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No-till Wheat Production in Oklahoma

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Should I Switch from Conventional Till to No-till Wheat Production?

This is one of the most common questions asked by Oklahoma farmers, but it is also one of the most difficult to answer. There are several considerations to be taken into account when making this decision, and there is certainly no one-size-fits-all program for converting from conventional till to no-till wheat production.

A few factors that should be considered include management intensity, ability to include rotational crops, importance of soil conservation, labor availability and cost, equipment upgrade needs, and fuel cost. Simply put, because of the need to change agronomic practices to meet changing environmental situations, the managerial requirements of a no-till wheat production system are generally greater than that of a conventional till system.

Equipment

While there are many similarities between equipment used for conventional and no-till systems, there are some distinct items to consider. In general, these items deal with managing crop residue. Residue management is important during harvest and seeding. Residue, including chaff material that comes across the cleaning shoe, must be spread as evenly as possible during harvest. Spreading crop residue at harvest improves seeding conditions of the following crop. Spreading straw and chaff can easily be accomplished with a straw chopper and a chaff spreader. Depending on combine design, these are either optional equipment on newer combines or aftermarket add-ons.

Table 1. Likely effect of switching from conventional-till to no-till on several management factors for small grains production.

Management factor	*Increases with no-till*	*Decreases with no-till*	*No change*
Managerial requirement	✓		
Importance of crop rotation	✓		
Labor requirement		✓	
Drill/planter expense	✓		
Horsepower requirements		✓	
Tillage equipment needs		✓	
Fuel expenses		✓	
Herbicide expenses	✓		
Long-term N-P-K requirement			✓
Short-term N requirement	✓		
Stratification of nutrients and acidity	✓		
Need for quality seed	✓		
Soil compaction during grain fill			✓
Importance of variety selection	✓		
Plant-available moisture	✓		
Soil erosion		✓	
Selected foliar and soilborne diseases (without crop rotation)	✓		
Overall insect activity	✓		

Having well-maintained, high-quality seeding equipment is of paramount importance when attempting to no-till small grains. Originally, no-till drills were conventional drills with a coulter-caddy attachment or heavy-duty disc-openers. Often, these designs left much to be desired. During the past 10 to 15 years, however, there have been several improvements in the design and durability of no-till drills. Perhaps one of the best innovations has been the introduction of heavier drills that are designed to effectively transfer the weight of the drill to the disc openers either by hydraulic or direct linkage.

There are two basic drill designs on the market, those that use coulters to manage residue (Figure 1) and those that are designed to simply cut through crop residue (Figure 2). Each has advantages and disadvantages, but both designs are equally effective at placing seed. More important than drill design, is adjustment and use.

Figure 1. Some no-till drills, such as the one shown above, use a coulter that slices through sesidue and performs a small amount of tillage in front of the disc-opener.

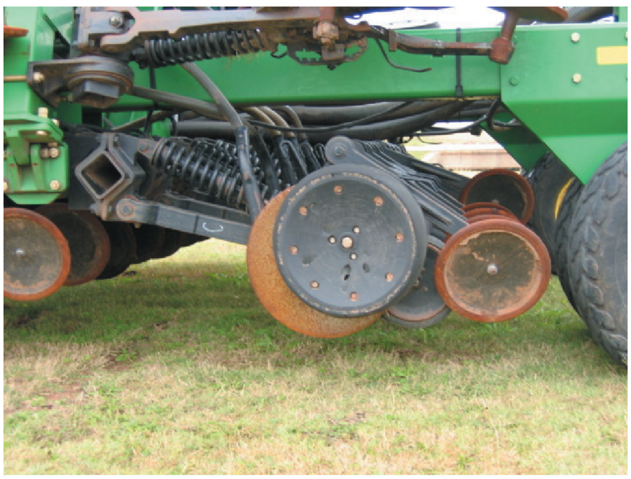

Figure 2. One of the most popular no-till drill designs uses a single disc opener that both slices through residue and opens the seed trench.

Effectively cutting through residue, either with the coulter or opener, is crucial. A disc opener that effectively cuts through residue avoids "hair-pinning" or pushing of residue into the seed trench. If residue is pushed into the seed trench, good seed-to-soil contact cannot be achieved and poor emergence often results, especially if dry or hot conditions are prevalent after planting.

Drills equipped with coulters (Figure 1) have less hair-pining because residue is cut and mixed with soil ahead of the opener. Avoiding times when residue is 'tough,' like early in the morning, reduces the chances of hair-pinning. Furthermore, drills should be adjusted for seeding conditions. Planting into a field that was grazed-out last year, for example, does not present the same residue management issues as a field that produced a 70 bu/ac wheat crop or a 90 bu/ac corn crop. The soil, however, may be harder in the grazed field.

While there are many no-till drill choices and options, one thing is common among models….they are generally more expensive than conventional-till drills. The greater cost associated with purchase of a no-till drill may be somewhat offset by decreased total equipment costs.

Another way to manage equipment costs is to consider a good used no-till drill. Since some of the newer designs have been in production for more than 10 years, there are many options on the used equipment market. Nonetheless, due to the higher cost of no-till equipment, it might be worthwhile to survey neighbors and discuss their experiences or explore the possibility of leasing or borrowing equipment.

Management Tips

- Spreading crop residue at harvest improves seeding conditions of the following crop.
- Avoid hair-pinning of residue with properly adjusted equipment.
- Reduce initial costs of no-till equipment by purchasing well-maintained, used equipment.

Variety and Seeding Rate

If you are incorporating a rotational crop into your no-till strategy, there usually is little difference in variety performance under no-till or conventional-till management, so it is best to review current variety trial results and variety comparison charts (www.wheat.okstate.edu).

As long as high-quality seed is sown, seeding rates for no-till wheat production should be similar to those for conventionally-tilled wheat. High-quality seed is characterized as being free from weed seed and foreign material, having good vigor, and having greater than 80 percent germination. High-quality seed is necessary to ensure adequate germination in cool, wet soil conditions that can be prevalent in no-tilled soils. This is especially true when planting after October 15.

Management Tip

- Sowing high-quality, high-purity seed is extremely important when no-tilling

Rotation

Research has demonstrated that crop rotation increases overall productivity in a wide variety of geographic locations and rotational strategies. This is true whether conventional or no-till seeding strategies are implemented, but the yield boost from a crop rotation is generally greatest in no-till situations. Rotational crops and strategies vary according to location, production goals, and yield potential.

Perhaps the most important criteria for choosing a rotational crop is the profit potential of the enterprise. From an economic standpoint the rotational crop must be able to stand on its own and not be a drain on resources. Several factors influence whether or not positive cash flow is generated by a rotational crop. Among these are knowledge level and competence of the producer in growing the rotational crop, availability and proximity of marketing points, and yield and price stability over time.

Corn or soybean, for example, might be the best rotational crop for a producer in northeastern Oklahoma, while cotton might be a more logical rotation for a producer in the southwestern part of the state. Perhaps one of the best strategies for deciding on a rotational strategy is simply observing if a rotational crop or strategy is working for your neighbor, and deciding if it might work for you.

Management Tips

- Crop rotation is likely to benefit yield regardless of tillage practices.
- From an economic standpoint, the rotational crop must be able to stand on its own and not be a drain on resources.

Soil Compaction

Grain only. Soil compaction is often one of the biggest concerns raised by producers considering no-till wheat production; however, soil compaction in a no-till grain-only production system should be similar to that of a conventional-till, grain-only production system.

In a conventional-till grain-only system, the new compaction can be introduced as a result of equipment traffic and tillage implements. In a no-till, grain-only production system new compaction is created exclusively through equipment traffic. Therefore, it is extremely important not to introduce any new soil compaction once a no-till production system has been initiated, as correction methods are limited.

To minimize new compaction, limit traffic and reduce tire inflation pressures or switch to radial ply tractor tires. Reducing tire pressure to the minimum manufacturer's specification increases the contact patch of the tire and distributes the equipment's weight over a greater area, along with increasing traction.

Equipment management techniques that spread the equipment load over a greater surface area become even more important during wet harvest years. It is important to remember that ruts created during harvest will require tillage and, therefore, eliminate no-till as an option for that particular year.

Dual-purpose. Cattle traffic creates compaction, regardless of the tillage system used (Figure 3). In a conventional-till program, the upper level compaction is alleviated through tillage operations prior to seeding, but research conducted in Oklahoma and elsewhere indicates that soils are typically re-compacted by the time of cattle removal (i.e. March 1st).

Compaction from cattle traffic can be an issue during wheat grain fill regardless of the tillage system used, and the primary difference between conventional and no-till systems is whatever effect soil compaction might have on fall growth of wheat.

It is likely that the effect of soil compaction on fall forage growth is minimal, especially when a small amount of tillage is performed by coulters during planting operations. Furthermore, the load-bearing strength of soil typically increases with no-till cropping systems, thus reducing the cumulative effect of years of cattle traffic and allowing for greater support of cattle hooves during wet years.

Figure 3. In a wet year, cattle traffic frequently results in soil compaction regardless of the tillage system used.

Management Tips

- Reduce tire pressure or switch to radial tires to reduce compaction from equipment traffic.
- Avoid equipment and/or cattle traffic on waterlogged fields.

Disease

The downside of residue. No-till operations in wheat production can significantly impact the incidence and/or severity of diseases, especially when residue left on the soil surface is from a previous crop of wheat. In such cases, increases in disease incidence and severity generally are more typical than are decreases (Table 2).

Usually an increase in disease incidence and/or severity occurs because a greater quantity of inoculum of the pathogen is present on the wheat residue left above the soil surface. For example, with a disease such as take-all root rot, increased residue results in increased amounts of inoculum because the fungus that causes take-all survives on the residue.

Other examples are the foliar diseases tan spot (*Pyrenophora tritici-repentis*) and septoria leaf blotch or stagonospora glume blotch (*Septoria tritici* and *Stagonospora nodorum*). As you can see in Figures 4 and 5, the small black bodies on the wheat straw from the previous crop harbor the spores of the tan spot fungus.

During late fall through spring, spores in these black bodies are discharged and infect the lower leaves of wheat plants. If temperature and moisture favor continued spread of tan spot, the disease then spreads up through the wheat canopy (Figure 6). Thus, wheat residue on the surface of the soil from a crop heavily infested with tan spot provides a large amount of spores to infect the subsequent wheat crop.

Table 2. Effect of increased wheat residue* on the incidence and severity of various wheat diseases.

Disease	Effect of increased residue* on incidence and severity of disease	Explanation for effect
Tan spot	Increases disease	Increases pathogen inoculum
Septoria leaf blotch	Increases disease	Increases pathogen inoculum
Stagonospora glume blotch	Increases disease	Increases pathogen inoculum
Aphid:barley yellow dwarf virus	Decreases disease	Fields with increased residue are less attractive to aphids
Take-all	Increases disease	Increases pathogen inoculum
Strawbreaker [also called eyespot, foot rot]	Decreases disease	Related to inhibition of spore dispersal and hence, a reduction of infected plants.
Other root rots including dryland root rot, common root rot, sharp eyespot, Pythium root rot	Increase or decrease, depending on the pathogen	Effect is through multiple factors including soil moisture, temperature

*In this table, "residue" indicates straw from a previous crop of wheat as opposed to residue from a rotated crop such as canola or legumes, which would be non-hosts for these pathogens and diseases of wheat.

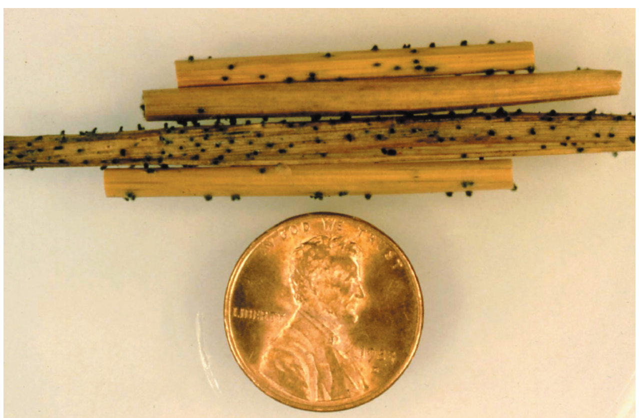

Figure 4. Black fruiting structures containing spores of tan spot on wheat residue.

Figure 5. Closer view of black fruiting structures containing spores of tan spot on wheat residue.

The upside of residue. With some diseases, increasing the amount of wheat residue left on the soil surface in a field may favor a reduction in disease incidence and/or severity. Such an effect often occurs as a result of altering microenvironmental conditions such as increasing soil moisture and/or decreasing temperature. This is especially true for some of the root rots such as dryland root rot (*Fusarium spp.*) and common root rot (*Bipolaris sorokiniana*), which are favored in warmer and drier soils. In the case of strawbreaker foot rot or eyespot (*Pseudocercosporella herpotrichoides*), the increased straw seems to inhibit the spread of spores from the soil to the base of young plants so that there is less infection.

Increased residue also can affect the incidence and/or severity of barley yellow dwarf virus (BYDV) by altering the behavior of the aphids that transmit this virus. These aphids are attracted to more openly spaced wheat plants, with large amounts of residue being less appealing to the aphids. Thus, no-till field may attract fewer aphids, which may translate into a lower incidence of BYDV.

Rotation is the key. Approaches to disease control are a major consideration when switching to a no-till operation. Therefore, without a doubt, rotation with a non-host crop is the single most valuable approach in helping to limit disease in no-till systems. Wheat-following-wheat in a no-till system will almost assuredly result in significant increases in diseases such as tan spot, leaf and glume blotch, and take-all.

Rotation with a crop that is a non-host for these pathogens (for example, canola or various legume crops such as soybean or alfalfa) is highly desirable. Varieties with disease resistance (see www.wheat.okstate.edu for reaction of current varieties to diseases), application of fungicides, and planting date all can be used to help limit losses from diseases in no-till fields. Also remember that such a rotation is more effective if the field is not planted to wheat for at least one entire season, as this provides sufficient time for the wheat residue to completely decompose.

Although switching to a no-till operation results in some challenges related to controlling diseases, approaches are available that should help alleviate these diseases. Among these approaches, crop rotation, variety selection, correct application of appropriate fungicides (including seed treatments), and planting dates are the most important to consider. Knowing the effect that increased residue on the soil surface has on the diseases listed in Table 1 is the first step toward employing approaches to help minimize losses from these diseases and make wheat production in a no-till operation successful.

Management Tip

- Rotation is the key to reducing disease incidence and severity.

Insects

Arthropod pests are affected by many aspects of their environment, including tillage practices. Soil-dwelling pests are affected by tillage directly and indirectly. The mechanical changes that heavy tillage imparts on the soil can directly affect the physical survival of soil-dwelling pests. Indirectly, changes in soil moisture, temperature, organic matter, bulk density and porosity can affect pest status. One example is grasshoppers that overwinter as eggs in the soil. Mechanical tillage destroys many grasshopper eggs.

Some pests use crop residue to overwinter, and may be more likely to survive in reduced tillage or no-till systems, for example, the Hessian fly. It overwinters, and oversummers in crop residue. Undisturbed residue provides a better habitat for the overwintering/oversummering life stages to survive. Such systems often produce "volunteer" germination from the seed that was left in the field. These volunteers can provide a green "bridge" which becomes a potential source for pests such as the wheat curl mite to develop and spread the virus diseases that they vector.

Figure 6. Spores on previous crop residue allow for rapid movement of tan spot in the wheat canopy.

In addition, reduced tillage systems are often accompanied by more diversified cropping systems that can change the makeup of the pest complex, and the individual pest status of many arthropods. Some may become less of a problem, while others may become more of a pest. A pest such as the white grub or wireworm can develop in a grass pasture system and become an important pest of a wheat crop that is planted as no-till.

Despite the potential changes in pest complexes that may be encountered when using no-till, effective management guidelines and tactics are available to control arthropod pests regardless of the tillage system being used. Integrated pest management (IPM) programs can be developed successfully in any cropping system. Many of the tactics that might be included in such a program are effective across a broad range of tillage systems. Others, such as the tactic of burying residue may not be available as a management technique. Still others, such as longer-term crop rotations, may become available because no-till can help "break" the pest status of some pests. Ultimately, the ability to control or not control arthropod pests should not discourage anyone from considering the adoption of no-till crop production.

Management Tips

- Switching to conservation tillage may cause a shift in the makeup of insect pest populations.
- Integrated pest management (IPM) programs can be implemented successfully in any cropping system.
- Control volunteer wheat to eliminate the "green bridge" for pests such as the wheat curl mite.

Soil Fertility and pH

A successful no-till production system starts with proper management of soil pH and fertility. The acidification process and nutrient distribution in a no-till soil are somewhat different from those of a conventional system due to limited mixing of soils under no-till; therefore, prior to adopting a no-till system, soil pH and nutrient levels should be tested.

A soil test provides guidelines for liming and fertilizer application. If the pH is low, lime should be applied to bring the pH to a normal range. The pH of soil in continuous no-till fields should be checked every two years. When lime is needed, the same amount of lime as recommended for conventional practices should be applied, but it may take longer to correct soil acidity in the lower portion of the tillage zone under no-till than conventional tillage system. Furthermore, nitrogen applied to the soil surface under no-till can produce very acidic conditions in the surface layer. This acidic soil not only affects crop growth directly but also affects pesticide activity.

If P and K are deficient, apply adequate amount of fertilizers before the switch to a no-till system. Similar to conventional till, banding P and K fertilizers is advantageous over broadcasting in a no-till system. In fact, banding may be even more advantageous in a no-till system because P and K movement in the soil are very slow. Furthermore, P applied on the surface may be subject to erosion or runoff loss more easily than when (or if) it is band applied.

Crop residue covering the soil surface under continuous no-till increases water infiltration, reduces runoff, and decreases water losses from evaporation. This same residue, however, may also increase N loss due to volatilization if N fertilizers are broadcasted over the surface of residue. However, placing N fertilizer just below the soil surface with a coulter can effectively reduce volatilization loss.

Additionally, some N may be temporarily tied-up by microorganisms as they decompose crop residue with a high C:N ratio. This may reduce plant available N during the early stage of plant growth, but applying $^{1}/_{3}$ to ½ of the total N pre-plant, preferably injected into the soil, should avoid residue-decay-induced N deficiency. Ultimately, if managed properly, the amount of N needed for no-till should be similar to that for conventional tillage system.

Management Tips

- Identify and correct soil pH problems prior to switching to no-till.
- Band-apply fertilizers to increase efficiency.
- Inject $^{1}/_{3}$ to ½ of nitrogen pre-plant to reduce residue-decay-induced nitrogen deficiency.

Weeds

Much of the tillage expense saved by no-till wheat production will be spent on chemical weed control practices, but by planning the switch in advance, producers can keep their fields with problem weeds in tillage and only move cleaner fields into no-till production. Producers should avoid no-tilling fields infested with weeds that have no good in-season chemical control measures (e.g. jointed goatgrass, feral rye, rescuegrass etc.). Still, there are solutions to even these problem weeds, such as rotating to a summer crop, winter canola, or using the Clearfield wheat production system.

Summer weed infestations should be managed with non-selective herbicide mixes, such as glyphosate (the active ingredient in Roundup) and 2,4-D or some other broad-spectrum herbicides. Along with the cost of these applications, one should also consider the potential of off-target movement of these summer fallow treatments onto nearby susceptible vegetation and whether or not successful summertime herbicide applications will be possible.

Historically, one of the primary reasons Oklahoma wheat producers have shied away from no-till production was lack of good weed control tools, primarily cheat control. Today, however, producers have a wide array of herbicides that can be used to control many of the common in-season weed problems. For example, producers now have Finesse Grass and Broadleaf, Maverick, Olympus, and Olympus Flex to control cheat in the wheat crop. In-season control measures are also available for control of Italian ryegrass and wild oats and a host of problem broadleaf weeds as well.

Management Tips

- Manage summer weed infestations using nonselective herbicide mixes, such as glyphosate (the active ingredient in Roundup) and 2,4-D or some other broad-spectrum herbicides.
- Off-target movement of nonselective herbicides can cause considerable economic damage. Always use drift-control measures and be aware of neighboring crops.

Economics

The economics of no-till are farm and situation specific. In addition to the cost of tillage relative to the cost of herbicides and the cost no-till drills and air seeders relative to the cost of conventional drills and seeders, the economics of no-till depends upon farm size, soils, climate, crops grown, and the opportunity cost of the farm family's labor.

No-till is more likely to be economical in farm/soils/climate situations in which no-till enables farmers to increase the number of harvested acres per year on the farm. For example, in some regions of the United States, a no-till system enables the successful double-cropping of soybean or grain sorghum after wheat. The probability of a successful double-crop with conventional tillage is not as great due to timing and loss of soil moisture.

In some situations no-till enables the cropping of land too steep for conventional tillage. In effect, a no-till system may enable the conversion of pastureland to cropland. In both of these situations the appropriate economic comparison is not between no-till and conventional tillage. In the first case, it is between growing a crop and fallow. In the second case, it is between producing a crop and pasture. In both cases, no-till enables an increase in the number of harvested cropland acres for a given farm size, and the investment in a no-till drill or no-till air seeder may be weighed against the investment in additional land.

The overall trend for government programs is one of increased emphasis on conservation tillage measures, and no-till production practices are generally regarded as one of the best soil-conservation measures available to farmers (Figure 7). It is increasingly difficult for most farmers to find qualified labor to operate tractors and tillage equipment in a conventional tillage system. In contrast, for a no-till wheat production system, only one tractor operator is needed, horsepower requirements for a no-till drill are generally much lower than is required to pull large tillage equipment and fuel consumption can be considerably less.

The trade-off, however, is that no-till wheat drills are generally more expensive than conventional drills. The list prices of effective no-till grain drills are from two to three times greater than the list prices of conventional drills. No-till equipped air seeders list for 30 to 40 percent more than conventional air seeders of the same width, but the difference in drill/seeder costs decreases as the size of the drill/seeder increases.

For Oklahoma farms that produce continuous winter wheat (and only winter wheat), estimates of total operating plus machinery fixed costs range from \$3 per acre less to

Figure 7. Soil erosion can be a problem in conventional tillage systems. Qualification for certain government programs is increasingly hinged on prevention of erosion events, such as the one shown above.

$10 per acre more for no-till relative to conventional tillage depending upon farm size. The reduction in the price of glyphosate after the original patent expired has improved the relative economics of no-till for continuous winter wheat, but economic advantages or disadvantages are still farm specific.

Management Tips

- Expect lower fuel costs and higher herbicide costs when switching to no-till.
- No-till drills are more expensive than conventional-till models, but the difference in cost between no-till and conventional models decreases as the size of the drill/seeder increases.

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