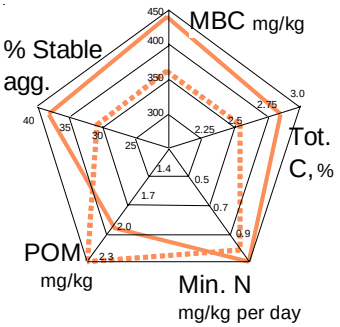
Assessing soil quality

Soil quality is the ability of soil to function to support plant growth and protect water quality, now and into the future. Soil quality is assessed by measuring indicators that change quickly in response to management differences and allow farmers to predict what will happen to their soil health and productivity in the long-term. Useful indicators reflect important soil processes, such as soil structure, nutrient supply, and soil microbial activity. The soil quality indicators reported in this fact sheet are:

- **Total organic carbon (Tot. C)** - an estimate of total soil organic matter. (Organic matter is about half carbon.) Tot.C changes more slowly than the other indicators.
- **Mineralizable nitrogen (Min. N)** - a measure of the amount of plant available N that can be released over time from the soil organic matter.
- **Particulate organic matter (POM)** - an estimate of "active" organic matter. A measure of large organic matter particles >0.053 mm.
- **Large stable aggregates (Stable agg.)** - a measure of how well the soil holds together. Aggregate stability affects workability, root growth, and water infiltration.
- **Microbial biomass carbon (MBC)** - an estimate of the number of microorganisms in the soil.



Reduced input (RI) = Reduced rates of banded fertilizer and herbicides. Reduced tillage, with no-till in most years.



Organic input (OI) = No chemical fertilizers or herbicides. Aged manure is applied. Weeds are controlled through delayed planting and cultivation.

The OI system had the greatest overall soil quality as seen in the greater areas delineated by both the 2- and 4-yr rotation lines. The RI system was comparable to the OI system for aggregation, microbial biomass, and total carbon levels.

The bottom line

The results of this study suggest that

- reduced tillage can improve soil structure and microbial activity within the 2-yr rotation.
- extended rotations including small grains and perennial legumes improve soil quality.
- soil quality is enhanced by organic systems that use manure inputs and diverse crop rotations, as long as nutrient balances are maintained.

The graphs on this page take a closer look at these results.

Tillage damages soil structure

- For the 2-yr rotation, soil structure was significantly better in the RI (least tillage) system. For the 4-yr rotation, soil structure was significantly worse in the HI system compared to the other three systems (figure 1).
- Minimizing soil disturbance by reducing tillage maintains good soil structure, resulting in less compaction and greater water holding capacity and infiltration.
- Reducing tillage also increased the amount of microbial biomass and activity (not shown).

Longer rotations improve soil structure

- More large aggregates were found following oats and alfalfa than following corn and soybeans (figure 2).
- All the systems had better soil aggregation in the 4-yr rotation compared to their 2-yr counterparts (figure 1), in part because of reduced soil disturbance.
- The abundant shoot and root residues of oats and alfalfa also helped ameliorate some of the negative effects of tillage. Other small grains or perennial legumes could have similar effects on soil quality.
- High residue crops like alfalfa and corn build organic matter in the soil, increasing aggregate stability. Low residue crops, like soybeans, are detrimental to aggregate stability.
- Beneficial effects of oats and alfalfa in the 4-yr rotation are apparent in the diagrams on the preceding page.
- The importance of the longer rotation in organic systems is illustrated by the increase in aggregation in the 4-yr OI system compared to its 2-yr counterpart (figure 1).

Manure improves soil quality

- Organic matter additions can improve aggregation, microbial biomass, and other soil quality attributes. The greater amount of POM (active organic matter) in the OI system is attributed to manure additions (figure 3).
- Although organic matter additions can benefit soil quality, manure applied to meet all the crop nitrogen needs can result in excessive accumulation of phosphorus. Other sources of nitrogen are needed. Alternative sources of nitrogen include nitrogen-fixing legumes in rotation as cover crops or cash crops.

For additional information about the VICMS study contact Deborah Allan at the University of Minnesota 612-625-3158, dallan@umn.edu.

April 2004

Fig. 1. Soil structure in different management systems

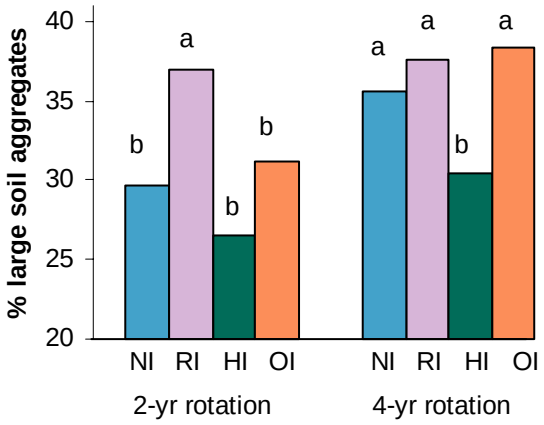


Fig. 2. Soil structure after different crops

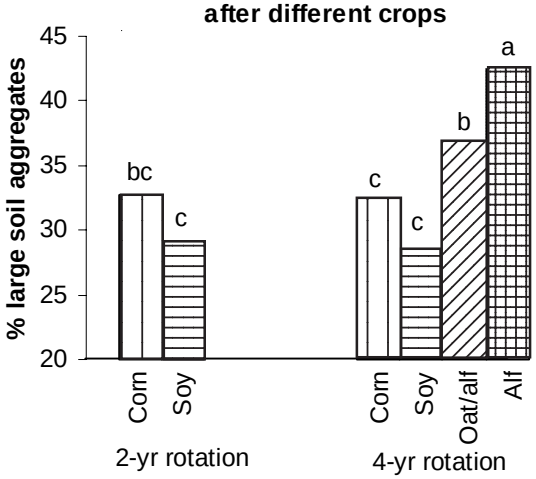
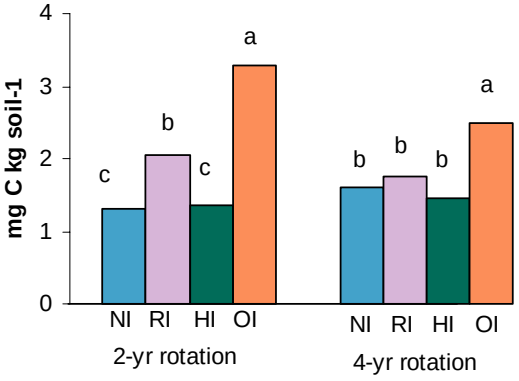


Fig. 3. Particulate Organic Matter Carbon



Identical letters above bars in a graph indicate that the values are not statistically different.

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Long Term Effects of Crop Management:

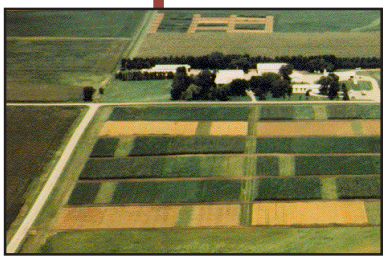
Yield

Results from the VICMS study at the Southwest Research and Outreach Center, Lamberton, Minnesota

Paul Porter, Dave Huggins, Catherine Perillo, Steve Quiring, and Kent Crookston
University of Minnesota, Departments of Agronomy and Plant Genetics, and Soil, Water, and Climate

What are the VICMS trials?

The Variable Input Crop Management Systems (VICMS) trials were started in 1989 at the Southwest Research and Outreach Center in Lamberton, MN to monitor long term differences among four management strategies and two crop rotations.



The VICMS 1 plots on the Elwell Farm are shown in the lower half of this picture. The VICMS 2 plots are the smaller set of plots at the top of the picture, north of the buildings.

The four management strategies are:

- No inputs (**NI**) = No fertilizers or herbicides. The only inputs are seed and tillage.
- Reduced input (**RI**) = Reduced rates of banded fertilizer and herbicides. Reduced tillage, with no-till in most years.
- High input (**HI**) = Broadcast fertilizer and herbicides. Moldboard plowed most years.
- Organic input (**OI**) = No chemical fertilizers or herbicides. Aged manure is applied. Weeds are controlled through delayed planting and cultivation.

Two rotations are used with each of the four strategies:

- 2-yr rotation = corn-soybean
- 4-yr rotation = corn-soybean-oat/alfalfa-alfalfa

Initial soil fertility

All eight treatments (four management strategies for each rotation) were established at two locations:

- VICMS1 (**V1**) = Low initial fertility. These plots were established on the Elwell Agroecology Farm on land with a history of no fertilizer or pesticide application and where soil fertility levels, specifically P, had been depleted over time.
- VICMS2 (**V2**) = High initial fertility. These plots are on land with a history of conventional fertilizer and pesticide application and where soil fertility levels had been built up over time.

Why study these management systems?

Acres devoted to corn and soybeans have approximately doubled in the last 50 years – a response, in part, to the development of effective fertilizers and pesticides, government policies, and favorable economics. These two crops now dominate the Midwestern countryside, and account for more than ninety percent of southwestern Minnesota's landscape. As acreage has increased and production has intensified, concerns have grown about the sustainability of this cropping system. The concerns relate to environmental issues, such as water quality; economic issues, such as increased reliance on government subsidies; and social issues, such as the continuing decline in rural populations.

In response to these concerns, the VICMS trials were established to examine alternatives to common management strategies.

The yield study

This fact sheet describes how rotation length and management strategies influenced crop yield. Results from the first four years, 1989-1992, are not reported to avoid the transition period while the new management systems were being established. Yield results are shown below and explained on the back of this fact sheet.

Corn, 1993-1999

	2-yr rotation		4-yr rotation	
	V1	V2	V1	V2
HI	143 bu/ac	139 bu/ac	137 bu/ac	139 bu/ac
OI			129 bu/ac	129 bu/ac

Soybean, 1993-1999

	2-yr rotation		4-yr rotation	
	V1	V2	V1	V2
HI	43.1 bu/ac	40.7 bu/ac	44.4 bu/ac	43.1 bu/ac
OI			35.0 bu/ac	34.1 bu/ac

Alfalfa, 1993-1999

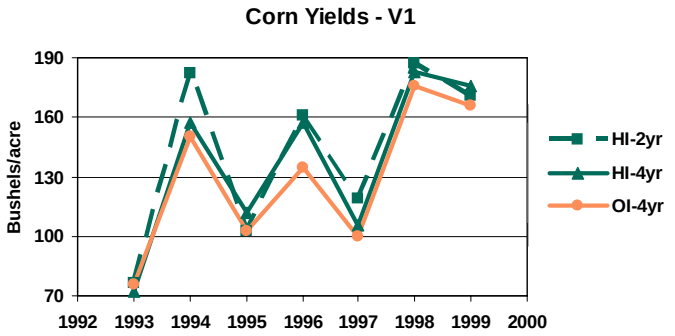
	4-yr rotation	
	V1	V2
HI	5.21 tons/ac	5.11 tons/ac
OI	4.77 tons/ac	5.11 tons/ac

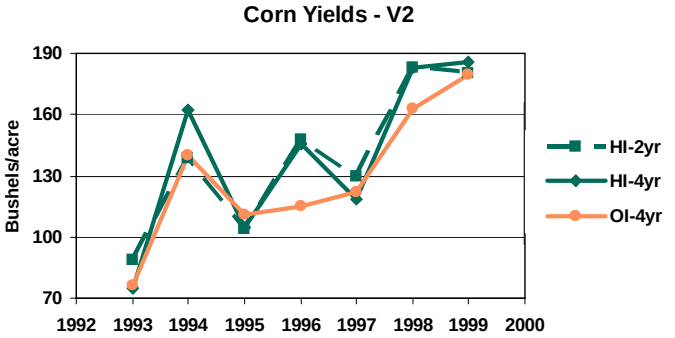
The bottom line

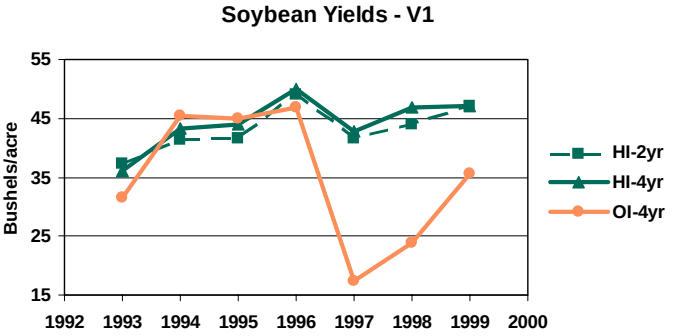
- Long-term corn and soybean yields were lower in the 4-yr organic input (OI) strategy compared with the 2-yr high input (HI) strategy. However, the OI strategy had lower production costs, and consequently net returns for the two strategies were equivalent, even without accounting for organic price premiums. These results are consistent with those of several other studies conducted in the Midwest, and suggest that organic production systems can be competitive with conventional production systems.
- This research documents the yield benefits for soybean of expanding a crop rotation from 2 years to 4 years. The beneficial effect of the longer rotation can be masked by external inputs in the reduced input (RI) and high input (HI) treatments.

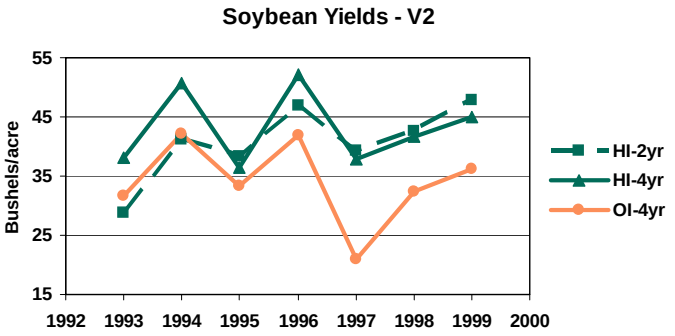
Results

- **HI corn yield** was 4% lower in the 4-yr compared to 2-yr rotation on V1 plots (initially low fertility), and not different on V2 plots (initially high fertility).
- **HI soybean yields** were 3% and 6% greater in the 4-year compared to the 2-year rotation on V1 and V2, respectively. These results suggest soybean was more responsive than corn to the expanded rotation length in the HI strategy. Diseases associated with soybean may have been more of a problem in the 2-yr rotation than in the 4-yr rotation, resulting in some of the observed yield differences between the two rotation lengths.
- **OI yields:** Corn and soybean yields from the 4-year OI plots were generally lower than from the 2-year HI plots. In comparison to conventional production practices, yield of organically produced soybean was reduced to a greater extent than yield of organically produced corn. Specifically, corn yield was lower by 9% on V1 and 7% on V2, and soybean yield was lower by 19% on V1 and 16% on V2.
- **Oat yields** were similar for all management systems when averaged across the seven years. The 4-yr OI and HI strategies yielded 49.2 bu/ac on the V1 plots and 51.5 bu/ac on the V2 plots.
- **Alfalfa yields** did not differ on the V2 plots, but on the V1 plots alfalfa yield was 8% less in the OI treatment compared to HI. We suspect the poorer performance of OI was related to the lower initial P levels in the V1 plots.
- **Year-to-year variation** in weather influenced how the crops responded to rotation length and management strategy (see figures). Weed control, especially in the OI and NI strategies, was greatly influenced by early-season climatic conditions. In 1993, 1996 and 1997 rainfall events precluded timely and effective rotary hoeing and cultivation. Inadequate weed control one season can negatively influence crop productivity that year and influence weed pressure and crop productivity in subsequent years.
- **RI and NI yields** (not shown): Yield under the reduced input (RI) system varied, but were comparable to HI. Yields under the no input (NI) system were severely restricted by the insufficient nutrient supply.









For additional information about these results see *Agronomy Journal* 95:233-244 (2003) or contact Paul Porter at the University of Minnesota 612-625-6719.

April 2004

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Small Changes, Big Impacts: Prairie Conservation Strips

Restoring the balance

Agriculture in Iowa owes its immense productivity to an extreme trade-off. Once, perennial prairie covered 85 percent of the state, and its deep root network built and held together a fertile topsoil layer many feet deep. Now, more than 85 percent is in agricultural production, with the majority in row crops.

However, shallow-rooted annual crops such as corn and soybeans cannot reproduce the soil-building capacity of a perennial prairie system. Other agricultural practices need to be implemented to keep soil, moisture and nutrients on the field. Without such practices, over half of the prairie-built topsoil of Iowa has been lost in the past 50 years, along with nutrient runoff and pollution of waterways. The large-scale conversion to row-crops also has drastically reduced native habitat and biodiversity.

But agriculture in Iowa does not need to compromise between production and conservation. Scientists from the STRIPS research team (Science-based Trials of Row-crops Integrated with Prairie Strips) have shown that **by strategically converting as little as 10 percent of a row-cropped field to perennial prairie**—in narrow patches along contours and foot slopes—**farmers and landowners can reduce sediment movement off their field by 95 percent, total phosphorus loss by 90 percent, and total nitrogen loss by nearly 85 percent**.

Establishing prairie strips involves minimal farmland conversion at relatively low cost, while offering multiple farmland and environmental benefits. The patches of prairie create landscape diversity that supports wildlife such as birds and pollinators, recreation, grazing, as well as other multifunctional purposes. Prairie strips promise to be an innovative and effective conservation practice that sustains both Midwestern farming and its natural resources. In other words, **small patches make a big difference**.

"Want to stem biodiversity loss, enhance fresh water supplies, curtail climate change AND improve people's lives? Then enhance modern agriculture with perennials and partnerships."

- Lisa Schulte Moore, STRIPS researcher

"This is the kind of agriculture I love, to talk about the soil, about sustainability, about production. Will I be able to say that I left the land better than I found it? That's what matters to me."

- Seth Watkins, STRIPS practitioner

INSIDE THIS DOCUMENT:

Dive into the anatomy of a prairie conservation strip (page 2)

Let the numbers do the talking, for costs and benefits (page 3)

FLIP TO THE BACK:

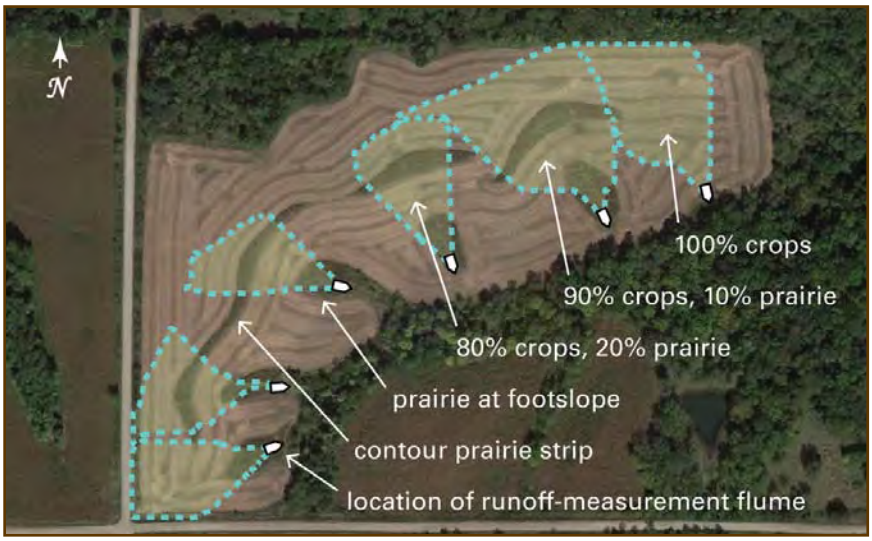
To find STRIPS demonstration sites and other resources (page 4)

July 2014

From experiment to practice: STRIPS in Iowa

The STRIPS research team established experimental study sites in central Iowa at the Neal Smith National Wildlife Refuge in Jasper County in 2007—twelve small watersheds of 1 to 8 acres, annually producing corn or soybeans on slope inclines between 6 and 10 percent. The researchers monitored each watershed for sediment, water, nitrogen and phosphorus movement off the field, greenhouse gas emissions, as well as plant, insect and bird biodiversity.

Some of these watersheds were planted with tallgrass prairie vegetation in one or two contour strips among row crops, with separate prairie plantings at the footslope. The total land planted with prairie vegetation in a row-cropped watershed was either 0 (100 percent of the field in row crops), 10 or 20 percent.

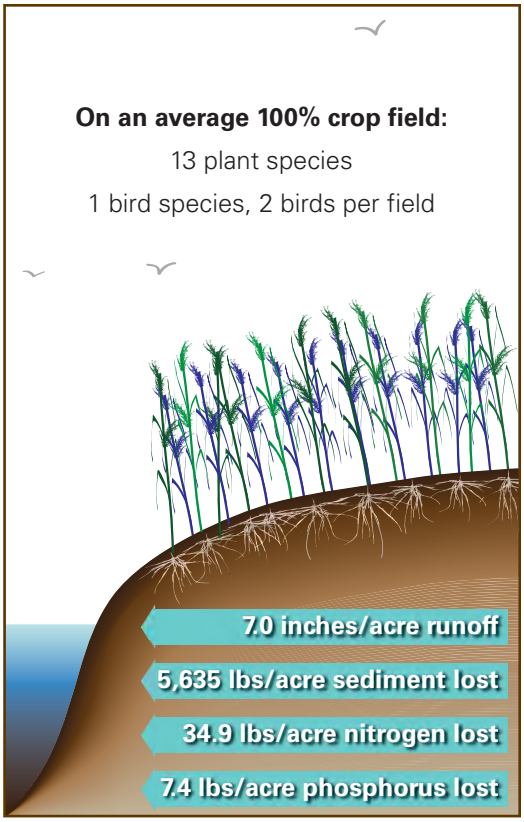


Catchment boundaries of six STRIPS watersheds after crop harvest, with bands of prairie left standing. Flumes measuring runoff are marked in white.

During 2007 to 2012, the STRIPS team found that watersheds with only 10 percent prairie reduced sediment export by 95 percent, total phosphorus export by 90 percent and total nitrogen export by nearly 85 percent when compared to losses from the 100 percent row-crop (no-till) watersheds. Meanwhile, financial assessment studies show that prairie strips are one of the most affordable conservation practices available to landowners (page 3).

Based on these results, **farmers have increasing interest in implementing this practice on farm fields in Iowa**. The STRIPS research team and Iowa Department of Agriculture and Land Stewardship (IDALS) are establishing STRIPS demonstration sites on farms throughout Iowa. In December 2012 the STRIPS team worked with the first private adopter in Taylor County, southwest Iowa, to flag the boundaries of strips planted in June 2013.

In addition to private land locations, STRIPS demonstration sites are planned for implementation at several ISU research farms. Field days will be held at all of these sites during which anyone interested in the practice can view the fields and interact with the landowners and land managers.



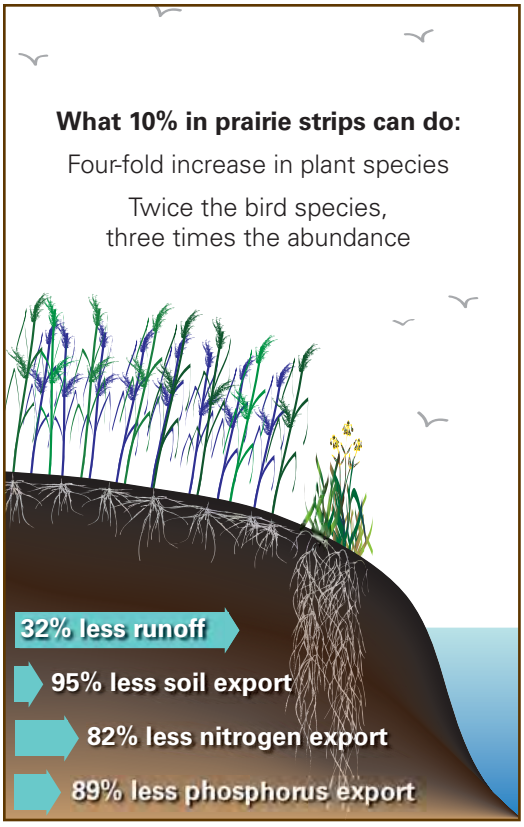
STRIPS researchers calculated average values for surface water runoff, soil and nutrient export from a field cropped entirely in corn, as well as various indicators of biodiversity. Compare this figure to the one on page 3.

Tallgrass prairie: What roots hold

Tallgrass prairie is a diverse mixture of native grasses and flowering plants (forbs) uniquely adapted to the climate and soils of the central United States.

Prairie strips keep vital soil resources in crop fields. Deep-rooted prairie plants increase soil organic matter and improve infiltration of water. The plants' stiff, upright stems slow surface runoff and help hold soil in place during heavy rains.

These flumes measure runoff from the STRIPS watersheds. Note the amount of sediment displaced from a 100% no-till crop field (left) compared to a field enhanced with 10% prairie (right).



On a 10% strips field, all of the above-measured biological and environmental indicators show improvement. There is no appreciable loss of yield on land that remains in annual crops.

Diversity: More than just "more"

Prairie strips, with multiple plant species, have an advantage over similar conservation practices such as contour buffer strips or filter strips, which often are planted in a single species of grass. Plant diversity lets a prairie thrive under a variety of climatic conditions. Even if an individual species performs poorly because of yearly nutrient or water fluctuations, the ecosystem as a whole thrives, staying resilient to climate extremes.

A diverse plant mix also supports a diversity of unique animals, insects and birds that are only found in the central United States. A diverse ecosystem supports multiple land uses, for example bird watching, honey production, hunting and grazing.

A flume measuring outflow from a 100% prairie field. Note the absence of sediment.

Biodiversity by the numbers

The STRIPS watersheds demonstrate substantial biodiversity benefits. On average, 51 plant species were found in areas surveyed within prairie strips as compared to 13 species within all row-crop areas. This native plant diversity provides habitat that fosters conservation of native communities—not only of plants, but birds and beneficial insects such as pollinators and natural enemies of crop pests.

STRIPS support several species of insect predators (e.g. lady beetles) that **reduce insect pests of corn and soybean**. The enhanced floral resources that prairie strips provide throughout the growing season supports a diverse community of pollinators (70 species of native bees along with the European honey bee).

Catchments with prairie strips also provide habitat for 118 percent more bird species and 133 percent more total birds than those with 100 percent row-crops. Bird species documented using prairie strips include **species of greatest conservation need**, including the eastern meadowlark, grasshopper sparrow, field sparrow and dickcissel.

The cost of installing prairie strips

The STRIPS team has calculated that the **average annual cost of treating a farm field with prairie strips ranges from $24 to $35 per acre**. The USDA NRCS offers Conservation Reserve Program (CRP) contracts that can **reduce the cost to farmers by more than 80 percent**.

Costs associated with prairie strips include site preparation, strip establishment and annual and periodic maintenance to prevent weed establishment while the prairie plants take hold. The STRIPS team calculates that the annual opportunity cost (of foregone rent or net revenue loss associated with land taken out of crops) represents over 90 percent of the total cost. Overall, it is **one of the least expensive conservation practices available to landowners and farmers**.

The STRIPS team continues to conduct financial assessments of prairie strips. This year they will calculate the monetary value of environmental benefits associated with the conservation practice.

Top ten priorities for agricultural policies and programs

Preliminary data from the STRIPS team

Priority	Addressed by STRIPS
1. Drinking water quality	✓
2. Water quality for aquatic life	✓
3. Rural job opportunities	✓
4. Flood control	✓
5. Water quality for recreation	✓
6. Game wildlife habitat	✓
7. Reducing greenhouse gases	✓
8. Tourism opportunities	✓
9. Crop production	✓
10. Non-game wildlife habitat	✓

STRIPS researchers asked more than a thousand Iowans to rank a list of benefits that could be derived from agriculture, and thus be promoted by policies and programs. Drinking water quality topped the list. More than just crop production (which ranked 9th on the list), respondents valued agricultural practices that improved water quality, rural livelihood and wildlife habitat, and reduced greenhouse gas emissions and flood risk. Agriculture enhanced by prairie strips addresses all 10 top priorities for Iowans.

VISIT STRIPS in Jasper County:

Neal Smith National Wildlife Refuge
9981 Pacific Street, Prairie City, Iowa
(515) 994-3400, NealSmith@fws.gov

FIND more resources on the web:

The STRIPS research team website includes information on partners and participants, as well as upcoming field days and demonstration site locations. Find more at: www.prairiestrips.org.

The Leopold Center for Sustainable Agriculture has compiled various multimedia resources, including: *A Landowner's Guide to Prairie Conservation Strips* and *The Cost of Prairie Conservation Strips*. Find more at: www.leopold.iastate.edu/strips-research-team.

The future of agriculture in Iowa

Agricultural production in Iowa has grown to meet the demand for products that supply food, feed, fiber and fuel. But the continued expansion of row-crop agriculture has been accompanied by a profound loss of natural resources, including nutrient and sediment loss into waterways, as well as a drastic reduction of native biodiversity, especially of those species dependent on prairie habitat.

The public as well as local and federal governments increasingly urge for measures that reduce the impacts of agricultural production on grassland biodiversity and water quality—from the Mississippi River Basin down to the Gulf of Mexico. Programs like the USDA's Mississippi River Basin Healthy Watersheds Initiative (MRBI), Iowa Nutrient Reduction Strategy (INRS) and Iowa's Wildlife Action Plan encourage farmers and landowners to voluntarily adopt practices that improve watershed and ecosystem health.

The STRIPS study documents a conservation practice that can sustain agricultural production while also providing diverse and extensive benefits across a broad range of ecological and economic criteria. **Climatic extremes continue to put pressures on the productivity of monoculture cropping systems**. Landscape diversity in the form of prairie strips creates a natural buffer against soil erosion and nutrient loading of streams, and helps water infiltrate soil so it can later be used by crops. It also preserves important habitat for wildlife, including pollinators and natural predators of crop pests.

The STRIPS team shows that **planting prairie strips is a feasible and effective conservation practice with real benefits for farmers, landowners and society**. Prairie strips provide disproportionate, multifunctional benefits that improve farmland and ecosystem health in the Midwest.

Project partners include the U.S. Fish and Wildlife Service, Neal Smith National Wildlife Refuge, Leopold Center for Sustainable Agriculture, Iowa Department of Agriculture and Land Stewardship, U.S. Department of Agriculture, U.S. Forest Service Northern Research Station, Iowa State University, National Science Foundation and Trees Forever. Document written by: Mary Harris, ISU Natural Resource Ecology and Management, and Geetha Iyer, Leopold Center. Production: Geetha Iyer, Laura Miller, Leopold Center. Graphics by: Geetha Iyer. Photo credits: Amy Mayer/Harvest Public Media (Watkins, page 1), Sarah Hirsh, Anna MacDonald, the STRIPS team and the Leopold Center.

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The Cost of Prairie Conservation Strips

Adapted from the STRIPs research paper:
Tyndall, J. C., L. A. Schulte, M. Liebman, and M. Helmers. "Field-Level Financial Assessment of Contour Prairie Strips for Enhancement of Environmental Quality." *Environmental Management*, 2013. DOI: 10.1007/s00267-013-0106-9.

What are prairie conservation strips?

Prairie conservation strips are a tool for improving the function and integrity of row-cropped farms. Researchers at STRIPs (Science-based Trials of Rowcrops Integrated with Prairies) have found that strategically planting small patches and strips of native prairie in farmland provides multifunctional benefits disproportional to the amount of land converted. In other words, small patches make a big difference.

How much does prairie planting cost?

Table 1 represents typical costs for a prairie strip planting after soybean. The range of costs is calculated based on average land rent across cropland quality, as measured by its Corn Suitability Rating (CSR). The soil and nutrient runoff from every nine acres of row crops can be treated with just one acre of perennial prairie. So, for every ten acres of farmland, the average total annual cost of converting one acre of cropland to prairie ranges from $240 to $350. In other words, **converting a tenth of every acre from annual crop to prairie costs between $24 to $35 per year**.

In Iowa, land rent or foregone revenue can scale higher than the averages used here, so the range of values calculated here may underestimate the actual total—costs may be upwards of $60 per year for every row-crop acre treated with prairie. However, Iowa also offers Conservation Reserve Program (CRP) contracts. Under a 15-year CRP contract, farmers could receive a cost reduction of more than 80%, thus costing them only $3 to $5 per year per crop acre treated with prairie.

Table 1: Annualized total costs of prairie strips calculated over a 15-year management period at a 4% discount rate (in 2012 dollars)

	High quality (CSR 83)	Medium quality (CSR 73)	Low quality (CSR 60)
Per acre of prairie	$350	$290	$240
Per treated crop acre	$35	$29	$24
Per treated crop acre with CRP	$5	$4	$3

See following page for detailed cost breakdown.

Why plant prairie strips on my land?

Prairie strips are of primary importance because they prevent soil erosion and nutrient runoff from farmland. Specifically, converting just 10 percent of farmland to prairie can reduce sediment and nutrient transport off the field into waterways by more than 90 percent. They also increase pollinator, plant and wildlife diversity, create opportunities for forage and biomass, and suppress the proliferation of annual weeds within the strips.

What else should I consider?

Land management decisions on farms are a trade-off between maximum yearly profit per acre and long-term health and sustainability of the acreage. Ongoing studies continue to establish the long-term benefits of conservation measures in farming systems. Prairie strip plantings require minimal land conversion and maintenance, and are among the cheapest best management practices (BMPs) you can employ on your farm, especially when combined with a CRP contract.

For their size, prairie strips result in dramatic, disproportionally large benefits to the landscape. In other words, a little goes a long way toward soil conservation, ecosystem health and long-term economic productivity and sustainability of farmed landscapes.

Below, visitors tour the prairie conservation strip research plots at the Neal Smith National Wildlife Refuge.

Table 2: Estimated range of costs for a 15-year management plan of 10% prairie strip planting after soybean (in 2012 dollars)

		Mean price per acre
Site preparation		
Year 0:		
Tillage	$6–30 per acre	$18
Herbicide	$40–80 per gallon	$15
Herbicide application	$20–85 per acre	$53
Establishment		
Year 0:		
Seed	$120–$250 per acre	Variable
Seed drilling	$10–48 per acre	$15
Seed packing	$5–30 per acre	$17.50
On average, site preparation and establishment are less than 10% of the total cost per year per treated crop acre		
Management		
Annual:		
General operating costs	1–3% of upfront costs	Variable
AND		
Years 1–15:		
Mowing 3 times in year 1, annually years 2–15	$5–55 per acre	$30
Years 2–15:		
Baling	$9–16 per acre	$11
OR		
Years 2–15:		
Burning Annually years 2–6, every 2 years thereafter	$30–100 per hour	$36
Management costs are about 10–15% of the total cost per year per treated crop acre		
Opportunity costs		
Annual:		
Land rent	Variable	$80–525
Opportunity costs are up to 90% of the total cost per year per treated crop acre		

Where can I learn more about prairie restoration?

The following publications are found at the Leopold Center website: www.leopold.iastate.edu/pubs/alpha. Search by title for:

- A Landowner's Guide to Prairie Conservation Strips
- Incorporating Prairies into Multifunctional Landscapes
- A Targeted Approach for Improving Environmental Quality

Learn about the STRIPs Research Team at their website: www.prairiestrips.org or visit the Neal Smith National Wildlife Refuge at 9981 Pacific Street, Prairie City, Iowa. Contact the Refuge at (515) 994-3400 or NealSmith@fws.gov.

How are these costs calculated?

Costs fall into two categories: the cost of land conversion and maintenance, and the opportunity cost of the management decision (Table 2 details these costs). For prairie strip planting, there are three kinds of land conversion and maintenance costs: **site preparation**, **prairie strip establishment** and **annual and periodic maintenance**. The range of costs varies depending on multiple factors. Proper site preparation reduces the time and money spent on subsequent management steps. The prior quality of the land also influences these costs. For example, fewer herbicide applications are needed if there are fewer established weeds in the area.

Landowners must also consider the missed opportunity represented when changing a land management regime from the status quo. The **annual opportunity cost** is the cost of foregone rent or net revenue loss associated with land converted to perennial prairie. Opportunity costs vary depending on factors relating to ownership, soil quality, management practices, and crop and land value, but they scale up incrementally with the amount of land taken out of crop production. They are often calculated using average land rent as a proxy for foregone revenue.

On most sites, site preparation and establishment are less than 10 percent of the total cost of a prairie strip planting and management about 10 to 15 percent. Opportunity costs represent the greatest proportion—upwards of 90 percent—of the total cost of prairie strip planting.

Where can I find financial support?

- The USDA offers state-specific financial and technical support: www.ia.nrcs.usda.gov/programs.
- Conservation Reserve Program (CRP) offers 10-15 year contracts.
- Environmental Quality Incentives Program (EQIP) may assist with prairies you plan to harvest or graze.
- Wildlife Habitat Incentive Program (WHIP) offers a maximum of $30,000 to install and maintain habitat on private land.
- U.S. Fish and Wildlife Partners Program works with landowners to restore wildlife habitat: www.fws.gov/midwest/partners.
- Resource Enhancement and Protection (REAP) gives small grants for soil and water protection: www.iowadnr.gov/Environment/REAP.
- Trees Forever offers financial support to landowners interested in planting native habitat: www.treesforever.org.

Project partners include the US Fish and Wildlife Service, Neal Smith National Wildlife Refuge, Leopold Center for Sustainable Agriculture, Iowa Department of Agriculture and Land Stewardship, US Department of Agriculture, US Forest Service, Iowa State University, National Science Foundation and Trees Forever. Layout by Melissa Lamberton, Leopold Center. Photographs courtesy of Anna MacDonald, graduate research assistant, and the Leopold Center.

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THE IMPACT OF PRAIRIE STRIPS: MORE THAN JUST "MORE"

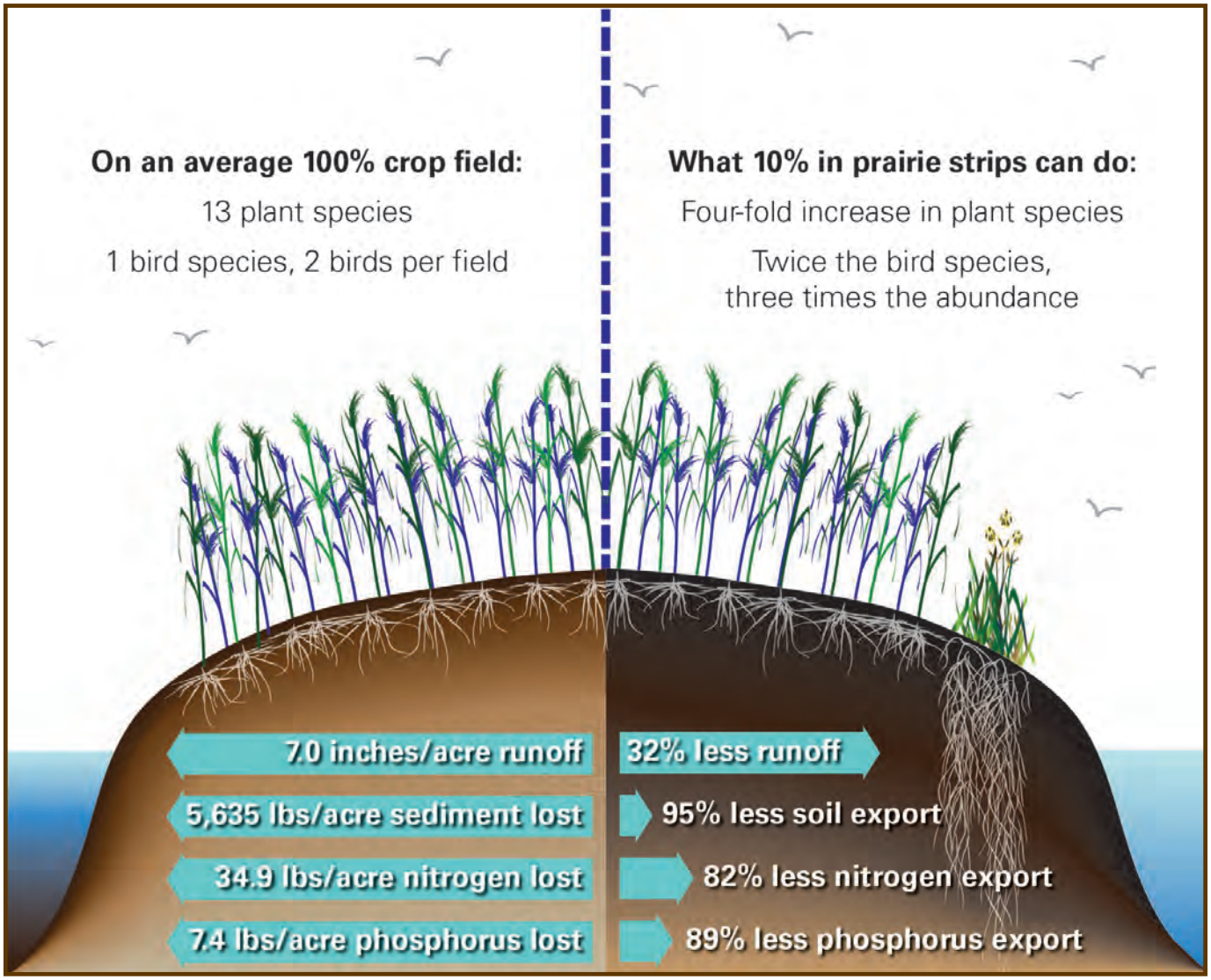
STRIPS* researchers calculated average values for surface water runoff, soil, nitrogen and phosphorus export off field sites cropped entirely in corn (on left), compared to field sites enhanced with 10 percent prairie strips (right).

They also measured various indicators of biodiversity, including plant and bird species and abundance. This *infographic* compares the average values for both types of fields.

On a 100 percent row-cropped field, each arrow illustrates average export values off the field into waterways. A field planted entirely in crops is "leaky," losing much of its natural resources through erosion. It also has little ecological diversity.

On a field with 10 percent in prairie, all biological and environmental indicators measured by the STRIPS team showed improvement. The lenghts of the arrows are proportional to the measured improvements in natural resource retention on the field.

Apart from the 10 percent taken out of crop production, there is no appreciable loss of crop yield on the rest of the field. A field enhanced with prairie strips also shows increases in biodiversity. A diverse ecosystem is better able to withstand climate extremes and other variables.



*Science-based Trials of Row-crops Integrated with Prairie Strips

This document adapted from *Small Changes, Big Impacts: Prairie Conservation Strips*, Mary Harris, ISU Natural Resource Ecology and Management, and Geetha Iyer, Leopold Center for Sustainable Agriculture. More at: www.prairiestrips.org and www.leopold.iastate.edu/strips-research-team.

The values listed in the figure above come from the following sources:

Zhou, X., M.J. Helmers, H. Asbjornsen, R. Kolka, M.D. Tomer, and R.M. Cruse. 2014. Nutrient removal by prairie filter strips in agricultural landscapes. *Journal of Soil and Water Conservation* 69(1):54-64. doi: 10.2489/jswc.69.1.54

Hirsch, S.M., C.M. Mabry, L.A. Shulte, and M. Liebman. 2013. Diversifying agricultural catchments by incorporating tallgrass prairie. *Ecological Restoration* 31(2):201-211. doi: 10.3368/er.31.2.201

Helmers, M.J., X. Zhou, H. Asbjornsen, R. Kolka, M.D. Tomer, and R.M. Cruse. 2012. Sediment removal by perennial filter strips in row-cropped ephemeral watersheds. *Journal of Environmental Quality* 41(5):1531-1539. doi:10.2134/jeq2011.0473

MacDonald, A.L. 2012. *Blurring the lines between production and conservation lands: Bird use of prairie strips in row-cropped landscapes* (Masters thesis). Retrieved from Dissertations and Theses database. (UMI No. 1531486)

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