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## Grass: Using nature's way of building the soil

By David Granatstein, project coordinator for the six-state Dryland Cereal/Legume Project.

Most of the dryland cereal-producing regions of the inland Pacific Northwest originally were native grasslands. Over thousands of years, the thick roots of the perennial plants added valuable organic matter to the soil and held it tightly in place.

Native perennial grasses are known to produce a greater amount of their plant biomass below ground than above ground when compared to

common cultivated crops, both perennial and annual. See Table 1, page 3.

A trade-off in the development of grain crops has been an increase in above-ground production for food and a relative decrease in the root biomass. This was partly accomplished by shifting from perennial to annual life cycles, thus leading to disturbance of the soil with tillage to plant a new crop each year.

The value of perennial grasses in conserving and restoring soils in dryland regions is

widely documented in scientific and popular writings. Grass plantings have long been encouraged by the U.S. Soil Conservation Service. In 1961, V.G. Kaiser\* estimated that, by the end of the Korean War, more than half the farmers in the Palouse had included a grass/legume phase in their cereal rotations. But limited economic returns and adverse commodity program rules gradually reduced perennial grass plantings essentially to those acres in grass seed production. Farmers who plant grass, thereby engaging in

**More GRASSES, page 3**

## At last: Farm Bill recognizes benefits of sustainable farming techniques

By the Alternative Energy Resources Organization (AERO), Helena, Mont., and the Center for Rural Affairs, Walthill, Neb.

An important new component of the 1990 Farm Bill is the Integrated Farm Management Program Option (IFMPO).

IFMPO is a commodity program flexibility option designed to allow producers to adopt farming systems that incorporate resource-conserving crop rotations. The IFMPO will help farmers use improved stewardship practices by providing farm program payments on resource-conserving crops planted on paid acres and by allowing some harvesting on set-aside acres.

How does it work? Farmers will

develop farm management and crop rotation plans to maintain or enhance profitability and productivity, reduce soil erosion to nondegradation levels ("T"), improve soil fertility and tilth, and protect surface water and groundwater from contamination. The plan and the contract period must be for at least three years and may, at the farmer's option, be for four or five years. During this period, base acres devoted to resource-conserving crops receive certain protections. Plans may be revised due to changing conditions, as long as the modifications are consistent with the basic objectives.

The Farm Bill defines resource-conserving crops as forage

**More FARM BILL, page 2**

### Inside the SFQ

On-farm tests yield data tailored to each individual operation. Page 5.

Intensive management, grass in rotations, help keep this eastern Washington farm sustainable. Page 6.

Computers crunch farm-test numbers: No experience necessary. Page 7.

AERO to release firsthand farmer experience handbook. Page 7.

Six-state sustainable ag database at WSU ready for public debut. Page 9.

**FARM BILL, from page 1**

legumes (such as alfalfa), legume/small grain mixtures (such as oats/clover), or legume/grass mixtures which, when added to a rotation, reduce erosion, improve fertility and tilth, interrupt pest cycles, and conserve water. Soybeans and other oilseeds or edible beans are not eligible as resource-conserving crops, nor is wheat, except for wheat interseeded with other small grains not for human consumption.

To be eligible, at least 20 percent of the base acreage enrolled in the program must be devoted to resource-conserving crops as part of a rotation. Set-aside acres may count toward the 20 percent and may be integrated into the rotation. While the farm plan will likely need to describe a general management plan for the whole farm, only base acres will actually be enrolled in the program. The farmer may choose to enroll one base but not another if, for example, the farm had both a barley and a wheat base and the farmer wanted to experiment with extensive rotations only on the barley base.\*

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Evaluative comments, ideas for articles and questions should be forwarded to AESO, 44 N. Last Chance Gulch, Helena, MT 59601, (406) 443-7272.

These benefits apply to resource-conserving crop acres:  
 ✓ The farmer will not lose any base acres (i.e., for the purpose of calculating base acres, the land will be treated as if it were planted to the program crop) and program payment yields cannot be reduced.

✓ Deficiency payments will be made (except on set-aside or triple base acres) as if the program crop had been planted, provided that certain restrictions on haying and grazing are followed.

✓ If set-aside acres are used to plant resource-conserving crops, up to one-half of the set-aside acres may be hayed or grazed at any time, without restriction. In addition, non-program small grains (e.g., buckwheat, rye, triticale, etc.) may be harvested for grain, and haying and grazing is permitted after the small grain harvest.

To be eligible for deficiency payments, the resource-conserving crop may not be hayed or grazed during the five months that haying and grazing are not allowed on CRP acres, except in the case of a resource-conserving crop that includes a small grain, in which case it can be hayed or grazed any time after the small grain has been harvested in kernel form.\*

IFMPO producers, like all farm program participants, will be subject to triple base in addition to set-aside requirements. Hence, 15 percent of base, over and above the set-aside acres, will be ineligible for deficiency payments. Triple base acres are, however, eligible for price support loans, including the new marketing loans for soybeans and other oilseeds.

Two other restrictions apply:

• Deficiency payments will not be made on any resource-

conserving crops planted on "traditionally underplanted acres" (e.g., land that is flooded in most years) nor on the 8 percent of 0/92 acres that are unpaid should a producer enroll land into IFMPO that is currently in 0/92.

• USDA is allowed to restrict the option of year-round haying and grazing on half of the set-aside acres if it determines that it will have a significant adverse effect on the hay market in any area.

For each year 1991 through 1995, between 3 and 5 million acres will be allowed in the program, for a total of up to 25 million acres by 1995.\*

IFMPO participants are eligible for other new conservation programs in the Farm Bill:

• The Water Quality Protection Program offers incentive payments of up to \$3,500 per year for periods of three to five years for the implementation of farm management plans designed to protect surface and ground-water.

• The 0/92 program has been amended to allow the planting and harvesting of oilseeds other than soybeans (e.g., canola, sunflowers, safflower, etc.). If a farmer enrolled only part of the farm in IFMPO, this might be an option to consider in certain areas of the country.

This article reflects the language of the Farm Bill as approved by Congress. On Feb. 26, 1991, the USDA made public draft rules that are contrary to Congressional intent in the areas marked with asterisks. At the time of this writing (late March), the final rules had not been established. Watch for updates on the Farm Bill in future issues of the Sustainable Farming Quarterly. □

**Table 1. Root biomass contributions (0-4 inches of soil) by various crops — Nebraska**

Crop	Pounds/Acre	Percent
Big bluestem (native)	8,200	100*
Bromegrass	3,505	48
Alfalfa	3,497	43
Winter wheat	1,308	14
Oats	847	11
Corn	1,160	14
Sudan grass	1,374	17

\* Relative percent compared to bluestem (=100 percent)

Kramer and Weaver, 1938.

**Table 2. Effect of historical and current management on water runoff and soil loss — Pullman, Wash.**

Total runoff and soil loss (1936-1940)

Current Cover	Runoff (inches)		Soil Loss (T/Acre)
	Runoff (inches)	Soil Loss (T/Acre)	
<b>Virgin land<sup>1</sup></b>			
Winter wheat	.06	.00	
Wheat stubble	.04	.06	
Grass	.01	.00	
<b>Cultivated land<sup>2</sup></b>	2.97	6.99	
Winter wheat	.05	.11	
Wheat stubble	.20	.00	
Grass			

<sup>1</sup> Broken out of sod in 1904 and cropped to wheat-fallow. Average yield 40 bushels/acre.

<sup>2</sup> Cropped for the past 60 years. Average yield 25 bushels/acre.

Stephens, 1944.

### GRASSES, from page 1

perhaps the most soil-conserving practice available, have been severely penalized by farm program rules over the past two decades.

### Water infiltration and erosion control

From a practical standpoint, perennial grass plantings almost always lead to improved water infiltration and reduced soil erosion. This is caused by increased organic matter, stabilized soil aggregates, more root and earth worm channels, permanent ground cover, and the absence of tillage for a period of time.

Many studies have looked at the differences in soil properties and soil loss between fields with a long history of grass versus intensively-cropped fields. The positive effects of the grass were still

evident after eight years of cropping in one Pullman research plot study (Table 2). Even without a long grass history, cultivated land with a grass cover experienced no soil loss.

Nebraska researchers found that the infiltration rate increased during rainfall under a native prairie cover, while it decreased with both pasture and bare ground.<sup>15</sup> They also found that annual runoff percentages for prairie, wheat field, and fallow land were 1, 12, and 18 percent, respectively. Reduced runoff lowers the erosion hazard and raises the yield potential by increasing stored soil moisture. Another comparison measured 4 percent runoff from prairie and 19 percent runoff from an alfalfa field.

This latter observation was stressed by researchers in the Pacific Northwest in their recommendations to generally mix alfalfa and grass in a planting for the greatest benefit.<sup>3</sup> Alfalfa adds nitrogen to the system and helps open subsoil layers with its taproot, but grass is even better at keeping the surface open to infiltration.

The positive effect of several years of grass was evident after four years of fallow-wheat cropping in Nebraska, as shown in Table 3. Two years of grass gave the largest single yield benefit, while infiltration steadily increased with increasing years of grass. Infiltration benefits appeared to be optimized after four to six years of grass. This type of information is needed to design cropping systems that maintain long-term soil conditions.

**Table 3. Effects of grass in rotation on wheat yields and water infiltration after four years of cropping — Nebraska**

Years of grass in rotation	Wheat yield Bu/Ac	Water infiltration rate (inches/hour) after ponding for:			
		10 min.	1 hr.	2 hr.	3 hr.
0	42	1.5	.6	.4	.3
2	49	1.6	.8	.6	.5
4	51	1.7	.9	.8	.7
6	50	1.9	1.0	.9	.8
8	53	1.8	1.0	.8	.7
20	52	2.6	1.2	1.0	1.0

Mazurski and Ramig, 1963.

One strategy might balance periods of "restoration" of soil properties with periods of intensive cropping that draw down the soil "bank account."

A perennial crop such as grass reduces erosion

**More GRASSES, page 4**

**GRASSES, from page 3**

by providing a permanent ground cover, and by decreasing the frequency of mechanical movement of soil downhill on sloping lands. The latter process, called tillage erosion, is of significant magnitude in areas such as the Palouse hills. Thus, the length of time that a field is in a

**Table 4. Average soil loss from water and tillage erosion in different cropping systems in the Palouse**

Cropping system	Soil loss (T/Acre)
Alfalfa/grass (4-6 yr); grain (1-2 yr.)	1.8
Alfalfa/grass (2-3 yr); grain/peas (3-5 yr.)	4.4
Alfalfa/grass (2-3 yr.); grain/peas (8-10 yr.)	4.9
Peas/clover - clover green manure - grain	5.0
Grain cropping	5.0
Peas/clover - clover GM - grain - peas - grain	6.0
Grain - peas	7.5
Grain - fallow	12.0

Kaiser, 1961.

perennial crop can greatly affect this process.<sup>4</sup> Table 4 illustrates the combined soil loss from both tillage erosion and water erosion, giving an idea of the full conservation impacts of various rotations. Other management aspects, such as straw burning and residual soil moisture (dependent on the previous crop), can affect water infiltration and erosion potential as well.

**Soil organic matter**

Thousands of dryland acres have gone into the Conservation Reserve Program (CRP) the past five years. These acres are now covered with perennial vegetation that normally includes grass. It would be useful to know how fast soil organic matter can be increased under such a perennial cover. A Nebraska study<sup>18</sup> from the 1940s took a systematic look at this, but the results must be used with caution in higher rainfall areas. It took at least six years in grass (brome/western wheatgrass) to maintain significantly higher soil carbon or nitrogen in the top six inches than in continuously cultivated plots. There was little change in soil carbon or nitrogen in the 6 to 12 inch depth. Inadequate moisture and nitrogen may have limited the productivity of the grass in this study.

With adequate fertility and moisture, considerable plant biomass can be produced by a perennial grass/alfalfa stand, as shown in Table 5.<sup>7</sup> Grasses translocate as much as 50 percent of their photosynthate below ground, which helps distribute organic matter through the fine roots.<sup>1</sup>

A study at Tetonia, Idaho, found that grass could restore soil organic matter levels, even to above the levels of soils in a native condition. Other studies in the Pacific Northwest found that grass in rotation was generally effective in increasing soil organic matter levels, as were rotations with legume green manures.<sup>20</sup> Most other rotations experienced a net loss of organic matter over time.

A study of adjacent fields in Columbia County, Wash., found that the field with a history of grass in rotation had higher organic carbon levels and from 8 to 12 inches more topsoil than the field in a long-term wheat-pea rotation. These differences were found on the summit and north slope, but not on the south slope.<sup>21</sup>

**Soil structure**

Good soil structure can improve water infiltration, provide easy seedling emergence and root penetration, reduce the tillage power requirement, and lessen the soil erosion hazard. The formation of stable soil aggregates helps to develop good structure, and perhaps there is no management condition better than perennial

**Table 5. Yields of roots and tops on alfalfa-grass plots - Pullman, Wash.**

Grass	Biomass Pounds/Acre		
	Alfalfa	Grass	Total
Hard fescue	3,845	11,328	15,168
Crested wheatgrass	3,356	8,896	12,252

Kent, 1957.

grass to promote aggregate stability.<sup>1-3</sup> In grass soils, ideal conditions for both aggregate formation and stabilization occur simultaneously by promoting the needed physical forces and microbial activity.

Studies have shown annual crops to be similar to perennials in their ability to increase water-stable aggregates during the growing season, but perennials were superior at maintaining aggregation. Perennial grasses were found to be the best at maintaining soil aggregation, while annual cereals and root crops were the least effective. Other research found that the weight of roots produced by winter cereals in the whole soil profile were similar to that under pasture, but the pasture had far more of the roots in the top eight inches of soil. This accounts for the superior benefit to topsoil structure from grass compared to cereals.

Australian researchers found that both soil organic matter and water-stable aggregation

**More GRASSES, page 8**

## On-farm testing gives first-hand results

By David Granatstein, project coordinator for the six-state Dryland Cereal/Legume Project.

Growers in the dryland Northwest are increasingly interested in on-farm testing, but unsure of the best approach to take on their farms.

Highly-publicized successful efforts from the Midwest have typically come from row-crop systems with relatively uniform soils and climate. Row-crop systems simplify on-farm testing where field-length strip testing is easy for the farmer and valid for statistical analyses. Replicated strip tests are not necessarily appropriate to the diverse environments that characterize grain farms in our region.

The initial results of an innovative barley variety testing project at Washington State University in 1990 show one example of an on-farm testing approach adapted to the region. Jerry Johnson and Steve Ullrich, researchers in the Department of Crop and Soil Sciences, are testing four barley varieties on farms in eastern Washington. They are comparing varieties under real farm conditions, using long drill strips that traverse the hilly and variable landscape. While their primary objective is to evaluate on-farm testing as a more accurate indicator of varietal performance, their experience with grower-managed on-farm tests helps to assess this approach to answering other questions.

Growers sometimes fail to adopt new crop varieties (believed to be superior based on small plot results) because small plot testing is not always able to predict varietal perform-

ance under growers' conditions. Also, the relatively high gains in yield achieved by earlier breeding efforts no longer occur. Thus it is harder to detect the superiority of new varieties when the yield differences between old and new are relatively small. Johnson and Ullrich hope their on-farm approach can overcome these problems.

Potential cooperators for the project were identified with the help of County Extension Agents, and 42 growers agreed to conduct the test. Each grower received seed and a few

A second approach used double-drill unit widths, which allowed for full header width combining and fit smaller fields. This approach seemed best except on steep and uneven terrain. For steeply sloping fields, a third method used single drill unit widths, but called for two separate sets at two landscape locations, and altered the order of the varieties for each set. This helped reduce the influence of slope position on the results.

Several blank rows were left between the varieties by plugging one or more drill

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*Replicated strip tests are not necessarily appropriate to the diverse environments that characterize grain farms in our region.*

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guidelines for planting, managing, and harvesting the strips. The growers contributed their time, land, fertilizers, pesticides, and machinery, and were asked to plant in locations where they would be most convinced by the results.

Four spring barley varieties were planted — Steptoe (6-row feed), Harrington (2-row malting), Camelot (2-row feed), and Cougar (6-row feed and malting). Three planting schemes were recommended. With the single, long drill width approach, each drill unit received a single variety and planted across the landscape for about 3,000 feet. This was suited for large fields where the effect of slope position could be averaged out. One drawback was the need to harvest less than a full header width on these 10-foot to 12-foot wide strips.

operators at planting. This allowed easy identification of the strips during data collection and harvest. At harvest, each variety was cut and weighed separately.

The researchers collected soil samples, rainfall records, plant samples and cropping data. The information will be used to classify the results according to climate and soil type, allowing assessment of how the individual varieties might best suit particular farm conditions. This will lead to the development of "recommendation domains" for the region. These domains indicate conditions in which a given variety or farm practice would be expected to produce similar results. Two farms within a few miles of each other might have less in common than two farms far apart, due to the

**More TESTING, page 8**

## Intensive management key to this farm's sustainability

**"If we don't take care of our best land it will soon become our poorer land."**

By Eric Thors, a dryland farmer from Dayton, Wash.

My wife and I are the fourth generation to operate our farm. Our average rainfall is 18 to 20 inches, and the predominant soils are Palouse and Athena silt loams. We consider our operation to be low-input in terms of tillage operations, but high-input in every other category, including management. We also consider our operation to be sustainable as a business entity and with regard to the long-term productivity of the soil.

In our efforts to preserve and enhance the soil resource, our farming operation stresses tillage management, crop rotation management, and structural feature management. Let's take them one at a time.

### Tillage management

Winter is our erosion season, so our efforts are directed toward soil protection over the winter. Wheat seeded in the fall is our main crop. Any seed bed preparation, including the seeding itself, increases the erosion risk, so we try to leave the soil surface as rough as possible with as much crop residue as practical.

These results are best achieved if the ground is dry when the primary tillage is accomplished and if the primary tillage is done at a speed of 3-4 mph. The moldboard plow is our most-used primary tillage tool. Despite widespread criticism, it is the only implement which will actually move soil uphill. All other implements move soil

downhill — as will the plow if used improperly. The chisel plow is our second primary tillage tool, used mainly on pea ground to prepare for winter wheat. Secondary operations, such as cultivations and weedings, are kept to a minimum and done only for weed control, with no attempt to change the surface of the soil as left by the primary tillage tool. We are using no-till to some degree every year and we are gradually learning to control weeds and diseases using a no-till system.

### Crop rotation management

- A rotation of winter wheat and summer fallow is the most efficient method of raising wheat. But a wheat-summer fallow rotation can leave the soil susceptible to erosion. Our main rotation is winter wheat, spring crop, winter wheat — commonly known as annual cropping. We use spring crops such as peas, lentils, barley, oats, and spring wheat. Spring crops are not usually income producers; we just hope to break even. We use them only as an alternative to summer fallow.

- A secondary rotation is winter wheat following winter wheat, or re-cropping. This rotation is a form of annual cropping but controls the erosion risk better than a spring crop. It does present weed and yield problems, however.

- A third rotation is winter wheat following a green manure crop such as sweet clover or Austrian winter peas. Before commercial fertilizers, this

rotation produced tremendous amounts of organic matter and fixed some nitrogen. The main problems were the tremendous erosion hazard and the lack of fixed nitrogen if the sweet clover did not prosper. A secondary problem was managing the plowing of the sweet clover before it grew so tall as to be impossible to plow. Commercial fertilizers eliminated these problems.

- The final rotation is winter wheat following a long-term perennial grass or grass/legume mixture. This has the most potential for duplicating nature's way of building topsoil. Once we establish a perennial grass/legume stand, we leave it in anywhere from 5 to 30 years, usually about 10 years.

We try to keep about 20 percent of our farm in grass at any one time. We use about a third of this perennial grass/legume acreage for seed, hay, or cattle production. The other two thirds is strictly for conservation and soil enhancement, and is left as long as the stand produces soil benefits. It is important that even the best land receives this treatment of a perennial grass/legume rotation; if we don't take care of our best land it will soon become our poorer land. Over the last 40 years all of the farm has experienced this perennial grass/legume rotation at least once.

We are interested in green manures because ammonia-based commercially-available nitrogen is gradually making

**More ROTATIONS, page 7**

**ROTATIONS, from page 6**

our soils more acidic. We are devising a system using a high nitrogen-fixing legume such as sweetclover, red clover, or medic, which would allow wheat to be produced every other year. This means interseeding growing wheat with these legumes. Our experience has been that the legumes don't survive the first summer. My guess is that our modern wheats are too competitive.

**Structural feature management ■**

This refers to practices such as grass waterways, diversions, and strip cropping. This area of management is for backup purposes. Nothing that we have discussed so far will control erosion completely. So we need to go farther.

Waterways and diversions attempt to divert runoff water in such a way that erosion isn't too bad. We want to try to use all the water that comes our way by making the soil absorb the moisture. So our main emphasis is strip-cropping.

This practice is simply an effort to reduce the length of a slope by dividing that slope into more than one field. When erosion occurs in one field, hopefully the field below or downhill will be in condition to stop the erosion and absorb the water.

In summary, a strict sustainability program requires a substantial investment in time, skill, money, and luck. It has cost us about 25 to 30 percent more. There are no easy answers. Our program does not pay for itself in higher yields. But we are convinced such a program is necessary. □

## On-farm test number cruncher doesn't require computer genius

A simple computer program for statistically analyzing data from on-farm tests is now available from Oregon State University.

According to program author Russ Karow, the AGSTATS program requires an IBM PC with at least 256K (or compatible) and DOS 2.1 or later, and no prior statistics experience.

The program will handle a single factor experiment with up to 12 treatments and six replications. This program can help simplify the evaluation of results from individual or group on-farm tests.

To order, send a check for \$5, payable to Oregon State University, to Extension Crop Science, Crop Science Building, Room 131, Oregon State University, Corvallis, OR 97331-3002. Be sure to specify what size diskette you require. □

## Coming soon: Farmer case studies will provide more firsthand data

Nine farmers who've developed successful resource-conserving rotations will be featured in a case studies handbook to be released later this spring by the Alternative Energy Resources Organization in Helena, Mont.

Farmers were selected from AERO's seven-state, two-province database of sustainable and transitional operators, based on their use of soil-building crops, the duration of their transition to sustainable agriculture, record-keeping, representation of the agro-climatic conditions of the region, and overall success as farmers.

"This project will help answer the questions many conventional farmers have about shifting to lower-chemical, sustainable agriculture," said Nancy Matheson, project coordinator.

Each case study will include a description of the basic rotations or rotations used on each farm, what some of the variations on the basic rotation are and why, Matheson explained. The rotation's effect on weeds, insect pests, disease, fertility, and soil condition will be described. The specific objectives that the rotation is meeting for the farmer will be listed, as well as problem areas, marketing arrangements, and labor and equipment. Integration of the rotation with livestock components will be described where applicable. A context for each case study will be provided with a description of how it differs from typical operations and rotations in the area.

Watch for more details in the next *Sustainable Farming Quarterly*, or call AERO at (406) 443-7272. □

**GRASSES**, from page 4  
increased as the cropping system moved from crop-fallow to the inclusion of several years of pasture.<sup>13</sup>

### Practical considerations

Growers have incorporated grass into their operations in many ways. The greatest success has come from using it as a set part of the rotation, thus avoiding planting or removal decisions based on the volatile grass seed market. Grass seed prices, currently at low levels, are expected to fluctuate widely in the foreseeable future. Changes in government commodity and conservation programs will influence grass planting. The Integrated Farm Management Program Option in the 1990 Farm Bill is one example of an incentive for grass. (See Farm Bill article, page 1.)

Most growers avoid planting winter wheat into grass sod, and opt for a spring crop instead. After killing bluegrass (grown for seed) with herbicides, a grower near Pullman, Wash., no-till plants lentils into the sod with good results. He

### TESTING

, from page 5

combined effect of elevation, aspect, slope, soil type and other conditions.

First-year results showed Steptoe to be higher yielding in most locations, but in the drier areas of several counties, Camelot was better adapted. While first-year yield results must be viewed with extreme caution, the practicality of this on-farm testing approach appears promising. Forty-one of 42 tests were successfully completed and feedback from cooperating growers was favorable. Most participating growers want to repeat the test this year. The yield data was surprisingly uniform (C.V. = 11 percent) and similar to variability in on-farm tests in the Midwest. Differences of 140 pounds per acre or more

normally keeps his grass fields in for seven years, and then crops the ground for about 18 years before returning to grass.

One grower in a drier area uses intermediate wheatgrass for three to five years. He harvests seed for his own use and sells some, if there is a market. He found that the subsequent

### *Management practices that increase soil organic matter will get increasing attention as a strategy to cope with global warming...*

three wheat crops after the grass yielded 10, 8, and 7 bushels per acre more, respectively, than wheat after summer fallow.

A study by the SCS and Washington State University in the late 1940s compared three pairs of farms with similar characteristics. One farm per pair used a grass/legume in rotation with wheat and peas, and the other used a wheat-pea rotation. On the grass/legume farms, wheat and pea production was 17 percent higher, net income per acre was 38 percent

in yield between two varieties were considered statistically significant. This affirms the power of on-farm testing to detect relatively small differences in yield among varieties.

While this single replicate on-farm strip design breaks with research tradition, it has great potential as a practical approach to on-farm testing in the dryland region.

When results from farms within an agroclimatic zone are pooled, they are more predictive than what an individual could accomplish with multiple replicates on a single farm. This example of "people power" affirms the importance of farmer involvement in an activity traditionally reserved for agricultural scientists. □

greater, and soil erosion losses were less than one-third, compared to the wheat-pea farms.<sup>7</sup>

The benefits from grass or a grass/legume mix increase with the number of times they are grown. Field surveys in the 1950s found far less erosion where two cycles of a grass rotation had occurred

versus one. Grass also can help to restore the yield potential of eroded hilltops and slopes by improving the physical condition of the soil, which can then more readily respond to fertility inputs.

In addition to the long-term soil conservation benefits, grass plantings can significantly increase soil organic matter. Management practices that increase soil organic matter will get increasing attention as a strategy to cope with global warming, and could be supported with incentives in the future.

In contrast, the burning of grass seed fields, a necessary practice, reduces the organic matter benefit. Restrictions on burning are likely to increase and make grass seed production less attractive.

Extensive research on the development of suitable grass germplasm and its proper management occurred earlier this century.<sup>14</sup> This research provides a solid base for incorporating grass into current farming systems. But favorable political and economic conditions will be necessary to further the use of this beneficial practice.

**More GRASSES**, page 9



## GRASSES, from page 8

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## Calendar

The Soil Conservation Service is offering a series of training workshops on windbreak technology this year at the following locations: Pasco, Wash., April; Salt Lake City, Utah, May; Fort Collins, Colo., June; Bismarck, N.D., August; and Shelby, Mont., September. For exact dates and other details, contact your local SCS office.

## April

9-11: "Cover Crops for Clean Water," West Tennessee Experiment Station, Jackson, Tenn. Sponsored by the Soil and Water Conservation Society. A comprehensive look at how cover crops can be used to protect soil and conserve water. Registration prior to April 5 is \$80. SWCS, 7515 Northeast Ankeny Road, Ankeny, IOWA 50021-5764.

28 - May 4: Soil Stewardship Week.

## May

10-12: "Varieties of Sustainability: Reflecting on Ethics, Environment, and Economic Equity." Ashman Conference Center, Pacific Grove, Calif. Participants will identify the social and ethical aspects of sustainable agriculture, and discuss how they can be integrated.

23: Progressive Farmers Inland Northwest field tour. Colfax, Wash. Subsoiling, rotation, and moisture monitoring. Contact David Granatstein at (509) 335-3491 for more information. ☐

## Sustainable-farming database debuts

Extensive research into sustainable agriculture techniques for the dryland Pacific Northwest is now available to the public on computer disk.

The Northwest Dryland Cereal/Legume Cropping Systems (CROPSYS) database at Washington State University is a compilation of historical and current information on sustainable practices assembled from scientific journals, popular magazines, formerly-unpublished documents, oral presentations, and firsthand farmer experience.

CROPSYS was developed as part of the six-state Low Input Sustainable Agriculture (LISA) project, which funds the *Sustainable Farming Quarterly*.

Information is entered in a citation format, and most citations contain a synopsis of

the material. The database focuses on crop rotations, legumes and grasses, and soil quality, but it also includes information on pests, fertility, alternate crops, and economics.

The database was written for use with the PCFile version 5.0 database software program, and can run with any software that will read a .DIT and .DBF file (e.g., dBase or Paradox). An IBM or IBM-compatible computer with a hard drive is needed.

A user's guide, the necessary diskettes, and shipping costs are included in the \$15 price. Send a check, payable to Cooperative Extension Publications, to Bulletin Office, Cooper Publications Building, Washington State University, Pullman, WA 99164-5912. ☐

## RESOURCES

**Farm Program Options Guide.** 1990. Alternative Energy Resources Organization, 44 N. Last Chance Gulch, Helena, MT 59601. The 30-page guide explains each sustainable agriculture-related program under the 1990 Farm Bill, and takes farmers through a step-by-step process for assessing whether each option makes economic and stewardship sense for their farming operations. The *Farm Program Options Guide* includes an addendum showing examples of how the new Farm Bill provisions can be used on dryland grain farms in the semi-arid area of the inland Pacific Northwest and Northern Plains. \$3 ppd.

**The Thompson Farm On-Farm Research.** 1990. Rodale Institute, 222 Main St., Emmaus, PA 18098. On-farm testing gurus Dick and Sharon Thompson summarize the results of dozens of tests on their Boone, Iowa, farm in an annual homegrown research

report. This year, the Rodale Institute has helped produce a more polished version. While most of the results are pertinent to Corn Belt farmers, the types of questions they ask and experiments they conduct can stimulate growers in any area. This edition includes an 11-page section, "Learning from Each Other — Inspiration, Documentation, and Education," in which the Thompsons describe how they got involved in on-farm testing and how it has evolved for them over the years.

**Protecting Groundwater from Agricultural Chemicals: Alternative Farming Strategies for Northwest Producers, Second Edition.** 1991. Alternative Energy Resources Organization, 44 N. Last Chance Gulch, Helena, MT 59624. Christine Kaufmann and Nancy Matheson, authors. The first edition sold out in 1990 and the second edition includes new material in response to comments from readers. This publication describes how to

minimize the need for agrichemicals in farming operations in the inland Pacific Northwest. A must for producers, policymakers, and public officials interested in soil fertility and weed, insect and disease management. \$4 each, or \$3 each for five or more copies.

**Dryland Agriculture: Strategies for Sustainability.** 1990. R.P. Singh, J.P. Parr, and B.A. Stewart, editors. *Advances in Soil Science*, Vol. 13, Springer-Verlag, N.Y. A wealth of technical detail on sustainable dryland farming principles and practices from around the world. Soil degradation is universal throughout dryland areas, and its reversal poses a major challenge for scientists, farmers, and policymakers. Conservation tillage is proving to be an effective strategy when practices are tailored to local conditions. Harvesting water efficiently is the key to successful dryland farming, and affects both profitability and resource conservation. □

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