NO-TILL: NORTH DAKOTA RESEARCH EMPHASIS

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Introduction of no-till into North Dakota soil management systems has raised many questions relative to performance under present cropping or climatic conditions. A number of long term cooperative research projects were established in 1977 to answer these questions and set some guidelines for no-till production systems. The areas of research emphasis at various experiment stations are discussed along with preliminary results on one year's data.

No-till, sometimes referred to as minimum, reduced, or zero tillage, is not new. Many areas of the country have employed for quite some time, with moderate success, this type of tillage or crop management system. The system entails the elimination of most primary tillage operations with minimal disturbance of the soil surface during the remaining crop production sequence.

Interest in no-till in other states and Canada, increased emphasis on soil erosion and nonpoint source pollution control, along with the energy crunch, has brought no-till systems into the forefront in North Dakota. No-till systems are designed to reduce the number of tillage operations performed for crop establishment, reducing labor and energy requirements. No-till systems must rely on dependable herbicides for weed control, since primary tillage for weed control is essentially eliminated, plus proper planting equipment to insure adequate plant stands when seeding directly into standing stubble or surface residue. The lack of proper seeding equipment is one major drawback to no-till in North Dakota, especially under small grain production systems. Modification of existing grain drills and/or introduction of commercially available no-till drills should open the way for increased no-till acreage.

Interest in no-till in North Dakota has raised more questions than answers. Since no-till is relatively new in the state, there is little information on how no-till systems will perform under present cropping systems or local climatic conditions. No-till experience from other areas cannot answer these questions because the results were generally developed under different cropping systems. However, the information may offer guidelines for areas of research emphasis. North Dakota has a diversity of crops which are grown under varied management systems. This diversity makes it even more difficult to obtain information or develop an ideal no-till system, because a no-till system that performs well in one area may be entirely unsuitable for another area of the state. Separate no-till systems will probably need to be developed to fit the needs of the crop management system of the area.

To answer questions in the development of no-till systems, a vast amount of information needs to be obtained about the complex soil-plant environmental changes associated with no-till. The changes and associated problems or benefits achieved can only be fully evaluated by comparing no-till with conventional tillage systems. A number of physical or chemical plant and soil variables, along with economic comparisons, should be monitored. Soil variables measured should include temperature, moisture, nutrient status, bulk density, strength, porosity, aggregate stability and residue accumulation. Plant measurements should include emergence and growth characteristics, dry matter production, nutrient analysis, final yield, yield components, and grain quality. Disease symptoms, weed species or population changes and insect or pest incidence will also need to be monitored and/or defined during each tillage investigation. Data collected on these variables from extensively monitored research trials

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along with input from area farmers conducting no-till demonstrations should aid in answering questions about no-till systems as this tillage principle unfolds in North Dakota.

Figure 1. No-till experimental drill designed and constructed to evaluate different types of furrow openers and packer wheels in no-till research.

WESTERN

NORTH DAKOTA No-till seeding of small grains into untilled, previously cropped land can offer farmers another 'tool' for crop production. There is a trend toward more intensive cropping rather than following the crop-fallow rotation which for so long characterized the cropping pattern in western North Dakota. Relaxing of government controls on crop acres, increased farming expense, and the need to eliminate fallow acres in an attempt to control the ever increasing problems caused by saline seeps are the main reasons for the change.

In more intensive cropping, seedbed preparation requires the most time and energy. Tillage during seedbed preparation causes soil moisture loss which could be used for crop production. Seeding directly into untilled stubble with a no-till drill greatly reduces time, energy use and soil moisture loss.

No-till drills for small grains that seed through crop residues without 'plugging' and place the seed properly into the soil are not generally available. Hoe type drills, and in some instances conventional drills with double disk furrow openers, have been used with varying degrees of success for seeding winter wheat into stubble. These hoe drills were designed to seed fallow soil where stubble mulching was practiced and tend to plug when used on untilled soil where residues remain, unless accompanied with wide row spacing. Conventional disk press drills have not been satisfactory because the soil is generally too hard and packed for good penetration and seed placement. Also, the disks tend to ride over the residue bunches, leaving the seed exposed.

To evaluate no-till seeding with conventional seeding methods at the Williston Experiment Station, a special custom-built drill was used. The drill was designed and constructed through a cooperative effort of interested people in Montana, South Dakota, Nebraska, Wyoming and North Dakota. One experimental drill, funded by the Old West Regional Commission, was built for use in each state. The drills were constructed from John Deere parts so several different types of furrow openers and packer wheels could be evaluated. A large coulter is placed ahead of the furrow opener to cut through the crop residue and open a slot in the soil for better opener penetration. The 8-foot drill has eight furrow openers in a two-rank arrangement with 12-inch spacing.

Several different combinations of furrow openers and packer wheels were evaluated in 1977 under both winter and spring wheat no-till seedings. Narrow, hoe-type openers, commonly known as HZ and spear pointers, 3-inch shovel openers, and conventional double disk openers were used in the planting trials. Winter wheat yields, from the openers compared, were not significantly different. All openers worked well except for the 3-inch shovel, which plugged when seeding through heavy (5000 lb/acre) residue. Spring wheat trials were not as successful because extremely dry conditions at planting caused poor emergence and erratic stands which led to poor yields. The double disk opener worked best on spring wheat.

A trial conducted cooperatively between the Soils Department at NDSU and the Williston Station compares no-till (residue erect) under a continuous spring wheat cropping system with spring plow, packer and pony press drill (residue incorporated), and spring chisel plow (16-inch sweeps) plus disk drill (residue flattened). These systems will be evaluated against the standard summer fallow-spring wheat sequence (residue decomposed). Numerous measurements are being taken in this trial to determine the cumulative effects of tillage on the soil environment and what effects crop disease, insects and weeds will have on no-till seeding over a several year period.

Glyphosate (Roundup) was applied at 1 qt/acre (12 oz/acre AI) to control vegetative growth prior to seeding. A combination of bromoxynil-MCPA (each at 4 oz/acre AI) was used to control post emergence broadleaf weeds. First year results showed the best yields on sweep tillage followed by no-till. Weather conditions were not ideal in 1977 with erratic emergence and poor stands in all systems, which questions how representative the results were.

Another trial is being conducted to evaluate the performance of crop varieties when grown under no-till conditions. Eight varieties of spring wheat, four durum varieties and two barley varieties were planted in a conventionally prepared seedbed, no-till in 9-inch standing stubble, and no-till where stubble was clipped and left on the soil surface. First year results show varieties perform differently and

spring wheat yields more than durum under no-till conditions. Studies will be continued to fully evaluate the differences.

Results with no-till at the Williston station were encouraging, in spite of poor stands and low yields obtained by seeding on previously cropped land with minimal stored soil moisture. Weed control in spring grains appears to be a problem under no-till. Weeds do not appear to be a major problem in no-till winter wheat as herbicides and knowledge are available to minimize weed problems in this crop.

Continuation of the research effort, along with the collection and evaluation of the data, should give some insight into the primary objective of no-till studies in western North Dakota, that of devising new seeding methods where heavy residue or standing stubble occur in any crop production system.

Figure 2. A vigorous stand of spring wheat — planted into standing stubble with the no-till drill shown in Figure 1.

CENTRAL
NORTH DAKOTA No-till farming is being looked at closely by north central area farmers. Speakers on the subject are in demand for farmer meetings and personal consultation. Most of the present knowledge concerning no-till utilized in this area is based on information or research conducted in Canada and Montana. This past year, a few farmers tried no-till with varying degrees of success. Results were generally good. Those who have tried no-till intend to continue. Spring wheat, winter wheat, durum, barley and flax were planted to no-till and generally were planted directly into standing stubble.

The North Central Experiment Station at Minot established two long-term trials covering no-till in 1977. One trial compared no-till planting equipment with conventional planting equipment presently used by area farmers. Results from this test were too variable in 1977 to draw any precise conclusions. The second trial is conducted in cooperation with the Williston Experiment Station and the Soils Department, and is similar to the tillage trial at Williston. It compares no-till with two conventional planting methods, spring cultivation planted with a double disk press drill and spring plow, pack and pony press drill. The trial will be expanded in 1978 to compare the conventional fallow practice. Experimental plots were designed large enough to accommodate large field equipment. Butte wheat was planted at a seeding rate of 60 pounds per acre for all tillage methods. The no-till treatment was planted into standing stubble with the modified John Deere drill with 12-inch row spacing described earlier. Fertilizer was applied for a 35-bushel per acre yield goal as recommended by soil test results. The entire trial was planted on April 28.

Soil conditions were dry and it was necessary to plant deeper in the no-till and spring cultivated plots to place the seed into moisture. Few weeds were present at planting but precipitation received on May 4 encouraged germination of weeds along with excellent crop emergence. Stand counts of both the wheat crop and weeds were made. The best crop stand occurred on the spring cultivated-press drill plots but it also contained the most grassy weeds and total weed infestations. No-till had the lowest total weed infestation. The major grassy weeds were foxtail and barnyard grass. Broadleaf weeds were controlled with bromoxynil plus MCPA. Additional crop and soil measurements were collected throughout the growing season. Wheat yields, harvested from 5,000 square feet, were very good. The yield goal of 35 bushels was exceeded in each of the tillage treatments. Yields and test weight were similar among tillage treatments. Grain protein was highest on the spring plow plots (15.0%), lowest on the spring cultivated plots (13.6%), with no-till (14.0%) in the middle.

Results from one year of testing, although inconclusive, suggest maximum production (38.3 bu/acre) with the spring plow, pack and pony press drill but this tillage method has the least soil erosion resistance. The slightly lower yield with the spring cultivate-press drill treatment (35.5 bu/acre)

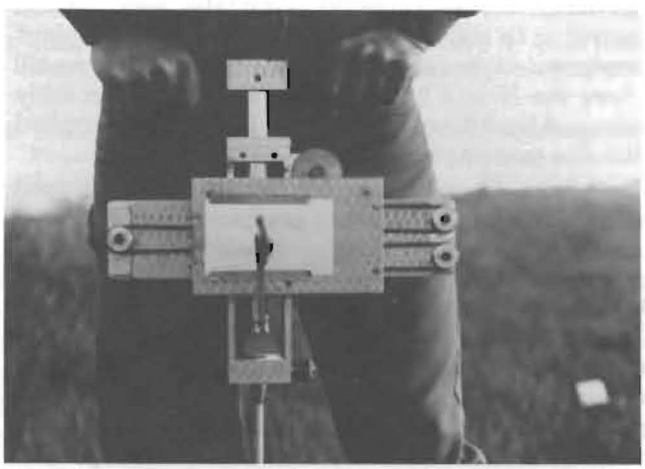

Figure 3. Penetrometer used to measure soil strength (mechanical impedance), one soil physical property monitored in tillage investigations.

was influenced by the heavier weed infestation. Production from no-till (37.0 bu/acre) was encouraging, assuming no other problems will occur under this system. The 12-inch spacing in no-till compared to 6-inch in the other press drills may have been a factor in the results obtained and will need to be considered in future comparisons.

EASTERN
NORTH DAKOTA The no-till concept has attracted more interest throughout eastern North Dakota during the past year, generated by ongoing research being conducted just across the border in Manitoba and the initiation of no-till research in 1977 at the Langdon Experiment Station in northeast North Dakota. Since the cropping systems utilized in eastern North Dakota and the Red River Valley differ considerably from central and western areas, a different approach to no-till cropping systems is being used.

The no-till experiment at Langdon was set up to test the concept of planting adapted crops into nondisturbed soil using a no-till drill and to compare no-till seeding with conventional methods of seedbed preparation common to the area. Hard red spring wheat, barley, tame mustard, flax and navy beans were chosen to utilize both broad leaf and grass crops in a long term rotation without summer fallow.

Primary tillage operations being compared to no-till include fall plow, fall chisel plow, spring chisel plow and spring plow. Replicated treatments were imposed on an area previously cropped to a semi-dwarf durum wheat which had approximately 2300 pounds/acre of residue remaining on the non-tilled soil surface. Normal spring tillage to prepare seedbeds was used just prior to planting on the fall plow, fall chisel plow and spring chisel plow treatments. This consisted of two operations with a field cultivator and harrow. Spring plow treatments were harrowed to smooth the surface for planting. Nitrogen fertilizer, as ammonium nitrate, was applied according to soil tests. The N was applied preplant incorporated on all treatments except the no-till where the N was broadcast on the surface in early spring. Also 50 pounds/acre of 18-46-0 was applied with the seed at planting.

A John Deere model 71 flax planter equipped with front mounted cutting coulters and rear ribbed packer wheels was used to plant the beans. All other crops were planted with a modified double disk Kirschman press drill. Modification on the drill consisted of mounting a single cutting coulter in front of each double disk opener to cut through any residue encountered. Wheat, barley and mustard were planted on April 28. The flax and navy beans were planted on June 10 and June 2, respectively. Propachlor (Ramrod) was applied pre-emergence to all treatments for weed control. Glyphosate (Roundup), a contact herbicide, was applied preplant to the no-till beans and flax to control established weeds. Glyphosate was not used on the no-till plots planted to wheat, barley and mustard because no early spring seed growth occurred. No post emergence herbicides were required.

Additional measurements, in cooperation with other NDSU personnel, were collected throughout the growing season. These included soil tests for N, P, K and organic matter before planting and after harvest; soil moisture measurements before planting, during the season and after harvest; soil compaction using a penetrometer and bulk density; soil temperatures during the season; and crop emergence and plant height. Economic comparisons were made among tillage treatments. Additional plant and soil measurements will be taken in succeeding years.

The entire plot (30 feet x 40 feet) was harvested for grain yields with a small plot combine. Test weight and grain protein determinations were made on the grain samples. 1977 results showed differences among tillage systems. The differences changed with crop grown. The highest Kitt wheat yields were obtained on the spring plow (37.5 bu/acre) followed by fall chisel plow (35.7 bu/acre), no-till (34.1 bu/acre), fall plow (32.5 bu/acre) and spring chisel plow (32.0 bu/acre). Beacon barley yields were 47.6, 46.7, 58.5, 49.4 and 48.6 bu/acre for the no-till, fall plow, fall chisel plow, spring chisel plow and spring plow, respectively. Fall chisel plow produced the highest mustard yield (829 lb/acre) followed by no-till at 726 lb/acre. Yields for the other treatments were slightly lower. The highest flax yield (14.3 bu/acre) was obtained with fall chisel plow. All other flax yields ranged from 9 to 10 bu/acre. Higher navy bean yields were obtained with the spring chisel plow (672 lb/acre) and fall plow (630 lb/acre). Other tillage treatments were in the 400 pound range. It should be pointed out that these data are based on one year's research and may be the result of the 1977 weather conditions rather than the tillages performed.

Crop emergence and plant height for individual crops were similar among tillage operations. Some stand reductions were observed in the no-till where proper placement of the seed in dry hard topsoil or residue accumulations was a problem. This may have had a bearing on the no-till yields obtained. These problems should be alleviated with further drill modifications and/or proper residue management. Generally, increased soil moisture and cooler soil temperatures at the 2 and 4 inch depth were found under no-till at planting. No-till plots required four field operations while some conventional treatments required as many as six additional operations. Economic comparisons showed a savings of over $20/acre with no-till.

Continuation of this tillage experiment, along with research investigations on no-till in other areas of the state, should provide answers to questions about performances of no-till systems under North Dakota conditions.