No-Till Rotation Systems for Wheat Production

Objective: Determination of the most profitable rotations for no-till production of wheat.

Duration: The study began with a uniform crop of wheat in 1986. Rotations were established in 1987. Pertinent data were collected from 1988-1991.

Narrative: The no-till crop rotation study, jointly supported by the South Dakota Wheat Commission and the SDSU Agricultural Experiment Station, was designed to provide much needed research verification and also meet the need of producers in the area to witness no-till techniques applied on a field-scale basis.

The study area, 5 miles east of Redfield on the north side of highway 212, covered an L-shaped 80 acres of land. Everything at the site was done no-till, meaning only a drill, a sprayer, and a combine were used for all field operations.

Seven different crop rotations were tested. They included: Spring Wheat-Soybeans; Spring Wheat-Corn-Soybeans; Spring Wheat-Barley; Spring Wheat-Winter Wheat; Barley-Winter Wheat-Corn; Winter Wheat-Corn-Fallow; and Corn-Soybeans. Each rotation was replicated four times in different parts of the field. This resulted in plots which are just slightly less than one acre in size.

All field operations were performed with standard equipment, including a JD 752 no-till drill, a corn planter, a 4400 JD combine with either 13-foot flex header or a five-row corn head; and a 25-foot field sprayer. Yields were determined using a 250-bu grain cart equipped with scale. Use of these techniques helped to assure that yields and input costs are the same as those a farmer can expect.

Each rotation in this study was managed as if it were a commercial production field employing techniques presently available for farmer use. The ultimate goal was maximum return. Herbicides were chosen on the basis of cost and effectiveness; fertilizers were applied according to soil tests; etc.

This approach had two major advantages. The first was research verification, a fancy way of saying it allowed SDSU scientists to examine how current best management practices being recommended for no-till fit together and work in field-scale situations; and it let them know where more small plot research is needed to better define these techniques. The second advantage is that it provides producers interested in adopting no-till with both a highly reliable set of input cost and yield figures.

The study was begun in 1986 when a uniform crop of wheat was planted on the field. In the 1987 growing season (fall 1986 for winter wheat) the proper crops were planted in each plot to establish the rotations. The 1988 growing season was the first year that each crop followed the proper sequence in each rotation. The study was ended following harvest in the fall of 1991 when emphasis switched to a similar study west of the Missouri River.

Substantial improvement in soil physical properties were becoming evident after this period of time in continuous no-till. Work has begun to document these changes. No earthworms are present in this study at the present time, most likely due to the lack of a native earthworm source.

Rainfall recorded for the years of the study is shown in Table 1. Some of these years were very dry. The last 2 years were very wet. Rainfall received at the Pierre airport over the same period was included in the table as a means of comparison. This does not mean that yield levels would be similar at Pierre to those obtained at Redfield. The environment and soils are quite different. It does point out that there is not a large difference in rainfall between the Pierre airport and the old research farm at Redfield.

Table 1. Rainfall received at Redfield and the Pierre Airport, 1987-1991.

	4/1-9/1		1/1-12/31	
	Redfield	Pierre	Redfield	Pierre
1987	5.93	9.98	11.82	16.57
1988	10.69	9.96	16.73	13.8
1989	7.99	11.35	14.66	16.75
1990	18.7	13.1	21.31	17.16
1991	22.4	17.79	25.88	23.13
Normal	13.12	13.88	18.51	18.08

Results: The results obtained from the study in the 1988-1990 period presented some interesting insights into the effects of crop rotations under no-till conditions. The surprisingly good yields obtained with some of the rotations in two consecutive dry years (1988 and 1989) give us substantial confidence in the data for dryer-than-normal conditions at Redfield. It is also interesting to see how these results compare to yields obtained in 1990 and 1991 which were wetter than normal.

Several items stand out in the yield data. One of the most dramatic is the 5 bu/acre average reduction in yield for winter wheat experienced when it was grown following spring wheat and the 6 bu/acre reduction on average when spring wheat followed winter wheat as compared to the same crops following barley.

Table 2. Yields for the Wheat Commission Study.

Based on snow catch and available moisture, winter wheat following spring wheat and spring wheat following winter wheat would be expected to yield at least as much as when following barley. The fact that they are much lower yielding demonstrates the importance of the ôrotational effect.ö Disease is probably one of the main culprits along with phytotoxic effects.

The 3 to 4 bu/acre reduction in spring wheat yields when following soybeans as compared to barley appears to be primarily a moisture effect since the soybeans use more water and leave no standing stubble to catch snow. This trend occurred the first 3 years but not in the wetter-than-normal 1991 season.

The 11 bu/acre increase in barley yield following spring wheat as opposed to that behind corn is probably also a moisture effect. Similar moisture differences increased yield of soybeans in wheat stubble compared to those grown in corn stalks in dry years. The yield difference was 7 bu/acre in 1988, a very dry year. There was no difference in 1990, and in 1991 the wetter environment appears to have decreased yield slightly.

Fallowing prior to growing winter wheat did not increase yields in 1989 or 1991 as compared to wheat ôstubbled into barley.ö Based on the moisture patterns that occurred, that is not surprising. Fallowing for winter wheat at Redfield produced only an average yield increase of 3 bu/acre.

Corn is the crop which has responded the most consistently and dramatically to the increased moisture found in wheat stubble. It has produced on average 11 bu/acre more than that grown following soybeans.

A poor variety in 1988 limited yield differences, or they would have been even more apparent.

It was surprising that corn following wheat produced 26 bu/acre more than that following soybeans in 1990 until the timing of the rainfall is analyzed. The corn in wheat was able to avoid detrimental effects from early season dryness and take advantage of late rains. The corn following soybeans had already been hurt some by the time rains fell. The rains came early in 1991, consequently no differences occurred. A higher plant population and more nitrogen fertility in 1991 may have increased yields substantially.

Profitability: The profitability of each rotation was calculated using actual costs of land, seed, chemicals, fertilizers, etc.; harvest time market prices for each commodity; and custom rates for all field operations and transportation.

Table 3. Profitability for the No-till Rotation Study.

Based on previous experience in production fields, it was known that the soybean-spring wheat rotation produced very good returns in normal to wet years in the James River Valley; it was a surprise to see it beat the field in profitability in 1988 and finish second in 1989, two dry years.

Good market prices for soybeans in 1988 and wheat in 1989 helped, but two other factors play a role here: the cost savings in nitrogen fertilizer allowed by growing a legume, and the reduction in herbicide costs associated with this system as compared to where soybeans follow corn or spring wheat follows another small grain.

The biggest surprise in the study was the relatively strong showing of the corn-soybean rotation in the dry years. It was anticipated that this rotation could be profitable in good years and very unprofitable in bad years since it has the highest input costs. In 1989, 1990, and 1991, it had the highest net returns and finished a close second in 1988. It produced the greatest average return over the life of this study.

The corn-soybean-spring wheat rotation finished in a strong position for third place in the average and was number two in profits in 1990. This longer rotation has some definite advantages in spreading workload and risks. The economy of scale associated with being able to produce more acres of crops with the same machinery using a wider variety of crops as compared to rotations 1 and 7 could very well make this rotation more profitable than it appears in this analysis.

The less water-use intensive number 3, 4, 5, and 6 rotations did not fare well in any year or in the average. Although both 1988 and 1989 were dry years, the more intense rotations were more profitable even in those years.

The profitability of the less intense rotations varied little when the good years (1990 and 1991) came along because they could not take advantage of the better moisture conditions, even if we discard the number 3 and 4 rotations which are very poor. The number 5 and 6 rotations have produced less than a fourth the profit of the more intense number 1 and 2 rotations and less than a fifth the profit of the very intense corn/soybean rotation.

These results are sensitive to commodity prices and were gathered during a period of wheat prices usually less than $3/bu. Increasing wheat prices while holding the other commodity prices stable would have improved the relative profitability of the low intensity rotations but not enough to equal the profitability of the more intense rotations.

Even adding one dollar to the wheat price over the life of this study (keeping corn and soybeans the same) will only bring the profitability of rotations 5 and 6 up to a third of the number 7 rotation. The improved wheat price would also make the intense number 1 and 2 rotations more profitable, approximately equal to the number 7 rotation, again at least three times more profitable than the less intense rotations.

The bottom line of this research so far seems to indicate that in order to take the moisture savings that occur with no-till and turn it into profit, wheat producers may have to utilize rotations which are more intensive than they would commonly grow using conventional tillage. This may or may not affect wheat acreage slightly but will substantially increase the diversity and profitability of the wheat producer.

It is true that Redfield differs in soil type and climate from Pierre, or Gettysburg, or Winner, or Presho. The principles documented by this research should, however, have application over all areas where rainfall is in short supply during some period of the growing season.

It is uncertain at this time what rotations will work best for producers in areas farther west adopting no-till. It is almost certain that they will be less intense than the best ones at Redfield and they may contain different crops, but they will be more intense and more diverse than those that are common when conventional tillage is used.

Consequently, a similar rotation study was slated to be initiated in the fall of 1991 at a site south of Ft. Pierre, S.D. This study will encompass approximately 280 acres and is located on an Opal-Promise soil series. These are heavy clay soils typical of the West River winter wheat growing areas. Seventeen rotations will be included in this study varying in intensity from a Winter Wheat-Fallow to Corn-Soybeans. New crops to be included are safflower, field peas, and lentils. It is hoped that within 4 or 5 years there will be information for rotational planning in the dry areas of the west as good or better than the information provided by the Redfield study. The Wheat Commission sponsorship of both of these studies is sincerely appreciated.

Back to Dakota Lakes