Conservation Tillage Systems for Northwest Indiana

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Introduction

Since the various methods of conservation tillage must be tailored to each individual soil, conservation tillage is becoming the "conventional" method of farming for the future.

Information from the USDA, Soil Conservation Service and the Indiana Cooperative Extension Service (CES) was used to study the adaptability of four conservation tillage methods for thirteen counties in northwest Indiana.

This study area consists of about 3,706,725 acres (1,2,3,6,7,8,9,14,15,16,19,20,21). Fall chisel and spring chisel systems are suitable for all the soils in the study area. About 34.0 percent of the area is highly adapted to the fall chisel systems. This increases to about 89.5 percent of the soils when the well adapted and moderately adapted soils are included. About 64.5 percent of the area is highly adapted to the till plant on ridges system. This increases to 87.4 percent when the well adapted soils are included. Only about 30.6 percent of the area is highly adapted to the no-till system. This increases to about 83.8 percent when the well adapted and moderately well adapted soils are included. Only about 5.3 percent of the area is not suitable for till planting on ridges or no-till systems for continuous corn (10,11,12).

In the past few months much has been written and discussed about conservation tillage which is defined as any tillage sequence that reduces loss of soil or water relative to conventional tillage. Studies have been made on the benefits of conservation tillage, how individual soils relate to different tillage systems, and the adaptability of individual soils to different tillage methods. This paper takes a look at current ideas about conservation tillage for the soils in northwest Indiana.

Conservation tillage leaves all or part of the crop residue on the soil surface. Benefits of farming with conservation tillage are: (1) reduced soil erosion, (2) reduced soil compaction, (3) increased available water to plants, and (4) lower fuel costs. Conservation tillage systems commonly used in Indiana are no-till, till plant on ridges, and spring and fall chiseling. Each system has its own definition and has been compared with the conventional moldboard plow method of farming.

The moldboard plow system normally consists of first chopping or discing cornstalks before moldbord plowing. After plowing, spring seedbed preparation consists of two or more shallow (less than 6 inches) tillage operations with a disc, field cultivator, or harrow. This method buries all the crop residue in the upper 6 to 8 inches of the soil (10,12,18).

The chisel equipment used in comparing spring and fall chiseling with moldboard plowing consisted of two-inch wide chisel points spaced 12 to 15 inches apart and designed to till to a depth of 8 inches. It is important to point out that the amount of crop residue left on the surface decreases (1) if the width of the chisel points is increased, (2) if the spacing between the points is decreased, or (3) if a twisted chisel point is used (18).

The fall chisel method normally consists of first chopping or discing the cornstalks before chiseling. After chiseling in the fall, spring seedbed preparation is the same as in the moldboard plow method. The soil surface before planting remains cloddy over winter, with about 30 to 50 percent of the previous year's corn residue remaining on the surface. After planting, only 19 to 35 percent of the residue remains on the surface (17,18).

The spring chisel method consists of the same equipment and seed bed preparation as in the fall chisel system for moderately well drained and well drained soils. The wetness characteristic of the somewhat poorly, poorly, and very poorly drained soils limits the chiseling depth to less than 6 inches. Therefore, additional tillage is generally necessary to break up the clods. The final operation for all soils before planting is a final pass over the surface with a cultimulcher or rotary tiller (17,18).

Till planting on ridges is a once-over operation in the spring, planting in ridges made the previous year. A wide sweep or disk row cleaners are placed ahead of the planters to remove the top 1 to 3 inches of soil from the ridges. Clods and crop residues are pushed between the rows. A ridge, 6 to 8 inches high and about 12 inches wide, is made in the row at cultivation with a disc-hiller or rolling type cultivator. Ridges may be built during cultivation time or after the crop has been harvested. When ridges are formed at cultivation time, all corn residue remains on the surface over winter. Generally, 8 to 35 percent of corn residue remains on the surface after planting, but the residues are concentrated between the rows. The amount of residue left is determined by the amount of corn residue produced from the previous year's corn crop, method of harvest, and width of the tilled strip. Therefore, the erosion control on highly erosive soils may not be adequate if the ridges are made in the fall or if ridges and rows run up and down slopes (17,18).

The no-till method generally has the corn stalks chopped in the fall and left on the surface. However, recent research has shown that chopping stalks may not be necessary. This system does not use a moldboard plow or chisel plow, disc, harrow, rotary tiller, or any other full-width tillage tool. At planting, a 1 to 2 inch wide strip is prepared in the row. Generally 60 to 95 percent of corn residue is determined by the amount of corn residue produced from the previous year's corn corp, method of harvest, and width of the tilled strip. All of the conservation tillage systems except no-till leaves relatively little residue on the surface following the previous year's soybean crop (17,18).

The benefits from conservation tillage include conserving soil and water plus significantly improving the physical properties of the soil (18).

Soil moisture is increased because the residue material reduces surface water runoff and reduces evaporation from the surface of the soil. Soils under a no-till row crop planting system commonly contain 1 to 2 inches more available water in the root zone than soils under a moldboard plow system (18).

Soil loss levels are reduced as the amount of surface residue increases. With 1,000 to 2,000 pounds of residue on the surface, the till plant on ridges and chisel systems have about 89 percent of the soil loss of the moldboard plow system; while the no-till system has only 71 percent of the soil loss of the conventional moldboard plow system. When the residue is increased to 3,000 to 4,000 pounds, the till plant on ridges and chisel systems have only 48 percent of the soil loss of moldboard plowing, while the no-till system is reduced to 33 percent. When the residue is greater than 6,000 pounds, the till plant on ridges and chisel systems have only 20 percent of the soil loss of the moldboard plow system while the no-till system is reduced to 8 percent (17).

Soil temperature is affected by the type of tillage system used. Average daily soil temperature, in the crop row at a depth of 4 inches during the first 10 weeks

after no-till planting, were reduced by 4 to 5 percent Fahrenheit when compared to moldboard plowing. Little difference was found between the moldboard plow and till plant on ridges. This was expected in the till plant system because the residue was pushed to the between-row area and away from the growing plant. Chisel systems were slightly cooler than either the moldboard plow system or the till plant on ridges. This slow warm-up is primarily due to the insulative properties of the residue cover (18).

During the early part of the growing season, the soils that have been planted by no-till have a higher density than those planted using the moldboard plow or chisel system. However, the no-till soils often contain a greater number of earthworm and root channels than the moldboard plowed soils (18).

Generally the soil's organic matter content will increase in areas where crop residues are concentrated. Experiments have shown that after 6 years the soil's organic matter in the upper 3 inches was 4.0 percent for the moldboard plow system, 4.3 percent for till plant on ridges, 4.5 percent for chiseling and 4.7 percent for no-till (18).

On sloping, erosive well drained soils and sandy droughty soils, changes in soil properties brought about by conservation tillage are nearly always positive in regard to crop preformance. On nearly level, high organic matter, wet soils the increased moisture content and reduced soil temperatures from corn residues may adversely affect crop performance (18).

Additional benefits of conservation tillage are reduced energy requirements and lower actual cost per acre for corn production. Fuel requirements for the moldboard plow system average 5 gallons per acre; for the chisel system, 3.95 gallons per acre; for till plant on ridges, 1.50 gallons per acre; and for the no-till system, 1.45 gallons per acre (11). The total cost per acre for producing corn using the moldboard plow and chisel systems is about $82.40, but it drops to about $70.30 per acre for till plant on ridges and about $70.87 per acre for the no-till system (11,13).

Using fertilizer, insecticide, and herbicide programs that have been developed specifically for each individual conservation tillage system seems to enhance that particular tillage system. The adaptability of various conservation tillage systems varies for different soil. The estimated yield for an individual soil increases or decreases by the amount indicated in Table I when the tillage system changes, if all other management factors remain the same.

Cooperative Extension Service (CES) specialists in Indiana have separated some of the more common Indiana soils into three groups for estimating corn yield potential. These three groups have been used to show the average yield relationships for conservation tillage systems.

Table I shows the yield relationships for the moldboard plow system, the fall chisel system, the spring chisel system, the till plant on ridge system, and the no-till system (4,5).

Table I shows that for continuous corn expected yields change with tillage system used on these selected soil groups. The no-till system has the lowest yield in soil groups I and II, yet claims the highest yield in soil group III. This table shows that the tillage system to be selected for optimum yield potential depends on the soil type being farmed. Indiana soils not included in Table I are muck soils; bottomland soils; dark sandy soils; loam textured soils; silt loam textured soils with a high water table; and light, flat soils over fragipans. These soils were omitted from this table so that only three soil groups were needed for the data available. These soils were included in the determination of the total acreage for the study area, but were not rated as to their adaptability for the four conservation tillage methods (4,5).

CES specialists prepared a detailed soil grouping for Indiana soils using the natural drainage, landscape position, surface and subsoil character, and surface slope. This

TABLE I. Relative Corn Yield For Five Tillage Systems and Soil in Indiana (1,2)

Cropping System and Tillage System	Soil Groups[a] I	II	III
Continuous Corn			
Fall Plow	1.00[b]	1.00[b]	1.00[b]
Fall Chisel	.97	1.02	1.05
Spring Chisel	.95	2.00	1.05
Till Plant	1.00	1.02	1.10
No-Till	.90	.95	1.10

a Soil Group descriptions included:
I—Dark, poorly drained silty clay loams to clays, 0-2 percent slopes
II—Light (low organic matter), somewhat poorly drained silt loams to silty clay loams, nearly level
III—Light, well drained, shallow terrace soils, sands, sandy loams and silt loams with 3 percent or greater slope, i.e., most soils that are subject to wind or water erosion and/or drought.
b Fall mold board plow system is used as reference point (1.00) for each group, but actual yield potential may be different between soil groups.

classification lists 23 soil groups and sub-groups (3). This information was used to classify the individual soils contained in each of the 13 counties in northwest Indiana.

Information from the USDA Soil Conservation Service and the Indiana CES was used to study the adaptability of four tillage methods for the 13 counties of northwest Indiana (1,2,3,6,7,8,9,10,14,15,16,19,20,21). This area included Benton, Cass, Fulton, Jasper, Lake, LaPorte, Marshall, Newton, Porter, Pulaski, Starke, St. Joseph, and White counties. The four methods of conservation tillage considered were fall chisel, spring chisel, till plant on ridges and no-till.

TABLE II. Conservation Tillage Planting Systems Adaptability Rating For Northwest Indiana Using Twenty-three Soil Groups—Continuous Corn (1,2,3,6,7,8,9,10,14,15,16,19,20,21)

Planting System	Adaptability Rating* (percentage of 3,706,725 acres) 1	2	3	4	5
Fall Chisel	34.0	16.5	39.0	7.5	0.0
Spring Chisel	0.3	62.4	29.3	4.7	0.0
Till Plant	64.5	22.9	0.0	0.0	5.3
No-Till	30.6	19.8	33.4	6.4	5.3

* The tillage-planting system adaptability rating scores are defined as follows:
1 = highly adapted by all applicable standards
2 = well adapted, but limitations may occur at low frequenty or over a small part of an area. Limitations can be overcome with good management.
3 = moderately will adapted, but limitations similar to those causing a 2 rating occur more frequently or over a wide area. Management will be more difficult.
4 = marginally adapted. Limitations occur more frequently or over wider areas than those causing a 3 rating.
5 = unadpated due to high frequency of limitations or their occurence over an entire area.

The total percentages of each system does not equal 100 because of urban land, water, and other miscellaneous land.

This study area consists of about 3,706,725 acres. Table II indicates that only about 5.3 percent of the area is not suitable for till planting or no-till systems for continuous corn. Fall chisel and spring chisel systems are adapted for all of the soils in the study area.

About 34.0 percent of the area is highly adapted to the fall chisel system. This

increased to about 89.5 percent of the soils when the well adapted and moderately adapted soils are included.

Because of wetness in the spring which limits the tilling depth of the chisel equipment, only about 0.3 percent of the area is highly adapted to the spring chisel system. When including the well adapted and moderately well adapted soils, this increases to about 92.0 percent.

About 64.5 percent of the area is highly adapted to the till plant on ridges system. It is interesting to note that none of the soils in the area fall into the moderately well adapted and marginally adapted ratings. Therefore, about 87.4 percent of the area is highly adapted or well adapted to the till plant on ridges system.

Only about 30.6 percent of the area is highly adapted to the no-till system. This increases to about 83.8 percent when the well adapted and moderately well adapted soils are included.

As the cost of producing grain increases and the price the farmer receives remains about the same, farmers must reduce expenses. The high operating expenses are already starting to make farming operations become more "soil selective." Farming operations are becoming more selective to individual soils. There are alternatives to using a single method of tillage for farmer's entire operation. Fertilizer, insecticide, and herbicide practices are being developed for individual tillage systems. This has helped achieve the maximum yield potential for each individual tillage system. With the development of new seed varieties that have been genetically selected for individual soils, farming operations may be based on similar soils in the future. This may cause the formation of new field boundaries based on similar soils instead of past agricultural uses.

As indicated, the various methods of conservation tillage must be tailored to each individual soil. Therefore, conservation tillage will become the "conventional" method of farming in the future. Conservation tillage not only reduces the farmer's expenses, but helps improve the "quality of the environment."

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