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Factors to Consider in No-Till Small Grain Production

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FACTORS TO CONSIDER IN NO-TILL SMALL GRAIN PRODUCTION

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Winter annual small grains, especially wheat and barley, are an important part of the cropping systems used in Kentucky. They are a source of early cash flow and livestock feed, and serve as cover crops to reduce soil erosion during the winter.

The early spring growth of winter annuals takes advantage of spring rains and stored soil moisture. Prompt, timely harvest permits the planting of either soybeans or grain sorghum as a second or double crop, making this cropping system profitable and widely adapted. Much of the increased acreage sown to small grains since 1967 has occurred primarily on sloping, erodible land considered marginal for continuous full-season corn and soybean production, especially with conventional tillage.

Seedbed preparation for small grains has typically involved various amounts of primary and secondary tillage, causing a large percentage of residue from the previous crop to be buried below the soil surface. Eliminating one or more of these tillage steps would reduce soil erosion, labor and energy costs. Most important the opportunity for timely small grain planting would be substantially increased. Wet fall weather can add greatly to the conflict between corn and soybean harvest and tillage for small grain establishment. Some producers have resorted to surface broadcasting and a disk to place seed in the ground in reasonable time. Though this procedure works well for some, seed placement and emergence can be very uneven. Both the broadcasting and disking operations must be properly calibrated for best results.

Interest in no-till small grain production has increased because narrow row (10 in. or less) planting equipment is now capable of drilling seeds ranging in size from forage legumes to soybean directly through crop residues. This publication will help those considering no-tillage for wheat and barley production. The information presented in this guide is based on recent University of Kentucky research and field trial observations.

Residue Management

Successful no-till small grain production starts with the harvest of the previous crop. Crop residues from the combine should be spread evenly over the field so that grain drills with narrow row spacing can operate more efficiently, and also so that the crop will develop more uniformly. The combine corn header should not be operated too low to the ground. This allows the heavy, thick portion of the stalk to remain attached to the soil, where it is less likely to tear loose and clog up the drill. Attached stalks may even act as a rigid "comb," retaining other pieces of loose residue on the soil surface which could otherwise hinder the planting operation.

If the combine is not equipped with a chopper, rotary mowing may be necessary before planting. Mowing stalks to a height of 6-8 in. or more would probably be best to prevent further increase of loose residues on the soil surface. Corn plants infested with root worms usually have smaller root systems that tend to break loose from the soil and impede smooth drill operation. Such corn fields usually require a more experienced no-till drill operator.

Drill Management

Grain drills designed for no-till seeding are equipped to cut through crop residues to ensure proper seed placement. Planting speed, soil moisture, soil density, drill weight and row spacing are all factors in seed placement. Placing the seed at the proper depth (1-1.5 in.) to get good seed-to-soil contact and proper crown development is critical. Settings may need to be changed several times as soil characteristics change within a single field. When the soil begins to dry, lighter drills may need more weight added to increase soil penetration.

The cutting unit may not slice through all the residue if the soil and residue are wet, or if certain parts of a field have a high residue rate due to non-uniform spreading. In such a situation, residue may be "hairpinned" into the slit and the seed then dropped into a cradle of plant debris. Without adequate seed-to-soil contact, germination and emergence will be reduced.

Although research data indicate that row spacings as narrow as 4 inches give some yield advantage in winter wheat production, narrow rows and heavy crop residues become more difficult to manage in a no-till situation. As row spacings are narrowed, less space is available for residues to pass between double disk openers, press wheels, coulters and other parts of the grain drill assembly. These residues may build up in front of the drill and disrupt seed placement. Narrow spacings also tend to dilute the weight delivered per row. In extreme cases, even heavy drills may be limited to a shallow seeding depth. Further, planting speed will have to be reduced when the soil is dry. Otherwise, at higher speeds the grain drill will tend to raise up and reduce the planting depth.

Most of the no-till drills available in Kentucky utilize one or more disk openers to cut through residue and provide adequate seed placement (Figure 1). No-till drills with hoe openers and air seeders mounted over field cultivators have also been used to seed small grains into stubble. Coulters are used ahead of seed delivery units on many drills. Because of the need to strongly secure coulters and seed delivery disks or shoes to the frame, residue clearance may be sacrificed in some drills. Other models offset every other row by about one foot to improve trash movement through the drill assembly.

Seeding Rates and Varieties

The seeding rates for no-till small grains should be the same as those for conventional tillage in most cases. Only if planting conditions are less than optimal should the no-till rate be increased. Research data at Princeton (four years) showed final plant stands for no-till and conventional to be equivalent. In 1986 and 1987, the stands were equal with both tillage systems. However, no-till stands were higher in 1985 and lower in 1984. These data indicate that higher seeding rates for no-till can probably not be justified unless there are unusual situations such as high amounts of residue, poor residue distribution, or drills being used with reduced capability to penetrate residue. Seeding rates should be 30-35 seeds/sq ft with the goal of obtaining 25-30 plants/sq ft. In most cases, this will require 80-125 lb of seed/ac depending on seed size. Because of seed size differences among wheat varieties and seed lots, grain drills should be calibrated to insure proper seeding rates. If conditions are not optimal for no-till, then 4-5 additional seeds/sq ft may be needed to insure an adequate stand. Growers should ask seed retailers for seed size information on their chosen varieties.

There is no research data to indicate that varieties vary in performance due to the tillage system used with planting. Varieties should be chosen according to local adaptation, yield potential and disease resistance. Producers should probably plant 2 or 3 good yielding varieties resistant to the most common occurring diseases. Wheat planted after corn may have a greater risk of head scab because the causal organism is parasitic to both crops. At present, this disease-residue association has not yet been observed to any significant extent in Kentucky. Refer to the *"Kentucky Small Grain Variety Trials"* Progress Report for good information on varieties.

Weed Control

For good weed control, no-till small grains should be integrated into a crop rotation. Weed control is improved in a rotation with full-season corn or soybeans where small grains are planted every second or third year. In field trials where wheat was overseeded into no-till soybeans continuously for several years, an increase in weed pressure was observed. If weeds are beginning to emerge at planting or heavy vegetation already exists, then a contact herbicide at planting or post-emergence herbicide applied in the fall or late winter will need to be used. Table 1 shows the yield benefit from using a contact herbicide at planting over a 4-year period. In 2 of the 4 years, there was no benefit while in the other 2 years the response was very positive. It was sometimes difficult to predict the need for a contact herbicide at planting. For current information on chemical weed control, consult your county agricultural Extension agent for the latest copy of Cooperative Extension publication AGR-6, *"Chemical Control of Weeds in Farm Crops in Kentucky."*

Soil Factors in Winter Survival

Winter freezing and thawing often force the plant's root system to the surface, exposing them to adverse environmental conditions. Crop residues on the surface insulate the soil, keeping the soil warmer as air temperatures begin to decrease. (Figure 2). Crop residues also prevent the soil from warming quickly during temporary warming periods, thus reducing the potential for winter heaving.

Regardless of tillage, rapid surface and internal drainage can play a critical role in the crop's ability to survive the winter months. Prolonged saturated soil conditions deprive the plant root system of necessary oxygen and consequently reduce root growth. Saturated conditions also increase the potential for nitrogen loss via denitrification.

Generally, most winter-hardy wheat and barley varieties can survive the average Kentucky winter without the residues maintained by no-tillage. However, the no-till soil environment does appear to improve the odds for survival (Table 2). For example, the Beasley soil, though well drained, contains more clay and is much more slowly permeable than the Pembroke soil. This slow permeability results in severe winterkill when water remains on the soil surfaces disturbed by tillage. Barley on the more permeable Pembroke soil suffered stand loss as well (Table 2). Under very adverse conditions, with prolonged freezing periods, little snow cover, and high soil moisture levels, no-till wheat or barley also may not survive.

Fertilization and Liming

Phosphorus, potassium and lime may be applied to the soil surface in the fall before planting. No yield losses in no-till small grains due to phosphorus or potassium deficiency have been observed when these nutrients are applied on the soil surface according to soil test recommendations.

One of the most important yield-determining factors in winter cereal production is nitrogen availability. The residue remaining on the surface in no-till wheat or barley influences nitrogen availability in ways similar to those observed in no-till corn production. In no-till situations, nitrogen fertilizer applied to the soil surface can be tied up while the residue is decomposing or can be lost via denitrification when the soil is too wet. Thus, part of the applied nitrogen is either lost or unavailable for plant uptake, and nitrogen deficiencies may result. Table 3 shows some of this effect. The no-till yields are lower at the two lowest rates of N fertilizer. Examination of the yearly results indicates that no-till wheat will require an additional 30 lb N/acre for yields equivalent to conventional tillage. This trend was present 2 of the 4 years. It is also interesting to note that wheat yields after soybeans were higher. N availability after soybeans was probably responsible for at least part of this increase. While current N fertilizer recommendations call for 60-90 lb N/acre for small grains, no-till producers should remember the potential for some N loss and stay at the high end of the range, especially when planted after corn. For the latest information on soil testing and fertilizer recommendations refer to the Cooperative Extension publication AGR-1, "Lime and Fertilizer Recommendations," available from your county Extension office.

When large reservoirs of carry-over nitrogen are available to the small grain crop and high rates of nitrogen fertilizer are applied, the potential for lodging is increased. An example of such a reserve of residual N from corn and its influence on lodging in the following wheat crop is detailed in Table 4. Both the amounts of available carry-over N at seeding and the lodging pressure were reduced by no-tillage. At the recommended corn N fertilization rate (100 lb N/acre) for this soil, no-till wheat benefitted from carry-over N. Wheat grown with conventional tillage, however, yielded less as the corn N fertilization rate was increased on this soil. Such carry-over patterns would be less likely with increasing soil wetness or greater rainfall before small grain planting.

Yield Potential

No-till small grains appear to perform as well as conventionally grown small grains (Tables 3 and 5) when adjustments in nitrogen management and seeding rates are made as specific conditions dictate. No-tillage should not be considered primarily as a tool for higher small grain production, unless higher production results from improved timeliness of planting. Rather, no-tillage is an alternative establishment method that can help conserve time, labor and soil resources.

Table 1. The Effect of Herbicides on Yields of No-Till Wheat Established in Corn and Soybean Residue, 1984-87.

Treatment*	Time Applied	-----Wheat Yield (bu/acre)-----	
		Following Corn 1984-87	Following Soybeans 1984-1987
Paraquat	Planting	67	72
Untreated	--	60	67

*Paraquat at planting = 2 pints/acre (all years) plus Harmony (1986 only). Nitrogen rate for both treatments was 90 lb N/acre.

Table 2. Winter Barley Response to Tillage on Two Soils.

Tillage System	Stand Density Heads/ft ²	Grain Yield (Bu/Acre)
BEASLEY SILTY CLAY		
Chisel Plow plus Disk	14.6	34
Disk Only	15.1	30
No-till	38.1	81
PEMBROKE SILT LOAM		
Chisel Plow plus Disk	21.3	57
Disk Only	19.4	58
No-till	31.9	80

Variety Barsoy planted October 18, 1983. Marion Co.

Table 3. Wheat Yield Response to Tillage and Nitrogen Following a Corn and Soybean Crop, 1984-1987.

Tillage System	N Rate (lb/ac)	-----WHEAT YIELD (BU/ACRE)-----		
		Following Corn 1984-1987	Following Soybeans 1984-1987	Avg.
CONVENTIONAL	0	39	49	44
	60	64	69	67
	90	66	72	69
	120	71	76	74
NO-TILL	0	36	38	37
	60	59	64	62
	90	67	72	70
	120	70	76	73

Table 4. Effect of Tillage System on Corn N Fertilization, Soil Nitrate N at Seeding, Wheat Lodging, and Wheat Grain Yield.

Tillage System	Applied N Rate Corn	Soil Nitrate N, Oct. 82	-----WHEAT +-----	
	-----lb N/acre-----		Lodging Rate**	Yield bu/acre
No-till	0	16	0	54
	100	40	0	65
	200	128	0	64
Moldboard	0	26	0	69
Plow plus	100	96	3.2	61
Disk	200	196	5.1	42

*Tillage system used for both corn and wheat. Maury silt loam, Fayette Co.

**0 = no lodging, 9 = entire area flat.

+Variety Caldwell, seeded October 15, 1982. Averaged over 3 rates of N applied to wheat in the spring.

Table 5. Effect of Tillage System on Small Grain Yields.

Tillage System	Grain Yield by Production Year			
	1982/ 83+	1983/ 84+	1984/ 85**	1984/ 85++
	-----bu/acre-----			
No-Tillage	91	68	71	93
Conventional Tillage*	82	70	71	98

*Primary tillage for 1982/83 and 1983/84 = moldboard plow; for 1984/85 = chisel plow. Intensive cereal management trial. Loradale silt loam, Fayette Co.

+Average of Caldwell and Wheeler wheat cultivars.

**Average of Caldwell and Massey wheat cultivars.

++Barsoy barley.

Steps to Successful No-Till Small Grain Production

1. Spread residues evenly during harvest of the previous crop.
2. Choose well-adapted small grain varieties with good resistance to plant diseases most likely to occur in the area.
3. Weed control appears to be best when wheat is grown in rotation after full season corn and soybeans. A contact herbicide may be required at planting to control emerged weeds.
4. Be prepared to adjust drill weight and planting speed frequently to insure proper soil penetration and seed placement. Increase seeding rates by 4-5 seeds/sq ft if conditions are less than optimal.
5. Drills with narrower row spacings (less than 7 inches) become more difficult to operate as the level of residue increases. Planting diagonally across the rows of the previous crop can reduce trash buildup during drill operation.
6. Apply lime, phosphorus and potassium prior to or shortly after small grain establishment. Base amounts on a recent

soil test. If double cropping is anticipated, base P_2O_5 rates on small grain needs, and K_2O rates on the needs of the double crop component (usually grain sorghum or soybeans).

7. Spring nitrogen rates should be around 90 lb N/acre, because of the greater potential for reduced N recovery under no-till conditions. Any fall N application should be limited to 30-40 lb N/acre.

8. Scout the crop regularly, noting weeds, insects, diseases, etc. Use control measures only when an economical response is expected.

9. Consult with the local county Extension agent when questions arise.

Other agronomic information is contained in Extension publication AGR-32, "Producing Small Grains for Grain and Silage," which may be obtained at your local county Extension office.

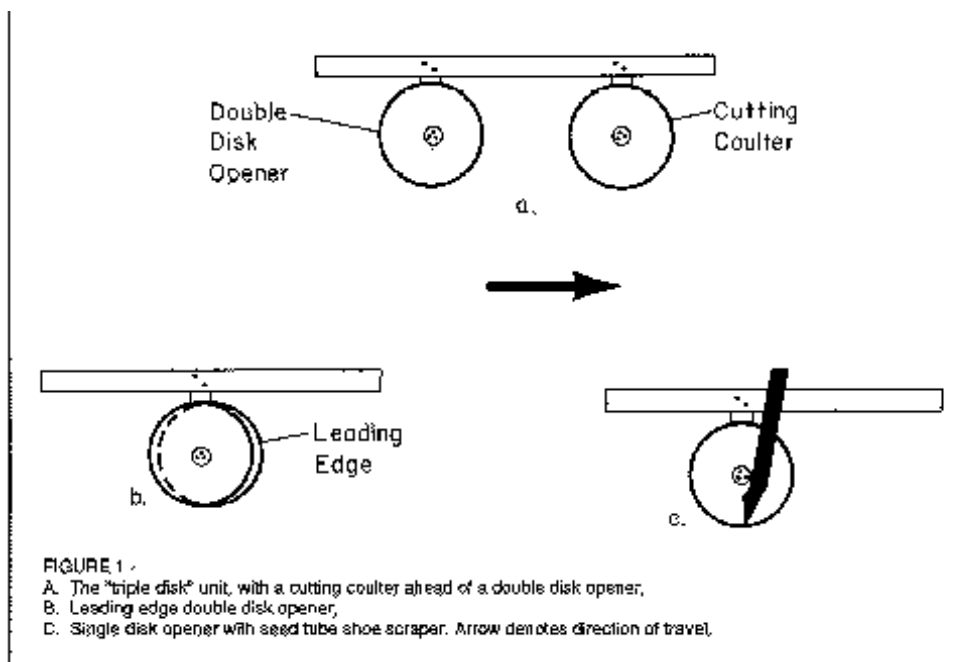


Figure 1

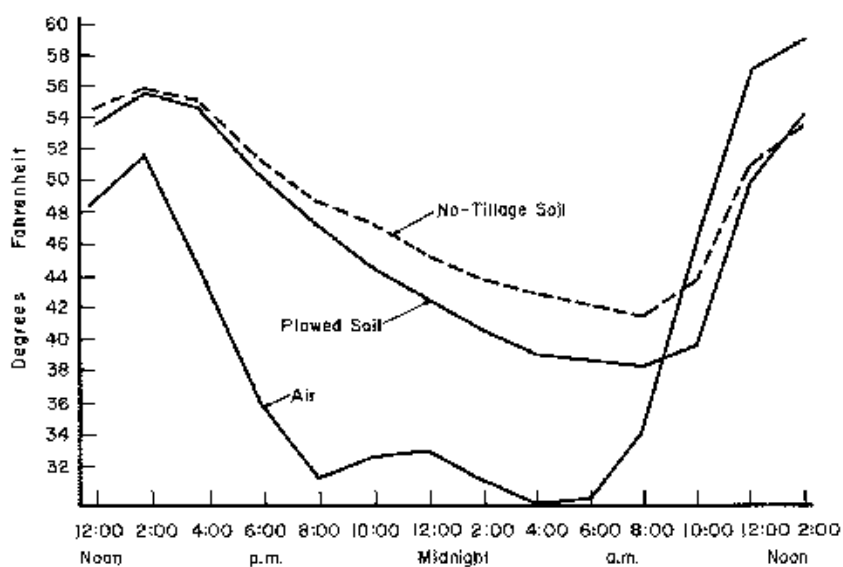


Figure 2