Advantages of crop rotation &
crop rotation embedded in integrated crop management.

1. Crop rotation helps to create a biodivers soil which reduces the chance of soil bound organisms to get a pest and **reducing the use of pesticides** (see annexes)
2. Crop rotation helps to minimise the growth of herbs getting a weed that needs to be eradicated and so **reducing the use of pesticides**
3. Crop rotation helps getting a good soil structure (alternatively shallow and deep rooting roots), high organic matter, good water provision, especially in combination with conservation tillage, resulting in **a higher yield**
4. Crop rotation, especially performed with nitrogen-fixating rotation crops, will reduce the input of fertilizers and so **reduce the pollution by nitrogen;** a high nitrogen-supply will even contribute to soil organic matter depletion (S.A.Khan et al. J. Environ. Qual. 36:1821-1832, 2007: "*The myth of nitrogen fertilization for soil sequestration")* pointing to the role of high N-fertilizer use as a reason for carbon depletion)
5. Crop rotation, especially combined with conservation tillage, will lead to higher soil-carbon content and so **contribute to combating climate change** (proven in decade-long surveys in the US, Illinois, see Annex, and also by research, L.M.Vleeshouwers et al. Global Change Biology 8:519-530, 2002: *"Carbon emission and sequestration by agricultural land use: a model study for Europe").*

For further information:
Hans Muilerman, PAN Europe Brussels office
tel: + 316-55807255; email: hans@pan-europe.info

Pesticide Action Network Europe (PAN Europe) was founded in 1987 and brings together consumer, public health, and environmental organisations, trades unions, women's groups and farmer associations from across 19 European countries. PAN Europe is part of the global network PAN working to minimise the negative effects and replace the use of harmful pesticides with ecologically sound alternatives.

Annexes.

Value of crop rotation in nitrogen management

by Mahdi Al-Kaisi, Department of Agronomy

Understanding the relationship between nitrogen (N) and crop rotation is very important when making N management decisions. There are several benefits to using crop rotation, including improved nutrient cycling, soil tilth, and soil physical properties; and enhanced weed control. Crop rotation also may influence the rate of N mineralization or the conversion of organic N to mineral N by modifying soil moisture, soil temperature, pH, plant residue, and tillage practices.

The incremental increase in N use over the past five decades, due to emphasis on maximizing yield, has led to a subsequent increase in N in the soil profile of some agricultural fields. Therefore, the influence of agricultural practices on water quality has prompted studies to develop best management practices to optimize the use of fertilizer N and reduce N loss to surface and groundwater. Crop rotation can play a major role in minimizing the potential risk of nitrate leaching to surface and groundwater by enhancing soil N availability, reducing the amount of N fertilizer applied, and minimizing the potential risk of N leaching.

Research on the impact of long-term crop rotation on soil N availability shows that planting alfalfa, corn, oat, and soybean significantly increased the mineralized net N in soil compared with planting continuous corn. Because soil N mineralization can effect yield, crop rotation thus can be used as a management system to enhance the soil nutrient pool, thereby reducing the fertilizer N input and minimizing the risk of leaching of excess N during wet weather.

A combination of conservation tillage practices and crop rotation has been shown to be very effective in improving soil physical properties. Long-term studies in the Midwest indicate that corn-soybean rotation improves yield potential of no-till compared with continuous corn. The reduction in yield of continuous corn in no-till is attributed to low soil temperature during seed germination, which is evident on poorly drained soils under no-till. Studies show that the poor performance of no-till corn following corn is more likely due to the previous crop than to surface residue conditions preventing early-season warming and drying of soils.

The use of a legume cover in crop rotation can provide a substantial amount of N to a succeeding crop. Research has indicated that seeding rates for legumes can be reduced by approximately one-third of that recommended for forage production when used as cover crops without sacrificing biomass or N accumulation. Also, the type of crop grown in the previous year can impact the efficiency of conservation tillage, especially for no-till systems, due to the kind and amount of crop residue from the previous crop.

This article originally appeared on page 49 of the IC-486 (6) -- April 23, 2001 issue.

Crop rotation considerations for 2004 management season rotation

There are many management strategies for improving soil productivity. Crop rotation or cropping sequence is proven to be very effective in addressing concerns related to soil, water, and environment quality from long- or short-term perspectives. Producers who are innovative in diversifying their cropping systems and management strategies will be more successful than others who are not.

As producers search for better ways to achieve profitability, one management tool that has been largely overlooked for too long is a robust multiple-crop rotation management system. There are several proven benefits of a multiple-crop rotation system.

Crop rotation--a winner from many perspectives

Although extensive crop rotations are largely considered an age-old farming practice, they have many agronomic, economic and environmental benefits over 'continuous cropping.'

Crop rotation can improve yield and profitability over time, control weeds, break disease cycles, limit insect and other pest infestations, provide an alternative source of nitrogen, reduce soil erosion, increase soil organic matter, improve soil tilth, and reduce runoff of nutrients and chemicals, as well as the potential for contamination of surface water.

Improved soil structure

Annual crop rotations (especially in no-till systems) cause dramatic differences in root structure over time. From taproot crops to fibrous-root crops, diversity in root structure will improve the soil's physical, chemical, and biological structure. Soil improvement, in turn, creates a variety of macro pores (the channels in soil that allow infiltration of water, nutrients, and oxygen), and facilitates new root growth of successive crops.

Improvement in soil organic matter and nutrient pools is another benefit as a result of crop rotation, which can improve soil structure and increase the soil's water-holding capacity.

Diminished soil erosion

Soils with good structure improve water infiltration due to increased macro pores. The improvement in microbial communities and soil tilth will also help reduce soil erosion because of more stable soil structure, improved water infiltration, and reduced surface runoff -- the mechanism by which soils are lost to streams, lakes and rivers.

Access the crop rotation nutrient cycle

Producers can calculate and allow for the impact of additional nutrients (nitrogen, for example) from crops such as soybeans and alfalfa. More nutrients in the field, from crop rotation, means sustaining nutrient availability with fewer inputs, lower costs, and increased margins.

Pest and disease control improves

Diversifying cropping sequences takes away the 'host organism,' and disrupts the annual life cycles of diseases, insects and weeds. For example, nematodes and anthracnose--two big problems in Iowa right now--are highly susceptible to crop rotation. Besides, using crop rotation to control pests and disease means that producers use fewer crop inputs to fight pests, and thus, reduce both costs and environmental repercussions.

The end result -- better soil fertility and carbon storage

The Morrow plots at the University of Illinois were established in 1876, to study the effects of crop rotation and fertilization on yield (see Table 1). Crop sequences, in a single replication, were continuous corn, corn-oats, and corn-oats-clover, with and without lime, manure, and rock phosphate.

The results: Continuous corn with no fertilizer decreased soil organic matter content by 45.6% in 55 years compared to adjacent sod. Removal of carbon from the soil will lead to a decline in soil fertility and aggregate stability. Although the study shown in Table 1 is dated, the principle demonstrated remains applicable today.

Management concerns with crop rotation and some possible solutions

As with any management system, there are some concerns with crop rotation systems. Herbicide carryover is an issue that needs constant attention in the plan and the field. Introducing new crops also means new skills and use of different equipment or increased labor costs. Also, strategies need to be created for marketing multiple crops.

In the end, however, many Iowa producers might find themselves surprised by the results of cost\benefit analysis of crop rotation in their operations. Take the time to establish clear objectives and understand the consequences--pro and con--of choosing any management strategy for producing sustainable and balanced system.

Table 1. Long-term effect of rotation and treatments on soil organic carbon content in Morrow plots (1876-1940), University of Illinois.

Rotation	Treatment	% Organic C	% Organic Matter	% C Change
Corn	none	1.74	2.99	- 45.6
	MLP	2.09	3.59	- 34.7
Corn/oats	none	2.14	3.86	- 33.1
	MLP	2.44	4.20	- 23.6
Corn/oats	none	2.28	3.92	- 28.7
/clover	MLP	3.35	5.76	+ 4.0
Sod	none	3.20	5.50	0.0

[a] MLP = Manure - Lime - Phosphorus

Do I need to till my soil?

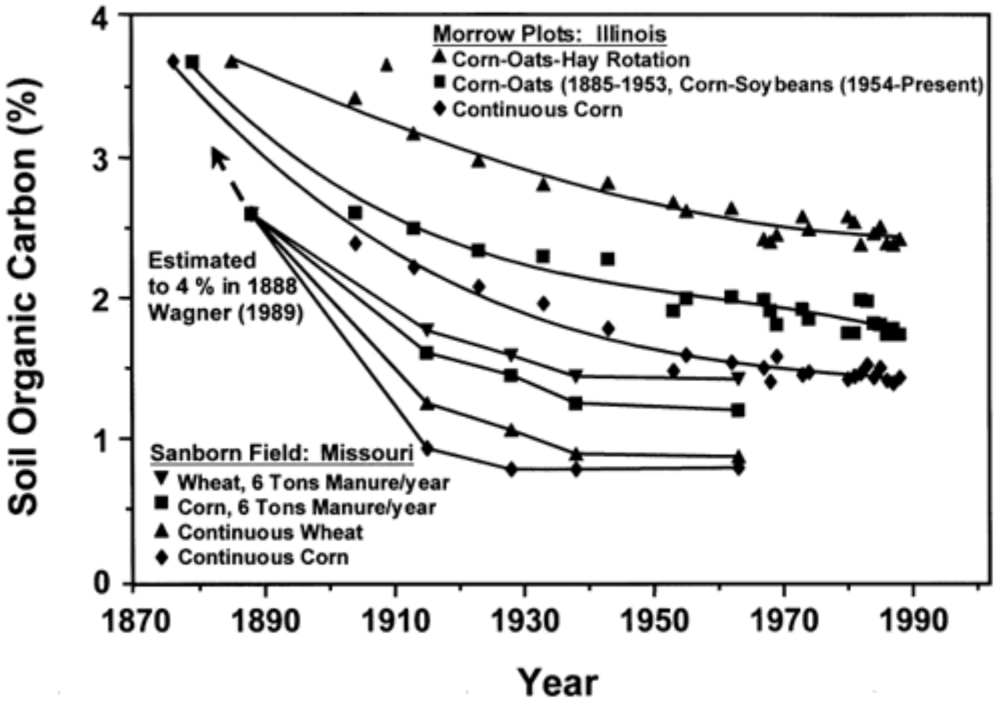
by Mahdi Al-Kaisi, Assistant Professor, Department of Agronomy, and Don Reicosky, soil scientist, Department of USDA-ARS North Central Conservation Research Laboratory

There was a considerable amount of tillage activity during fall 2001 in different parts of the state, which suggests that we have a long way to go in adopting conservation tillage practices. In 1999, a survey of 340 corn and soybean producers in 19 Iowa counties was conducted by the Iowa Resources Management Partnership, established in 1999 as an informal partnership of private and public organizations promoting and addressing issues related to conservation tillage in Iowa. Survey results showed that conventional tillage, various types of conservation tillage, and no-till systems were equally used (one-third each) by producers on corn and soybean.

These findings bring us back to our observation about the level of tillage activity during fall 2001, when weather conditions seemed to provide ample opportunities for recreational tillage. The fall weather (warm temperature and lack of moisture) and the current mild winter are the conditions under which conservation tillage is most needed. Our hope is that you think twice about any tillage operation this spring and ask yourselves the following question: Do I need to till my soil and why? If you can answer based on facts and not hearsay then you are justified to use tillage operations; otherwise, do not waste your time and money on an operation you do not need.

Here are a few facts to help you make the decision whether to use conservation tillage. Conservation tillage benefits are numerous and include moisture conservation, improved organic matter by minimizing carbon release due to oxidation of organic matter, and water quality improvement by stabilizing the soil surface by keeping more plant residue on the soil surface. The point is that you need to look at the sustainability of your soil. Producing high yields is important for your economic well-being. However, the intensity of tillage does not contribute to increasing yield without substantial input of fertilizer, a cost that needs to be considered for any production system. Research shows that intensive tillage and lack of diverse crop rotation result in a significant decline of organic carbon content over many years. Long-term studies of different crop rotations have been conducted since 1885 and show a significant decline in soil organic matter with continuous crop rotation (Fig. 1). The rate of organic matter decline is not going to be realized in a short time and neither is the improvement of soil organic matter after an intensive tillage system.

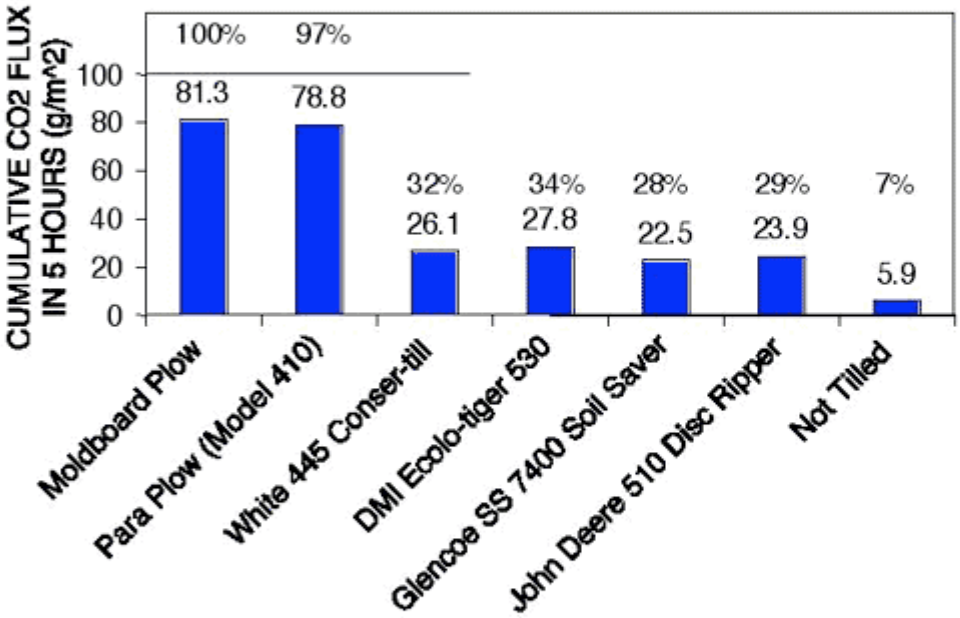
Figure 1. Long-term effects of crop rotations on soil organic carbon.



There is a misconception that conventional tillage and high fertility can increase soil organic matter, but here are some facts to the contrary. First, intensive tillage causes oxidation or burning of soil organic matter, leading to an increased release of carbon dioxide. Second,adding more nitrogen can increase yield and plant residue; however, if these residues are plowed or chiseled in, they are subsequently broken down, which increases loss of stored soil carbon from the previous season. Thus, there will be a net loss of soil carbon. Third, a reduction in plant residue cover and exposure of bare soil surface lead to soil organic matter loss due to soil erosion. Research has shown that a significant loss of soil carbon due to tillage systems ranges from 7 percent under no-till to approximately 30 percent when using disc rippers compared with moldboard plow. The short-term carbon dioxide loss from the paraplow was similar to that from the moldboard plow due to similar soil fracturing, but without inversion (Fig. 2).

In summary, the intensity of a tillage system has serious negative impacts on soil degradation and water quality. The adoption of conservation tillage systems and the payoff of such systems take time. There are no quick fixes for soil properties that have been destroyed by intensive tillage practices. For no-till or any other conservation tillage to work, you need to think long-term environmental benefits and give it time.

Figure 2. Impact of different conservation tillage tools on soil carbon loss.



This article originally appeared on page 26 of the IC-488 (3) -- March 18, 2002 issue.

Updated 03/17/2002 - 1:00pm

Carbon sequestration

by Mahdi Al-Kaisi, Assistant Professor, Department of Agronomy, and Mark Hanna, Extension Agricultural Engineer, Department of Agriculture and Biosystems Engineering and Miachael Tidman

Carbon is essential for life on earth -- it sustains biological activity, diversity, and ecosystem productivity. Humans and animals release carbon dioxide (CO_2), while plants take it in and release oxygen, returning carbon to the soil when they die. It's generally accepted that the carbon cycle flowed more or less in balance until the late 1880s.

What is carbon sequestration?

Carbon sequestration is the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere. The idea is (1) to prevent carbon emissions produced by human activities

It has been documented that the world's CO_2 levels have increased over the last century. And, although doubt remains regarding the cause or causes -- whether from human activity or a natural cyclical change in the environment -- there is general agreement that at least some rise in CO_2 levels result from human activity. Regardless of the cause, we do know that emissions to the atmosphere from power and industrial plants and vehicles have increased CO_2 in the atmosphere to levels above the pre-industrial trend.

from reaching the atmosphere by capturing and diverting them to secure storage, or, (2) to remove carbon from the atmosphere by various means and 'storing' it in the soil.

How does carbon sequestration work?

Reducing atmospheric CO_2, that is sequestering carbon, can take place three ways:

- carbon production or trapping carbon within plants. The more permanent vegetation that is present, the more CO_2 is required.
- minimizing organic carbon mineralization. That means managing crops and soil to reduce conditions that break down or oxidize organic matter -- letting plant material decompose more slowly and naturally.
- reducing soil erosion and keeping carbon trapped in the soil. Eroded soil is exposed soil -- and exposed carbon.

Managing for carbon sequestration

When it comes to managing soil for organic matter and carbon sequestration, there is no single practice that works alone to enhance soil function, and no prescribed set of practices can work everywhere. The goal is improved soil organic matter and soil function everywhere -- croplands, pastures, and woodlands.

The most often recommended practices include some familiar strategies and some not so familiar. Using higher residue cover crops and rotations, such as oats and hay, creates larger volumes of plant biomass and stores more carbon in the soil. And less soil disturbance means less erosion. Some of the best candidates include a high-biomass crop rotation and cover crops, residue management (mulch-till, no-till, strip-till), compaction prevention, and rotational grazing.

Conservation tillage gives this central Iowa field the protection it needs from wind and water erosion (photo by Lynn Betts, USDA, Natural Resources Conservation Service).

Enlarge

Benefits of Soil Carbon Sequestration

Changes in soil properties and environmental quality. As management changes, benefits might appear in several ways. The first is improved soil structure, with surface structure becoming more stable and less prone to crusting and erosion. Water infiltration could improve, meaning less surface runoff. As soil organic matter increases, soil water and nutrient capacity increases significantly. And crops will fare better during drought because infiltration and water holding capacity have improved.

Also, organic matter and the associated soil biological population will increase in vigor and numbers with more diverse crop rotations. Organic matter also may bind pesticides, suppress disease organisms, and improve crop health and vigor as soil biological activity and diversity increase.

Improvements can be expected in air quality as dust, allergens, and pathogens in the air decline; in water quality as sediment and nutrient loads decline in surface water from better soil aggregation; and in agricultural productivity. Wildlife habitat also is improved with higher residue levels.

One possible future -- managing for carbon sequestration. The concept is real, and Iowa producers should expect more dialogue, not less, about the issue. The longer they pay attention to the issue, the more they will know about it, which puts them in the best position possible when it's time to make a decision. For more detailed information about carbon sequestration, call your local Iowa State University Extension office and request PM 1871, Impact of Tillage and Crop Rotation Systems on Soil Carbon Sequestration.

Managing for 'T'-- is it good enough?

For many years, conservationists have advised farmers and land managers to implement management practices to keep soil erosion at or below the level at which productive soil can be replaced, or a value called 'T'. Now, some conservationists are beginning to reassess this strategy for the following reasons:

First, on many landscapes soil is still eroding at rates greater than T. Even though important soil savings have been achieved through soil erosion control technology, focusing on organic matter might further reduce erosion.

Second, T is not adequate for resource protection -- at T, the U.S. will continue to displace over a billion tons of soil per year. At those levels, air quality, water quality, and wildlife habitat remain at risk.

Third, controlling soil erosion does not equal sustaining soil function. Keeping soil in place is only part of the job. Soil also has to function well -- holding nitrogen, phosphorus, and pesticides in place and keeping them out of surface water. Soil delivers nutrients and water to growing plants as needed. And soil minimizes the effects of excess water and droughts.

This article originally appeared on pages 139-140 of the IC-490(19) -- August 4, 2003 issue.