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USDA-ARS
Northern Great Plains
Research Laboratory

July 2005

NORTHERN GREAT PLAINS INTEGRATOR

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NORTHERN GREAT PLAINS RESEARCH LABORATORY

Our Vision:

An economically sustainable and environmentally sound agriculture.

Inside this issue:

USDA-ARS Northern Great Plains Research Laboratory

Back To The Future

The Ag of specialization is over, especially in central and western Dakotas.

The hot new trend: Diversification.

That's according to Jon Hanson, director of the USDA-ARS Northern Great Plains Research Laboratory at Mandan, N.D.

He says that for the past two decades, farm management advisors have preached specialization. The idea was that raising crops and livestock had become so complicated that you have to specialize in just one enterprise to be good at it.

But with the spread of dawning of the information age and the ability to hire consultants and advisors, that argument doesn't ring true anymore.

Diversification is again profitable, he says. NGPRL is focusing on helping farmers and ranchers figure out ways to diversify profitability. They have several projects aimed at enabling crop producers to bring livestock back into their operations. Research ranges from developing a feeding program to raise the healthy omega-3 levels in meat to perfecting a low-cost swath grazing program for wintering cows.

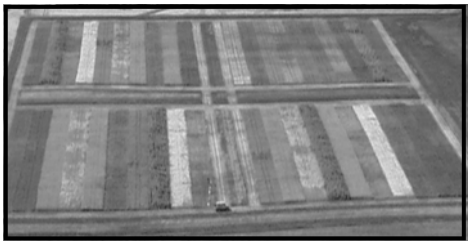
Learn more at NGPRL's annual Friends and Neighbors Day, July 21. The event begins at 4 p.m. with a research tour, presentations, equipment displays and food.

Lon Tonneson
Dakota Farmer
May 2005

Crop Sequencing: Making Soil Biology and Water Use Improve System Efficiency

Adoption of residue- and water-conserving management practices has facilitated the ability of producers to adopt principles of dynamic cropping systems, whereby crop and soil management decisions are adjusted annually to meet changing conditions of climate, economics, and environmental care needs.

Using a diversity of crop species is the principal way to practice the principles of dynamic cropping system management. Crop species diversity in rotations is the most important means for controlling pests – weeds, plant disease, insects, and others.



All above and below ground factors that affect crop growth operate through the soil. Efficient and productive crop rotation management is developed by planting crop sequences that maximize positive soil biology responses.

In dryland agriculture, soil water movement and use by crops especially affects production efficiency. Optimum cropping system management requires knowledge of the effects of crop sequencing on soil water use.

Scientists at the Northern Great Plains Research Lab have completed or are in the process of carrying out several crop sequence projects to discover principles of soil biology and soil health linked to crop ecology. All research is conducted under no-till management.

Crop Sequence Experiment

Research was carried out by formation of a ten-crop by ten-crop matrix over a two-year period. The ten crops were: barley, dry bean, dry pea, canola, crambe, flax, safflower, soybean, spring wheat, and sunflower. In the first year, the ten crops were planted in randomly positioned 30-foot wide strips. In the second year, the same ten crops were planted in strips perpendicular to the first set, but in new random sequences.

The crop matrix, which had 4-fold replication, was repeated at a second site immediately adjacent to the first.

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FRIENDS and Neighbors Day

is July 21 at the USDA Northern Great Plains Research Laboratory and Area 4 Soil Conservation District Research Farm, Mandan, N.D.

The event, which starts at 4 p.m., has evolved into much more than a typical research station tour. It features presentations, equipment displays, a barbecue and entertainment in addition to a tour of research projects.

The 2,000-acre USDA-ARS facility is well-known for its agronomy research. The main area of focus has been crop rotations, moisture management, no-till production and soil quality. Current projects also involve development of new grazing alfalfas and a new Russian wild rye grass and restoration of native grasses.

But NGPRL is also doing some significant research in beef production. Scientists are experimenting with flaxseed in rations to boost omega-3 levels in the meat. Omega 3s are normally found in high levels in some fish and, when part of a healthy diet, are believed to help reduce the risk of heart attacks in humans. They see a potential for North Dakota and South Dakota producers to one day market a special, healthy beef brand from cattle fed flax.

NGPRL researchers also have been conducting swath grazing trials to determine how to best reduce the cost of producing and harvesting forages that are going to be fed to livestock. Swath grazing involves concentrating forages in swaths in a field and having cows graze the swaths over winter.

Lon Tonneson
Dakota Farmer
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The matrices were preceded by winter wheat or barley crops, and both were followed with spring wheat. Crops were seeded with a John Deere 750 no-till drill. During seeding of all crops, nitrogen was band applied at 60 lb N per acre mid-row between every other row. Phosphorus was applied with the seed at 10 lb P per acre as a 0-44-0 formulation.

Crop Sequence Effects and System Efficiency

The pattern of crop sequence effects observed for crop matrices at Site 1 (1998-1999) and Site 2 (1999-2000) are shown in Table 1. Growing season precipitation in 1999 was considerably greater than average, and growing season precipitation in 2000 followed a pattern that was quite near to the long-term average. What stands out in the pattern of results in Table 1 is the negative effects of growing a crop on its own residue, as seen along the diagonal of the Table. Flax on flax produced a notably negative interaction both years. The various crop-on-same-crop negative interactions appear to be largely the result of plant disease processes. There is positive crop sequence effects in the upper half of Table 1; a result that is attributable to the fact that legumes are listed as the first three residue crops.

Table 1. Crop sequence results showing effects of matrix crops (right side, vertical) on matrix year (1999 and 2000) crops (top). Statistically significant decremental or enhancive effects of residue crops on matrix crops' seed yields are shown as percentages of annual average yields.

Residue Crop	Year	Dry Bean	Dry Pea	Soybean	Canola	Crambe	Flax	Barley	Spring Wheat	Sun-flower	Saf-flower
Dry Bean	1999									+29%	
	2000				+15%						
Dry Pea	1999					+31%					+17%
	2000		-13%								
Soybean	1999			+25%			+18%				
	2000		+15%				+21%		-9%		
Canola	1999										
	2000	-17%			-33%	-77%	-18%				-41%
Crambe	1999		-15%								
	2000	-44%		-28%							
Flax	1999						-54%				
	2000						-61%	+10%			+36%
Barley	1999	+24%									+24%
	2000							-17%			
Spring Wheat	1999	-29%	+20%	-10%							
	2000								-14%		
Sunflower	1999										
	2000	+16%		+29%		+46%	+17%				
Safflower	1999	-24%		-16%		-16%			-10%		-49%
	2000						+24%		+11%		
Average lb/A	1999	957	2260	1834	1231	1607	1327	4120	2998	1405	796
	2000	1646	2904	1919	1293	943	950	3137	2958	1070	895

A scoring system was set up in order to compare the sequential effects on all other crops by a crop species acting as the residue crop (Table 2). Rather prominent differences among the crops are shown by their net sequence effects scores. Canola, crambe, and safflower all have net sequence effect scores of -26 or more negative. Dry bean, soybean, and sunflower all have positive net sequence effect scores of 20 or greater.

Table 2. Crop sequence effects scores for individual crops.

	Dry Bean	Dry Pea	Soybean	Canola	Crambe	Flax	Barley	Spring Wheat	Sunflower	Safflower
Positive sequence effect score	+20	+20	+39	0	0	+20	+20	+13	+39	+20
Negative Sequence effect score	0	-7	-7	-52	-33	-26	-13	-26	0	-46
Net sequence effect score	+20	+13	+32	-52	-33	-6	+7	-13	+39	-26

Crop sequence effect scores for groups of crop species or for categories of crop sequences have been averaged on a single-crop basis, as shown in Table 3. The strongly negative, decremental crop sequence effect (score -28) of the mustard family crops, canola and crambe, may possibly be related to the fact that these two species are known to not have endomycorrhizae on their roots, while all the other crops involved here do have them. Endomycorrhizae are known to provide mineral nutrient and other soil biological benefits to plant species, most notably for phosphorous nutrition. The positive net sequential effect (score 22) of the three legumes studied may possibly reflect some positive soil biological and/or soil health benefit from this class of symbiotic nitrogen fixers that is above and beyond any nitrogen benefit.

It should be noted that all crops in this research, including the legume crops, received nitrogen fertilization. In this research, sunflower had a positive crop sequential effect (Table 3, score 39). Other research in this region has shown negative crop sequential effects of sunflower on following crops, particularly because of the ability of sunflower to root deeply and use more soil water than other crops. In this research, sunflower was a residue crop during years of average and significantly above average precipitation.

The results here show that plant pathology and the principles of soil biology are linked. Crop rotations can be designed that achieve higher production efficiency by applying these principles. The positive soil biological and soil health benefits of legume crops are well supported by our results. Legume crops can boost system efficiency further through their nitrogen benefits.

Producers must exercise considerable caution with the "stacking" (growing two years in a row) of certain crops. This may work for some circumstances for some crops (e.g., corn) in some years, but for other crops, stacking can well result in not only soil biological inefficiency, but in a strong increase in plant disease.

Water Use and Crop Sequencing

In this research, sunflower and safflower depleted more soil water than other crops. Dry pea consistently depleted the least over the cropping season. The NGPRL results showed that Flax and soybean tended to be heavier than average water users, and barley and crambe tended to be lesser than average water users. Length of active crop growing season is the most important reason for heavy water use, followed by depth of root growth.

A critical soil and crop management consideration is the effect of various crop species on the amount of water left in the soil at seeding time the next spring. On average, the least heavy water user, dry pea, tended leave the most water in the soil the following spring. Spring snowmelt can alter soil water differences built up during the previous growing season.

Observations made in this crop sequence experiment and in a more recent successor experiment have shown that the springtime difference between sunflower and dry pea can be about 3 inches or more. If drought occurs in the year following the growth of sunflower or some other heavier water user, suppression of yield can be considerable.

Table 3. Crop sequence effects scores for crop categories.

	Three legumes	Two mustards	Two small grains	Sun-flower	All ten crops	Crop on own residue
Positive sequence effect score, single crop basis	+26.3	0	+16.5	+39.0	+19.1	+1.3
Negative sequence effect score, single crop basis	-4.7	-28.3	-19.5	0	-21.0	-8.5
Net sequence effect score, single crop basis	+21.7	-28.3	-3.0	+39.0	-1.9	-7.2

Roland Mihulka joined the maintenance staff at NGPRL in May. He grew up at Bowman, ND, is a Navy veteran, and spent his early youth laboring in the western North Dakota oil industry. Mihulka has been a Certified Master Auto Technician for 25 years.

Jeremy Will is not a new face at the Northern Great Plains Research Lab! He graduated from the University of Mary in 2000 with an accounting degree and has worked in the maintenance department for the last five years. He assumed his new responsibilities as Purchasing Agent in March.

Dr. Rebecca Phillips began Plant Physiologist duties at NGPRL in June.

Her duties include working on rangeland plant physiology and carbon sequestration.

Phillips earned a B.S. in Biology and Physical Science at the Mississippi University for Women, an M.S. in Ecological Studies at Colorado State University, and a Ph.D. at the University of North Carolina. She served as a post-doc at the University of Michigan's School of Natural Resources.

Phillips moved to NGPRL from the Atmospheric Sciences Department at the University of North Dakota's John D. Odegard School of Aerospace Science. Her previous research projects include rangeland plant-animal interactions, soil microbial metabolism and community structure, organic and precision agriculture greenhouse gas flux and carbon cycling, greenhouse gas exchange, and agricultural remote sensing.

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Technology Transfer Product of the Northern
Great Plains Research Laboratory
United States Department of Agriculture
Agricultural Research Service

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