ECONOMICS OF NO-TILL CROP PRODUCTION

ANDREW L. SWENSON AND ROGER G. JOHNSON

The primary purpose of tillage are weed control and seedbed preparation. No-till production was not feasible until the development of modern herbicides and no-till seeding equipment. Under no-till, nonincorporated herbicides are the sole means of weed control, and special seeding machines replace the need for tillage for seedbed preparation. No-till is a superior soil conservation practice and offers reductions in fuel, labor, and machinery requirements. No-till is also often cited as a means to conserve soil moisture. Increased costs of pesticides and seeding equipment plus the greater potential for certain disease and insect problems are negative aspects of no-till.

SURVEY OF NO-TILL PRODUCERS

Farmers are hesitant to change from proven production techniques and risk the yield uncertainties which often accompany major changes in management procedures. A 1979 survey located 19 farmers who practiced no-till. The no-till cropland represented only about 10 percent of the total cropland of the farmers surveyed. Information on 1979 no-till small grain production practices and yields was gathered. Winter wheat was the most popular crop for no-till, accounting for 63 percent of no-till small grain acreage. Fourteen of the 19 producers raised winter wheat without tillage.

The main reasons farmers initially tried no-till were soil and moisture conservation, followed by fuel savings. After using no-till, farmers found that reduced fuel consumption was the greatest advantage, followed by soil conservation and timeliness or reduced labor. Those who indicated timeliness or reduced labor usually were referring to winter wheat production which better distributes labor requirements throughout the season,

Swenson is former graduate student and Dr. Johnson is Professor, Department of Agricultural Economics.

Producers expressed concern over weed and disease problems when asked about the future of no-till. However, only two farmers planned to discontinue no-till operations while most intended to increase no-till acreage.

Uniform straw distribution at harvest is important when planning to seed directly into stubble. Straw that is not cut by drill discs is "speared" or pushed into the ground, resulting in poor soil to seed contact. Also, concentrated straw increases the danger of phytotoxicity (the production of substances, during decomposition, toxic to plants). Five farmers noticed poor stands in chaff windrows and a sixth farmer had a spotty stand because of "poor straw management." Eleven farmers used straw management by either harrowing after harvest, modifying combines for better straw distribution, or by a combination of these methods. No thin stands were reported from farmers who modified combine straw choppers with long straw deflector fins.

Commercial no-till drills were used by 17 producers. Twelve used a double disc drill which utilizes increased weight for residue cutting and soil penetration. Five farmers had purchased triple disc drills with a coulter, directly in front of the double disc openers, to cut through residue. Two farmers used conventional double disc drills, modified with the addition of cutting coulters. All farmers reported fair to excellent drill performance except in a couple of cases where hard ground reduced penetration.

Herbicide management is critical under no-till. All farmers who used no-till for spring seeded crops applied glyphosate (Roundup) near seeding but before crop emergence. A nonionic surfactant was used with low rates of glyphosate to increase effectiveness. Glyphosate was used on only two fields before seeding winter wheat. In other instances, no fall herbicide application was used for winter wheat. Postemergence herbicides were similar to those used under conventional tillage.

All no-till spring seeded small grains were fertilized. The soil disturbance associated with normal anhydrous ammonia application procedures would limit it from being part of a no-till system. However, one producer did use fall application of anhydrous on several of his "no-till" fields. All other nitrogen applications, except one using liquid nitrogen (28-0-0), were confined to dry fertilizer either broadcast or applied with the drill. Producers did not show a clear preference between the urea or ammonium nitrate form of nitrogen. All phosphorus and potassium, except in one instance, were applied with the drill.

YIELDS

Yields and costs are of primary importance when making an economic comparison of tillage systems. North Dakota no-till yield data are limited. Farmers reported yields of no-till small grain acreage in the 1979 survey. Nearly all yields were from crops grown from 1977 to 1979. Seventeen no-till spring wheat yields averaged 24.2 bushels/acre compared to an average of 24.3 bushels/acre for the counties in which the no-till producers were located. Barley yields averaged 48.0 bushels/acre on 15 no-till observations compared to 37.7 bushels/acre for the county averages.

No-till winter wheat averaged 28 bushels/acre for 15 observations compared to an average of 15.2 bushels/acre from respective county averages. In addition, seven other no-till winter wheat fields averaged 26 bushels/acre in counties where no harvested acreage of winter wheat was reported by the North Dakota Crop and Livestock Reporting Service. This indicates that no-till winter wheat production is possible in areas where conventional production is not considered feasible. A similar conclusion was made by Anderson (1) and Stobbe and Rourke (7) in Canada. Comparison of no-till yields with county averages are, at best, rough approximations because of the small number of no-till yields and variation in land, weather, and management within counties.

In 25 North Dakota Experiment Station (2, 3, 5, 8) comparisons and four direct on-farm comparisons, no-till spring wheat averaged 4 percent less than yields achieved under conventional tillage. No-till barley yields in 16 comparisons averaged 7 percent greater than conventionally grown barley.

COST ANALYSIS

Spring Seeded Grains

The costs of raising spring wheat or barley under no-till and conventional tillage were compared for three cropping systems: continuous cropping, crop-crop-fallow, and crop-fallow representing eastern, central, and western areas, respectively. Crop rotations were assumed to prevent excessive buildup of foliar pathogens. Budgets were prepared to determine operating, machinery ownership, and labor costs.

Machinery complements and tillage operations for average size farms in eastern, central, and western areas of the state (6) served as the basis for comparison with no-till operations. Tillage equipment and the largest of the three tractors in the conventional machinery complement were omitted from the no-till machinery complement. However, a no-till drill replaced the less expensive conventional drill in the machinery complement.

Nitrogen fertilizer rates of 49 pounds per acre on continuous crop and 31 pounds per acre on the recrop of the crop-crop-fallow systems were used. Ten and 9 pounds of nitrogen per acre were used for grain on fallowed land in the crop-crop-fallow and crop-fallow systems, respectively. Average rate of phosphorus application was 26 pounds per acre. Fertilizer rates were the same under conventional and no-till planting. Nitrogen not applied at seeding was injected as anhydrous ammonia under conventional tillage and spread in urea form under no-till.

The same postemergence herbicide control for wild oats, foxtail, and broadleaf weeds was budgeted under the two production systems. A postharvest fall application of 2,4-D (16 ounces) to control winter annuals and set back certain perennials was used under no-till. Glyphosate (6 ounces) + 2,4-D Amine (4 ounces) + a nonionic surfactant (15 ½ percent of total spray volume) was used before seeding under no-till. Chemical fallow consisted of a late fall or early spring application of Atrazine + Cyanazine (Bladex) at .5 and 2.0 pounds per acre, respectively. This mixture replaces about two tillage operations. Glyphosate (6 ounces) + dicamba (Banvel) at 2 ounces + a nonionic surfactant (½ percent of total spray volume) was then applied three times in the central area and twice in the western area. This mixture replaces between one and two tillage operations.

A summary of per acre cost differences under no-till and conventional tillage for the three crop systems is shown in Table 1. Costs of ⅓ of an acre in fallow and ⅔ of an acre in crop are portrayed under the crop-crop-fallow system column. The crop-fallow column includes costs of ½ acre fallow and ½ acre crop. Spring 1981 prices were used for all inputs.

Cost of no-till under continuous cropping is only slightly higher than conventional tillage because cost savings related to the nonuse and nonownership of tillage equipment offset the increase in herbicide and fertilizer costs. Fertilization under no-till is more expensive because urea is more expensive than anhydrous ammonia.

The cost of the chemical fallow in areas of the state where crop-crop-fallow and crop-fallow rotations are common puts no-till at an economic disadvantage. The per acre costs of herbicides for chemical fallow in the no-till crop-crop-fallow and crop-fallow rotations were $39.95 and $29.71, respectively.

TABLE 1. COST INCREASES UNDER NO-TILL COMPARED TO CONVENTIONAL TILLAGE FOR SPRING GRAIN PRODUCTION FOR DIFFERENT CROPPING SYSTEMS IN NORTH DAKOTA, 1981[a]

	Cropping System		
Costs Per Acre	Eastern Continuous	Central Crop-Crop-Fallow	Western Crop-Fallow
	$ per acre		
Nitrogen fertilizer	4.20	0.73	0.00
Herbicides	12.47	20.64	19.61
Machinery repair	-1.54	-0.78	-0.62
Fuel and lubrication	-5.17	-3.75	-2.85
Machinery ownership costs	-8.79	-8.43	-6.48
Labor	-2.23	-1.81	-1.35
Other costs	1.90	1.88	0.77
Net preharvest operating, machinery, and labor cost increases	0.84	8.49	9.08

[a]A (-) indicates the amount by which no-till costs are less than costs under conventional tillage.

Costs were also budgeted for a situation in which all tillage equipment and tractors were maintained on a farm where no-till was used. This budget portrays a situation in which a farmer is not committed to total no-till, but is merely testing no-till on a part of his small grain acreage. For example, the cost of raising small grain in the eastern area using no-till on 20 percent of acreage and conventional tillage on 80 percent of acreage was $2.52 per acre higher than if all small grain was grown conventionally. Savings in machinery repair, fuel, and labor were more than offset by higher fertilization and herbicide costs. Also, machinery ownership costs were higher because the no-till drill replaced the less expensive conventional drill and was used on all acreage. It should be noted that not all no-till drills are suitable for seeding into conventionally prepared seedbeds.

Winter Wheat

Under no-till, winter wheat can be raised in areas otherwise thought too risky because of winterkill. Budgets were developed comparing the costs of raising winter wheat without tillage to the costs of conventional spring wheat production.

Similar fertilizer rates were used under the two tillage systems. Nitrogen was spread in urea form in late fall or early spring on the no-till winter wheat. Herbicide control of foxtail, wild oats, and broadleafs was assumed under conventional tillage. Winter wheat is more competitive with foxtail and wild oats, so only broadleaf control was used.

The cost of raising winter wheat in a complete no-till system was 39 percent less than growing conventional spring wheat in a continuous crop rotation common to eastern North Dakota. The machinery complement under the complete no-till system had no tillage equipment nor the largest tractor used under conventional tillage. Savings in herbicides and machinery related costs, but higher fertilization expense, gave no-till winter wheat the cost advantage.

If machinery complements are similar, except for drills, no-till winter wheat is still less expensive to raise than conventionally grown spring wheat. A cost reduction (from savings in herbicides, fuel, and labor) of $3.69 per acre over all wheat acreage was realized when just 20 percent of acreage was devoted to no-till winter wheat.

The option of raising no-till winter wheat the recrop year of an otherwise conventional crop-crop-fallow rotation (common to central North Dakota) is attractive. Seeding winter wheat directly into barley, oat, or flax stubble reduces costs $13.94 per recrop acre. Seeding into spring wheat stubble will likely lead to leaf spot disease problems (4). The only change in machinery complement necessary for the conventional grain-no-till winter wheat-conventional fallow rotation is the replacement of the conventional drill with a no-till drill.

FUEL AND LABOR REQUIREMENTS

Fuel and labor requirements are reduced with no-till. Periods of labor use for winter wheat differ from spring sown grains. Table 2 shows the fuel and labor requirements of three production alternatives in eastern North Dakota. No-till winter wheat had the lowest labor and fuel requirements. Especially evident is the small spring labor requirement for no-till winter wheat (spraying).

LIMITATIONS

The complete chemical fallow associated with no-till in developing cost budgets represents an extreme. Chemical-mechanical fallow combinations may be more economical. Also, less costly herbicides for chemical fallow are being developed and tested. The buildup of

TABLE 2. PREHARVEST LABOR AND FUEL REQUIREMENTS, PER ACRE, OF CONVENTIONAL AND NO-TILL GRAIN PRODUCTION IN EASTERN NORTH DAKOTA, 1981

	Time Period	Spring Grain Conventional	Spring Grain No-Till	Winter Wheat No-Till
		minutes		
Labor	Fall[a]	31	9	21
	Spring[b]	25	19	4
	Summer[c]	4	4	0
	Total	60	32	25
		gallons		
Fuel	Total	5.77	2.02	1.67

[a] Machinery labor from August 21 to December 31.
[b] Machinery labor from January 1 to May 20.
[c] Machinery labor from May 21 to August 20.

foliar pathogens is more likely to be a problem under a no-till system, especially if the practice becomes widespread (4). It may be necessary to use fungicides to control this problem. The cost of two applications of fungicides would increase costs about $13.00 per acre.

The surface residues present under no-till protect soil particles from the erosional forces of wind and water. Inclusion of a valve for soil loss in cost budgets would enhance the economics of no-till.

SUMMARY

When proper management has been utilized, spring seeded small grain yields under no-till are similar to conventional tillage yields. Costs of no-till on continuous cropping are slightly higher than production with conventional tillage practices when reductions are made in the amount of machinery owned. The high herbicide expenditures of complete chemical fallow presently make it economically uncompetitive with mechanical fallow.

Substantial cost and labor distribution advantages of raising winter wheat in untilled seedbeds make it an attractive alternative to conventional spring seedings. Seeding directly into stubble provides a more favorable environment for overwinter survival, enabling winter wheat production in areas previously considered too risky.

BIBLIOGRAPHY

(1) Anderson, C. H., "Cultural Developments in Winter Wheat Production," **Canada Agriculture**, Vol. 14, No. 3, 1969.

(2) **Annual Report: North Central Agricultural Experiment Station.** Minot, North Dakota, North Dakota State University, Fargo, 1977, 1978, 1979, 1980.

(3) **Annual Report: Williston Experiment Station,** North Dakota State University, Fargo, 1977, 1978, 1979, 1980.

(4) Lamey, H. Arthur. "Cereal Disease Problems Associated With Minimum Tillage," **Crop Production Conference Report, 1981,** Crop Quality Council, Minneapolis, Minnesota.

(5) Miller, S. D. Unpublished Data, Agronomy Department, North Dakota State University, Fargo, 1980.

(6) Schaffner, L. W., R. G. Johnson, and R. R. E. Barrios. **Small Grains Production Practices and Size and Type of Machinery Used;** Statistical Series, Issue Nos. 34, 34, 36, 37; Department of Agricultural Economics, North Dakota State University, Fargo; May 1979.

(7) Stobbe, Elmer and David Rourke. "Tillage Practices in Winter Wheat Production," paper presented to Tillage Symposium, Bismarck, North Dakota, September 9-11, 1980.

(8) "Yield of Several Crops as Influenced by Seedbed Tillage Methods, Langdon Experiment Station," **Manitoba-North Dakota Zero Tillage Workshop,** Brandon, Manitoba, January 10-11, 1979.

continued from page 2

cereal chemists to evaluate crop quality and economists to evaluate management systems. In addition to the applied research, each new crop needs research from the basic sciences to explore the fundamental issues of plant physiology, basic chemistry of plant systems, etc., if future advances in production are to be accomplished.

The new greenhouse pictured on the cover of this issue is one of many needed investments in the agricultural research establishment needed to help carry the load of increased research needs in the many new areas of crop production in North Dakota. It appears that in general production management problems increase as more intensive crops are introduced. Disease, insect and fertility issues are more numerous and complex for sunflower than were the production problems for the wheat or barley crop those acres replace. The same can be said for dry edible beans, corn and other of the intensive crops that are becoming significant additions to the North Dakota agricultural economy.

continued on page 24