No-Till Crop Production Systems in North Carolina-- Corn Soybeans. Sorghum, and Forages

north Carolina
AGRICULTURAL EXTENSION SERVICE

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No-Till Production in North Carolina

No-till is no longer in the experimental stage. In 1980 there were approximately 300,000 acres of conservation tillage in North Carolina, based on an SCS survey. Potentially, there are approximately four million acres of corn and soybean land that could be no-tilled. What are the keys that will lead us toward more no-till? Why should North Carolina farmers consider this alternative?

Management is the keystone to a sound no-till program. Like any new production technique, you need to understand the basic principles. No-till is not immediately adaptable to all farming situations. Past management plays an important role.

If the soil pH or fertility status is very low, this correction must be made. If troublesome weeds, such as common bermuda or johnsongrass, are present in the field, these must be brought under control. If traffic pans are present, they should be corrected. Planting equipment must be modified or new equipment purchased to fit no-till needs. Spray equipment may need to be modified.

These plus other considerations need to be accounted for, but all can be overcome with the current state of technology and management. Briefly, our experience has been that through management all these deficiencies can be overcome. If a farmer can grow 150 bushels of corn with conventional tillage, he can equal or surpass this yield with no-till production.

Why change to no-till? There are five basic reasons: (1) to control erosion, (2) to conserve moisture, (3) to save time, (4) to intensify land use, and (5) to increase profits.

Soil Erosion Control

Soil erosion is the dominant soil conservation problem and water quality problem on thousands of acres of land in North Carolina. We have two basic types of erosion-wind and water. No-till crop production offers a viable solution to both problems.

Wind erosion not only transports soil particles laden with surface applied fertilizer and chemicals, but also causes physical damages to plant seedlings from the abrasive effect of the blowing particles. Adequate surface mulch of no-till production will eliminate this problem.

The more serious problem of erosion in North Carolina is water erosion. This problem is most severe on the steeper slopes, but is also a costly problem on the more gently sloping Coastal Plain soils. According to a 1977 survey conducted by the SCS, USDA, 64 percent of the total erosion in North Carolina occurs on cropland. Even though only an average of 7.5 tons per acre per year is eroded from cropland, the large acreage of cropland make a signficiant total contribution'. When topsoil is lost, farmers are losing their productive base.

In 1979 Langdale reported that at current production in the Southern Piedmont, each centimeter of soil eroded from Class II land cost the producer about 147 kilograms of corn (grain) per hectare (5.9 bu/A for 1" of soil loss). This means that for every inch of topsoil lost with corn at $3.00/bu., the loss will be $17.70/A potential production. Therefore, for every ton of soil lost, the loss over a 50-year period will be approximately $160.00.

Work by Frye[3] at the University of Kentucky shows that over a wide range of observation using different winter cover crops on eroded versus uneroded Maury soil there was a 14 percent increase in yield over a three-year period on the non-eroded soils. Erosion also causes important nutrient losses, approximately $3 to $5 per ton per year. As the soil particles are transported by water not only do the soil particles carry a nutrient load, but the water many times transports fertilizers and chemicals in the solution. As the clayey textured subsoils are exposed, power and fuel costs increase as well as nutrient requirements to satisfy the lime and phosphate needs.

Based on comparison of different conservation systems on the rate of erosion reported by the SCS, USDA ,[4] soybeans grown on a 4 percent slope, contour farming with terraces yields 8 tons/A/yr. soil loss, while no-till farming on contour soybeans in wheat stubble yields 3 tons/A&r. soil loss. Clearly no-till crop production reduces erosion, thereby reducing sediment transport and consequently enhancing water quality.

To Conserve Moisture

Moisture conservation is another positive benefit from no-till over conventional tillage. Loss of soil moisture through runoff and evaporation will reduce the amount of plant-available water and consequently limit crop yields. Work done by Langdale, et a1.,[5] over a four-year period showed that runoff was reduced 47 percent with no-till practices compared to conventional practices and erosion was reduced 98 percent. Crop residues soften the impact of rainfall and reduce surface sealing that can limit infiltration.

Ten years of research by Beale, et al. [6] at Clemson has shown that no-till corn in winter cover mulch averaged 3.11 inches less water runoff per year and 2.38 tons/A less soil erosion per year. Beale reported that yields were equal to or greater than that of the conventional unmulched corn. Clearly, as more water is forced into the soil profile and less is evaporated from the surface because of the mulch cover effect, more water is available in the root zone for plant use.

Time Saving

Time is another positive consideration related to no-till crop production. First, no-till crop production will save the farmers one-half to 1½ hours per acre in total production time. Because there is less heavy tillage, smaller, more fuel efficient tractors may be used and thereby reduce machine cost. Second, no-till offers an opportunity for timeliness of operation. Because this type of system does not require land preparation other than broadcast fertilization, one trip over does the job of planting, land preparation, weed control, and insect control. At the end of each work day the crop is planted and ready to grow.

This is important in a multicrop system (i.e., no-till corn - conventional wheat - no-till soybeans) in that it allows very timely planting of the soybeans. The area of small grain acreage that is harvested in the afternoon is planted to soybeans the next morning prior to the small grain being ready to cut in the afternoon. This system adds one to two weeks or even more critical growing time for the soybeans.

More Intensive Land Use

No-till allows for more intensive land use. Soils that do not have the potential to produce good crop yields with conventional tillage cannot be expected to produce any better yields under no-till systems. There are many thousands of acres of land that have good yield potentials; however, they are subject to severe erosion under conventional tillage. With no-till it is possible to grow high-value row crops and still hold erosion levels to well within the permissible soil loss limits. Areas where row crops could only be grown with strip farming and terraces can now be planted no-till and eliminate these more expensive time consuming practices.

Not only does no-till allow more intensive use of the more rolling land; it allows more opportunities for double cropping. There are many opportunities for cropping combinations where using no-till allows timeliness of operation to maximize yields and provides nearly year-round ground cover. Some examples are:

(1) No-till corn - conventional wheat - no-till soybeans = 3 crops in 2 years.

(2) No-till corn (silage) - conventional wheat silage - no-till corn silage - conventional wheat silage = maximum TDN production with full growing season for each crop and 11 months of ground cover.

(3) Alfalfa for 3 to 4 years - no-till corn followed by reseeding in the fall = breaks the cycle for one year and utilizes N from alfalfa.

(4) Farmers imagination is the only limitation as far as combinations.

One researcher in the "No Nonsense Guide to No-Till Farming"' said, "After 30 years and about $30 billion of soil conservation work in this country, we stumble onto a system that cannot only eliminate the need for further spending, and not only pay its own way, but will actually yield an immediate return. There aren't many soil conservation efforts that can show such immediate and sizable returns. And the best part is that new land that can be put into production with this system is primarily in the marginal, hilly areas where farm income needs the biggest boost; it will more than double the productive acreages on many small farms."

To Boost Profits

Finally, profit opportunities from no-till and conservation tillage systems have been documented by many university researchers and on-the-farm experiences. Budgets prepared by NCSU Extension specialists in crops and economics show the same returns to land, overhead and management for corn at $121.26 and $121.47 per acre respectively for conventional and no-till systems. Labor is substituted for herbicides, but this does not nearly reflect all the profit picture. Less erosion from the no-till systems equate to multiple cropping systems allowing more intensive machinery use for equipment such as the combine, which is the most expensive single item on the farm. The system also equates to less erosion, less loss of nutrients and chemicals, and higher sustained yields for future generations. Now is the time to switch and insure higher water quality and more effective use of our natural resources.

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Cultural Practices for No-Till Corn, Sorghum and Soybeans

Cultural practices for no-till crop production differ from conventional tillage since the crop is established into living cover crops, weeds or previous crop residues and tillage operations are eliminated. The important difference most producers will note is the need for more precision and careful management in nearly all operations.

Crop Establishment

Planting dates for corn or sorghum may be delayed slightly since soils under a mulch tend to warm more slowly than clean tilled fields. On the other hand, bedded land left from previous crops tends to warm sooner.

Soil moisture may also be different. Where a cover crop is growing, the soil may dry faster in the spring than a clean tilled field since the cover crop is using water. In contrast, previous crop residues remaining on the soil surface retard evaporation which results in slower drying.

Under either system soil temperature, soil moisture and the weather forecast are still important factors to use in determining when to plant. Begin planting when early morning soil temperature at seeding depth is 50°F for corn and 65°F for grain sorghum, soils are dry enough to be properly tilled, and warm, sunny weather is forecast for the next few days. In some cases, no-till fields can be planted earlier than conventionally tilled fields in extended wet weather since equipment can operate sooner.

Planting Dates

Since no-till soybeans usually follow a small grain crop, they are planted later than ideal and should be seeded as soon as possible after small grain harvest. As soybean planting is delayed, potential yield is reduced. Frequently, the difference in surface soil moisture in no-till fields as compared to clean tilled fields makes the difference between immediate soybean seed germination and having to wait for rain to initiate germination. This can be very critical with double-crop soybeans.

To increase the ease of planting no-till double-crop soybeans, use a straw shredder on the combine to chop the small grain straw and distribute it over the field.

Variety selection for soybeans is quite important. When growing double-crop beans, early maturing varieties frequently do not produce a large enough plant to provide maximum yields. Therefore, medium to late maturing varieties are preferred. Medium maturing varieties include Centennial, Coker 156 and Davis while later maturing varieties are Bragg, Coker 237, GaSoy 17 and Ransom. For corn or grain sorghum the same varieties may be planted no-till as in conventional tillage. However, when planting extremely late, early maturing corn or grain sorghum varieties are preferred.

In no-till corn increase seeding rates 10 percent above that for conventional tillage or 15 to 20 percent above the first stand recommended by the commercial company for the variety planted. It is more difficult to get good uniform soil-seed contact in no-till planting than in conventionally tilled seedbeds. This is also true for grain sorghum and soybeans.

Row Width

Row width for no-till planting is the same as suggested for conventional planting. Plant corn in 30-, 36- or 38- inch rows with a slight preference for 30 inches. Grain sorghum will do best in 14 to 20-inch rows. The later sorghum or soybeans are planted, the more desirable narrow rows become. Furthermore, narrow rows aid in late season weed control by shading out weeds. In soybeans, whatever row width will allow you to get the row middles covered by the soybean foliage before flowering begins is best. For double-crop soybeans in 20-inch rows, plant 5 to 7 seeds per foot of row.

No-Till Planters

Usually in no-tillage, some crop residue, weeds or cover crop have to be cut through with a coulter prior to the actual planter opening a furrow for the seed. The coulter must cut through this residue, not just push it into the ground. Generally the coulter should run just slightly deeper than the desired seeding depth. No-till planters have a fluted, rippled, serrated or notched coulter in front of the seed opener.

It is undesirable for the coulter to move soil. If the coulter throws soil out of the furrow, the soil is too wet, you are driving too fast, or the coulter is inappropriate for the soil moisture and texture. It should only slice through any organic material on the soil surface and allow the planter to penetrate into the soil, cover the seed and establish seed-soil contact.

The other key to no-till planting equipment is the press wheel. As mentioned earlier, getting good soil-seed contact is more difficult in no-till planting than in conventional, so the press wheel must be relied on more heavily to firm the soil back around the seed. The ribbed press wheel is the most frequently used, but units which firm the soil from the side work well as long as they can effectively press the soil against the seed. This is more difficult when you have a heavy residue on the soil surface, moist firm soil or a living root mass than it is in a freshly prepared conventional seedbed.

Depth Control

Finally, especially in grain sorghum and soybeans, good depth control is necessary to obtain excellent stands. The seed must be placed consistently between one and two inches deep. Seeds too shallow are frequently not properly covered with soil and may not germinate. Those placed too deep may not be able to reach the soil surface as they germinate, especially if weather conditions are not ideal. Depth bands or gauge wheels next to the seed opener appear to work best to control seeding depth in no-tillage.

Farmers in North Carolina have found that no-till planting soybeans, grain sorghum and corn can be just as successful as conventional. They also have found that little mistakes quickly become bigger problems in no-till planted crops and therefore more precision is required.

Fertilization and Liming

Optimum soil pH and fertility are especially important to promote vigorous early growth of any no-till planted crop. If soil tests indicate a low P status or the need for lime, it is recommended that these materials be applied and mixed into the topsoil by plowing and/or discing, since lime and phosphorus move very little in the soil. This can be done prior to any crop but if time and weather permit, a good time is in the fall prior to planting a small grain crop. It is most important to not let a low pH develop in the surface few inches of soil, since this may greatly reduce the effectiveness of triazine herbicides.

When soil tests suggest only a low rate of phosphorus (20 lbs $P_2 0_5$ or less), this may be applied from any phosphorus fertilizer in a band 2 to 4 inches to the side and 3 to 4 inches deep at planting. The application of K_2O and micronutrients is not different from conventional tillage.

Special consideration should be given to nitrogen application for no-till corn or grain sorghum. The need for splitting the application and use of an ample rate may be even greater for no-tillage. Recent research evaluating sources of N for no-till corn suggest that urea-supplied N may be subject to some loss of availability under no-till conditions. The degree of loss is difficult to predict but is most likely to occur with application on moist soil followed by lack of enough rainfall soon afterward to move the fertilizer deeper into the root zone. The greater amount of crop residue on the surface under no-till corn as compared with conventionally tilled corn (or grain sorghum) contributes to volatilization of ammonia from the urea. A nitrogen source containing no urea (ammonium nitrate-33 percent N) is not affected while those with a partial urea component (30 percent solution contains one-half the N as urea and one-half as ammonium nitrate) are less susceptible than pure urea fertilizer (46 percent N). If 30 percent solution is used it would be desirable to dribble it near the plant rather than spray it, over the surface to minimize the amount of residue contacted. Although somewhat difficult to do, optimum response from urea containing N sources would be enhanced if the urea or urea solutions could be shallowly banded below the soil surface. Anhydrous ammonia is not affected by,the surface residue except that it must be injected through the residue and then adequately sealed at the surface to prevent gaseous loss.

In conjunction with N fertilization, if late season weed control is needed, layby N solutions containing 2,4-D, or contact herbicides such as Lorox or Evik, will be convenient and an efficient production practice.

No-till soybeans should be fertilized similarly to corn except there would be no need for N; there may be some benefit from a small amount in the mixed fertilizer although the yield response will probably be small or non-existent.

Cover Crops and Cover-Crop Management

Cover crops are crops grown in the fall, winter and/or early spring which will be killed and left as mulch into which another crop is planted. Some research has been done with corn in North Carolina comparing hairy vetch, crimson clover, or rye with no cover crop. It would also apply to grain sorghum with only a few exceptions. For soybeans, we are generally not interested in growing a legume cover crop, so small grain cover crop or stubble are the only covers usually considered.

Benefits from Cover Crops

Cover crops are of interest for several reasons: (1) They supply some erosion control during the fall, winter and spring. (2) When combined with no-till planting, they continue to provide erosion control because of the mulch left on the soil surface. (3) They reduce water evaporation from the soil surface but on the other hand lower soil temperature. (4) Legume cover crops produce nitrogen which is available to the subsequent corn or grain sorghum crop. (5) Cover crops aid in weed control by providing early shading.

Legume cover crops need to be seeded during September to be most successful, although October seedings in the southern Coastal Plain may be satisfactory. Late seeding results in weak plants which provide little erosion control during the winter, may be lost due to heaving during the winter, and seldom provide robust growth in the spring prior to corn planting time.

A September seeding date is practical when corn follows tobacco or corn silage-or in eastern North Carolina corn for grain. However, in the Piedmont or Mountains corn for grain is frequently not harvested in September. Soybeans are never harvested this early. Therefore, in these cases the cover crops would need to be seeded into or over the previous crop. Especially with the legume cover crops, seeding into standing soybeans has been very unsuccessful in a limited number of trials. Therefore, we do not expect the use of a legume cover crop following soybeans in a soybean-corn or soybean-grain sorghum rotation to work very well.

When a legume cover can be established in September, we have found that 60 to 100 pounds of nitrogen per acre from the cover crop is available to corn or grain sorghum.

There have been problems with management of cover crops, however:

(1) Hairy vetch has been difficult to kill. Paraquat or Roundup mixed with commonly used preemergence herbicides have not been effective enough.

(2) Both hairy vetch and crimson clover depleted so much of the soil moisture that it was frequently difficult to obtain a good stand of corn. This problem could be reduced in grain sorghum by killing the cover crop about two weeks prior to planting the sorghum. Early killing prior to planting corn does not work out well because the legume needs every day possible during this part of the season to grow and produce the desired nitrogen.

(3) The legume cover crops provide minimal erosion control during the winter.

Small Grain as Cover Crop

In contrast to legume cover crops, small grain cover crops work quite well in some areas of North Carolina. Rye, wheat and oats all have been used. Rye usually works best because it is easiest to kill and provides maximum erosion protection. In the Piedmont, yield advantages have been consistently obtained when no-till planting into rye compared to conventional tillage with no cover crop. This practice should not be used where johnsongrass is a problem. In contrast, no-till into rye has been less favorable in the Coastal Plain where corn yields at several locations have been lower than conventional tillage yields. The reason for the lower yields is unknown.

In summary, we find that legume cover crops, hairy vetch and crimson clover work well when they can be seeded in a conventional seed bed during the month of September. During dry springs it may be difficult to obtain a good corn stand. Rye works very well in Piedmont locations where johnsongrass is not present, but not as well in the Coastal Plain. No-till corn or grain sorghum seeded directly into soybean residue works well but again should not be used where johnsongrass is present. No-till planting of double-crop soybeans into the small grain residue is preferable to conventional tillage.

A modification of the cover crop concept is that of using the cover crop as silage and following the no-till corn or sorghum for silage. This can work very well, but does delay corn planting and increases the risk of the second crop suffering from drought and heat stress, and insect damage (true armyworm).

Weed Management in No-Till

Weed management in no-till planted crops depends almost entirely on foliar and surface applied herbicides because seedbed preparation is eliminated and incorporated herbicides and cultivation cannot be used. In no-till cropping systems a mixture of a contact herbicide plus a residual herbicide is necessary. The contact herbicide kills grass or broadleaf weeds and any cover crop present at planting while the residual herbicide controls germinating weed seeds. To complete the herbicide program, a postemergence herbicide may also be needed for additional control of broadleaf and/or grass weeds.

Weed Management Tools

Rotations

Rotations can play an important role in no-till as well as conventionally planted crops, for a weed may be easier to control in one crop than another. In corn or grain sorghum you can control weeds which are more difficult and/or expensive to control in soybeans. In corn, for example, cocklebur, morning glory and Pennsylvania smartweed can be controlled at three different times-preemergence, early postemergence and layby, using different herbicides. Thus, in corn you have greater flexibility in time of application, number of applications, and herbicide selection.

For economical control of these weeds in soybeans, timing of postemergence applications is very critical and some injury may occur. Also, the control of perennial weeds such as trumpetcreeper, horsenettle, and bigroot morning glory can only be done effectively in corn with 2,4-D amine.

Rotating both herbicides and crop may reduce the potential buildup of problem weeds and harmful herbicide residues. A good multiple cropping system with three crops in 2 years which aids in weed control is corn and small grain followed by double-crop soybeans. The corn and soybeans are no-till planted and the small grain is conventionally planted.

The cropping system may effect the herbicide choice or rate. If a winter small grain is to be fall seeded after corn harvest, Bladex would be best in the tank-mix combination for broadleaf weed control instead of Atrazine or Princep.

Competition

A competitive crop which provides shade to weeds aids the overall weed management in no-till crops and especially double-crop soybeans and late-planted grain sorghum. These later plantings should be in narrow rows, 15 to 20 inches, to give quick shade.

Follow recommended production practices-lime, fertilizer, proper stand, insect and disease control, etc.-to encourage a vigorous crop which has a competitive edge in shading out weeds. Since stand establishment is more difficult in no-till planting, special care should be given to planting rates and depth for weeds will come into plant skips within the row. Heavy mulch covers left from cover crops also aid in weed control. Dense small grain stands can also reduce the potential weed infestation and weed size at planting time for double-crop no-till soybeans or grain sorghum.

Cultivation and Seedbed Preparation

If the weeds present dictate cultivation and/or plowing or disking for seedbed preparation, then no-till is not the planting system to choose. For example, johnsongrass, bermudagrass and yellow and purple nutsedge are difficult to control in a no-till system. However, certain preplant soil incorporated herbicides can control these perennial weeds.

In no-till double-crop soybeans, our experience indicates that small grain should be planted in a conventional seedbed rather than over-seeding in the previous crop. The stand of small grains has been better and hence better yields. Also, weed control and yield of the no-till planted soybeans have been greater following small grain which is conventionally planted. When fields are fall tilled and planted to small grain, cutleaf evening primrose, horseweed, whiteheath aster, and wild lettuce-which are difficult to control with Paraquat-are not a problem. In addition, perennial weeds such as trumpetcreeper, horsenettle, and briars, are less prevalent where fields have been tilled in the fall.

Effects of tillage in weed control is one reason we do not advocate continuous no-till planting but do suggest no-till as one alternative planting system within a total crop management system.

Herbicides

To select the proper herbicide for no-till planted crops, you must know the weeds present in the field, the soil organic matter and texture, and the capabilities of herbicides labeled for no-till crops. The first step in any weed control program is to identify the weeds. There are several helpful weed identification manuals available. Scout or survey fields each summer or fall and record weeds present. These will most likely need to be controlled the following year.

The existing weeds will indicate whether or not to no-till plant. Next, they aid in selecting the herbicide to provide residual weed control and in determining possible needs for additional postemergence applied herbicides.

Weed Management Programs

The herbicide combination for no-till planted crops contains a contact herbicide for control of existing vegetation plus a surface applied residual herbicide for the control of germinating weeds. Specific herbicide mixtures for no-till are listed in Table 1. Discussion on herbicides and weed management programs in corn, soybeans, and grain sorghum follows.

Control of Existing Vegetation

Paraquat or Roundup in the tank mix control emerged annual grass and broadleaf weeds and small grain cover crops. Paraquat rates are 1 to 2 pt/A. Use the lower rate when emerged annual weeds are small-l to 3 inches tall. Increase to 2 pt/A when weeds are 4 to 6 inches tall. Add Ortho X-77 Spreader to Paraquat tank mixtures.

Crabgrass, fall panicum and lambsquarter over 3 inches tall are difficult to control with Paraquat. In this case Roundup is better. Also, legumes (alfalfa, clover and vetch, for example), cutleaf evening primrose, wild lettuce and larger plants of some weeds such as Pennsylvania smartweed, ragweed, common lambsquarters and horseweed are more effectively controlled with Roundup.

Roundup used in no-till plantings is primarily for the control of annual weeds. We have noted that it gives improved suppression of perennial weeds over Paraquat. However, in most cases corn is planted too early for perennial weeds to be at the proper stage of growth for most effective control with Roundup. For annual weeds less than 6 inches tall use 1 quart of Roundup per acre. To control larger annual weeds increase the rate to 1.5 quart/A. There is considerable evidence from research in North Carolina that Roundup at 1.5 to 2.0 qt/A has economically increased yields in no-till corn planted into a green small grain cover crop and in soybeans if planted into weeds.

Paraquat or Roundup may be used to control winter small grain cover crops. Use 1 pt/A of Paraquat for rye and 2 pt/A for wheat, oats or barley plus Ortho X-77 surfactant. It takes 1.5 quarts/A of Roundup to kill cover crops.

Frequently, in earlier planted corn, summer annual grass weeds have not emerged. The weeds present may consist of winter annual broadleaf weeds and a few summer annual broadleaf weeds plus weeds which are difficult to control with Paraquat, such as, cutleaf evening primrose, horseweed, wild lettuce, plantains, and dock. Many no-till farmers are treating these weeds with 2,4-D amine prior to applying a residual herbicide. As planting is delayed the potential for emergence of annual grass weeds increases, which means that either Paraquat or Roundup needs to be used.

In double-crop no-till soybeans, planting and herbicide application should immediately follow small grain harvest. Weeds at this time are smaller and easier to control. Furthermore, because of the competition provided by a properly managed small grain crop, the weed seedlings are frequently small, spindly and succulent. Given a few days after small grain harvest, these weeds develop rapidly and become more difficult to control with foliar applied herbicides.

If tall weeds are present at small grain harvest, set the combine header as high as possible to save the foliage of the weeds in order to have a greater contact area for the foliar applied contact herbicide. Weed stubble or stems will not be controlled and resprouting usually occurs.

If a field has a severe infestation of existing weeds at small grain harvest, you should consider conventional tillage rather than no-till planting for your double-crop soybeans. This is particularly true when annual grass and broadleaf weeds, for example, common ragweed, common lambsquarters and pigweed, exceed 8 to 10 inches in height.

Using ground application equipment, apply tank mixtures with Paraquat or Roundup in 20 to 60 gallons of water per acre immediately before, during, or after planting, but before the crop emerges. Paraquat and Roundup may be applied in water or clear fertilizer solutions. However, do not apply in muddy water or fertilizer suspensions. To Paraquat tank mixtures, add Ortho X-77 Spreader at 1 pint per 100 gallons of spray solution. Do not add additional surfactant to Roundup tank mixtures.

Thoroughly coyer the live vegetation with spray. The amount of spray solution per acre should be increased as the density of stubble, crop residues or weeds increases. We suggest at least 40 gallons of spray solution per acre applied at a minimum of 40 psi through flat fan nozzles.

When double cropping, if the small grain straw has been left in a windrow and has not been removed or baled, it may trap the spray, lessening kill of existing vegetation and residual weed control. When no-till planting double-crop soybeans or grain sorghum use a straw shredder on the combine. This not only aids in improved weed control but also in increased ease of planting.

In spray mixtures the addition of Atrazine or Bladex in corn and Lorox, Lexone or Sencor in soybeans assist in killing existing vegetation in addition to providing residual weed control.

Corn-Residual Weed Control

1. *Crabgrass, fall panicurn, goosegrass, foxtails, and annual broadleaf weeds.* For the control of crabgrass, fall panicum, goosegrass, and foxtails, select either Dual or Lasso. Rates are slightly higher for no-till than conventional planted corn. The minimum rate for Dual 8E should be 2 lb active/A and for Lasso 4EC 2.5 lb active/A. These herbicides provide excellent grass control and adequate control of some broadleaf weeds. However, for additional broadleaf control tank mix AAtrex, Atrazine, Bladex, or Princep as indicated in Table 1. Follow labels.

If you are concerned about herbicide carry-over effecting crops following no-till corn such as fall planted small grains, select the Lasso + Bladex combination for residual control because this combination does not have any label restrictions on fall planted or spring planted crops.

High rates of animal manure or decomposed crop residues will reduce the effectiveness of surface applied herbicides. Residual herbicides tend not to persist as long under no-till conditions as conventional.

When the corn is 12 inches tall, scout or check the corn field for presence of grass weeds. If there is a considerable number of grass weeds 1 to 3 inches tall, a layby treatment will be beneficial. When the corn is 15 to 20 inches tall, postdirect Evik + surfactant or Lorox + surfactant. Addition of the surfactant is critical for success of the layby herbicide, whether applied in water or in nitrogen solution.

Grass weeds up to 3 inches tall can be effectively controlled with minimum rates of 1 lb active/A of Evik or 0.75 lb active/A of Lorox. These herbicides will also control small annual broadleaf weeds. Postemergence herbicides are more effective on actively growing young weeds than mature weeds or those growing under stress. If the problem is only broadleaf weeds at layby, postdirect 2,4-D amine (0.5 lb active/A) or Banvel (0.25 lb active/A).

2. *Broadleaf signalgrass, Texas panicurn and annual broadleaf weeds.* For the preemergence control of broadleaf signalgrass and Texas panicum, use Dual or Lasso. Under adequate rainfall these two herbicides perform very similarly and control broadleaf signalgrass from 5 to 6 weeks after application. More rainfall is required for activating Dual than Lasso. On the other hand, under heavy rainfall conditions for several weeks following application, Dual will give longer weed control.

To improve broadleaf weed control, tank mix AAtrex, Atrazine, Bladex, or Princep according to the combinations listed in Table 1.

A layby application, in addition to the at-planting treatment, is usually necessary in controlling these two grass weeds. Apply Lorox + surfactant or Evik + surfactant when the corn is 15 to 20 inches tall. Direct the spray solution to the lower one-third of the corn stalk. Make sure the weeds are adequately covered. Lorox + surfactant at 0.75 lb active/A or Evik + surfactant at 1.0 lb active/A gives excellent control of broadleaf signalgrass and Texas panicum less than 4 inches tall; Lorox or Evik may be applied in nitrogen solution or water.

3. *Yellow Nutsedge.* If a field is severely infested with nutsedge, we suggest not planting no-till. However, light infestations of yellow nutsedge can be controlled with Dual at a minimum rate of 2 lb active/A. Atrazine and Princep may also be tank mixed with Dual for additional broadleaf weed control. If nutsedge has emerged at time of planting, use Roundup in the tank mixture. If a planting treatment of Dual has not been used, Basagran may be used for treating infested spots of yellow nutsedge within a field. When the yellow nutsedge is 6 to 8 inches tall, apply Basagran over the top of corn at 0.75 qt/A. It will take 2 applications spaced 7 to 10 days apart to do the job. Treat only the infested areas to cut cost.

Scout the corn field when corn is 12 to 15 inches tall. If there is considerable nutsedge present, a layby postdirected application of Lorox + surfactant will give additional control. In most cases, however, if the planting treatment has performed satisfactorily the addition of a layby treatment has not proven beneficial.

Soybeans-Residual Weed Control

1. *Annual small-seeded broadleqf weeds plus moderate infestation of annual grass weeds.* Tank-mix combinations with Lorox, Lexone or Sencor provide' grass and broadleaf weed control for a short duration-3 to 4 weeks. Control may be long enough for no-till double-crop soybeans planted in narrow rows but too short for full-season soybeans. These herbicides assist in killing existing vegetation in addition to providing residual weed control. Do not select these treatments if fall panicum or broadleaf signalgrass is a problem.

Lorox should not be used on sand or loamy sand soils nor on any soil with less than ½ percent organic matter for it may injure the soybeans. Five percent organic matter is the upper limit for use of Lorox, because organic matter ties it up, reducing the amount available for adequate weed control.

Do not use Lexone or Sencor on sandy loam or loamy sand soils with less than 2 percent organic matter. In these soils, Lexone or Sencor may injure soybeans, particularly under heavy rainfall which moves the herbicide into the soil where it is absorbed by the soybean roots and moved into the top of the plant. Plant soybean seed at least 1.5 inches deep on flat or raised seedbeds to reduce potential injury from Lorox, Lexone or Sencor.

2. *Annual small-seeded broadleaf weeds plus control of annual grass weeds including fall panicum and*

broadleaf signalgrass. For improved annual grass weed control, Dual, Lasso or Surflan should be added to the tank-mix combination. Dual will also control yellow nutsedge. Lasso is a consistently effective preemergence grass control herbicide since very little rain is required for its activation. It usually provides control for approximately 6 weeks. Surflan, on the other hand, requires more water for activation but offers the advantage of longer grass control. Dual appears to require a little more water for activation than Lasso but under heavy rainfall it provides longer control than Lasso. Often rainfall is less reliable following application for no-till double-crop soybeans and consequently weed control from Surflan is less favorable.

Any of these three herbicides in tank mixes is a good candidate for full-season or double-crop no-till soybeans. One of these three herbicides in combination with Lorox, Lexone or Sencor will provide good control of annual small-seeded broadleaf weeds such as pigweed, lambsquarter and ragweed and only partial control of larger seeded weeds such as cocklebur, jimsonweed and morning glory.

3. *Postemergence weed control.* Frequently it is necessary to apply additional herbicides for the control of large-seeded broadleaf weeds such as cocklebur and sicklepod. These weeds usually do not emerge as readily in no-till as tilled fields and are less of a problem in late planted no-till soybeans than in early planted conventional soybeans. Also, in no-till these applications may be more expensive because the potential for band application plus cultivation does not exist.

Scout the field a few weeks after planting. If cocklebur or ragweed are present apply Basagran over-the-top of the soybeans before the cocklebur or the ragweed reaches 4 inches tall. If morning glory and cocklebur are present, apply Blazer when both the cocklebur and morning glory are still small, cocklebur no more than 2 inches tall, and morning glory not running. Attac plus oil concentrate controls sicklepod only in the cotyledon stage. We do not suggest the use of Dyanap or Premerge in no-till double-crop soybeans because these herbicides have the potential of delaying the development of the crop.

Another approach to postemergence control of weeds is a postdirected application of Lorox + 2,4-DB (Butoxone or Butyrac). This treatment is effective on sicklepod, morning glory and many annual grass and broadleaf weeds. Add surfactant to spray mixture according to label directions. Soybeans must be at least 8 inches tall and weeds no bigger than 2 inches in height. Do not spray higher than 3 inches on the soybean stem or crop injury may result. Shielded sprayers are suggested in no-till to reduce potential crop injury, particularly in the presence of small grain stubble. Do not use if the soil has been wet for 2 or 3 days.

Table 1
Herbicide Tank Mixtures for No-Till Crops

Contact Herbicide		
Paraquat	**Roundup**	**Residual Herbicide**
		CORN
X	X	AAtrex + Princep
X	X	Dual + AAtrex
X	X	Dual + Princep
X	X	Lasso + Atrazine
	X	Lasso + Bladex
	X	Lasso + Princep
		SOYBEANS
X		Lorox
X		Lexone or Sencor
X	X	Dual + Lorox
X	X	Dual + Lexone or Sencor
X	X	Lasso + Lorox
X	X	Lasso + Lexone or Sencor
X		Surflan + Lorox
X		Surflan + Lexone or Sencor
		GRAIN SORGHUM
X		Atrazine

(Add Ortho X-77 Spreader to tank mixes with Paraquat)

For suppression and control of light infestations of seedling and rhizome johnsongrass, Vistar may be applied over-the-top of soybeans. Soybeans should have at least two trifoliate leaves and the johnsongrass should be less than 15 inches tall. Roundup may be used in recirculating sprayers and in wick applicators to control johnsongrass once it has grown taller than the soybeans.

Grain Sorghum-Residual Weed Control

The only labeled, tank mixture for no-till grain sorghum is Paraquat plus Atrazine. However, Atrazine may be used only on silt loam, clay loam and loam soil with more than 1 percent organic matter. Another approach is to apply Paraquat or Roundup to control existing vegetation. Then follow this with a preemergence application of Bicep or Milocep in fields planted only with Concept treated grain sorghum seed. Do not use Bicep on sand, loamy sand or sandy loam soils or on any soil with less than 1 percent organic matter. Milocep should not be used on sand and loamy sand soils.

Narrow rows, 14 to 20 inches, help in weed control for the plants shade out later germinating weeds.

When grain sorghum is 10 inches tall check for the presence of weeds. If needed, apply Lorox + surfactant as a postdirected spray for additional grass and broadleaf control or 2,4-D amine or Banvel for broadleaf control.

Insect Problems in No-Till Soybeans and Corn

No-till culture represents a major ecological change to many insects and mites. Tillage is extremely disruptive of soil insect habitat and produces high mortality of many pests. Thus, generally no-till insures greater survival of many pest and beneficial insects that may remain within the no-till field or move to other fields and/or crops. The full consequences of a widely practiced no-till culture are difficult to predict but some short-range consequences are apparent.

No-till soybeans planted into small grain stubble do not appear to suffer more overall insect damage than conventionally tilled soybeans of similar variety, planting date, and row width. Although more seedling loss is probably encountered in no-till, soybeans are not a population sensitive crop and therefore this increased plant loss is compensated for by increased plant size. No-till soybeans following small grain are usually seriously infested with corn earworm but this is due to lateness of planting, not no-till culture. Insect management for no-till and conventional till soybeans is identical. The unanswered question with no-till soybeans regards the survival of pest species which can infest other crops as well as soybeans. Armyworm, brown stinkbug and other pest insects build up in wheat and move to other areas.

Corn Problems

No-till corn presents a different situation since it is plagued by several kinds of soil insects and it is a plant population sensitive crop. Tillage destroys or disrupts soil insects and reduces populations by killing or forcing these pests to move. This effect is lost in no-till. Also, in no-till the killing of winter annual weeds or cover crops with herbicides presents the plant feeding insects three basic options: (1) move out of the field, (2) feed on those young, tender corn seedlings, or (3) die.

Another factor that fits into the picture of more insect damage is the increased probability of cool, wet conditions. Such conditions lead to slow growth and, because small seedlings are more readily damaged, slow growth decreases the crop's tolerance to insects. These conditions make insects a more serious threat in no-till corn, as compared to conventional culture.

Management of seedling corn insects in no-till follows a systemic approach and is focused on producing a vigorous, fast growing crop and on reducing populations of seedling insects.

One of the most important aspects in producing a vigorous no-till corn crop is advanced planning and site selection. Poor drainage, pH, fertility, and weed management can greatly affect plant vigor and insect damage. By giving up tillage, the options to correct drainage, pH and many fertility problems (i.e. phosphorus and some micronutrients) are lost. Heavy weed growth in the previous crop can foster the buildup of overwintering insects, such as cutworms, which may attack the no-till corn crop.

Because of these factors, advanced planning is needed so that fields to be planted into no-till are left in good condition. Also, site selection is crucial during the year of no-tilling so that a no-till crop will not be placed into a field with critical, yield reducing problems. Insects generally affect a poor crop more seriously than a healthy crop and attention to these factors helps insure a vigorous, tolerant crop.

Management Skills

Variety selection, plant population, and planting accuracy may greatly influence insect damage. Some hybrids grow off better in cool, wet conditions than others. Since no-till conditions favor low soil temperatures and fast grow-off is related to less insect damage, hybrid choice aimed at selecting vigorous germination and grow-off is important. Stalk strength is another important characteristic since plant residues and insect damage tend to foster stalk rots.

Initial stand and planting accuracy must be closely watched. Corn is a population sensitive crop and affordable plant loss is directly influenced by seeding rate. A farmer who plants less than the recommended plant population cannot tolerate additional loss to insects. On the other hand, seeding at 10 percent to 15 percent over the recommended population for each hybrid allows for some loss without affecting yields. Placement of seed either too deep or shallow can reduce vigor or increase exposure to pests, particularly insects and birds. Planter regulation is more difficult and more critical in a no-till situation and added attention is usually needed.

Growth promotion through the use of pop-up, starter, or banded fertilizers is frequently a good insurance policy on cool, wet-natured soils. No-till favors slow warm-up and phosphorus is tied up under these conditions; purple, phosphorus-deficient plants are much more susceptible to insect damage. Pop-up or starter treatments utilize a high analysis, low salt, fertilizer containing nitrogen and phosphorus (ratio 1 to 3 or 4, i.e. 10-34-0, 6-18-0, 18-46-O). Pop-up is placed into the seed furrow and utilizes liquid fertilizer (i.e. 10-34-o) at no more than 50 lbs/A; do not use on sandy soils. Starter treatment is placed to the side (about one inch) of the seed furrow and can include liquid or dry fertilizer (i.e. 10-34-0 or 18-46-0) up to 100 lbs/A or more; starters may be used on light soils. These treatments will produce vigorous, early growth and work well with soil insecticides in protecting plants.

Rotation and Insecticides

Reducing the numbers of potential corn seedling pests involves rotation and soil insecticides. In no-till, rotation is even more important than in a conventional system since the tillage effect is lost. Soil insecticides also are recommended for no-till corn. Furadan 10G (10-20 lbs/A-furrow), Counter 15G (6.5-13 lbs/A-furrow), or Lorsban 15G (6.5-13 lbs/A-banded) are suggested. Higher rates should be used if more than a light infestation is expected (i.e. 50% to 100% above the lowest rate). Lorsban 15G is unique in that it is active on cutworms, a common problem on no-till corn.

Postemergence treatments for armyworms, cutworms, or billbugs may also be necessary in no-till corn. However, treatment should only be done if needed and this implies scouting. The threat of cutworms and other insects is serious enough to warrant checking no-till corn on a weekly basis from about 2 inches until 16 inches tall. Thresholds are influenced by plant population, and 5 percent or more damaged plants can be tolerated in full population stands, but 2 percent damage may be economic in fields with marginal or deficient stands.

Lorsban, Dylox or Proxol, or Sevin may be used postemergence on cutworms. Billbug treatments should be with Lorsban, Furadan, or Counter. Treatments should be directed to the plant base (directed or over-top spray). Lorsban and Sevin may be tied up on soil with high organic matter content.

Soybean and Corn Diseases in No-Till Systems

Control of corn and soybean diseases in no-till is based largely on our knowledge of them in conventional tillage systems. One cannot assume that pathogens will behave similarly in conventional and no-till systems because some are known to be reduced by no-till whereas others are increased.

It is important to recognize that reduced tillage changes many aspects about a field that may affect pathogens. It does require us to consider that the control options have changed, particularly for soilborne pathogens. In cases where resistant varieties are available and where rotation can be used, there probably will be little change; where chemical control is required, the disease may have a major impact upon the way the crop is grown.

Good crop husbandry is still basic in crop production. Vigorous growing varieties with disease resistance should be selected when needed. Crops should be rotated as frequently as possible. Adequate fertility helps maintain nutrient balance in the plant and makes it more tolerant to the damage caused by certain pathogens.

Soybeans

Seedling Diseases. Fungicide seed treatments protect seeds and seedlings from several damping-off diseases caused by *Pythium, Phytophthora, Rhizoctonia, Fusarium,* and *Sclerotium. Phytophthora* resistant varieties are effective where this fungus is present.

Foliar Pathogens. Many foliar pathogens survive in crop residue. When crops are rotated, foliar pathogens are not any more severe in no-till than in conventional tillage. Several foliar fungicides are labeled for use on soybeans, but the yield increases in North Carolina have not been sufficient to justify their widespread use.

Soilborne Diseases. Phytophthora root and stem rot: Phytophthora in more mature soybeans is minimized by planting resistant varieties.

Southern blight: This disease is caused by *Sclerotium rolfsii.* The fungus survives on plant residue in the soil.

Red crown rot: The causal fungus is *Cylindrocladium crotalariae.* The diseases was reported to be less severe in Virginia in no-till than in conventional plantings.

Nematodes: Populations are likely to remain higher in fields that are not tilled and decrease as more tillage is done. Soybean cyst *(Heterodera glycines),* sting nematode *(Belonolaimus longicaudatus),* lesion *(Pratylenchus brachyurus),* and root-knot *(Meloidogyne incognita, M. halpa, M. arenaria,* and *M. javanica)* nematodes are the principle ones to consider. Crop rotation and resistant varieties are effective but are species specific. Nematicides are difficult to apply in no-till. County agents and specialists should be consulted for the most current practical and legal information on nematicides.

Corn

The disease incidence and severity in no-till corn in North Carolina, as well as in many other states, are similar to conventional planted corn.

Stalk rot: Stalk rot might be decreased in no-till corn.

Aflatoxin: Aflatoxin severity might be less in no-till because there is less moisture stress than in conventional tillage.

Gray leaf spot: This disease is becoming worse in Virginia and Tennessee in reduced tillage systems but not in Kentucky. It is likely where corn is grown continuously in reduced tillage systems in North Carolina that gray leaf spot will increase, if the corn is produced in areas where the environment is favorable for the causal fungus *(Cercospora zea-maydis).*

Nematodes: The effect of nematodes in reduced tillage systems has not been noted to be any worse than they are in conventional tillage. The problem may be enhanced over time in reduced tillage because control of corn parasitic nematodes is largely dependent upon nematicides. There is not a good method of applying nonfumigant nematicides in no-tillage systems.

No-Till Forage Production

The Crop Science Society of America defines pasture renovation as "the improvement of a pasture by the partial or complete destruction of the sod, plus liming, fertilizing, seeding, and weed control as may be required to establish desirable forage plants."

No-tillage is a widely applied term referring to many reduced tillage seeding practices-zero-till, minimum-till, sod seeding, top seeding, over-seeding, slot seeding and inter-seeding. Since pasture renovation refers to the renewal or restoration to vigor of old, worn-out pastures by introducing desirable forage species, most of these terms can be directly related to pasture renovation procedures.

Fundamentals

Planting new pastures or rejuvenating old ones by minimum or no-till methods is a viable option for North Carolina growers. Over the years, research and experience have proven that several methods or variations such as sod seeding, minimum-till, surface seeding, etc. will work.

Regardless of method, certain fundamental principles apply to no-till or minimum-till pasture seedings. These include:

(1) Test the soil and apply the needed nutrients and lime. If pH is below 5.8 and a legume is to be planted, apply lime several months before seeding.

(2) If weeds dominate the area to be seeded, control or eliminate these weeds prior to seeding by mowing or using herbicides. If broadleaf weeds are present, spray 0.75 to 1 pound per acre of 2,4-D amine in late May to early June but not later than 6 weeks before seeding. To control hard to kill perennial weeds, such as dogfennel or red sorrel, tank mix 0.25 pound per acre of Banvel plus 0.75 pound per acre of 2,4-D amine. Spray in May or early June but not after June 15.

(3) When no-till seeding a legume into a grass sod, there should be at least a 50 percent stand of desirable grass (fescue, orchardgrass or bluegrass).

(4) The sod *must be supressed* by grazing, clipping, chemicals or combinations of the above prior to seeding. No more than 1 to 2 inches of grass stubble should be present at seeding.

(5) Judicious grazing or clipping may be needed during the establishment period in order to control excessive competition from the grass.

(6) Planting at the proper time can be critical to obtaining a good stand.

(7) Insects can destroy seedling legumes rapidly. They are especially troublesome during hot, dry autumns. The decision to spray or not should be made on a site by site situation analysis.

No-Till Planting Methods

Sod Seeding *with No-till Drills.* Several drills are available that are designed to place seeds in contact with the soil without significantly disrupting the sod (Midland Zip seeder, Tye Pasture Pleaser, Moore or KMC Unidrill, John Deere 1500 Power Till, and others). These drills operate by making a narrow slit or trench in the soil and placing the seed into the trench at ¼ to ¾ inch depth. Almost all of these drills have pack wheels which firm the soil around the seeds. Often a conventional grain drill can be used, especially for the large seeded forages, when soil moisture is favorable.

Planting can be done any time during the recommended seeding periods if the ground can be penetrated by the disk openers. Dry, hard, soils often make fall sod seeding difficult for light-weight drills and grain drills. No-till drills can also be successfully used when seeding directly into small grain stubble or other crop residue if the amount of residue is not too great.

Minimum-till. This method involves partial destruction of the sod by disking, harrowing or other light tillage methods that disturb about 50 to 60 percent of the sod. A drag or cultipacker may be used for smoothing. Seeds can be broadcast on the surface and cultipacked or they can be sown with a standard grain drill or no-till drill. When seeding in the spring, disking may be clone in early winter before the soil becomes too wet.

Surface Seeding. This method is used only for late-winter or early-spring seedings. During this period, soil moisture is normally near field capacity. Seeds are broadcast onto the surface of closely grazed or clipped pastures (1 to 2 inches) in late February or early March so there is a good chance that freezing-thawing or rainfall will result in good soil-seed contact. If seeding is delayed until mid-March it may be desirable to band spray Paraquat at time of seeding to reduce grass competition. After sowing, it may be helpful to use a drag or spike tooth harrow to assure soil-seed contact. Cattle can also be used to tread seeds into the soil surface.

Aerial Seeding. This is a surface seeding method and thus if it is to be used for perennial pastures all of the concepts stated for surface seeding apply. Fall sowing of winter-annual forages onto crop land by airplane has been successful in some situations. The most common practice is to "fly-on" rye or ryegrass seed into soybeans just prior to leaf drop. When the bean leaves fall they provide a mulch for the seed thereby providing for better germination. However, a short term residual herbicide which has no label restrictions on succeeding crops should be selected in the soybeans for successful emergence of the over-seeded crop.

Examples of Applications of No-till Practices for Establishing Forage Crops

(1) Seeding perennial legumes such as ladino clover,, red clover or alfalfa into cool-season grass sods such as tall fescue ***or*** orchardgrass.

(2) Seeding winter annual grasses and legumes like rye, ryegrass, crimson clover, subclover or hairy vetch into warm-season perennial pastures such as bermudagrass.

(3) Seeding summer annuals such as sorghum-sudan hybrids, sudangrass hybrids or pearlmillet into small grain stubble or into "worn-out" cool season pastures prior to reestablishment of the perennial pasture.

Table 2
No-Till Seeding Rates

Crop	Rate per acre
Alfalfa	20-25 lbs
Crimson clover	15-20 lbs
Hairy vetch	20-30 lbs
Ladino clover	4-5 lbs
Pearlmillet	15-20 lbs
Red clover	8-12 lbs
Rye	2-4* bu
Ryegrass	20-40* lbs
Sorghum-Sudan	20-30 lbs
Subclover	15-20 lbs

* For aerial seeding use the high rates.
Use quality seeds (certified if available). Always inoculate legumes with the proper strain of N-fixing bacteria.

Special Considerations

When seeding into perennial grass sods, it is often desirable to use chemical as well as physical suppression of the grass top-growth. Clipping or grazing the grass to 1 to 2 inches plus the use of Paraquat, a contact herbicide used to kill or suppress the grass, will give small legume seedlings a better chance to compete for light, water and nutrients. Paraquat may be applied as a broadcast or as a banded spray. In either case, 1 to 2 pints of Paraquat per sprayed acre is usually sufficient. Add 1 pint of Ortho X-77 Spreader per 100 gallons of spray mixture. Use 25 to 35 gallons of spray mixture per sprayed acre. Paraquat controls many annual weeds and gives top-kill of perennial weeds.

Table 3
No-Till Planting Dates

	Clover into Perennial Cool-season Grass Sod	
	Preferred	**Possible**
Mountains	July 25 - Aug l0* Aug 1 - Sept 1 Mar1-Mar20	 Aug 1 - Sept 15 Mar1-Apr15
Piedmont	Aug 25 - Sept 15* Oct 7 - Oct 15 Feb 20 - Mar 10	 -Aug25-Oct25 Feb 15 - Mar 20
Coastal Plain	Sept 1 - Sept 30* Oct 7 - Oct 15 Feb 15 - Feb 28	 Sept 1 - Oct 31 Feb 10 - Mar 15

	Alfalfa into Perennial Cool-season Grass Sod	
	Preferred	**Possible**
Mountains	July 25 - Aug l0* Sept 15 - Oct 1	 July 25 - Oct 15
Piedmont	Aug 25 - Sept 15* Oct 10 - Oct 20	 Aug 25 - Oct 20
Coastal Plain	Oct 15 - Oct 25	Sept 1 - Oct 31

	Summer Annuals into Small Grain Stubble or "Worn-out" Cool-season Pasture Sod	
	Preferred	**Possible**
Mountains	May 15 - May 31	May 1 - June 30
Piedmont	May 1 - May 31	May 1 - June 30
Coastal Plain	May 1 - May 15	Apr 25 - June 30

	Winter Annuals into Bermudagrass Sod	
	Preferred	**Possible**
Mountains	-	-
Piedmont	Aug 25 - Sept 15	Aug 20 - Oct 15
Coastal Plain	Sept 5 - Sept 20	Sept 1 - Oct 31

*The best time to sod seed depends on the prevalence of insects in late August and early September and the drought prediction for September. If insects are not evident and moisture is adequate, plant on the early dates.

Some points to remember when planting alfalfa or clover are:

Insects. Insects such as grasshoppers, crickets, leafhoppers, armyworms and slugs can be devastating to young forage seedlings during some years. The most severe problems have occurred in late-summer and early-fall plantings, especially during dry periods.

The best way to combat insect damage is to survey fields at planting to decide if populations are heavy enough to cause damage to emerging seedlings. If populations are heavy (for example, 5 to 8 grasshoppers per square foot), spray with approved insecticide at planting or before germination occurs. The decision to spray should be based on a field by field survey of insect populations.

Another approach to combat insects is to make fall sod plantings 3 to 5 weeks later than dates recommended for conventional establishment. The onset of cool weather usually results in diminished insect populations while the sod offers protection to young seedlings from heaving and winter injury.

Alfalfa. When drilling alfalfa, always broadcast Paraquat at time of planting or shortly before. Since Paraquat kills on contact it will kill germinating alfalfa seedlings if spraying is delayed (often seeds germinate in 3 days). At present, planting alfalfa into perennial grass sods in late winter-early spring is not recommended.

Clover (fall planting). When drilling clovers into sod during the fall, the use of Paraquat may or may not be needed. This depends on the amount of residual soil nitrogen, soil moisture, and insect population following planting. If soil moisture is limiting it is advisable to spray Paraquat before or *immediately* after planting. About one-half of the sod should be sprayed in 6 to lo-inch bands and the seeding row should be within the band.

If moisture is not a limiting factor and residual soil nitrogen is low, spraying may not be advantageous, but the area should be kept grazed as close as possible without allowing cattle to bite the tops out of the developing seedlings.

Clover (spring planting). Paraquat will not be necessary unless plantings are made late (when grass is vigorously growing). Plantings made after March 30 do not usually have a good chance for survival because of stress from moisture, temperature and grass competition.

Cost Differences and Erosion Implications of No-Till and Conventional Tillage

A decision to change to no-till planting should include consideration of factors such as soil erosion hazard, planting equipment available, whether the weeds present can be controlled, whether a granular nematicide is required, the pH and fertility status of the soil, and the general level of management available.

These factors determine the importance of using no-till and strongly influence its agronomic and economic success. Many farmers have the choice of continuing with conventional tillage or making minimal changes in equipment and herbicides to allow no-till planting.

A change to no-till may reduce some input costs (fuel and labor) but usually increases pesticide costs and the need for quality labor. With the elimination of plowing and several secondary tillage operations the power and machinery requirement for a given acreage is reduced, as are related investment and ownership costs. This reduction in tillage work may permit more timely planting, extended years of equipment life, and the opportunity to make more efficient use of the labor available. Successful use of no-tillage systems has been clearly shown to greatly reduce the risk of soil erosion.

It is important to recognize the cost trade-offs between conventional tillage and no-tillage, especially in view of recent escalation of input prices and interest rates. This section will emphasize cost analyses for the production of corn and soybeans with a typical conventional tillage procedure versus several observed no-till procedures.

Estimation Methods and Assumptions Used

All estimates are based on a 400-acre operation (200 acres corn, 200 acres soybeans) using standard procedures of budget generation applied by agricultural economists. Budgets for conventional tillage include a medium-sized tractor (65 hp), a moderately-large tractor (115 or 140 hp), a chisel plow, disc, sprayer, rolling cultivator, rotary stalk chopper, combine, two-ton truck and pickup truck.

Unless otherwise noted, no-tillage budgets include the same equipment items except that the larger tractor, chisel plow, and rolling cultivator were excluded and the size of disc was reduced to be compatible with the power of the medium-sized tractor. Ten-year useful lives were assumed for field machines, a 5-year life for the pickup, and 8-year life for the truck.

All costs are based on 1981 price levels. Fertilizer and lime costs include custom spreading of typical maintenance rates for productive cropland and are the same for all tillage procedures. The following operations were assumed:

Conventional Tillage

For corn following soybeans-disc / chisel plow / disc / disc / plant / preemergence spray / postemergence spray / harvest / chop stalks / disc.

For soybeans following corn-disc / chisel plow / disc / disc / plant / preemergence spray / cultivate / harvest (leave residue over winter).

No-Tillage

For corn following soybeans-no-till plant / preemergence spray / postemergence spray / harvest / chop stalks / disc.

For soybeans following corn-no-till plant / preemergence spray / postemergence spray / harvest (leave residue over winter).

In all of the following budgets corn received a postemergence herbicide treatment valued at about $7 per acre when planted either conventionally or no-till. For soybeans, however, one cultivation was assumed with conventional tillage whereas a postemergence herbicide treatment valued at about $20/acre was used with no-till. In some weed situations less costly soybean postemergence herbicides may be more appropriate. No-till planted double-crop soybeans sometimes require less postemergence treatment than where tillage has been done. In other cases more than one treatment may be required.

Except where indicated otherwise the no-till budgets include the upper labeled rate of the contact herbicide Paraquat, a 33 percent increase in the rate of one preemergence herbicide over the rate used in conventional tillage, a 10 percent increase in the seeding rate, and slightly slower planting speed. A list of the major production inputs used in the budgets is presented in Table 4.

In all budgets corn residue is rotary chopped and then disced once in the fall with the intention of controlling insect and disease pests while leaving some residue exposed for erosion protection. Soybean residue is left untilled over winter. Crop rotation is assumed in all cases. These are generally considered to be sound residue management practices for production of these crops.

Three Cases Analyzed

Cost estimates and comparisons between tillage systems were made for three situations or "cases" differing in the type of planter used and no-tillage production procedures.

Case A assumes the modification of conventional flex-type, unit planters (addition of tool bar, fluted coulters, ribbed press wheels) to make a good no-tillage planter. An investment requirement of $1638 for these modifications to a 6-row planter was assumed. (The charge for modifying a John Deere "MaxEmerge" planter for no-till would be approximately 50% less than this but narrow rows for late planted soybeans might require double planting.) The complete no-till herbicide program outlined above was followed.

The Case A example is intended to have wide applicability to current farm conditions in all of North Carolina and neighboring states. Its applicability to a specific field would, of course, require adjustment for fertilization and pesticide use to fit that specific case.

The Case B example is a minimal-cost approach to no-till and is offered for comparison purposes primarily. *It is not intended to have widespread applicability.* In this case *no contact herbicide* is included and no change in preemergence herbicides is made. Only the seeding rate (10% increase) and planting speed (from 5 mph to 4 mph) are changed. A minimal 4-row planter modification charge of $250 was included. This example would apply to a farmer already owning a no-till planter which needs improvement or having purchased a set of used fluted coulters and miscellaneous parts needed to suitably modify his existing planter. Narrow row soybeans would require double planting in Case B.

It is recognized that some situations exist where the contact herbicide may not be needed but these must be selected very carefully since this savings in herbicide cost could often be greatly suprassed by the value of decreased crop yield. This case is only applicable to certain situations where corn is no-till planted into soybean residue early in the spring before any summer annual weeds have germinated and where all weed pressure is minimal. Early application of 2,4-D may also be required but is not included in this budget. Case B may also apply to infrequent cases of no-till, double-cropped soybeans planted into small grain residue where essentially no grass or broadleaf weeds have germinated.

Case C is a higher-investment approach which includes the same levels of contact, preemergence and postemergence herbicides, seeding rates and planting speed as used in Case A. In this comparison, however, a no-till ripper planter is used. It is assumed that the farmer's existing flex-type, unit planters will be remounted directly onto the no-till ripper unit and will be pulled by the same 140 hp tractor which would otherwise be used for conventional tillage operations. Because of the weight of this ripper-planter unit a lift assist wheel assembly is included. In this no-tillage budget the 65 hp tractor is retained and used primarily for spraying.

The Case C no-tillage approach should be viewed as more than traditional no-till planting because it provides in-row subsoiling as well as the capability of one-pass planting into most crop residue situations with resultant soil and moisture conservation benefits. However, the applicability of this example is considered greatest in certain soils of the Coastal Plain where yield increases from subsoiling may readily justify some added cost.

Cost Estimates

Based on the assumptions specified above, cost budgets were developed to compare chisel plow/disc land preparation with no-tillage for Cases A, B and C. Estimated annual per acre cost and fuel consumption for corn and soybean production are presented by case in Tables 5, 6 and 7, respectively.

For Case A-a widely applicable situation-the no-tillage procedure was less costly by $4.76/A for corn but more costly by $15.85/A for soybeans (Table 5). No-till permitted a total cost savings for machinery ownership, operation and labor of $20.30/A for corn and $22.06/A for soybeans. However, these savings were offset by cost increases for herbicide, seed and interest on operating capital totaling $15.54/A for no-till corn and $37.91/A for no-till soybeans. The notably high cost of no-tillage soybean herbicide was influenced by the costly postemergence treatment. In many cases this cost may be reduced where weeds present and careful management permit use of less expensive postemergence treatments. (One cultivation was assumed for clean-tillage soybeans.)

In Case B the total cost of no-tillage corn and soybeans (presented in Table 6) was reduced by $16-24/A compared with Case A, largely because standard no-tillage herbicides were left out. Compared with chisel/disc, no-till reduced the machine ownership, operating and labor costs by $22.07/A for corn and $28.40/A for soybeans. Although seed, herbicide and interest costs for no-till were still somewhat higher, the overall cost of no-till in Case B was $20.77 less for corn and $7.04 less for soybeans.

As in Case A, even greater cost savings would occur if less expensive postemergence weed control could be used for no-tillage soybeans. Clearly the cost savings of our Case B no-tillage would be helpful, but we again caution you that these procedures would not be widely applicable. Except under the conditions previously indicated, this procedure could result in significant yield reductions.

Use of a no-tillage ripper planter (Table 7), a larger tractor and allowance for use of both the 140 hp and 65 hp tractors in the Case C no-till budget pushed average machine ownership costs upward about $19/A compared with Case A. In Case C no-tillage allowed a savings in machine ownership, operation and labor costs of only $0.54/A for corn and $6.47/A for soybeans. The increased herbicide, seed and interest costs resulted in net increases of $15.06/A for no-tillage corn and $31.53/A for no-tillage soybeans compared with the chisel plow/disc treatment. As indicated previously, for much of the light, colored, sandy land of the Coastal Plain yield increases in response to this subsoiling technique are likely to more than pay for this increased cost-especially for corn.

Effect of Owning Unnecessary Equipment

Farmers who change to no-tillage planting are likely to find it difficult or impossible to sell larger tractors and tillage equipment which would provide excessive tillage capacity in a total no-tillage program. This may be due to unsuitability of no-till to a portion of acreage farmed or to certain crops grown (tobacco, peanuts, cotton). In many cases it may also be advantageous to maintain a diverse tillage program for periodic incorporation of lime, for pest management, or in the hope of increasing chances with adverse weather factors. With the same general assumptions as to acreage and procedures, keeping the 115 hp tractor and its matching chisel plow and disc would increase the annual per acre cost in Case A or Case B by $14.76 for no-tillage corn and $19.51 for no-tillage soybeans based on lo-year expected useful lives of these items.

Since hours of use of this larger equipment would decline as the no-tillage portion of the acreage increased, it may be desirable to assume an extended useful life expectancy of 20 years. This would reduce net increases in machinery ownership costs for Case A or Case B to $9.73/A for no-tillage corn and $13.41/A for no-tillage soybeans. In all of the above comparisons the chisel/disc procedure already included the use of the larger tractor and matching plow and disc as well as the smaller tractor.

Tillage Cost for Two-Year System

Some North Carolina farmers have successfully used a wheat-soybean-corn system which minimizes clean tillage, offers excellent erosion protection, makes maximum use of our summer growing season, and contributes to timeliness by reducing tillage trips and labor. For this comparison we used the same assumptions as in Case A above for planting corn and soybeans.

The system begins with a conventionally prepared seedbed for wheat, which is planted with a grain drill. The wheat received N topdressing and 2,4-D for weed control in the spring.

After wheat harvest a soybean double crop is planted by either conventional seedbed preparation (disc/disc/chisel plow/disc/plant) or by no-tillage planting. At harvest of the soybeans the residue is left over winter in either case. In the second year corn is planted by the same steps for conventional tillage versus being planted into soybean residue by no-tillage. This cost comparison is shown in Table 8.

As in the earlier comparisons for a single crop, substantial reduction in machinery ownership and operational costs and labor were nearly offset by increased costs of herbicides, seed and interest on production inputs. For the two year, three crop system no-tillage planting of the corn and soybeans resulted in a net cost decrease of $10.23/A as compared with the chisel/disc procedure.

Fuel Savings

Based on the same assumptions and utilizing standard guidelines established by Agricultural Engineers, the estimated fuel consumption for each of the above comparisons is given in Tables 5 through 8. Of course, the difference in direct fuel consumption was almost entirely in Diesel fuel used in the tractor and combine. Gasoline was consumed by trucks. A pickup was used to transport production materials to the farm and field and a 2-ton truck was used to transport water for spraying to the field and crop products from the field.

A meaningful comparison can be made by averaging the fuel consumed in producing an acre of corn and soybeans. In this manner no-tillage production resulted in an annual savings of 2.87 gal/acre in Case A, 3.12 gal/acre in Case B, and 2.32 gal/acre in Case C. For the two-year production of wheat, soybeans and corn the no-tillage procedure saved 5.64 gal/acre. These estimates closely resemble a recent analysis in Kentucky which reported an energy savings in machinery manufacture and fuel consumption of 3.9 gal. Diesel/acre for no-till corn and 3.4 gal. Diesel/acre for no-till soybeans as compared with conventional tillage.

Yields

Any complete economic analysis of production practices must include the resulting yields. Here we have chosen to emphasize only a comparison of costs under several sets of assumptions. Knowing the differences in costs of production, one can readily estimate the yield differences (either increases or decreases) which would allow a change in tillage practices. Space does not permit rigorous comparison of expected yields under conventional versus no-tillage planting. It should be obvious, however, that the differences in total costs between the two tillage methods (Tables 5-8) are equivalent in value to yield differences of 1 to 8 bushels of corn/acre or 1 to 5 bushels of soybeans/acre. Inadequate plant population of corn or faulty weed, insect, or disease control in either crop can readily cause yield decreases of double or triple these amounts.

The importance of consistently achieving at least equal yields under no-till production as compared with conventional tillage cannot be over-emphasized. Test plot and farmer experience in North Carolina includes many cases of equal or slightly better yields with no-till but there also are cases of much lower no-till yields resulting from poor weed or insect control or inadequate stand establishment.

Since no-tillage production generally is nearly equal if not more costly, it is clear that nothing less than the best management should be devoted to this practice to maximize the chances for high yields. Specific suggestions for yield-saving techniques in no-tillage production are given in other sections of this publication.

Erosion and Water Quality Implications

Nationwide the estimated loss of soil by erosion from cropland is nearly 2 billion tons per year. In North Carolina it is estimated that 49 million tons of soil is lost from eroding cropland, which represents 64 percent of the total erosion occurring in the state.[2]

The water pollution costs of excessive erosion are difficult to quantify. These arise from losses of nutrients, organic material, pesticide and sediment. In the simplest case of reservoir sedimentation the cost per ton of sediment can be calculated. Nationally it has been estimated that $250 million is spent yearly removing sediment from streams, harbors and reservoirs. Flood damages related to excessive sedimentation are estimated at one billion dollars yearly.

There are additional costs due to loss of recreational, aesthetic and fishery benefits related to excessive sedimentation. These are real but difficult to quantify because the values are subjective. There are instances when public water supplies are damaged by eroding cropland, in which case the costs to society may be almost without limit.

Five studies of streams and rivers in the North Carolina Mountains and Piedmont have shown that soil sediment from cropland erosion was associated with a moderate (30%-60%) or severe (over 60%) reduction in the number of aquatic insects which form the basis of the food chain for many fishes.[3] These and similar studies suggest that a 30-60 percent reduction in aquatic life is common in most Piedmont and Mountain streams of North Carolina.

Excessive erosion also has direct costs to the farmer. Fertilizer nutrients move off the land in association with the runoff water and eroding sediments. In a recent report the value of N, P, K and lime included in transported sediments varied from $3.33 to $28.78 per eroded acre, depending upon assumptions as to fertility level of the soil and availability of the nutrients.[4] This was based upon an assumed soil loss of 14 tons/acre/year. This is a high rate of soil erosion, but is common in our Piedmont region. Average soil erosion is estimated at 10-15 tons/acre/year in 17 counties and at over 15 tons/acre/year in 11 counties.[5]

The characteristics of the topsoil have great influence on crop growth. In soils in which the subsoil is clayey, erosion exposes this material at the surface. Studies have shown that when such less favorable

Table 4
Production inputs assumed in all budgets except where otherwise indicated in the text.

Herbicides for Corn
- Lasso 4EC (1.5 qts clean till; 2.0 qts no-till)
- AAtrex 4L (1.25 qts clean till; 1.25 qts no-till)
- Paraquat 2CL (2.0 pts + surfactant in no-till)
- Evik 80W (1.25 lbs/A + surfactant in clean till and no-till)

Herbicides for Soybeans
- Lasso 4EC (1.5 qts clean till; 2.0 qts no-till)
- Lorox 4L (1 pt clean till; 1.5 pt no-till)
- Paraquat 2CL (2.0 pts + surfactant in no-till)
- Basagran 4SL (2.0 pts in no-till)

Insecticides - none [1]

Fungicides - none

Fertilizer - 20 lbs. N + 20 lbs. P_2O_5 + 120 lbs. K_2O preplant for corn and soybeans (bulk blended); 130 lbs. N (30% solution) layby for corn; 60 lbs. N (with 2,4-D) topdress for wheat; lime @ 1 T/A every three years.

Seed - Corn - 16 lbs./A; soybeans 0.8 bu/A certified seed (plus 10% for no-till)

Fuel Prices - Diesel - $l.05/gal; gasoline - $1.25/gal.

NOTE: Inclusion of these products and rates for budgeting purposes does not constitute a recommendation of these products or rates for any specific situation nor imply criticism of other similar products or rates by the N. C. Agricultural Extension Service.

[1] No soil insecticide was budgeted for corn planted either conventionally or in no-tillage, although under some circumstances it would be needed. If corn is planted no-till into relatively weed-free soybean residue without previous history of heavy infestation of seedling-attacking insects, the need for soil insecticides is generally no greater in no-till than conventional tillage. This was assumed in these examples.

Table 5
Estimated costs and fuel use per acre of chisel/disc versus no-till corn and soybeans in North Carolina, 1981. Case A.[1]

Item	Corn		Soybeans	
	Chisel/disc	No-till	Chisel/disc	No-till
Seed	$ 17.60	$ 19.36	$ 12.29	$ 13.82
Fertilizer and lime	76.21	76.21	45.35	45.35
Herbicides	17.84	30.94	11.74	45.95
Fuel, oil, lub. and repairs	25.11	21.34	15.86	12.79
Interest on operating capital @ 15 percent	8.85	9.53	6.31	8.48
Total operating costs	$145.61	$157.38	$ 91.55	$136.39
Labor @ $4/hour	14.52	12.85	8.30	6.44
Machinery ownership costs	75.49	60.63	50.20	33.07
Total costs	$235.62	$230.86	$150.05	$165.90
Fuel consumption (gallons):				
Gasoline-truck and pickup	3.90	3.90	1.45	1.85
Diesel-tractors and combine	8.63	5.88	6.53	3.54

[1] No-till planter developed by $1638 modification of flex-type planters (4-36” rows for corn; 6-24” rows for soybeans). Typical no-tillage herbicide program included.

Table 6
Estimated costs and fuel use per acre of chisel/disc versus no-till corn and soybeans in North Carolina, 1981. Case B.[1]

Item	Corn		Soybeans	
	Chisel/disc	No-till	Chisel/disc	No-till
Seed	$ 17.60	$ 19.36	$ 12.29	$ 13.82
Fertilizer and lime	76.21	76.21	45.35	45.35
Herbicides	17.84	17.84	11.74	30.47
Fuel, oil, lub. and repairs	24.83	20.70	15.59	10.27
Interest on operating capital @ 15 percent	8.83	8.37	6.29	7.39
Total operating costs	$145.31	$142.48	$ 91.26	$107.30
Labor @ $4/hour	14.44	12.77	8.22	5.19
Machinery ownership costs	74.78	58.51	49.49	29.44
Total costs	$234.53	$213.76	$148.97	$141.93
Fuel consumption (gallons):				
Gasoline-truck and pickup	3.90	3.90	1.45	1.45
Diesel--tractors and combine	8.63	5.88	6.53	3.05

[1] Minimum no-till planter modification cost assumed ($250); no contact herbicide, and no increase in pre-plant herbicide rates; postemergence herbicide included for chisel/disc and no-till corn and for no-till soybeans. Caution-these no-till procedures will result in yield reductions except in some specific situations described in the text.

soil material is exposed yields decline. Such conditions are predominant in sloping areas of the North Carolina Piedmont and certain areas of the Coastal Plain and Mountains.

Obviously there are many factors that should be accounted for in assessing the costs of excessive erosion and resultant water pollution. To realistically assess the pollution costs of erosion, each water resource must be evaluated individually. But it should be noted that in almost every case where this has been done the benefits of erosion control have exceeded the costs.

When no-tillage planting succeeds in establishment of a crop with satisfactory stand, vigorous growth and good weed and pest control there is greatly reduced risk of soil erosion than with most forms of conventional tillage. The erosion control value of cropping systems involving no-till is of major importance. Generally the greatest erosion protection results from a well-established sod crop or small grain cover crop on the land over the winter. Corn can then be no-tilled into the killed residue of this crop. Very effective erosion protection also is provided by small grain residue into which double-cropped soybeans are no-till planted.

Soybean residue after harvest provides limited erosion protection. However, from an erosion standpoint leaving it untilled overwinter is far preferable to fall tillage without a cover crop. If corn is no-till planted into soybean residue (as assumed in the preceding budgets) the vulnerability to erosion following spring tillage can be greatly reduced.

Special Advantages of No-Till

Some farm situations fit well with no-till. In the following examples the advantages of no-till may outweigh its increased costs and special considerations.

(1) If soil erosiveness and/or collection of sediment or fertilizers in adjacent ponds or streams is a key concern, then ,successful no-tillage production as often as possible in the cropping system should be a management goal. If factors such as johnsongrass or the need for lime or phosphorus prevent successful no-tillage planting, these conditions should be corrected. In some cases on hilly land no-till planting may actually increase the acreage of potentially useful cropland and avoid or reduce the cost of alternative erosion protection measures.

(2) Farm operations having insufficient large tractors and tillage equipment in relation to their acreage can benefit from the reduction in machinery required with no-till *if* high quality management at the field level can be provided. This also applies to farmers who have limited credit for investment in machinery. The annual credit required for increased production inputs with no-till is likely to be more readily available.

(3) Relatively small farm operations or those heavily involved in livestock but having small crop acreages simply cannot justify large machinery investment. No-till production helps to keep per-acre ownership costs more reasonable.

(4) Farm operations where labor is in short supply or is primarily devoted to livestock enterprises or off-farm employment can benefit from no-tillage *if* quality management is available. Besides the actual hours of labor saved with no-till production this practice often permits greater timeliness of planting. A special example of this is the planting of double-cropped soybeans immediately after harvesting the small grain, thus avoiding loss of soybean yield potential through planting delays required for conventional tillage.

Table 7
Estimated costs and fuel use per acre of chisel/disc versus no-till ripper planter for corn and soybeans in North Carolina, 1981. Case C.[1]

Item	Corn: Chisel/disc	Corn: No-till Ripper	Soybeans: Chisel/disc	Soybeans: No-till Ripper
Seed	$ 17.60	$ 19.36	$ 12.29	$ 13.82
Fertilizer and lime	76.21	76.21	45.35	45.35
Herbicides	17.84	30.94	11.74	45.95
Fuel, oil, lub. and repairs	24.44	22.10	16.38	14.32
Interest on operating capital @ 15 percent	8.81	9.95	6.34	8.60
Total operating costs	$144.90	$158.16	$ 92.10	$128.04
Labor @ $4/hour	13.67	12.07	7.50	6.44
Machinery ownership costs	78.71	82.11	52.41	49.06
Total costs	$237.28	$252.34	$152.01	$183.54
Fuel consumption (gallons):				
Gasoline-truck and pickup	3.90	3.90	1.45	1.85
Diesel-tractors and combine	8.65	6.59	7.23	4.65

[1] A 140 hp tractor is used for both chisel/disc and no-till ripper procedures. Both tillage programs also include a 65 hp tractor. Typical no-tillage herbicide program (same as in Case A) was included. For corn four 36" rows were used; for soybeans six 24" rows were used.

Table 8
Estimated costs and fuel use per acre for two-year, three crop system comparing chisel/disc versus no-till planted soybeans and corn. Both planting methods include conventionally seeded wheat with double-cropped soybeans followed by corn in the second year.[1]

Item	Wheat-Soybeans: Chisel/disc	Wheat-Soybeans: No-till	Corn: Chisel/disc	Corn: No-till	Total (3 crops): Chisel/disc	Total (3 crops): No-till
Seed	$ 25.82	$ 27.36	$ 17.60	$ 19.36	$ 43.42	$ 46.72
Fertilizer and lime	59.60	59.60	76.21	76.21	135.81	135.81
Herbicides	33.48	48.96	17.84	30.94	51.32	79.90
Fuel, oil, lub. and repairs	28.28	24.31	26.10	22.35	54.38	46.66
Interest on operating capital	10.21	11.01	8.87	9.54	19.08	20.55
Total operating costs	$157.39	$171.24	$146.62	$158.40	$304.01	$329.64
Labor @ $4/hour	14.32	12.12	14.52	12.85	28.84	24.97
Machinery ownership costs	65.50	48.99	65.09	49.61	130.59	98.60
Total costs	$237.21	$232.35	$226.23	$220.86	$463.44	$453.21
Fuel consumption (gallons):						
Gasoline-truck and pickup	3.67	3.67	3.90	3.90	7.57	7.57
Diesel-tractors and combine	9.32	6.43	8.63	5.88	17.95	12.31

[1] No-till planter developed by $1638 modification of flex-type planters (4-36" rows for corn; 6-24" rows for soybeans). Typical no-tillage herbicide program (same as in Case A) was included.

Footnotes

[1] No-Tillage Agriculture. R. E. Phillips, R. L. Blevins, G. W. Thomas, W. W. Frye, and S. H. Phillips, 1980. Science, Vol. 208, June 6.

[2] Erosion and Sediment Inventory of North Carolina. 1977. USDA-SCS.

[3] Biological Evaluation of Non-Point Source Pollutants in N. C. Streams and Rivers. D. R. Lenat, D. L. Penrose, and K. W. Eagleson, 1980. Biol. Series No. 102. NC-DNRCD-DEM.

[4] Economic and Production Effects of Soil Erosion. 1980. L. W. Murdock, W. W. Frye and R. L. Blevins, Proceedings of Southeastern Soil Erosion Control and Water Quality Workshop. Nashville, Tenn.

[5] Erosion and Sediment Inventory of N. C. 1977. USDA-SCS.