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Crop and Livestock Enterprises, Risk Evaluation, and Management Strategies on South Dakota Sustainable Farms

Donald Taylor
South Dakota State University

Thomas L. Dobbs
South Dakota State University

David L. Becker
South Dakota State University

James D. Smolik
South Dakota State University

CROP AND LIVESTOCK ENTERPRISES, RISK EVALUATION, AND MANAGEMENT STRATEGIES ON SOUTH DAKOTA SUSTAINABLE FARMS

by

Donald C. Taylor, Thomas L. Dobbs, David L.Becker, and James D. Smolik*
South Dakota State University
Brookings, South Dakota

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*Taylor and Dobbs are Professors of Agricultural Economics and Becker is a member of the research staff in the Department of Economics and Smolik is a Professor in the Plant Science Department, all at SDSU, Brookings, SD.

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SUMMARY AND CONCLUSIONS

This report presents findings from personal interviews undertaken in January-March 1989 with 22 of the 32 sustainable/regenerative farmers in South Dakota who responded to a Summer 1988 mail survey concerning their sustainable farming practices. [For the mail survey results, see Taylor, Dobbs, and Smolik, 1989.] The major purpose of the personal interview part of the study reported herein was to gain greater insight into (1) the sustainable crop rotations and livestock enterprises on these farmers' farms and (2) the judgments of these farmers about the riskiness and managerial strategies for meeting selected challenges of sustainable agriculture. This report's most important findings are summarized below.

1. Information on the "organic purity" of the 22 personally interviewed sustainable farmers is as follows. Ten (45%) farmers can be viewed as being "totally crop organic" from the standpoint that they use no synthetic chemical fertilizers and pesticides on any of their cropland. Five (23%) farmers have "organic" crop rotations, but also have some cropland on which some synthetic chemicals are used. Seven (32%) of the farmers use reduced levels of synthetic chemicals on their crops, but are yet to completely eliminate the use of chemcials on any of their cropland.

2. At least one small grain is found in all 22 sustainable crop rotations. The most common small grain in the rotations collectively is oats (in 68% of the rotations), followed by spring wheat (55%), rye (46%), and millet (32%).

3. At least one row crop is found in 20 (91%) of the 22 sustainable rotations, with soybeans (77% of the rotations) and corn (66%) being the most common row crops.

4. Seventeen (77%) rotations have alfalfa and one red clover. Alfalfa is most commonly left down, after establishment, for 4-5 years (46% of reported

instances). The incidence of alfalfa being left down 2-3 years is 25%, for 1 year 14%, and for 6-7 years 14%. The 2 farmers who leave alfalfa down for 1 year do so to minimize alfalfa's impact on soil moisture depletion and maximize its impact on weed control.

5. Twelve (55%) of the 22 rotations involve at least 1 year of summer fallowing. In 7 of the 12 instances, a cover crop (most commonly sweet clover, but sometimes forage sudan) is used. The other 5 instances of summer fallowing involve tilled black dirt.

6. A "first-cut" typological description of South Dakota's sustainable crop agriculture, in terms of the four regions denoted in Figure 1, is as follows.

South Central Region

- Relatively small farm sizes (an average of 425 cropland acres on the 7 surveyed farms).

- Rotations relatively evenly balanced between small grains and row crops, with a definite presence also of harvest forage legumes.

- Relatively limited summer fallowing (2 of 7 studied rotations), which involves cover crops.

East Central Region

- Relatively small farm sizes (survey average of 535 cropland acres).

- Relatively non-complex rotations, with a rather definite orientation to a pattern of Soybeans - Corn - Small Grain - Forage Legume.

- Row crops slightly more prominent here than in the South Central Region, and far more important than in the West.

- Harvested legume forages slightly more prominent here than in the South Central Region. Alfalfa, after being established, left down in rotations here a shorter time than in any other region.

- Relatively limited summer fallowing that involves cover crops.

Northeast Region

- Intermediate size farms (survey average of 760 cropland acres).

- A fundamental component of sustainable rotations here is Small Grain - Summer Fallow. Soybeans are also present in each of the studied rotations.

- The extent and diversity of small grain greater here than in any other region, e.g., 80% of the farms have each of spring or winter wheat, rye, and millet.

- Black dirt summer fallowing fairly common (60% of the studied rotations).

- Forage legumes of definite less importance here than in the South Central and East Central regions.

West Region

- Large farms (survey average of 1,500 cropland acres).

- A fundamental component of sustainable rotations here is Small Grain - Summer Fallow.

- Fallowing more intensive (frequent) here than in any other region, e.g., black dirt fallowing included in 67% of the studied rotations.

- Row crops of almost zero importance.

7. From pre-plant land preparation through the post-harvest period, an average of 9 cultural operations is performed on each of corn and soybeans. This includes averages of 2.7-2.8 field tillage and 3.9 weed control operations per year per crop. Fifteen (94%) of the 16 farmers with each of corn and soybeans cultivate for weed control. From 2 to 3 cultivations per season are most common for corn; 2 cultivations are most common for soybeans. The second most

common type of mechanical cultivation with corn and soybeans is the rotary hoe.

8. Averages of between 5.9 (for winter wheat) and 7.9 (oats) cultural operations per year are undertaken with the main small grain crops. About the same numbers of field tillage operations are undertaken with small grains as with row crops, but several fewer weed control operations are involved.

9. The moldboard plow is used by only 10 (45%) of the 22 surveyed sustainable farmers. All of these farmers use the plow to break alfalfa or sweet clover ground. Two also use the plow following small grain, and one following the application of an organic input soil conditioner on soybean ground.

10. Eighteen (86%) of 21 sustainable farmers have commerical livestock enterprises. The most common type of livestock involves beef cow-calf operations, followed by cattle finishing. Herd sizes on the sustainable farms are considerably smaller than those typically found in the State. Less than one-fourth of the farms have each of hog farrowing, hog finishing, and dairy enterprises.

11. Fourteen (78%) of the 18 farmers with livestock consider themselves to raise their livestock sustainably, 2 follow a combination of sustainable and conventional practices, and 2 do not follow sustainable practices. Livestock management practices viewed as "sustainable" by a majority of the practicing sustainable livestock farmers are:

- The non-use of (a) antibiotics and other additives in concentrate feeds, (b) hormones and other growth stimulant/promotants, (c) insecticides, and (d) vaccinations with livestock;

- The feeding of only organically grown grain and roughage to livestock;

- The non-use of closed confinement facilities in handling livestock; and

- A greater reliance on roughages relative to grains in finishing cattle.

12. All 18 of the sustainable farmers who have livestock report using all the manure they produce on their farms. Two procure manure from neighbors. Nevertheless, manure applications to cropland appear to be limited. For example, 46% of the farmers report covering 5% or less of their cropland with manure. Twenty three percent of the farmers apply manure to between 6% and 20% of their cropland. The frequency of manure applications to particular fields on these farms ranges from once each 5 years to once each 10 years. The 3 farmers who make the heaviest manure applications cover the following percentages of their cropland once each 3 years: 30%, 50%, and 60-75%.

13. Eleven (52%) of 21 sustainable farmers indicate sustainable agriculture to involve less risk than conventional agriculture, 3 (14%) more risk, 2 (10%) both more and less risk, and 5 (24%) no difference.

14. Sustainable agriculture may be more risky than conventional agriculture from several standpoints.

- Since the transition from conventional to sustainable farming technologies involves a general venture into the "unknown," risks can inevitably be expected to increase, specifically with regard to problems such as (a) expanded weed and other pest pressures and (b) nitrogen shortages.

- Since Federal farm programs do not exist for legume forages and most livestock products integral to many sustainable farm operations, informal "government price guarantees" that can be enjoyed by grain farmers who

participate in the Federal farm program are not realizable to the same extent by sustainable farmers.

- Since "organic" product markets are thin, the risks of organic product price instability are greater.

- Since wholesale organic product buyers generally do not purchase and take possession of organic produce from farmers until the buyers have found markets for the produce, expanded risks of cash-flow problems may be experienced by sustainable producers.

- Since some lenders do not believe in sustainable agriculture, risks may increase of farmers being unable to successfully secure even modest amounts of credit.

- Since sustainable farmers sometimes experience personal ridicule from the local community and even threatening actions by some conventional farmers, risks of physical, mental, and emotional health impairment for sustainable farmers may increase.

15. On the other hand, risks with sustainable agriculture can be less than with conventional agriculture from several standpoints.

- Since sustainable farmers have their enterprise "eggs in more than than one basket," sustainable farmers experience less risk from potentially (a) adverse natural resource production conditions and (b) adverse product price movements.

- Since sustainable farmers commonly have livestock that can make constructive use of relatively low value feedstuffs, sustainable farmers incur less risk of economic disaster when crops fail.

- Since sustainable farmers make fewer off-farm input purchases than their conventional counterparts, risks become less of their (a) being unable

to meet creditor obligations and (b) experiencing expanded production expenses when input price movements are adverse.

- Since soil managed sustainably has an improved structure and organic matter content and hence an enhanced soil water holding capacity, sustainable farmers have less risk of experiencing (a) production disaster during drought and (b) exaggerated soil erosion during rainfall downpours.

- Since sustainable farm workers handle fewer or no potentially dangerous chemicals, risks of health impairment to them are less.

- Since synthetic chemical input use is less with sustainable agriculture, risks of ground and surface water contamination and health impairment to diet-sensitive consumers may be less.

- Since the managerial requirements of sustainable agriculture are great, special positive incentives exist for sustainable farmers to become even stronger managers, thereby resulting in their becoming better able to cope with risks and uncertainties.

16. Sustainable farmers indicate mixed judgments on relative crop yields with sustainable versus conventional practices under "normal" production conditions. Nevertheless, for all crops, a larger number believe yields to be less, rather than more, with sustainable practices.

17. During years of unusually favorable production conditions, sustainable corn farmers generally indicate a relative loss in sustainable versus conventional yields, i.e., a widened gap between sustainable and conventional yields. During years of unusually unfavorable production conditions, on the other hand, they indicate a relative gain in sustainable versus conventional yields--to the point where the sustainable versus conventional yield deficit is reduced or sustainable yields become greater than conventional yields.

These findings are consistent with those reported in the literature. For soybeans, oats, and spring wheat in the survey, however, farmers' judgments on relative yield changes under unusual production conditions hold up more strongly on the relative upside potential for sustainable practices with unfavorable production conditions than the relative downside potential with unusually favorable conditions.

18. Sustainable farmers indicate judgments that yield differences between crops grown under sustainable and conventional farming practices are greatest for the row crops (corn and soybeans), intermediate for the small grains (oats and spring wheat), and least for alfalfa. The latter is generally expected since relatively few synthetic chemicals are usually used in alfalfa production.

19. The most important weapon in waging the war against weeds during the transition from conventional to sustainable practices is implementing crop rotations to interrupt the growth cycles of individual weed species. Including forage legumes and weed competitive crops (e.g., rye, millet, buckwheat) in the rotations contributes to effective weed control. The second and third most important weed control weapons are mechanical cultivation and special attention to times of crop planting and tackling weed problems.

20. The most important means of overcoming transitional nitrogen shortages is also crop rotations. In this instance, the presence in rotations of (a) legumes for nitrogen fixation and (b) cover crops and plant residues for plow-down are particularly crucial.

21. The most common problem in marketing organic products reported by the sustainable farmers arises from wholesale buyers not purchasing and taking possession of organic produce from farmers until the buyers have found markets

for the produce. As a result, a producer has to bear the burdens of (a) providing and meeting associated costs of on-farm storage for his organic produce and (b) an uncertain and uneven cash-flow over time. A second rather commonly cited problem with marketing organic produce concerns the distance from producers to plants where the organic produce is cleaned and assembled for shipping.

22. The most commonly suggested sustainable agriculture issue meriting attention in research is the comparative testing of sustainable and conventional crop rotations. Suggested focal points for emphasis in such work are soil fertility, soil structure, soil microbial activity, and weed control.

23. The most common thread in responses of farmers on how they, private organizations, and universities can work most effectively with each other is that "everyone" remain open-minded about agriculture and not automatically dismiss any one way as necessarily being better or worse than another. Sustainable agriculture should be covered in the research, extension, and teaching functions of the university, rather than be dismissed as an alternative totally devoid of possible merit.

CROP AND LIVESTOCK ENTERPRISES, RISK EVALUATION, AND MANAGEMENT STRATEGIES ON SOUTH DAKOTA SUSTAINABLE FARMS

INTRODUCTION

In April 1989, the findings from a Summer 1988 mail survey of 32 sustainable/regenerative farmers in South Dakota were published (Taylor, Dobbs, and Smolik, 1989). The present report is based on more in-depth personal interviewing in January-March 1989 of 22 of those 32 farmers.[1]

The purpose of the interviews was to gain greater insight into (1) who the sustainable farmers are, (2) their sustainable crop rotations, (3) their sustainably raised livestock enterprises, (4) their judgments on the relative riskiness of sustainable versus conventional farming, (5) their participation in and views about government farm programs, and (6) their reactions to selected findings concerning sustainable agriculture from the Summer 1988 mail survey. This report covers these survey findings except for those concerning government farm programs that are reported in Dobbs, Becker, and Taylor (1989).[2]

Farmers indicating a willingness to be personally interviewed, in the earlier mail survey, were considered for possible inclusion in the personal interview survey. A further condition for inclusion in the personal interview survey was that a farmer be beyond--or at least well into--the transition from

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[1]Additional insights were gained during Summer 1989 when various members of SDSU's sustainable agriculture research team visited several of the farmers who had been interviewed earlier in the winter.

[2]The survey findings for 12 of the farms are also being used in the development of detailed cost-return budgets for major individual farm enterprises and crop rotations. These budgets will then be used in whole farm economic analyses under Phase II of the NWAF research project.

"conventional" to "sustainable" farming practices. Resulting from the application of these 2 criteria was the selection of 20 farmers. To widen modestly the personal interview coverage, 2 farmers who had been invited to complete the Summer 1988 mail survey, but who had been unable to do so, were also contacted; they agreed to participate in the personal interviews.

A 2-part questionnaire was used with the "personal" interviews (see Annex 1). Part I was sent in the mail to each respondent, with a request that the respondent complete as much of it as possible in advance of a later-to-be-scheduled visit of the personal interviewer, David L. Becker. At the time of Becker's visit to the individual farmers, he reviewed Part I to clarify any responses that were unclear and attended to any portions of Part I not yet completed. Most of Becker's personal interview time, however, was spent in soliciting the rather detailed information requested in Part II.

One of the personally interviewed farmers was unable to complete Part I of the questionnaire. Thus, the results reported herein are based on 21 Part I and 22 Part II responses.

SUSTAINABLE FARM FAMILIES

The size of family for the sustainable farmers interviewed--defined to include those considered part of households for living expense and tax purposes--ranges from 1 to 8 and averages 4.10 people per family. The families include averages per family of 1.25 sons and 0.85 daughters of the age ranges shown in Table 1. A larger percentage of the girls (76%) exceeds 10 years of age than is true for the boys (48%).

Twenty (91%) of the 22 sustainable farms are organized as sole proprietorships, with one being a rather informal partnership. The other 2 farms are family corporations. These percentages are roughly consistent with

those for South Dakota: 87% - sole proprietorships, 9% - partnerships, 3% - corporations, and 1% - other (USDC, 1989, 7).

Twelve (55%) of the 22 sustainable farmers use operator and family labor to perform all the work on their farms. Nine (41%) accomplish between 90% and 99% of the work on their farms with themselves and their families. Only one relies on family for less than 90% of his total labor needs (75-85% in this case). The most common type of hired labor is for hand weeding soybeans (one farmer for weeding sunflowers also), followed by picking up rocks in fields. Other specific tasks for which labor may be hired are for fence building, carpentry for fixing up buildings, pre-planting field work, baling, and farm chores.

The management decisions on the 22 sustainable farms are shared as follows:

- 7 (32%) husbands;
- 5 (23%) husbands and wives jointly;
- 2 (9%) brothers jointly;
- 2 (9%) single farmers;
- 2 (9%) sons, in consultation with fathers;
- 1 (5%) husband, wife, and son jointly;
- 1 (5%) husband, in consulation with wife;
- 1 (5%) husband, in consulation with wife and father; and
- 1 (5%) husband, in consulation with wife and son.

Thus, husbands clearly are the dominant decision-makers, but their wives and other family members in many cases either participate jointly or play supportive roles in the decision-making.

Seven (32%) of the 22 sustainable farmers perform custom work for others. Baling and combining are most common. One farmer also does each of the following: sharpening discs and welding, planting, windrowing, and trucking. Two farmers spend between 20 and 30 days annually performing custom work for others; one spends 10 days; and the others spend only 2-4 days each.

Fifteen (68%) of the 22 sustainable farmers have custom work done for them. The incidences of different types of custom work are as follows:

- 7 (33%) combining;
- 4 (19%) planting;
- 3 (14%) each of fertilizer/chemical applications, baling/stacking/hauling, and grain hauling; and
- 1 (5%) hay grinding.

For 11 farms, no more than 5 days each are involved annually with this custom work. For the other 4 farms, between 6 and 10 days are involved.

Ten (45%) of the 22 sustainable farmers derive 100% of their adjusted gross income exclusively from the farm. Six (27%) derive 80-99% of their adjusted gross farm income from the farm, 2 (9%) 60-79% of income, 1 (5%) 40-59% of income, 2 (9%) 20-39% of income, and 1 (5%) did not answer. On all farms with off-farm income except one (in which stocks, bonds, and other investments account for 20% of adjusted gross income), off-farm employment is the dominant alternate source of income.

Of the 12 (55%) instances of off-farm employment by the operator and/or his family, 4 involve the husband only, 4 the wife only, 3 both the husband and wife, and 1 both the father and son. Thus, 8 (36%) of the sustainable farm operators have off-farm employment, which is less than the 54% for the overall state of South Dakota (USDC, 1989, 7). At least part of this

difference arises, however, because the sustainable farmer surveys are limited to fully commercial farmers.

The types of off-farm employment undertaken by the sustainable farmers are diverse, with only 2 people having the same job, carpentry. Other jobs undertaken by the husbands are as follows: REA Board of Directors, County Commissioner, university professor, field disc sharpener, hog buyer, and private farm input business. The jobs undertaken by the wives include relief postal worker, baby sitting and store clerk, receptionist, owner of a clothing store, teacher, and nurse.

SUSTAINABLE CROP ROTATIONS

A crop rotation is commonly viewed to represent the successive planting of different crops in the same field. It is described in terms of the patterned sequence of crops that repeats itself during each rotation cycle. The principal crop rotations followed by 20 of the 22 sustainable farms studied, however, do not lend themselves to such a simple characterization.[3] The actual rotations commonly vary from year to year and even from place to place on a particular farm within a given year for 3 basic reasons:

- Many of the sustainable farmers are actively experimenting with different types of rotations to determine the most effective utilization of their unique combinations of natural production resources;[4]

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[3]Even for one of the other two farmers, the particular small grain included in his rotation varies from year to year.

[4]This experimenting is most often in regard to different cultural practices for "standard" small grains, row crops, and forages. In some cases, however, the experimenting is with respect to different varieties of "standard" crops and/or the introduction of "new" crops, e.g., lupine, mung beans, amaranth.

- Many of the sustainable farmers vary the crops in their rotations, from year to year, depending on current natural resource conditions (e.g., soil moisture, soil fertility, weed and other pest pressures), current conditions for participating in government farm programs, and prospective crop prices; and

- Some of the sustainable farmers do have something approaching "overall representative crop rotations," but in practice they follow different variations of the representative rotations at different times on different fields.

Thus, many of the sustainable crop rotations do not lend themselves to succint and definitive characterization. Nevertheless, the results of our best efforts to describe the rotations are reported in Annexes 2 and 3. Annex 2 provides a narrative description of the various crops included in the respective rotations and a highlighting of the management practices followed with the rotations. Annex 3 provides a detailed enumeration of the cultural operations followed in each rotation. Readers are encouraged to study these annexes carefully. These descriptions are placed in annexes, not because of a limited importance of subject matter content (especially Annex 2), but to avoid a rather severe interruption in the flow of text that would have resulted if the descriptions had been included directly in the text.

In the earlier mentioned mail survey report, the sustainable farmer respondents were described as being in 1 of 3 regional locations in South Dakota: the Southeast, Northeast, and West. In this report, the latter 2 regional identities are retained. Farmers in the southeastern part of the State, however, were reclassified as being in either the "South Central" or "East Central" region. The reclassification was undertaken because of a

certain rather distinctive micro-clustering of the personally interviewed farmers in these 2 sub-areas of the "Southeast" and a certain differentiation in the nature of the sustainable crop rotations in these 2 areas.

Figure 1 shows the location of the 22 personally interviewed sustainable farmers. The following numbers of farmers are from each region: South Central - 7, East Central - 7, Northeast - 5, and West - 3. The farms within the first 3 regions have a more well-defined regional identity than those within the fourth. The 3 farms in the West are located so far from one another and are representative of such a tiny part of the West that they can more appropriately be viewed as 3 case farms in western South Dakota. To simplify the text, however, they are described as being located in the "West," the same as the farms in each of the other regions.

Characterization of sustainable crop rotations

Of the 22 personally interviewed sustainable farmers, 10 (45%) can be viewed as "totally crop organic" from the standpoint that no synthetic chemical fertilizers and pesticides are used on any of their cropland (Table 2).[5] In addition, 5 (23%) farmers have "organic" crop rotations, but also have some cropland on which some synthetic chemicals are used. Finally, 7 (32%) of the 22 farmers use reduced levels of synthetic chemicals on their crops, but are yet to completely eliminate the use of chemicals on any of their cropland. The incidence of synthetic chemical use on sustainable farms

[5]Farmers were asked to report "typical" cultural practices on their farm, including their use or non-use of synthetic chemical fertilizers and pesticides. Those farmers in a transition stage in their use of chemicals gave us information on their 1988 and/or 1989 chemical use. When information for both these years was available, we based our classification on the 1988 data. Appropos to this, one farmer in the East Central Region has switched from very limited use of synthetic chemicals in 1988 to zero chemicals on his entire farm in 1989.

in the West and Northeast is less than that on the sustainable farms in the South Central and East Central regions.

At least one small grain is found in all 22 sustainable crop rotations. The most common small grain in the 22 rotations collectively is oats (in 68% of the rotations), followed by spring wheat (50%), rye (46%), and millet (32%). Oats and spring wheat are commonly used as nurse crops in the seeding of forage legumes (most commonly, alfalfa and sweet clover). Rye is becoming increasingly popular, partly for its perceived rather well-defined weed control features.

The most distinctive patterns of small grain crops, by individual region, are as follows:

- All 5 farms in the Northeast have either spring or winter wheat, and 4 have each of rye and millet;

- The most common small grain in the East Central Region is oats (6 of 7 rotations), followed by spring wheat (3);

- The most common small grains in the South Central Region are oats and rye (4 of 7 rotations for each), followed by spring wheat (3);

- The most common small grains in the West are oats, millet, and winter wheat (2 of 3 rotations for each); and

- Two of the rotations in each of the East Central and Northeast regions have flax, 2 in the East Central Region have barley, and 1 in each of the Northeast and West regions has buckwheat.

At least 1 row crop is found in 20 (91%) of the 22 sustainable rotations, including all the rotations in each of the South Central, East Central, and Northeast regions. The most common row crop is soybeans (77% of all rotations), with all 5 rotations in the Northeast and 6 of the 7 rotations in

each of the South Central and East Central regions having soybeans. Corn is second most common (66% of all rotations), with all 7 rotations in the East Central region, 5 of 7 in the South Central region, and 2 of 5 in the Northeast having corn. Two farmers include sunflowers in their sustainable rotations in the Northeast and one includes grain sorghum in the South Central region.

Seventeen (77%) of the 22 rotations have alfalfa, with alfalfa being included in all 7 of the East Central rotations, 6 of 7 South Central rotations, 2 of 3 West rotations, and in only 2 of 5 Northeast rotations. The only other reported harvested legume forage is red clover which is included in one of the East Central rotations.

Eighteen of the 20 reported instances of seeding legume forages involve the use of small grain nurse crops. However, one farmer seeds alfalfa directly in the fall (under the cover of fall-planted oats) and one interseeds alfalfa or sweet clover in corn either when the corn is planted[6] or when it is cultivated the last time.

Alfalfa is most commonly left down, after establishment, for 4-5 years (46% of reported instances). The incidence of alfalfa being left down 2-3 years is 25%, for 1 year 14%, and for 6-7 years 14%. The 2 farmers who leave alfalfa down for 1 year only do so to minimize alfalfa's impact on soil moisture depletion and maximize its impact on weed control. But still, because soybeans is less moisture-demanding than corn, they follow alfalfa with soybeans rather than corn.

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[6]If the farmer interseeds alfalfa or sweet clover when his corn is planted, he hand weeds rather than mechanically cultivates the corn.

Summer fallowing was viewed in the study to represent situations in which no crop was harvested from fields during an entire calendar year. About 55% of the 22 rotations involve at least 1 year of summer fallowing. In 7 of the 12 instances of summer fallowing, a cover crop (most commonly sweet clover, but sometimes forage sudan) is used.[7] The other 5 instances of summer fallowing involve tilled black dirt. The instances of cover crop summer fallowing are spread across all 4 regions, whereas instances of black dirt summer fallowing are limited to the Northeast and West.

Three of the reported intensities of summer fallowing involve fallowing once in 3 years. One incidence is reported of fallowing once in each of 2, 5, and 7 years. Fallowing is more intensive (frequent) in the West than in the Northeast, and far greater in these 2 regions than in either other region. Two sustainable farmers rest their land every 7th year, one in the South Central Region under the cover of forage sudan and sweet clover and the other in the West under the cover of matured weeds.

The most common summer fallow cover crop is sweet clover (7 of 9 reported instances), followed by forage sudan (2 of 9). Three rotations (one in each of the South Central, East Central, and West regions) also involve the spring plowing down of a sweet clover cover crop seeded the prior fall.

In concluding this section, attention is drawn to what appear to be the most distinctive characteristics of the sustainable crop rotations and overall farms in each of the 4 regions. This listing of regionally distinct characteristics represents a "first-cut" typological description of South Dakota's sustainable crop agriculture. Because this typology is based on so

[7]The land summer fallowed with a cover crop is sometimes used as set-aside in farm program participation.

few observations (South and East Central regions - 7 farms each, Northeast - 5, and West - 3) and the underlying issues are so intertwined, one should view this first-cut typology as indicative only.[8]

South Central Region

- Farms are somewhat smaller in this region (an average of 425 cropland acres in 1988) than in the East Central Region (535 acre average), considerably smaller than in the Northeast (760 acre average), and very much smaller than in the West (1,500 acre average).

- The rotations here are relatively evenly balanced between small grains and row crops, with a definite presence also of harvested forage legumes.

- Summer fallowing in this region is relatively limited (in only 2 of 7 rotations). The summer fallowing that is here involves cover crops (2 instances of sweet clover and 1 of forage sudan).

East Central Region

- Collectively, the sustainable crop rotations here are probably less complex than in the other regions. For example, 4 of the 7 rotations in this region have a common pattern of Soybeans - Corn - Small Grain - Forage Legume; 2 other rotations don't differ greatly from this general pattern.

- The rotations here are relatively evenly balanced between small grains and row crops, with a definite presence also of harvested forage legumes.

- Row crops (soybeans and corn) are slightly more prominent here than in the South Central Region, and are far more important than in the West.

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[8]As further research results on farmers' sustainable agriculture practices in South Dakota become available, this typology will be updated and modified. A specific focal point of attention will be comparing the sustainable farms with typical farms in the State based on U.S. Census and other pertinent data.

- Harvested legume forages are slightly more prominent here than in the South Central Region, with all 7 of the region's farmers harvesting alfalfa and 1 harvesting red clover as well. Also, the length of time alfalfa is left down, after being established, is shorter in the rotations here than in any other region.

- Summer fallowing here is relatively limited. That which is undertaken involves cover crops (2 instances of sweet clover).

Northeast Region

- A fundamental component of sustainable rotations here is Small Grain - Summer Fallow.

- The extent and diversity of small grains are greater here than in any other region, e.g., 80% of the farms have each of spring or winter wheat, rye, and millet.

- All 5 rotations have soybeans, but only 2 have corn.

- Forage legumes are definitely less important in this region and in the West than in either of the other 2 regions.

West Region

- These farms are far larger (averaging over 1,500 acres of cropland) than those in any of the other regions.

- A fundamental component of the sustainable rotations here is Small Grain - Summer Fallow.

- Black dirt summer fallowing is a slightly more common rotation component (67% of the rotations) here than in the Northeast (60%). Fallowing here is more frequent than in any other region.

- A row crop (corn) is found in only one rotation, and it covers less than one-tenth of the farmer's total cropland.

Cultural operations

The cultural operations undertaken by farmers for each crop, including summer fallowing, in the respective rotations are indicated in Annex 3. Six categories of cultural operations are indicated: (1) pre-plant land preparation; (2) fertilizer, manure, and pesticide application; (3) planting; (4) weed control; (5) harvest; and (6) post-harvest.

Except for fall-seeded winter wheat and rye, the cultural operations shown for each crop are those performed for the crop during the calendar year. Thus, for most rotation components, pre-plant land preparation covers spring-performed operations and post-harvest operations those performed in the fall. For fall-seeded winter wheat and rye, however, the fall-performed pre-plant tillage and planting operations are shown as if they were performed in the spring.

Data on selected cultural operations for major crops included in the the just-described sustainable rotations are summarized in Table 3. The average numbers of cultural operations for the row crops--corn and soybeans--are 9.2 and 8.9, respectively, per year per crop.. For the small grains, the average number of cultural operations ranges from 7.9 for oats to 5.9 for winter wheat. There is a wide diversity among farmers, however, in the number of cultural operations undertaken for specific crops. The widest relative range among farmers is 3 to 13 for oats and the narrowest is 6 to 11 for soybeans.

The average number of **field tillage operations** undertaken by the row crop farmers is 2.7-2.8 per year per crop. For the small grains, the range is 2.1 (spring wheat) to 2.9 (winter wheat). Somewhat over one-half of the farmers with spring wheat (64%) and corn (56%) in their rotations undertake fall

tillage operations after crop harvest. The corresponding percentages for oats and soybeans are 50% and 44%, respectively. The only discernible difference among regions in cultural practices is a greater relative incidence of fall tillage following soybeans in the East Central Region than in other regions.[9]

The average number of weed control operations undertaken with corn and soybeans is 3.9 per crop per year. Fifteen of the 16 (94%) farmers with each of corn and soybeans cultivate for weed control. From 2 to 3 cultivations per season are most common for corn; 2 cultivations are most common for soybeans. The second most important type of mechanical cultivation with corn and soybeans is the rotary hoe, with it being used in one-half or slightly more of the rotations. One rotary hoeing is most common, although in some instances 2 passes over the field are involved. Dragging or harrowing is involved with 38% and 44% of the soybean and corn rotations, respectively. Hand weeding is undertaken with 63% and 25% of the respective soybean and corn rotations. Of equal or less relative incidence is the use of herbicides (19% and 25% of the soybean and corn rotations, respectively).

For the spring-planted small grains--oats and spring wheat--averages of only 0.6 to 0.8 weed control operations are undertaken per year per crop. Dragging or harrowing is the most common (43% and 36% of the rotations) form of weed control. Herbicides are used with 29% and 27% of the oat and spring wheat rotations, respectively. In about 30% and 45% of the oat and spring wheat rotations, respectively, no post-planting weed control operations are undertaken. Weed control with the fall-planted small grains--winter wheat and

[9]One must remember, however, that the number of observations on which this and other findings are based is relatively small (Table 3, row 1).

rye--is limited to dragging and harrowing, and even then with smaller proportions of the rotations than with the spring-seeded small grains.

The **moldboard plow** is used by 80% of the Northeast sustainable farmers, 57% in the East Central Region, 29% in the South Central Region, and none in the West. All 10 (45% of the 22 sustainable farmers under study) farmers using the moldboard plow do so to break alfalfa or sweet clover ground. Two of the 10 also use the moldboard plow following small grain. One also moldboard plows following the application of an organic input soil conditioner on soybean ground.

The **tillage** operations undertaken during the **black dirt summer fallowing** periods in the 5 rotations under study are rather diverse, as follows:

- 7 chisel plowings, with sweeps;
- 6-7 field cultivations;
- 4-5 field cultivations, with sweeps;
- 3 tandem discings; and
- 1-2 field cultivations, with sweeps, in combination with 1 tandem discing and 1 rotary mowing of weeds.[10]

With 13 (59%) of the 22 rotations, **manure is spread** on at least one of the rotation components. Of the 19 reported instances of spreading manure, 47% involve manure being applied following small grain harvest, 26% following row crop harvest, 16% after fallow or legume forage plow-down, and 11% on alfalfa.

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[10]To conserve added moisture during summer fallowing, this farmer is experimenting in 1989 with summer fallowing in which rather frequent short-cut rotary mowings replace tillage for weed control.

LIVESTOCK ENTERPRISES

Nature of enterprises

Eighteen (86%) of the 21 sustainable farmers responding to Part I of the questionnaire indicate that they have commercial (arbitrarily defined to involve 5 or more head) livestock enterprises.[11] This is slightly higher than the 78% of the mail survey respondents who reported raising livestock.

The most common type of livestock reported by the 21 farmers involves beef cow-calf operations on 13 (72%) of the farms (Table 4). One-half of the farmers undertake the next most common livestock enterprise, cattle finishing. About one-fourth have hog farrowing operations, one-seventh hog finishing operations, and one sustainable farmer in the South Central region has a dairy herd (60 cows).

Eight of the 18 farms with livestock specialize in only one livestock enterprise as follows: 6 - beef cow-calf, 1 - cattle finishing, and 1 - hog finishing. The other 10 farms have diversified livestock operations as follows: 4 - beef cow-calf and cattle finishing; 2 - beef cow-calf and hog farrowing; 2 - cattle finishing, hog farrowing, and hog finishing; 1 - beef cow-calf, cattle finishing, hog farrowing, and hog finishing; and 1 - cattle finishing and dairy.

Differences among regions in the nature of livestock enterprises are as follows:

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[11]The questionnaire called for information on typical livestock enterprises on the sustainable farms over the period 1984-1988. As with crop rotations, however, these data are not yet stabilized on some farms. Thus, some farmers provided information for only 1988 and/or 1989. If so, we used their 1988 livestock data.

- All 3 sustainable farms in the West have beef cow-calf operations, whereas only between 40% and 60% of the farms in the other 3 regions do;

- The highest relative incidence of cattle finishing is in the Northeast (3 of 5 sustainable farms); in strongest contrast, no cattle finishing expectedly takes place on the sustainable farms in the West; and

- Farms with hog farrowing and hog finishing operations are limited to the South Central and East Central regions.

The 13 farmers with cow-calf enterprises have herds ranging in size from 5 to 150 cows and average 45 cows per herd (Table 5). The most common herd size category is 25-49 cows, followed by 5-25 cows. These sustainable farm beef cattle herds are considerably smaller than average in South Dakota, with only two being larger than the State average of about 80 cows per farm (USDC, 1989, 27). Herd sizes on sustainable farms in the different regions do not appear to differ with one another.

Of the 8 farmers that finish cattle, 4 raise all their feeders placed on feed, 1 raises 42 of his 45 feeders placed on feed, and 3 buy all their feeders. One of the 8 buys and feeds only Holstein steers. The mean size of the sustainable farmers' cattle finishing enterprise of 26 head is far smaller than the State average of 150 head per feeder (USDC, 1989, 28).

Four of the 5 sustainable farmers who farrow hogs have between 8 and 12 sows. The fifth farmer farrows about 45 sows. On the average, these sustainable farm hog farrowing operations are smaller than the State average of about 30 sows per farm (USDC, 1989, 31). Each of the 5 sustainable hog breeding enterprises involves sows farrowing twice per year. The 4 smaller farrowing operations involve sows farrowing at 2 different times a year, and the larger operation 4 times a year.

The 3 hog finishing operations involve 180, 250, and 700 hogs being finished per year. Each producer raises all his feeder pigs. In general, the scale of these sustainable hog finishing operations is in line with the State average of 315 head per feeder (USDC, 1989, 31).

Sustainable management practices

Of the 18 sustainable farmers with livestock operations, 14 consder themselves to raise their livestock sustainably, 2 follow a combination of sustainable and conventional practices, and 2 do not follow sustainable practices. The farmers' descriptions of their sustainable livestock management practices are presented in Annex 4.

Since "sustainable" management practices for livestock have not been, to our knowledge, described in the formal literature, we use the judgments of South Dakota's practicing sustainable livestock farmers to determine a "first-cut" statement of sustainable livestock management practices. The statement is two-part: practices consistent with the majority of practicing farmers and practices unique to 1 or 2 of the farmers.

Common sustainable livestock management practices. Management practices viewed as "sustainable" by a majority of the 16 practicing sustainable livestock farmers in the survey are as follows:[12]

[12]In reporting these practices, the research team is not implying that any or all of the practices are necessarily associated with the reduced presence of chemical residues in livestock meat.

- The non-use of (1) antibiotics and other additives in concentrate feeds, (2) hormones and other growth stimulants/promotants, (3) insecticides, and (4) vaccinations with livestock;[13]

- The feeding of only organically grown grain and roughage to livestock; and

- The non-use of closed confinement facilities in handling livestock.

Unique sustainable livestock management practices. The following practices were reported by only 1 or 2 farmers each:

- Finishing cattle with a higher proportion of roughage to grain;[14]

- Substituting hay for silage in cattle finishing;

- Substituting silage for grain in dairy production;

- Feeding probiotics to dairy cows;

- Allowing weaned calves to again run with their mothers both before and after subsequent calving;[15] and

- Preventing over-grazing.[16]

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[13]Some farmers report "not using drugs or shots" with their livestock. It is not fully clear, however, whether they refrain from treating infected animals with occasional antibiotics and/or believe that doing so is essential to raising livestock "sustainably."

[14]As noted later, the actual practice of all sustainable farmers who finish cattle is to feed atypically high proportions of roughage to grain. One farmer reports that he believes this practice leads to less disease problems.

[15]This farmer believes that his young cattle thereby have quieter dispositions and gain faster.

[16]This farmer believes that the prevention of over-grazing keeps his livestock from picking up soil-borne diseases and particles.

Feeds used

For the 9 farmers who use sustainable management practices with their beef cow herd and provided information on the mix of roughages fed to their beef cows, the most common roughage is grazing pasture (Table 6). Eight of the 9 farmers rely on grazing for more than 40% of their roughage needs, and 3 for more than 60% of their roughage needs. All 9 farmers also feed hay, but only 1 of them relies on hay to meet more than 60% of his roughage needs. Only 1 farmer feeds silage, and that to meet only 10% of his total roughage needs (on a rough dry matter basis).

Three of the 6 farmers using sustainable management practices in finishing cattle feed a combination of hay and grain, with the following hay-grain percentage combinations: 50-50%, 55-45%, and 80-20%, respectively. The other three feed their finishing cattle the following diets: (1) 50% - grazing, 25% - hay, and 25% - dry grain; (2) 50% - silage (haylage), 40% - dry grain, and 10% - hay; and (3) 90% - silage (haylage) and 10% - dry grain. The role of grain in these finishing diets is considerably less than the average of 75% to 80% for cattle feeders generally in the State (Taylor, Wagner, and Kappes, 1989).

The two hog farrowing farmers who follow sustainable practices feed grain-protein supplement combinations of 80-20% and 88-12%, respectively. For finishing hogs, the grain-protein supplement combinations are 83-17% and 84-16%, respectively.[17] The sustainable dairy farmer feeds the following combination of feeds: 60% - silage (haylage), 20% - high moisture grain, 10% - hay, 7% - grazing, and 3% - protein supplement.

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[17]One of the hog farmers feeds his sows and finishing hogs a limited quantity of straw (about 2% of their total diets).

Of the 14 sustainable livestock farmers, only 2 (14%) feed purchased grain and/or roughage. Both are beef cow-calf operators. One farmer in the West Region buys all the corn that he feeds to his 24 "backgrounded" feeder cattle and one farmer in the East Central Region buys 5% of the hay for his 14 beef cows.

Manure management

All 18 of the sustainable farmers who have livestock report using all the manure they produce on their farms. While no one reports buying manure from others, 2 farmers procure manure from others with no out-of-pocket expense. One does so from a neighbor--to meet 30% of the total manure he applies. The other farmer secures 20% of his farm's total manure applications through an arrangement in which his neighbor, in exchange, raises hogs in facilities on his farm.

The proportions of various farmers' cropland, over the periods of their respective crop rotations, that receive manure applications are relatively low. For example, 6 (46%) of the 13 farmers who provided information in response to this question cover 5% or less of their cropland with manure (Table 7).[18] Three (23% of the 13 farmers) apply manure to between 6% and 20% of their cropland. The frequency of manure applications on these 9 farms ranges from once each 5 years to once each 10 years. The 3 farmers who make the heaviest manure applications cover the following percentages of their cropland once each 3 years: 30%, 50%, and 60-75%.

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[18]Of these 6, 1 applies most of his limited manure to his garden, 1 applies his manure only to his pasture (because of pigweed problems on his cropland), 1 limits the application of his limited manure supply to hilltops to try to replace topsoil, and 1 applies his limited manure to cropland areas lowest in organic matter.

If an additional supply of manure were available, 5 farmers indicate that they would probably be interested in buying it. Two indicate that they might be interested, but first they would need to check the weed status and price being asked. One indicates he would take it if the manure were free. The other 10 say they would not be interested in buying manure from others, with the most important reason being concern over possible weed seed in the manure, followed by their already having too much work to do.

RISK EVALUATION[19]

Relative risks with sustainable versus conventional farming practices

The farmers responding to Part I of the questionnaire were asked to indicate whether in their judgment sustainable agriculture involves more or less risk than conventional agriculture. Eleven (52%) of the 21 indicate less risk, 3 (14%) more risk, 2 (10%) both more and less risk, and 5 (24%) no difference in risks.

In explaining their responses, farmers drew attention to 4 types of risk: financial, production, market (price), and health/environment.[20] Each is discussed in turn, with consideration (as applicable) first to ways in which sustainable agriculture is less risky and second more risky.

Financial risk. Eleven of the 12 farmers indicating that following sustainable farm practices impacts financial risks believe that risks are thereby reduced. Their main argument derives from reduced off-farm purchases for production inputs with sustainable practices. Thus, the need to use and

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[19]A current Graduate Assistant in the Economics Department, Liong Min Tiong, is responsible for some of the underlying tabulations in this section. Her thesis will cover in considerably more detail than here the topic of risks in sustainable agriculture.

[20]These categories of risk were <u>not</u> pre-specified in the questionnaire.

thereby incur a later obligation to pay back borrowed operating capital is less with sustainable agriculture. Two farmers also believe that risks are less if one does not have an obligation to seek and pay attention to the advice of external agricultural input suppliers and bankers.

On the other hand, some farmers find financial risks with sustainable agriculture to be greater than with conventional agriculture. This situation arises for one farmer because of greater difficulty in his being able to secure even the limited amount of credit needed to meet his production expenses. He has found a definite reluctance of financial institutions to grant credit for purchases involving sustainable farming practices.

Another sustainable farmer cites increased short-term financial (liquidity) risks with sustainable agriculture because of uncertainties about when he will be able to sell and actually receive payment for his organic produce. Payments can be delayed as much as 2 years after the time of crop harvest.

Production risk. Eight farmers cite an impact of sustainable agriculture on production risks. The most commonly emphasized source of reduced production risks with sustainable agriculture revolves around farmers' having "their eggs in more than one basket" through enterprise diversification. Since sustainable farmers generally have a larger number of enterprises than their conventional counterparts, the chances are greater that --when conditions are unfavorable for some of their farm enterprises--at least somewhat counterbalancing forces will be operating with respect to others of their enterprises.

A special variation of the enterprise diversification theme is that, in years of grain crop failure, livestock which are common on sustainable farms

can often make constructive use of lower-valued, failed crops. Thus, returns to the cropland can be enhanced through livestock relative to a non-livestock farmer either (1) having to incur harvesting costs that are large in relation to a small crop or (2) realizing no return at all from an unharvested crop.

Several farmers draw attention to sustainable farmers being less vulnerable to year-to-year fluctuations in rainfall than their conventional counterparts.[21] Production risks during years of limited rainfall are less because of the enhanced soil water holding capacity associated with improved soil structure and organic matter content resulting from sustainable farming practices. Production risks during years of excessive rainfall can be less because sustainable practices contribute to reduced soil erosion.

Two farmers mention a postive association between farmers deciding to undertake sustainable practices and their exercising sound management practices. One believes that when people elect to farm sustainably they thereby derive direct, positive incentive to improve their management. Part of becoming an improved farm manager is learning to cope better with risks. Another says that, when people take up sustainable farming practices, they know the managerial requirements will be greater. As they respond to the greater managerial requirements, they both (1) become more familiar with and make better use of the unique natural resources on their farms and (2) become overall more seasoned, stronger farm managers.

From certain standpoints, however, production risks can be greater with sustainable agriculture, particularly during the transition from conventional to sustainable practices. Such expanded risks arise with the change from

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[21]One farmer also mentions a lesser vulnerability of sustainable farmers to year-to-year variations in insects.

known conventional to unknown sustainable technologies, the same as with any other technological change. This point, emphasized by several farmers, is captured by the farmer who says, "it may take a few years to find out what does and does not work." Another farmer presents a meaningful analogy with drugs:

> "Any major change in your operation is risky. Of course, the risk is greater while you are making the switch. The land is like a drug addict, always wanting its 'fix' of synthetic chemical fertilizers and pesticides. The first 5-6 years you take the land off its addiction, the land will be slowly healing itself. The transition period can be a time of economic hardship and self-doubt. As time passes, however, you eventually realize that sustainable agriculture was really the only choice you had."

Because of unknowns in switching to sustainable agriculture, one farmer recommends managing risks by converting to sustainable practices only 20-30% of one's land at any one time.

From a more technical production standpoint, expanded weed and other pest pressures during the transition can make a crop especially vulnerable to yield impairment. Possible short-term nitrogen shortages that also frequently arise during the transition can lead to a similar end. No matter whether during or after the transition, some farmers believe the risks of untimely cultural operations to be particularly critical with sustainable agriculture.

Market (price) risks. Four of the 21 farmers draw attention to changed market (price) risks with sustainable agriculture. Output price risks for sustainable farmers can be less because of the argument noted above concerning "eggs being in more than one basket" as a result of greater enterprise diversification on sustainable farms. Risks of unexpected price changes for inputs are less with sustainable agriculture because of the purchase of fewer off-farm inputs by sustainable farmers.

Two farmers also cite price premium bonuses for organic products to result in reduced market risks for sustainable producers. Because organic product markets tend to be very thin, however, prices of organic products are likely to be less stable than are those for conventionally produced farm products. Further, the absence of Federal farm programs for legume forages and most livestock products integral to many sustainable farm operations removes informal "government guarantees" of prices for those commodities that can be enjoyed by grain farmers who participate in Federal farm programs.

Health and environment risks. Four farmers cite an impact of sustainable agriculture on health and environmental risks. Three emphasize the reduced risk to the health of farm workers because they no longer have to handle potentially dangerous chemicals. One also cites reduced risks from sustainable practices to groundwater contamination and wildlife habitat impairment. Further, the risks of health impairment to diet-sensitive food consumers can be less when such people eat sustainably produced farm products.

On the other hand, one sustainable farmer cites increased physical, mental, and emotional health risks that can arise as a result of personal ridicule to sustainable farmers from members of the local community and from possible actions by threatened conventional farmers.

Comparative sustainable and conventional yields under contrasting production conditions

Farmers were asked to provide comparative estimates of sustainable and conventional yields for each crop during each of unusually favorable ("best"), "most normal," and unusually unfavorable ("worst") production conditions during the period 1984-1989. As an intended aid in answering this question,

respondents were asked to first cite which year most fully illustrated each production condition.

Responses for illustrative best and normal years are widely divergent among farmers, with no one year being mentioned for either condition by a majority of farmers (Table 8). For example, 7 farmers selected 1987 as the best production year, but 9 selected a different year. Three years--1984, 1985, and 1986--were each cited by 4 farmers as being normal. A fairly strong consensus exists, however, on the year judged as worst for production, 1988.

The extent to which the divergence of judgments among farmers on the goodness of production conditions in particular years reflects (1) real differences in general production conditions from place to place, (2) real differences in some particularly critical production conditions from place to place,[22] and/or (3) an inability for farmers to be able to recall clearly prior production conditions is unknown.

The sustainable farmers' judgments on sustainable versus conventional yields are reported in Annex 5. They are discussed here by crop.

Corn. Of the 11 farmers indicating a judgment on relative sustainable versus conventional corn yields in normal production years, 3 indicate sustainable yields to be higher than conventional yields, 1 the yields to be the same, and 7 the yields to be less with sustainable practices (Table 9).

During the year with the best growing conditions, sustainable yields are reported to lose some ground relative to conventional yields, with 3 farmers

[22]The variable production condition mentioned most often by farmers is precipitation, both total amount and timing. Other variable production conditions cited by farmers are sub-soil moisture, temperatures, winds, hail, and weed and other pest pressures.

indicating yields to be the same and 6 yields less with sustainable practices. During the year with the worst growing conditions, on the other hand, 4 farmers report similar yields, 1 yields to be higher with sustainable practices, and only 2 yields to be less with sustainable practices. This pattern of a relative loss in sustainable versus conventional yields during years of unusually favorable production conditions and a relative gain in sustainable versus conventional yields durings years of unusually unfavorable production conditions is consistent with that reported by Klepper, et al. (1977) and Lockeretz, et al. (1980) for corn producers in the Corn Belt.

While the numbers of observations for individual regions is very limited, the general patterns of relative yield differences in sustainable versus conventional yields among best, normal, and worst crop growing conditions are the same in each of the South Central and East Central regions as those just described for the State. The one farmer with pertinent data in the Northeast reports no difference between sustainable and conventional corn yields under any of the 3 production conditions.

Soybeans. Of the 10 farmers indicating a judgment on relative sustainable versus conventional soybean yields in normal production years, 1 indicates sustainable yields to be higher than conventional yields, 4 the yields to be the same, and 5 the yields to be less with sustainable practices (Table 9).

During the year with the best growing conditions, sustainable soybean yields show some indication of losing ground relative to conventional yields, but not to the same extent as that reported above for corn. During the year with the worst growing conditions, however, sustainable soybean yields

definitely gain relative to conventional yields--with 7 farmers reporting comparable soybean yields and only 1 lower yields with sustainable practices.

The region most closely mirroring this pattern for the State is the Northeast. The South Central Region, on the other hand, fails to reflect a pattern of a relative loss in sustainable versus conventional yields during years of unusually favorable production conditions and a relative gain in sustainable versus conventional yields during years of unusually unfavorable production conditions.

Oats. Of the 9 farmers indicating a judgment on relative sustainable versus conventional oat yields in normal production years, 1 indicates sustainable yields to be higher than conventional yields, 4 the yields to be the same, and 4 the yields to be less with sustainable practices (Table 10). During the year with the best growing conditions for oats, the relative pattern of sustainable versus conventional yields differs little from that for normal production conditions.

During the year with the worst growing conditions, however, sustainable oat yields definitely improve relative to conventional oat yields. For example, during the worst year, only 1 farmer reports sustainable yields to be less than conventional yields, compared to 4 farmers during a normal production year.

Spring wheat. Of the 7 farmers indicating a judgment on relative sustainable versus conventional spring wheat yields in normal production years, 3 report sustainable yields to be the same as conventional yields and 4 report the yields to be less with sustainable practices (Table 10). The same general patterns of relative sustainable versus conventional yields for oats during best and worst production years are reflected with spring wheat.

Alfalfa. All 9 farmers responding to the comparative yield question for alfalfa report similar sustainable and conventional yields in normal production years (Table 11). During the year with the best growing conditions, 2 farmers report higher yields and one lower yields with sustainable practices. During the year of worst production conditions, no differences between sustainable and conventional yields are reported. Thus, alfalfa is reported to not show the same pattern of relative changes in sustainable versus conventional yields under unusually favorable and unfavorable production conditions as that shown for the above row crops and small grains. This finding is not surprising in view of the generally limited usage of synthetic fertilizers and pesticides on alfalfa by most conventional farmers.

In comparing the data in Tables 8-10, a pattern of intercrop differences emerges. In general, yield differences between crops grown under sustainable versus conventional farming practices are believed to be greatest for the row crops (corn and soybeans), intermediate for the small grains (oats and spring wheat), and least for alfalfa.

This pattern for row crops and small grains appears to be generally consistent with that reported by Shearer, et al. (1981) on Midwestern beef and hog farms. However, the pattern is only partially reflected in results reported by Lockeretz, et al. (1978 and 1981) for Midwestern farmers. The point of greatest contrast is a much greater relative disadvantage of sustainable versus conventional yields for wheat than for either corn or soybeans in the Lockeretz, et al. studies.

Risk protection

Sixteeen (73%) of the 22 sustainable farmers currently purchase some type of crop insurance (Table 12). All of the surveyed farmers in the Northeast and West do, but only 57% of those in each of the South Central and East Central regions do. Of those purchasing insurance, 94% buy Federal multiple peril crop insurance and 25% private hail insurance. Of farmers who purchase crop insurance, the following percentages insure the following crops: 63% - wheat, 56% - corn, 50% - soybeans and oats, 13% - barley, and 6% - rye and sunflowers.

Of those farmers purchasing Federal multiple peril crop insurance, 69% elect the 65%-of-normal-yield coverage level. This coverage level is most popular in the West and least popular in the East Central Region. Two farmers elect the 50% option and one farmer the 75% option. The most popular level of price coverage is "medium," followed by "low" and "high," respectively.

The average period that the currently insured have bought Federal crop insurance is 5 years, but this period varies much (from 1 to 28 years) among farmers. The average period of carrying insurance is greatest in the East Central Region (9 years), followed by the South Central Region (5 years), the West (3 years), and the Northeast (2 years). Slightly less than one-half of the farmers buying Federal crop insurance in 1989 did so because of the 1988 Federal drought relief program requirements.

Three-fourths of those currently purchasing crop insurance have at least at one time tried to collect crop insurance on crop losses occurring on sustainably farmed land. None of them has experienced trouble collecting insurance payments because of their land having been farmed sustainably.

REACTIONS TO SELECTED FINDINGS ON SUSTAINABLE AGRICULTURE FROM SUMMER 1988 MAIL SURVEY

Managerial strategies for meeting selected challenges of sustainable agriculture

Transition weed problems. The most critical problem in converting from conventional to sustainable farming practices reported by farmers in the Summer 1988 mail survey was exaggerated weed pressure. Thus, in the personal interviews, farmers were asked for their advice if they were counseling a farmer considering the possibility of shifting from conventional to sustainable farming how best to cope with likely increased weed problems.

The individual responses of the 21 personally interviewed sustainable farmers are reported in Annex 5. Strategic elements in a majority of the farmers' responses for waging the war against weeds during the transition period are noted first, followed by strategies mentioned by only a few of the farmers.[23]

The vast majority of farmers emphasize the importance of crop rotations in controlling weeds. The principal role of crop rotations in weed control is to interrupt the growth cycles of individual weed species. This pest control is achieved primarily through the seasonal change in food source (the crop) which usually prevents the establishment of destructive levels of pests. The presence of forage legumes is noted by farmers to be particularly effective in combatting weeds.[24] Some farmers draw attention to the allelopathic (a

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[23]In this discussion, attention is sometimes drawn to pertinent responses by farmers to questions other than those reported in Annex 6.

[24]Most farmers mention alfalfa in this regard. One farmer, however, draws attention to the role of sweet clover in mellowing the ground and eliminating pigeon grass.

suppressing of growth of one plant species by another, e.g., the exuding of chemicals from roots toxic to weeds), heavy tillering (root space competition), and wide leaf canopy (shadowing) features of crops such as rye, millet, and buckwheat in helping to effectively combat weeds. One farmer also indicates that the inclusion of non-row crops in rotations frees up time from the overall farm to do a better job of combatting weeds in those row crops that he does have.

The second most commonly mentioning strategy for dealing with weeds is through mechanical cultivation. Emphasis is placed on both the nature and timing of mechanical weed control. Several farmers mention the use of the moldboard plow (in particular circumstances only), chisel plow, noble blade, rotary hoe, offset and tandem discs, and rotary mower. Deep tillage is quite often mentioned as important to gaining control over weeds.

Several farmers emphasize the importance of the delayed planting of row crops in the spring to allow the prior tilling-in of weeds. One farmer suggests planting early crops (e.g., oats, wheat) one year and later crops (e.g., soybeans, sunflowers) the next year. Mechanical cultivation of row crops needs to be critically timed relative to weed and main crop plant growth. Several farmers indicate that tilling ground after small grain harvest helps them to achieve effective weed control.

Other practices suggested by farmers for controlling weeds include the following:

- Composting manure to destroy weed seed life;
- Increasing plant populations to provide wider canopy to shade out weeds;
- Clipping weeds before they go to seed in summer fallowed fields;

- Burning thistle patches with a torch; and

- Overcoming mineral deficiencies in the soil.[25]

Transition nitrogen shortages. Another problem in converting from conventional to sustainable farming practices commonly mentioned in the literature is nitrogen shortage. Nitrogen shortages can be acute during the transition period if a gap exists between (1) when external nitrogen supplies are withdrawn and (2) when natural nitrogen-producing processes become fully operational. Thus, the judgments of sustainable farmers for dealing with transition nitrogen shortages were also sought through the personal interview survey. Their responses are indicated in Annex 6.

Crop rotations dominate even more the responses for dealing with nitrogen shortages than for dealing with weed pressures. The specific feature of rotations most critical to meeting possible nitrogen shortages, of course, is the presence of legumes in the rotations. The legumes may be in the form of harvested or plowed down forages (e.g., alfalfa, sweet clover) and row crops such as soybeans. Legumes are conducive to meeting nitrogen shortages, of course, because they fix nitrogen from the atmosphere into the soil. The plowing down of legumes contributes to the building up of soil organic matter and general soil tilth, both of which contribute to enhanced soil productivity and erosion control.

The second most commonly mentioned strategy for coping with possible nitrogen shortages is using livestock manure. Some apply the manure to fields

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[25]One farmer suggests viewing weeds as "prairie plants," and learning to live with the presence of some of them. The only quite important means of weed control indicated by farmers in the mail survey that was not mentioned in the personal interview survey involves the use of only certified and/or "clean" seed (Taylor, Dobbs, and Smolik, 1989, 52).

"as-is," others compost the manure before applying it to fields, and 2 process and apply manure in liquid form.

Other strategies used by farmers for dealing with possible nitrogen shortages include:

- Turning back crop residues to the soil;
- Selecting crops that require less nitrogen;
- Setting "realistic" (presumably more modest) yield goals;
- Not leaving the ground bare during fallowing;
- Working the ground during fallowing to increase soil nitrogen; and
- Using modest amounts of chemical fertilizer, different forms of non-chemical fertilizer, or certain byodynamic preparations.

Finding markets for sustainably raised products. One of the 2 most important continuing problems with sustainable agriculture identified in the Summer 1988 mail survey is difficulty in farmers finding markets for their sustainably-raised products. The personally interviewed farmers were, therefore, asked to identify what they view as the 2 most important shortcomings in organic product marketing and for each to suggest possible solutions. The farmers' individual responses are reported in Annex 7.

The most common problem in marketing organic products arises from wholesale buyers not purchasing and taking possession of organic produce from farmers until the buyers have found markets for the produce. As a result, a producer has to bear the burdens of (1) providing and meeting associated costs of on-farm storage for his organic produce and (2) an uncertain and uneven cash-flow over time. Farmers suggest the following possible resolutions to this problem:

- Producers forward contracting with wholesale buyers for the production of certain quantities of organic produce; and

- Wholesale buyers either reimbursing farmers for storage (including interest) costs or purchasing and storing organic produce as soon as crops are harvested.

A second rather commonly cited problem with marketing organic produce concerns the distance from producers to plants where the organic produce is cleaned and assembled for shipping. Farmers suggest the development of additional terminals where organic produce could be cleaned and assembled.

A variety of other marketing needs are cited by various farmers: (1) a system for more formally accrediting wholesale buyers so farmers and others can have greater confidence in the integrity of buyers; (2) a more precise definition of "organic" and clear labeling of officially certified organic products in South Dakota; (3) expanded market outlets for certain types of organic produce (e.g., corn, beef); and (4) an elimination of perceived "price gouging" in the processing and distribution of organic products.

Some farmers argue that organic price premiums should be greater than at present to compensate for the extra effort required in marketing organic produce, while others argue that organic produce should be sold at about the same price as conventionally produced products. The two arguments underlying the latter viewpoint are that the quantity demanded of organic produce will expand at lower prices and that organic produce is "lower cost" to produce.

Several farmers emphasize the need to provide education to the general public on (1) the health and nutritional advantages of organic produce and (2) the value of sustainable agriculture in promoting soil life, retarding erosion, reducing soil compaction, and preserving water quality. Several

stress the value of sustainable agriculture organizations in identifying organic market outlets and in generally promoting sustainable agriculture interests.

Improving the development and dissemination of quality information on sustainable agriculture. The other most important continuing problem with sustainable agriculture identified in the Summer 1988 mail survey is a lack of up-to-date and accurate information on sustainable agriculture. As a result, this topic was also targeted for special emphasis in the personal interview survey.

One facet of exploration was determining farmers' current sources of information on sustainable agriculture (Table 13). The sources are quite diverse, with the most important being other sustainable farmers (20% of the responses). Own family experience and sustainable farming books and magazines each account for 16-17% of informational sources. At the other extreme, universities and organic product purchasers each account for only 6% of informational sources; the Soil Conservation Service was cited by no one.

The personally interviewed farmers were also asked to suggest possible sustainable agriculture issues meriting attention in research. Their individual responses are indicated in Annex 8.

The only research topic suggested in common by several farmers is the comparative testing in formal research of sustainable and conventional crop rotations. Suggested focal points for emphasis in such work are soil fertility (e.g., nitrogen, phosphorous, organic matter, trace minerals), soil structure, soil microbial activity, and weed control. One farmer suggests a specific emphasis in research on the transition from conventional to sustainable practices. Most farmers implicitly suggest the research to be

undertaken in formally controlled experiment station field plots.[26] One farmer, however, suggests the possibility of conducting such research on his and a neighboring conventional farm.[27]

Illustrative other areas suggested for research include: (1) the results of soil compaction on root growth, (2) breeding plants for disease resistance, (3) non-toxic methods of controlling weeds and other pests, (4) soil building crops to produce nitrogen and control erosion (e.g., vetch, clover, winter peas), (5) legumes for interseeding with cereal and row crops, (6) interrelationships between sustainable farming and groundwater contamination, (7) the impact on the presence of chemical residues in beef from sustainable versus conventional feeding and other cattle management practices, (8) comparative machinery and other capital investments on sustainable versus conventional farms, and (9) the purchase of organic inputs and the marketing of organic products.

The personally interviewed sustainable farmers were also asked for their suggestions on how sustainable farmers, private organizations involved with sustainable agriculture, and university extension and research personnel could communicate and otherwise work more effectively with each other. The responses to this question are reported in Annex 9.

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[26]Since 1985, SDSU has undertaken research at its Northeast Agricultural Experiment Station Research Farm on sustainable versus conventional and reduced tillage crop rotations. The most recent report covering the yield and economic results from the first 4 years of field trials is Mends, Dobbs, and Smolik (1989). Efforts by the U.S. Department of Agriculture and SDSU are currently underway to expand such comparative field trial testing of sustainable and conventional farming systems to another site in South Dakota.

[27]Since 1984, SDSU has been undertaking a comparative study of a pair of neighboring sustainable and conventional farms near Madison, S.D.

Perhaps the most common thread in the responses of the farmers is their suggestion that "everyone" remain open-minded about agriculture and not automatically dismiss any one way as necessarily being better or worse than another. Several farmers cite a perceived closed-mindedness historically by the university (extension, research, and teaching) to sustainable agriculture and a hope that this situation may turn around. SDSU's undertaking these surveys of sustainable farmers and other recent research on sustainable agriculture is viewed as possible beginning evidence for a turn around. Farmers welcome involvement of the university with studies of different aspects of sustainable agriculture to determine what will work and what will not. Workshops involving co-sponsorship among various groups with interest in sustainable agriculture and universities are advocated by some farmers.[28]

One farmer sees an unmet need that represents an opportunity for the Extension Service to become involved in sustainable agriculture. He notes that, in general, there aren't private businesses to support sustainable agriculture that parallel the private businesses which develop and provide information to conventional farmers. Thus, there is a crucial need for public involvement in developing and disseminating information on sustainable agriculture.

Farmers better or worse off from following sustainable practices?

Three of the 4 most important reasons indicated collectively by respondents for following sustainable practices in the Summer 1998 mail survey involved respondents being concerned about the implications of their farming

[28]Two sustainable agriculture workshops--involving both researchers and farmers as resource persons--are currently being planned in South Dakota for sometime during January-March 1990.

practices for other people. This prompted us to raise the following 2 questions in the personal interview survey:

- Are you a sustainable farmer in spite of short-term adverse repercussions to you and your family, or

- Do you believe you and your family are better off in the short-term than if you farmed conventionally?

The responses to this question are reported in Annex 10. Considering the answers to each question, one-at-a-time, we learned the following:

1. Of the 12 farmers answering the first question, 8 replied yes and 4 no. This response reflects a majority of responding farmers to indicate that they farm sustainably in spite of short-term adverse repercussions to them and their families.

2. Of the 21 farmers answering the second question, 18 replied yes, 2 no, and 1 both yes and no. This response, in contrast with the response to the first question, reflects a strong affirmation of the positive impact of sustainable agriculture on the short-term welfare of sustainable farm families.

In seeking to reconcile this apparent contradiction, we discovered that our initial hypothesis--that farmers would respond yes to one question and no to the other--failed in 6 of 12 instances. In particular, 4 farmers answered no to the first question and yes to the second, 3 answered yes to the first question and no to the second, and 6 answered yes to both.[29] The rationale for 3 farmers answering yes to both questions is that "life" involves more than just economics. For one farmer, adverse repercussions come from the heavier work required with sustainable practices; but he and his family do not

[29]One farmer who answered yes to the first question answered both yes and no to the second question.

experience special personal stress from the hard work and economically, in both the short- and long-term, they are better off with sustainable practices.[30]

[30]The other 2 farmers do not indicate the basis for their responding yes to both questions.

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