NRCS	**Michigan Technical Note** **USDA-Natural Resources Conservation Service**

TOPIC: AGRONOMY #49
Subject: Cover Crops on the Edge
Date: June 2010

GENERAL INFORMATION

Following for your use and distribution is a technical note, Cover Crops on the Edge. Reprinted from Crops and Soils, Nov – Dec 2009, pgs 5-8, and provided by Bill Kuentsler, Conservation Agronomist for NRCS Central National Technology Support Center.

Cover crops on the edge

cover cropping in marginal production areas could have far-reaching benefits

Rye cover crop. Photo by Stephen Ausmus (USDA-ARS).

The traditional use of cover crops provides a range of benefits, mainly soil fertility improvements, soil erosion management, and weed and insect pressure reduction. Farmers evaluate the economic and ecological aspects of cover crops by measuring the reduction in input costs such as fertilizer, herbicide, and other pesticide costs. Benefits of the practice vary by location and season, but at least two or three usually occur with any cover crop. As an additional measure, combining cover cropping with conservation tillage can also lead to reduced energy use.

Beyond their on-farm use, research conducted over many years indicates that clever cover crop choices have both local and larger-scale ecological benefits.

According to a report by the USDA Economic Research Service titled "Environmental Effects of Agricultural Land-Use Change" (www.ers.usda.gov/publications/err25/err25.pdf), the large-scale production of just a few crops has contributed to the degradation of water quality with sediment, nutrients, and pesticides; hydrologic modifications contributing to flooding and groundwater depletion; disruption of terrestrial and aquatic wildlife habitats; emission of greenhouse gases; and degradation of air quality with odors, pesticides, and particulates.

Ultimately, farmers tend to make strictly economic-based production choices, according to the report. Producers tend to keep highly productive land in crop cultivation regardless of changing economic conditions. But an increase in commodity prices or production input costs encourages farmers to expand production to less productive land or to shift less productive croplands to other uses. Agricultural and conservation policies also affect land use. Beyond the individual farm level, these wider-scale land-use changes have an impact on environmental quality, particularly when affected lower-quality lands are environmentally sensitive.

The USDA report says that almost three-quarters of the cropland that shifted into or out of cultivation between 1982 and 1997 had soil productivity ratings below the average acre of cropland. This suggests that policies that increase incentives for crop cultivation and stimulate production on economically marginal land may ▶

Cover Crop	Erosion Reduction	Increase soil organic matter	Capture, recycle, redistribute nutrients in the soil profile	Promote biological nitrogen fixation	Weed suppression	Provide supplemental hay	Provide supplemental grazing	Rooting Depth / Plant Water Use /1	Minimize / reduce soil compaction	Seed size (Large or Fine)	Crop Type /2	Seeding rate, lbs/acre	Seeding depth, inches	Salinity tolerance	C:N Ratio	Attract Beneficial Insects	Mycorrhizal fungi association
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
alfalfa	G	G	G	Y	G	F	F	DH	G	F	CB	6.5	0.25 - 0.75	P	L	Y	M
alsike clover	G	F	G	Y	G	F	F	SL	P	F	CB	3	0.25 - 0.75	P	L	Y	M
annual oregon ryegrass	F	G	G	N	F	G	G	MM	P	F	CG	15	.5-1.5	F	M	Y	L
barley	G	G	F	N	G	F	F	MM	F	L	CG	60	0.75 - 2	G	M	Y	L
buckwheat	G	F	G	N	G	P	P	SL	P	F	WB	50	0.5 - 1.5	P	L	Y	N
canola	F	F	G	N	P-G**	F	F	MM	G	F	CB	5	0.25 - 0.75	G	L	Y	N
chickling vetch	G	F	G	Y	F	F	F	SL	F	L	CB	70	0.5 - 1.5	P	L	Y	M
corn	G	G	G	N	P-G**	F	F	DH	G	L	WG	12*	1-1.5	P	H	N	H
cowpea	P	P	F	Y	G	F	F	SL	F	L	WB	30	1 - 1.5	P	L	Y	M
flax	F	F	F	N	P	P	P	SM	P	F	CB	20	.25-.75	F	H	Y	H
grain and forage sorghum	G	G	G	N	G	G	F	MM	G	L	WG	10	0.5 - 1.5	F	M	Y	H
hairy vetch	G	F	F	Y	P	F	F	SM	F	L	CB	15	0.5 - 1.5	P	L	Y	M
lentil	P	P	F	Y	P	F	F	SL	P	F	CB	30	1-1.5	P	L	Y	M
millet	G	G	F	N	G	G	F	SL	F	F	WG	30	.25-.75	P	M	N	H
mustard, oriental or brown	F	F	F	N	G	F	F	MH	F	F	CB	6	0.25 - 0.75	P	M	Y	N
mustard, tame yellow	F	F	F	N	G	F	F	MH	F	F	CB	12	0.25 - 0.75	P	L	Y	N
oat	G	G	F	N	F	G	F	MM	F	L	CG	70	0.5 - 1.5	F	M	N	L
pea	P	P	P	Y	F	G	F	SL	P	L	CB	90	1.5 - 3	P	L	Y	M
radish	P	P	G	N	G	P	G	DH	G	F	CB	10	0.25 - 0.5	P	L	Y	N
red clover	G	F	G	Y	G	F	F	SL	P	F	CB	5	0.25 - 0.75	P	L	Y	M
soybean	P	P	F	Y	P-G**	F	F	SM	P	L	WB	40	1-1.5	P	L	Y	M
spring rye or s. wheat	G	G	G	N	G	F	F	MH	F	L	CG	100	0.5 - 1.5	F	M	Y	L
sudangrass, sudan-sorghum hybrid	G	G	G	N	G	G	G	MM	G	L	WG	25*	0.5 - 1.5	F	M	Y	H
sugarbeet	P	P	G	N	F	P	G	DH	G	F	CB	4	0.25 - 0.5	G	L	N	N
sunflower	F	F	G	N	F	P	G	DM	F	L	WB	7	.5-1	F	M	Y	M
sweet clover	G	F	F	Y	F	P	F	MM	F	F	CB	4	0.25 - 1	F	L	Y	M
tall wheatgrass	G	G	G	N	G	G	G	DH	F	L	CG	13	0.25 - 1	G	H	N	L
teff grass	F	G	F	N	F	G	F	SM	P	F	WG	5	.125 - .25	P	M	N	N/A
triticale	G	G	G	N	G	F	F	MH	F	L	CG	100	.5-1.5	G	M	Y	L
turnip	P	P	G	N	G	P	G	DH	G	F	CB	4	.25-.5	P	L	Y	N
white clover	G	F	G	Y	G	F	F	SL	P	F	CB	1.5	0.25 - 0.75	P	L	Y	M
winter rye or w. wheat	G	G	G	N	G	F	F	MH	F	L	CG	100	0.75 - 2	G	M	Y	L

/1 Rooting Depth/Water Use

SL= Shallow rooted/Low water use
SM= Shallow rooted/Medium water use
SH= Shallow rooted/High water use
ML= Medium rooted/Low water use
MM= Medium rooted/Medium water use
MH= Medium rooted/High water use
DL= Deep rooted/Low water use
DM= Deep rooted/Medium water use
DH= Deep rooted/High water use

/2 Crop types

CG= cool season grass
CB= cool season broadleaf
WB= warm season broadleaf
WG= warm season grass

Shallow 6 - 18 inches
Medium 18 - 24 inches
Deep 24 + inches

Ratings

L= Low G= Good
M= Medium F= Fair
H= High P= Poor
N/A= Not Available

*Variable depending on seed size and row spacing.
**Poor weed competitor, but herbicide-tolerant varieties are available.

Common species and properties of cover crops. *Source: USDA-NRCS (see www.sd.nrcs.usda.gov/technical/CoverCrops.html).*

have disproportionately large unintended environmental consequences. On the other hand, large environmental benefits could be achieved at lower cost using targeted conservation programs because owners of low-quality and environmentally sensitive land require less payment to remove land from production than owners of higher quality land.

The USDA Natural Resources Conservation Service (NRCS) through its new Conservation Stewardship Program provides financial and technical assistance to eligible producers to conserve and enhance soil, water, air, and related natural resources on their land. Eligible lands include cropland, grassland, prairie land, improved pastureland, rangeland, nonindustrial private forest lands, agricultural land under the jurisdiction of an Indian tribe, and other private agricultural land (including cropped woodland, marshes, and agricultural land used for the production of livestock) on which resource concerns related to agricultural production could be addressed. Participation in the program is voluntary.

The program encourages land stewards to improve their conservation per-

formance by installing and adopting additional activities and improving, maintaining, and managing existing activities on agricultural land and non-industrial private forest land. The use of cover crops is one of the activities that the program encourages. The program directly refers to the planting of crops such as grasses, legumes, and forbs to provide seasonal cover that will reduce erosion, improve soil organic matter, promote efficient nutrient cycling, fix nitrogen in the soil, suppress weeds, increase biodiversity, and provide food and cover for wildlife. (For more on the Conservation Stewardship Program, see www.nrcs.usda.gov/Programs/new_csp/csp.html.)

Another group that is working to increase the practice of cover cropping in the Midwest is the Midwest Cover Crops Council (MCCC). The MCCC seeks to significantly increase the amount of continuous living cover on the agricultural landscape of the Upper Midwest. According to the MCCC, in a time when the Mississippi River Basin and Great Lakes watershed suffer from serious environmental degradation, a shift in agricultural systems can play a significant and positive role in revitalizing and restoring lakes, rivers, fields, and communities in the region.

Why cover crops?

Cover crops can provide many different benefits in modern cropping systems, according to ASA–SSSA member Dr. Eileen Kladivko, a founding member of the MCCC and professor of agronomy at Purdue University. However, they require a higher level of management and some experimentation to achieve maximum benefit.

"There are several good reasons to re-evaluate cover crops right now for use in modern cropping systems," said Kladivko during a recent online seminar to crop advisers about the use of cover crops. "These include higher fertilizer prices, higher energy costs, water quality concerns, soil tilth and compaction issues, and concerns about replacing organic matter with increased residue removal practices."

Cover crops are most commonly found in areas with longer growing seasons, Kladivko noted, such as the southeastern U.S. or areas with soils that are steeply sloping, low in organic matter, or sandy and blowing; they are also commonly found on vegetable and melon farms (for sand blasting control), organic farms, mixed farms that use cover crops for grazing, and farms around the Chesapeake Bay that participate in a cost-share program for nutrient management to reduce losses to the bay.

"Traditionally there has been a low level of use of cover crops in the Midwest as compared to a region such as the Southeast," Kladivko said. "However, recently there has been an increased interest in the use of cover crops in the Midwest, especially the eastern part of the Corn Belt region, to prevent nutrient input loss and [improve] water quality."

Cover crops can provide many different benefits in modern cropping systems.

A good fit for using cover crops in the Midwest would be after corn silage and after winter wheat, Kladivko said. "These situations have enough time for seeding and growth and provide significant benefits for soil structure, weed control, and nitrogen production if legumes are used. If corn stover is removed for biomass, cover crops should also be grown to protect soil productivity."

Preventing nutrient loss

According to Kladivko, cover crops are important in nutrient cycling. They trap nutrients that would otherwise "leak out" during fallow periods through leaching, erosion, or runoff and can release those nutrients later—ideally at the time needed by the next crop. Cover crops can translocate nutrients from deeper in the subsoil to near the surface and increase soil biological activity in topsoil, potentially releasing nutrients from soil minerals. Most cover crops do not "create" nutrients in soil; instead they recycle and release. However, leguminous cover crops do add nitrogen to the soil through atmospheric fixation.

A large body of research indicates that losses of nitrate and phosphorus from corn and soybean fields in the Upper Mississippi River Basin contribute to contamination of the Mississippi River and the Gulf of Mexico. For example, the northern portion of the Gulf of Mexico ecosystem, which contains almost half of the nation's coastal wetlands and supports commercial and recreational fisheries, has undergone profound changes due to nutrient enrichment of Mississippi River water from land-based sources. Nutrient over-enrichment can lead to excessive production of algae. When this organic material sinks and becomes decomposed, dissolved oxygen in bottom waters is reduced. Research indicates that this has resulted in seasonal hypoxia (very-low-oxygen water) over the Louisiana continental shelf. Hypoxic waters can cause habitat and marine life loss, affecting commercial harvests and impacting the ecosystem.

Even when farmers carefully manage fertilizers and put on only what is needed by the crop, substantial nutrient losses occur during the fall, winter, and spring when corn and soybean are not growing and the fields are bare. Nutrient loss happens, in part, because there are extended periods during each year when living plants are not removing nutrients from the soil and the nutrients are susceptible to losses. Summer annual grain crops, like corn and soybean, accumulate water and ▶

Cover crop terminology

Brown gap. Nutrient loss happens, in part, because there are extended periods during each year when living plants are not removing nutrients from the soil and the nutrients are susceptible to losses. Summer annual grain crops, like corn and soybean, accumulate water and nutrients only for about four months of the year. The remaining months of the year have been called the "brown gap" because there are no "green" plants that serve to protect the soil and recycle nutrients.

Catch crop. A catch crop is a cover crop established after harvesting the main crop and is used primarily to reduce nutrient leaching from the soil profile. For example, planting cereal rye following corn harvest helps to scavenge residual nitrogen, thus reducing the possibility of groundwater contamination.

Continuous living covers systems. These are agricultural cropping and livestock production systems that maintain continuous living cover throughout the year. This includes those based on perennial plants such as trees, shrubs, grasses, and legumes, as well as annual plants grown in combination, such as the use of cover crops as row crops.

Cover crops. Crops that "cover" the soil and may be used to reduce soil erosion, reduce nitrogen leaching, provide weed and pest suppression, and increase soil organic matter. Winter cover crops are planted shortly before or soon after harvest of the main grain crop and are killed before or soon after planning of the next grain crop.

Forage crop. Short-rotation forage crops function both as cover crops when they occupy land for pasturage or haying and as green manures when they are eventually incorporated or killed for a no-till mulch.

Living mulches. Living mulches are defined as cover crops planted either before or with a main crop and maintained as a living ground cover throughout the growing season. Living mulches are often perennial species and are maintained from year to year.

Perennials. Perennial crops grow for multiple years from a single planting and can replace annual grain crops as the cash crop. For a perennial crop to replace an annual grain crop, a market must be available or the crop must be used on the farm. The most common perennials found in the agricultural systems of the Upper Mississippi River Basin are forages such as grasses and legumes.

nutrients only for about four months of the year. The remaining months of the year have been called the "brown gap" because there are no "green" plants that serve to protect the soil and recycle nutrients.

One way to prevent these losses is to grow plants to take up nutrients and protect the soil surface when the main crops are not present. Cover crops, living mulches, and perennial crops can bridge the gap between harvest and planting of corn and soybean.

Cover crops only grow during the period between harvest and planting of the main crops. Living mulches grow year round between the rows of the main crop but are suppressed with mowing or herbicides during the summer. Perennial crops (e.g., alfalfa) replace the corn and soybean crops altogether. All three of these approaches have advantages, disadvantages, and potential applications. It is generally accepted by scientists that these practices have the potential to reduce nutrient losses, but their adoption is limited by management problems, unfamiliarity of farmers with these practices, and lack of financial incentives. More research is needed, but these practices in conjunction with fertilizer management and other practices can reduce nutrient contamination of the Mississippi River Basin and other surface waters.

Multifunctional agriculture

Advocates of cover crops mention the concept of agricultural multifunctionality, which is defined as the joint production of agricultural commodities and "ecological services." The term, "eco-agriculture" has also been used to describe how land can be managed to sustain a range of ecosystem services, including food and fiber production. Examples of ecosystem services include increased recreational opportunities in agricultural landscapes and protection of biodiversity and water quality.

"Giving up production on just 5% of a producer's most marginal land can pay dividends in terms of overall environmental friendliness," says Dr. Paul Porter, a professor in the Agronomy and Plant Genetics Department at the University of Minnesota.

Overall, these ecosystem services can be highly valuable. For example, the USDA-NRCS Conservation Reserve Program has been estimated to produce $500 million per year in benefits from reduced erosion and $737 million per year in wildlife viewing and hunting benefits at a cost of approximately $1.8 billion.

Continuous living cover crop systems are one component of the agricultural multifunctionality effort. Continuous living cover systems are agricultural cropping and livestock production systems that maintain continuous living cover throughout the year. This includes those based on perennial plants such as trees, shrubs, grasses, and legumes, as well as annual plants grown in combination, such as the use of cover crops as row crops.

The concept of the continuous living cover system has been promoted by the Green Lands, Blue Waters project, a long-term comprehensive effort by midwestern land grant institutions and various nongovernmental organizations to support the development of and transition to a new generation of agricultural systems in the Mississippi River Basin that integrate more perennial plants and other continuous living cover into the agricultural landscape.

"All farming decisions are based on economics, but for some farmers, it may make sense to convert some of their least productive acres into wetlands and open that to hunters or conservation," Porter says.

Individual growers will consider a variety of factors in determining whether a cover crop might be right for their particular situation such as: soil erosion and conservation, soil fertility, pest management, growing season, biomass production to increase organic matter, and the producer's resource-suitable acreage, irrigation capability, available labor, equipment, costs, capital, and personal goals and interests. ■