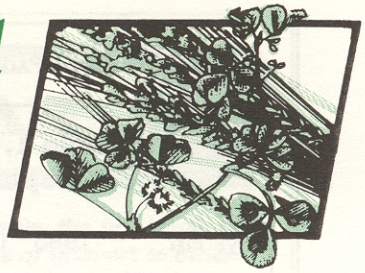
SUSTAINABLE FARMING Quarterly



VOL. 4 NO. 2 JULY 1992

CONSERVATION OPTIONS PAY DIVIDENDS TO UTAH GROWERS

BY DAVID GRANATSTEIN, COORDINATOR OF THE SIX-STATE DRYLAND CEREAL/ LEGUME PROJECT.

Utah State University researchers Phil Rasmussen and Bob Newhall have several projects under way to help dryland cereal farmers meet conservation compliance while maintaining or improving profits.

They are examining a range of practices, including no-till, continuous cropping, chemical fallow, and subsoiling, for comparison with a conventional wheat-fallow system.

In a study at Nephi, Utah, five different systems have been compared since 1985:

❶ No-till continuous spring wheat;
❷ No-till continuous winter wheat;
❸ Spring chemical fallow and no-till winter wheat;
❹ Fall ripping, chemical fallow, and no-till winter wheat, and
❺ Conventional winter wheat-fallow.

The plots were fertilized, and the weeds were controlled using low-rate technology. A chisel plow and disk were used for conventional tillage.

In the first two cycles, continuous cropping performed as well as the other systems (Table 1, page 2). But with several successive dry years, yields fell dramatically in 1989 and 1990. Yields with conventional wheat-fallow were generally lower than in the chemical fallow no-till systems. Fallow is an important stabilizing factor for yields in dry and variable climates. No-till

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INSIDE THE SFQ

Lentil Rotations Prove Themselves in Canadian Wheat Fields: More Protein, Organic Matter

REPRINTED FROM THE MAY ISSUE OF GRAINEWS, WINNIPEG, MANITOBA, CANADA. BY C.A. CAMPBELL, ROBERT P. ZENTNER, FERNANDO SELLES, AND V.O. "BIX" BIEDERBECK OF THE SWIFT CURRENT, SASK., RESEARCH STATION.

Lentil, when grown in rotation with wheat, will not only increase grain protein of the wheat, but it can lead to improved soil organic matter quality. It also provides an effective alternative to the frequent summer fallowing practiced in the semi-arid praire regions.

In a 12-year study, carried out in the Brown soil zone at Swift Current, Sask., wheat grown in a two-year rotation with lentil averaged one percentage point in protein greater than wheat grown annually, while grain yields were the same. Both systems were fertilized based on soil tests each year.

The results showed that after about four or five years, the amount of available nitrogen (nitrates) in the rooting depth of wheat in rotation with lentils, increased compared to that under continuous wheat. As a result, after four or five years, the wheat-lentil rotation required and received less and less fertilizer nitrogen than the monoculture wheat system.

The larger amount of nitrates present in the root zone under the wheat-lentil rotation suggested that this system might

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Table 1. Wheat Yields for Nephi Tillage Study

System	1985	1986	1987	1988	1989	1990
	bushels/acre					
1	7.8	39.3	12.6	27.2	13.9	5.3
2	11.3	24.4	13.5	24.4	12.4	7.8
3	—	45.0	—	33.3	—	39.1
4	—	54.4	—	32.9	—	37.9
5	—	42.1	—	31.3	—	35.4
LSD (0.5)	0.5	8.7	1.7	1.6	4.9	5.4
Precipitation*	+0.7	+6.2	-3.4	-3.7	-3.8	-1.8

*Deviation (in) from average annual precipitation 1903-1990 (12.7)

(Rasmussen and Newhall, 1991b)

systems appear to conserve more moisture under Utah conditions.

By using the flex-cropping approach developed in Montana (Ford and Krall, 1979), continuous cropping may be successful if it is only used when stored soil moisture exceeds a minimum level to support a crop.

A similar but larger cropping system study has been in place since 1986 at the Bluecreek Experimental Farm in Box Elder County, Utah. Eleven different management systems were tested (Table 2).

Annual precipitation ranged from a low of 9.5 inches in 1988-1989 to a high of 15.3 inches in 1985-1986, with a year-to-year pattern similar to that at Nephi. Wheat yields under continuous no-till cropping were significantly greater than those from conventional wheat-fallow in all but one instance (Table 3). In the wet years, continuous no-till cropping was more productive than other systems. Yields were more similar between continuous cropping and chemical fallow no-till during the dry years.

Continuous cropping can improve overall water-use efficiency. But over time, the monocropping of wheat can lead to serious disease and weed problems that will reduce yields.

In the Bluecreek study, yields were generally higher with the Yielder no-till drill compared to a deep furrow drill. Subsoiling tended to depress yields in both 1987 and 1989.

Given the potential productivity increases from continuous cropping, no-till, and chemical fallow, the researchers then estimated the net impacts on income and on soil loss (Table 4). Income estimates are based on a gross margin — the difference between variable costs and gross income. The chemical fallow no-till systems tended to have the highest gross margins. They had the lowest variable costs and the highest gross income. The conventional wheat-fallow system was the least profitable of all. The three conventional fallow treatments all had soil losses twice that of the

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Table 2. Cropping Systems Used in Bluecreek Study

1. Continuous winter wheat, no-till deep furrow drill (DFD)
2. Continuous winter wheat, no-till Yielder drill (YD)
3. Continuous spring wheat, no-till (DFD)
4. Continuous spring wheat, no-till (YD)
5. Spring chemical fallow, no-till winter wheat (DFD)
6. Spring chemical fallow, no-till winter wheat (YD)
7. Fall ripped, spring chem-fallow, no-till winter wheat (DFD)
8. Fall ripped, spring chemical fallow, no-till winter wheat (YD)
9. Conventional fallow, dammer diker, no-till winter wheat (DFD)
10. Conventional fallow, dammer diker, no-till winter wheat (YD)
11. Conventional fallow, conventional winter wheat (DFD)

Table 3. Wheat Yields for Bluecreek Farm Study

System	1986	1987	1988	1989
	bushels/acre			
1	41.2	11.8	6.6	25.8
2	59.0	15.8	7.2	27.0
3	23.9	16.3	14.9	23.2
4	33.5	21.0	17.2	26.4
5	—	45.5	—	35.0
6	—	47.0	—	38.7
7	—	44.0	—	28.7
8	—	41.8	—	36.5
9	—	45.3	—	29.4
10	—	41.5	—	29.4
11	—	44.5	—	24.3
LSD (.05)	—	5.6	3.3	6.1

(Rasmussen and Newhall, 1991a)

The *Sustainable Farming Quarterly* is a publication of the Dryland Cereal/Legume Project, a USDA Sustainable Agriculture Research and Education (SARE) project, based at Washington State University.

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Staff: Sally K. Hilander, editor; David Granatstein, project coordinator; Allen Bjergo, Extension Service liaison.

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Table 4. Gross Margins and Soil Loss Under Different Crop Systems at Bluecreek Farm

System	2-Year Variable Cost ($)	2-Year Gross Income ($)	Gross Margin ($)	Soil Loss (tons/ac./yr. USLE	WEE
1	130	139	9	0.73	0
2	130	147	17	0.73	0
3	130	165	35	0.73	0
4	138	188	50	0.73	0
5	86	148	62	0.73	0
6	86	164	78	0.73	0
7	91	122	31	1.36	0
8	91	155	64	1.36	0
9	106	124	18	3.45	3.3
10	106	124	18	3.45	3.3
11	106	103	-3	3.45	3.3

* USLE = Universal Soil Loss Equation for water erosion.
WEE = Wind Erosion Equation.
(Rasmussen and Newhall, 1991a)

tolerable loss T (three tons per acre per year), while all other systems were well below T. The environmental impact of increased herbicide use with chemical fallow remains a question and a concern. Nonetheless, the chemical fallow no-till systems offer a profitable and soil conserving option for dryland growers to protect the resource base for the future.

References

Ford, G.L. and J.L. Krall. 1979. The History of Summer Fallow in Montana. Montana Agriculture Experiment Station Bulletin 704, Bozeman.

Rasmussen, V.P. and R.L. Newhall. 1991a. Dryland tillage demonstration/research plots (FSA compliance plots). Agri-Hint Series 91-108. Utah State University, Logan.

Rasmussen, V.P. and R.L. Newhall. 1991b. Dryland tillage demonstration/research plots. Agri-Hint Series 91-111. Utah State University, Logan.

CALENDAR

(The SFQ is seeking calendar items for the fall issue. If you know of an event that would be of interest to other SFQ readers, please send the information to AERO, 44 N. Last Chance Gulch, Helena, MT 59601, or call Sally Hilander at (406) 442-8396.)

July

1: Washington State University Farm Field Day, Pullman. Contact Baird Miller at (509) 335-2858.

8: Northern Montana Agriculture Experiment Station field day, Havre, Mont. Call (406) 994-3681 for more information.

9: Central Montana Agriculture Experiment Station field day, Moccasin, Mont. Call (406) 994-3681 for more information.

14-15: "Building Quality from the Soil Up," field days and symposium co-sponsored by the North Dakota State University Carrington Research Extension Center and Farm Verified Organic, Inc. (FVO), at the station in Carrington. Focus will be on the indicators of good soil and how soil quality is linked to production of quality grains and beans. The field day only is no-charge; the two-day event is $20 per farm family. Write FVO, RR #1, Box 40A, Medina, ND 58467 or call (701) 486-3578.

16: Northwestern Montana Agriculture Experiement Station field day, Kalispell.
Call (406) 994-3681.

21: Eastern Montana Agriculture Experiment Station field day, Sidney, Mont. Call (406) 994-3681.

23: Park Conservation Farm Improvement Club tour, Montana. Miranda feed peas, dryland and irrigated pea and lentil cash crops, green manure and on-farm trials. Call John Bays at (406) 222-2899.

30-Aug. 1: Conference on Participatory On-Farm Research and Education for Agricultural Sustainability, University of Illinois, Urbana-Champaign. Call John Gerber at (217) 244-4232.

HOTLINE PROVIDES ANSWERS TO SUSTAINABILITY QUESTIONS

The Center for Rural Affairs in Walthill, Neb., has started a Sustainable Options Hotline to provide counseling for farmers and ranchers who want to enroll in the federal Integrated Farm Management Program Option and/or the Water Quality Incentives Program. Assistance also is available to those interested in enrolling field windbreaks, grass waterways and contour grass strips in the Conservation Reserve Program (CRP) or in making farm program adjustments for environmental purposes.

(402) 846-5428

FARMERS IN THE REGION

BIOSOLID PROOF: YIELDS JUMP WHEN NUTRIENTS ARE RETURNED

EDITOR'S NOTE: THIS ARTICLE WAS PUBLISHED IN THE WASHINGTON ASSOCIATION OF WHEAT GROWERS' *WHEAT LIFE*. AUTHOR GARY WEGNER, A DRYLAND FARMER NEAR SPOKANE, WASH., HAS BEEN EXPERIMENTING WITH ORGANIC WASTE PRODUCTS IN CEREAL PRODUCTION AND SOIL IMPROVEMENT, INCLUDING BIOSOLIDS, A TYPE OF SEWAGE SLUDGE. THE *SFQ* HAS EDITED THE ARTICLE.

The use of biosolids on agricultural lands has many benefits, which I will identify in terms of my farming operation at Reardan, Wash., and overall environmental impact.

ENERGY

Biosolids can replace a significant amount of petroleum-based fertilizer needed to produce a crop. Production of manmade fertilizers requires energy and raw materials. Biosolids can offset some of the need for synthetic fertilizers, but they cannot replace them entirely because biosolids are in limited supply.

GROUNDWATER

Biosolids can provide a substantial improvement in groundwater quality. How? Biosolids are derived from an organic source, and thus the nutrients that biosolids contain are not in the free and readily available form that we normally expect of a manmade fertilizer. This has two major benefits:

- The nutrients found in biosolids are much less available for leaching below the root zone or into the groundwater.
- The reserve of nutrients found in biosolids is also in a form that can be used by plants as needed. Instead of the nutrients being available quickly as with commercial fertilizers, the nutrients in biosolids are in slow-release form (organic).

AIR QUALITY

Biosolids have one minor drawback: The odor of newly-applied biosolids is recognizable. It is not offensive to most. In fact, most people are surprised at the difference between the actual odor and what they perceived the odor would be. On the other hand, biosolids increase the vigor of plant growth and the overall health of plants. This improved ground cover greatly reduces wind erosion, thereby keeping dust out of the air.

CROP YIELD

Using biosolids to produce small grains such as wheat and barley will increase yields, but why? A well-established crop rooted in a soil enhanced by biosolids has an improved ability to retain moisture. On my farm, we have seen better establishment and three times the seedling growth of a crop with biosolids as one without.

Biosolids also contain a broad range of nutrients, some of which can easily be replaced with commercial fertilizers. But some of those that cannot be so easily replaced are approaching deficiency levels in certain soils. These include:

NITROGEN is available commercially in the ammonia form, which is quickly converted to the nitrate form in the soil (nitrate is water soluble and therefore moves in the soil). The majority of the nitrogen found in biosolids is in an organic form. Organic nitrogen releases slowly. If moisture is in limited supply, this release is limited. If plenty of moisture is available, the release of organic nitrogen is accelerated.

PHOSPHORUS is also available commercially. After nitrogen, phosphorus is the most likely nutrient to be deficient in the soils found in wheat farming regions. The sufficient supply of phosphorus found in biosolids is one of the more obvious reasons that we see improved plant growth.

SULFUR is also available commercially. Sulfur, like nitrogen, is a component of the proteins in plants and is therefore part of the raw materials for building new plant cells and tissues.

POTASSIUM is available commercially, but is seldom supplemented in grain-producing areas because of the cost. Potassium is used by the plant to help balance positive and negative charges between the inside and outside of the cell.

MAGNESIUM is not normally supplemented on grain crops. Available in biosolids, magnesium plays an important role in chlorophyll, which is essential to photosynthesis in plants.

ZINC is available commercially and is sometimes supplemented on small grains. When I look at micronutrients in relation to

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crops on my farm, zinc is the most significant nutrient — because my soils were deficient in zinc before biosolids were applied. Zinc is critical to many plant functions.

COPPER is also a heavy metal, and like zinc, is involved in many cell functions within the plant. Many soils are not deficient in copper, based on current knowledge of soil tests. As with many of the micronutrients found in biosolids, it appears to further enhance the quality of my soils at Reardan.

The land I farm has been cultivated for almost 100 years and many nutrients have been removed from the soil during those years of cultivation. Biosolids have provided the first opportunity for me to replenish some of those nutrients, particularly the micronutrients, such as vanadium, chromium, manganese, iron, cobalt and molybdenum.

Additional nutrients are found in biosolids that contribute to the health of the soil environment, including boron, hydrogen, sodium, calcium, carbon, oxygen, chlorine, and selenium. If found in sufficient amounts, they contribute to the overall health and viability of the crop. A shortage of any of these nutrients in the soil can be devastating to the crop.

Our primary crop in 1991 was Steptoe barley. We had 425 acres of barley grown on land that had received biosolids and 315 acres that had received a typical commercial fertilizer application. The yield of the "biosolids barley" exceeded that of the fertilizer barley by more than 1,000 pounds per acre.

The average yield on our dryland "biosolids barley" on the 425 acres was 1.92 tons per acre.❐

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result in more leaching of soluble nitrates beyond the rooting depth in wet years. This could pollute groundwater if there were shallow aquifers in the vicinity. However, analysis of soil samples taken to 10 feet in 1990 showed that there was actually less nitrates present in the subsoil under the wheat-lentil rotation than under continuous wheat.

We speculate that there is greater synchrony in the availability of nitrate nitrogen (being produced from the decomposition of lentil roots and residues in soil) and the ensuing nitrogen uptake by the wheat crop, as compared to the synchrony between fertilizer nitorgen and uptake by the monoculture wheat.

These results are important with regards to economic viability and agricultural sustainabilty. From an economic standpoint, farmers using wheat-lentil rotations can look forward to lower costs for nitrogen fertilizers and, in some years, possibly higher grain protein and thus a higher wheat price.

On the sustainability side, the greater synchrony of nitrogen release and uptake by the wheat-lentil system means less chance of groundwater pollution or runoff (erosion) losses compared to fertilized monoculture wheat. Furthermore, the success of the wheat-lentil rotation means that producers in this semi-arid region have an effective alternative with which to replace the soil-degrading practice of summer fallowing, frequently employed in this region.

From a scientific standpoint, these results are also of interest. Some scientists have suggested that seed legumes, because they "export" (in the grain) most of the nitrogen they fix, have limited ability to improve the soil's nitrogen-supplying power. Our results appear to contradict this idea.

Low wheat prices and a desire by farmers on the Canadian prairies and dryland areas of the northwestern U.S. to lower fertilizer inputs and the frequency of summer fallowing, have resulted in a marked increase in grain-lentil production in recent years.

Our findings are therefore timely for the farming community. One caution, however: This type of rotation (lentil grown every other year) is only suitable in the drier parts of the prairies. In more humid areas, such frequent use of lentil can lead to a buildup of ascochyta disease.❐

SUSTAINABLE AG HAS POSITIVE INFLUENCE ON RURAL COMMUNITY

RESULTS OF SURVEY ON SOCIOLOGICAL IMPACTS NOW AVAILABLE IN BOOK FORM

BY KEITH JAMTGAARD, PH.D., A MONTANA STATE UNIVERSITY SOCIOLOGIST.

Montana "sustainable" farms and ranches are more family-oriented than their conventional neighbors, and those families support local merchants and contribute at least as much to rural community.

Furthermore, sustainable farming techniques are practical in large, commercial-scale operations, as well as on small acreages.

These are a few of the most important findings of a recent survey of nearly 600 Montana farmers and ranchers on the social impacts of sustainable farming, conducted by MSU, the Montana Agricultural Statistics Service, and the Alternative Energy Resources Organization (AERO) in Helena.

Results from the Montana Agricultural Assessment Questionnaire: A Survey of Sustainable Agriculture is now available for $5 (postage paid) from AERO, 44 N. Last Chance Gulch, Helena, MT 59601.

The study disputes the long-standing belief that agricultural operations employing sustainable techniques have reduced gross sales. And it confirms that sustainable operations generally are more labor-intensive and require more complex management decisions.

Sustainable agriculture is defined as any system of food or fiber production that enhances natural processes such as nutrient cycles, biological nitrogen fixation, and pest-predator relationships in agricultural production, and reduces the use of those purchased inputs with the greatest potential to harm the environment or the health of farmer and consumers.

Analysis of the data led to seven findings:

• SUSTAINABLE FARMS ARE SIMILAR TO CONVENTIONAL OPERATIONS IN TERMS OF SIZE AND LAND TENURE.

A long-standing criticism of sustainable agriculture has been that it might not be practical on large, commercial-scale farms and ranches. Previous surveys by AERO have suggested that sustainable operations in Montana are comparable in size to their conventional counterparts. Our research confirms those findings.

We looked at four measures of scale and land tenure: acres of land owned, acres rented out, acres rented in, and overall acreage of the operation. Dryland, ranching, and irrigated crop-livestock operations were evaluated separately. We found little variation that could be attributed to their degree of sustainability. The one exception was with the "acres of land owned" for the ranch category. Ranches that ranked high on the sustainability index tended to own more land than ranches that ranked low on that index. In other words, the more land owned by a ranch, the more likely that it would rank high on our sustainability index.

• SUSTAINABLE FARMS TENDED TO REPORT HIGHER GROSS SALES AND RECEIPTS THAN OPERATIONS THAT ARE OTHERWISE COMPARABLE.

Although the intent of our survey was not to do a detailed economic analysis, we looked at several income indicators, including amounts of off-farm income, gross sales and receipts, government payments, long-term debt, and stability of income. The strongest relationship we found was that operations that scored high on the sustainability index reported higher sales than otherwise similar operations with low scores. This relationship was particularly strong for smaller operations. In other words, smaller sustainable farms had a greater advantage in gross sales over their conventional counterparts than did larger sustainable farms.

A possible explanation is that the operators scoring high on our sustainability index are organic producers obtaining premium prices for their products.

• SUSTAINABILITY APPEARS TO HAVE LITTLE EFFECT ON OFF-FARM INCOME OR GOVERNMENT PAYMENTS.

Off-farm income has little apparent association with the sustainable agriculture index. Prior to the survey, we had thought that sustainable farms might have lower gross sales than conventional ones, and thus, sustainable farm households might make up the difference with more off-farm income. However, since sustainable farms tended to have higher gross sales, this lack of difference in off-farm income is not surprising.

• MORE FAMILY MEMBERS OF SUSTAINABLE PRODUCERS CONTRIBUTE LABOR TO THE OPERATION OF THEIR FARMS AND RANCHES.

One of the issues that concerns sustainable agriculture is whether or not these alternative practices

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require greater amounts of human labor. This additional labor would come from the farm family itself or labor hired from outside.

Our survey found that more family members of sustainable farms participate in running their operations than those of conventional operations. More family members tended to work full-time on farms ranking high in sustainability than on more conventional farms. This was accompanied by an even stronger tendency to find more household members working part-time on sustainable farms than on conventional farms.

There also tended to be more multiple household farms among the sustainable farms. These relationships are consistent with a pattern of somewhat greater involvement by family members in the farming operation, as well as extended family members through multiple household operations.

• THE TYPES OF AGRICULTURAL GOODS AND SERVICES PURCHASED BY SUSTAINABLE AND CONVENTIONAL PRODUCERS ARE SUBSTANTIALLY DIFFERENT.

However, the percentages of those purchases made locally were substantially the same for conventional and sustainable operators.

We asked respondents about their local purchases of fertilizer, agricultural chemicals, farm machinery, building equipment, and veterinary services.

Two issues are entwined here. First, purchase patterns help illuminate some of the differences between sustainable and conventional operations: What do sustainable farms need that conventional ones do not? Second, local purchasing has been associated with stronger agricultural communities because it keeps more dollars in rural communities and supports more local jobs.

Our survey found that respondents who were identified as sustainable were somewhat more likely to report purchasing farm machinery, building equipment, and veterinary services. This may be due in part to additional equipment and building requirements that alternative practices place on producers. However, increased use of veterinary services suggests that there may be a greater tendency toward the use of livestock in sustainable operations.

We found a more complex relationship concerning sustainability and agricultural chemicals. Operations that ranked high on the sustainability index purchased less fertilizers and chemicals (as one would expect), but we also found that operations that ranked as the most conventional also bought less fertilizers and chemicals. That is, those operations at the two extremes of the sustainability index were less likely to purchase either of these items than were operations in the middle. This suggests that there are a number of Montana operators who are conventional in the sense of not adopting any alternative farming practices, but neither are they users of fertilizers or chemicals. They might be thought of as "low-input conventional" farmers.

• SUSTAINABLE OPERATORS TENDED TO BE SOMEWHAT MORE OPTIMISTIC THAT THEIR FARMS WOULD BE PASSED ON TO THEIR CHILDREN OR GRANDCHILDREN.

A major issue in agriculture involves the transfer of farms from parents to children. With so many children leaving farms and rural agriculture communities, society has asked: Where will the next generations of farmers come from?

In our survey, we wanted to learn whether sustainable and conventional operators differed in their beliefs about whether their children or grandchildren would eventually farm their land.

Our survey found a modest tendency for sustainable farmers and ranchers to believe at least one of their children or grandchildren would one day farm their land.

There is no guarantee that having high expectations of transmitting the farm to children will lead to these expectations becoming realized. Still, the attitude of parents regarding the future of the farm can be an important factor in the decisions that children make regarding farming.

• FARMERS PERCEIVE GREATER MANAGEMENT COMPLEXITY TO BE ONE, IF NOT THE LARGEST, BARRIER TO MORE WIDESPREAD ADOPTION OF SUSTAINABLE ARICULTURE.

Increased labor concerns were also present. Both sustainable and conventional farmers believed that sustainable farming practices would increase fertility.

Finally, we asked questions concerning the potential consequences of adopting sustainable practices. There were strong concerns regarding an increasing burden of management decision-making among the respondents.

Also, increased labor needs were more often cited by the sustainable respondents than the conventional. This was another indication that more labor is required to operate farms and ranches with sustainable practices.

Strong support was found for the belief that soil fertility would be improved as a result of adopting these alternative practices. Nearly half of those with an opinion felt that soil fertility would be improved. ❐

RESOURCES

(THE FOLLOWING LIST OF RESOURCES IS OFFERED AS A SERVICE TO *SFQ* READERS. THE MATERIALS INCLUDED ARE NOT NECESSARILY ENDORSED BY THE *SFQ* OR THE DRYLAND CEREAL/LEGUME PROJECT.)

METHODOLOGIES FOR SCREENING SOIL-IMPROVING LEGUMES. 1992. Marianne Sarrantonio, Rodale Institute. A 340-page reference guide and field handbook that advocates a "systems approach" in which many interacting biological, physical, and socio-economic factors are taken into account when finding solutions to soil-related problems. A Legume Seed Source Directory is included, and will be updated yearly for readers on the mailing list. Send $24.95 to Rodale Institute, Attn: Barbara Bruno, 611 Siegfriedale Road, Kutztown, PA 19530 U.S.A., or call (215) 683-6383.

WHEAT PEST MANAGEMENT: A GUIDE TO PROFITABLE AND ENVIRONMENTALLY-SOUND PROTECTION. 1990. R. Stuckey, J. Nelson, G. Cuperus, E. Oelke, and H.M. Bahn, Extension Service/USDA Wheat Industry Resource Committee. Strategies for controlling weed, insect, and disease pests of wheat, including cultural, chemical, and biological, where available. Includes numerous photos of specific pests. Order from any extension publication office.

PACIFIC NORTHWEST CONSERVATION TILLAGE HANDBOOK. 1990. R.J. Veseth and D. Wysocki, Pacific Northwest Extension. Incorporates the findings of more than 15 years of research on conservation tillage systems in the dryland farming region. Chapter topics include tillage and equipment, erosion impacts, residue management, disease and weed control, fertility, and economics. Loose-leaf binder format has room for future issues of the Conservation Farming Update. Available from extension publication offices in Idaho or Washington for $20.

WEEDS OF THE WEST. 1991. T.D. Whitson, Editor. Western Society of Weed Science and Western Cooperative Extension Services. The most current guide to weeds in the region, with more than 900 photos and descriptions of 350 weeds, including growth stages and habitat. Available from extension publication offices for $19.50.

BEYOND THE LIMITS: CONFRONTING GLOBAL COLLAPSE, ENVISIONING A SUSTAINABLE FUTURE. Just released in time for "Earth Summit." D.H. Meadows, D.L. Meadows and J. Randers. Chelsea Green Publishing Co. Challenges readers to mobilize human and technological resources in an effort to "ease down" the global economy's enormous demands on Earth. Plans include minimizing use of non-renewable resources, efficient use of resources, developing goals that are based on "enough" rather than "more." This is the 320-page sequel to *The Limits to Growth*, which concluded 20 years ago that if present growth trends continued, the limits to growth could be reached within the next 100 years. Send $19.95 (U.S.) to Chelsea Green Publishing Co., P.O. Box 130, Post Mills, VT 05058, or $25.99 (Canada) to McClelland and Stewart Inc., 481 University Ave., Suite 900, Toronto, Ontario M5G 2E9. ❐

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