No Till Corn: 3

Soils

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Many terms such as no tillage, sod planting, chemical seedbed preparation, no plow, no plow tillage, direct planting, drilling, or seeding, slot tillage, strip tillage, etc., are used to describe a corn production method commonly referred to as "no-till." Each term describes a planting method which usually involves special planters and herbicides. In no-till, a narrow slot is made in untilled soil so that seed can be planted where moisture levels are adequate for rapid germination. The fluted coulter device is currently used most frequently in Michigan.

When properly used, no-till is one of the most effective management practices ever developed in commercial corn production for the control of wind and water erosion. Conserving soil materials also results in the conservation of essential plant food elements and in a reduction of air and water pollution problems. In addition, there can also be a significant reduction in time, labor, and energy requirements.

Variable degrees of success and failure have been obtained with no-till methods. The experiences of farmers and researchers (References 3, 4, 5, 6, 7, 10, 12) show that no-till was most successful on medium- and coarse-textured, well-drained soils, where herbicides were effective, where insect and disease problems did not develop, and where the soil had desirable physical properties. Less than successful results were achieved when one or more of seven soil conditions were present: 1) fine textured soil; 2) poor structure; 3) inadequate drainage; 4) underestimated organic matter levels; 5) eroded soil, especially on slopes; 6) low fertility levels and soil acidity; and 7) herbicide ineffectiveness due to inaccurate evaluations of clay levels and organic matter content or to extreme weather conditions.

All of these conditions can be evaluated by integrating the soil management group and unit concepts (8) with soil test levels.

Soil Management Groups and Units

Soil management **groups** are groups of soils (soil series) with similar properties and yield potentials. The groups are formed on the basis of the dominant texture of the upper 60 inches of the profile and the natural drainage conditions under which the soils were formed. Numbers are used to identify the dominant texture of

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Last year's corn stalks greatly reduce soil erosion. No-till production represents one of the newer and best conservation practices ever devised.

the profile (from 0 for fine clays to 5 for sands) and lower case letters to indicate the natural drainage conditions ("a" for well drained to "c" for poorly drained). The interrelationships and symbols of soil management groups, as related to corn production in Michigan, are shown in Table 1. In this table, the dominant texture of the **profile** is emphasized—not the texture of the **surface** soil as in soil type identifications. Thus soil series serve as the basis for groupings.

Soil management **units** are less inclusive than soil management **groups** in that the unit concept recognizes the slope which is indicated with the capital letters A through F. Severe and very severe erosion conditions are shown by the numbers 3 and 4 respectively. Thus, a 1.5aC3 symbol for a soil management unit represents soils whose profiles are dominantly clay loam, naturally well drained, have a slope ranging between 6 and 12 percent and are severely eroded. Each characteristic is important in evaluating opportunities for success with no-till.

The names of the more important soils series on which corn is grown in Michigan and the soil management groups to which they belong are shown in Table 2. To use this information, first refer to a soil map and determine the specific soil series or mapping units. This can then be related to the soil management groups and units referred to in the table.

If a Soil Conservation Service soil and water conservation plan map is not available refer to the county soil survey report which is available in most county offices of the Soil Conservation Service and the Cooperative Extension Service, or at the Department of Crop and Soil Sciences at Michigan State University.

Opportunities and Problems

When tillage methods are not required for: control of weeds, disease, or insects; disposal of trash and crop residues; use of fertilizer and lime; or for improving soil structure, then corn yields produced with no-till methods are equal to the best of other minimum tillage methods. In this instance, minimum tillage is defined as "the least tillage necessary for rapid seed germination, and a good stand" (2). Thus, no-till is a minimum tillage method. This definition does not state that tillage is essential. It implies that tillage should be done only if there is a reason.

Table 3 shows long-time average yields that can be obtained with minimum tillage, the best management practices, and without irrigation (1). This table indicates that different soil series within a single soil management group have similar yield potentials—other conditions being equal.

If primary tillage is necessary to improve soil structure, no-till methods are likely to produce lower yields than other methods. Soils having good structure are best-suited to no-till methods.

The interrelationship of soil management groups and opportunities for success with no-till methods are shown in Table 4. This table is a conservative interpretation by individuals from the Soil Conservation Service and the Cooperative Extension Service who have had experience with no-till methods (11). More than average care, however, greatly enhances the opportunity for success, especially where designated "poor" in Table 4. Thus, good managers could be successful on some soils which are downgraded in this table.

Degree of Slope

In general, where average slopes are less than 2 percent (Slope Class A) other minimum tillage methods usually result in fewer production problems, especially those related to soil structure, insects and rodents. Therefore, other minimum tillage methods are recommended over no-till unless slopes are long and unless wind erosion is a problem, which is likely on the more sandy (3, 3/1, 3/2, 3/5, 4, 4/1, 4/2, 5 or 5/2 groups) and organic soils (M, M/3, M/4 or M/m groups).

On steeper slopes, averaging between 2 and 6 percent (Slope Class B) soil erosion can be a significant problem. If soils are in good physical condition, no-till methods can be successfully used not only to produce high yields, but to reduce soil erosion. Where soils are compact, other minimum tillage methods involving moldboard or chisel plows have been more successful.

If slopes averaging 6 to 18 percent (Slope Classes C and D) are used for corn production, only no-till methods should be employed, preferably in combination with other conservation practices, such as strip-cropping. Otherwise, excessive erosion is likely to occur even with other minimum tillage methods. Where slopes are in excess of 18 percent (Slope Classes E and F), and especially if they are long, corn should not be grown because of excessive surface water runoff and perpetual erosion problems.

Soil Texture

The best no-till soils are the naturally well-drained sandy loam soils, 3a, 3/2a and 3/5a management groups. On coarser-textured soils, yields are not likely to be profitable regardless of tillage method, unless irrigation is used. Most other soils, especially those with a fine-textured surface horizon, have real problems that must be recognized and solved if no-till methods are to be effective.

"Good" in Table 4 suggests that these soils are best-suited to no-till methods. This evaluation is based upon the assumption that the soils have a desirable physical condition, and that herbicides are effective.

Table 1. Symbols for, and interrelationships of, soil management groups as related to corn production in Michigan.

		NATURAL DRAINAGE CLASSES		
Dominant Profile Texture	**Symbols**	**Well and Moderately Well-Drained**	**Somewhat Poorly Drained**	**Poorly and Very Poorly Drained**
		a	b	c
Clay (more than 60%)	0	0a	0b	0c
Clay (40-60%)	1	1a	1b	1c
Clay loam and silty clay loam	1.5	1.5a	1.5b	1.5c
Loam and silt loam	2.5	2.5a	2.5b	2.5c
Sandy loam, 14-40", over clay	3/1	3/1a	3/1b	3/1c
Sandy loam, 20-40", over loam to silty clay loam	3/2	3/2a	3/2b	3/2c
Sandy loam, 20-40", over sand and gravel	3/5	3/5a	3/5b	3/5c
Sandy loam	3	3a	3b	3/c
Loamy sand, 14-40", over clay	4/1	4/1a	4/1b	4/1c
Loamy sand, 20-40", over loam to silty clay loam	4/2	4/2a	4/2b	4/2c
Loamy sand	4	4a	4b	4c
Sand to loamy sand, 40-60", over loam to clay	5/2	5/2a	5/2b	5c
Sand with moderate to strong subsoil development	5.0	5a	5b	5c
Organic 16" +	M			Mc, M/mc, M/3c, M/4c

Table 2. Soil management group designation for soil series used for corn production in Michigan.

Soil Series	Soil Mgm't Group	Soil Series	Soil Mgm't Group	Soil Series	Soil Mgm't Group	Soil Series	Soil Mgm't Group
Adolph	2.5c	Charlevoix	3b	Hiawatha	5a	Matherton	3/5b
Adrian	M/4c	Chatham	3a	Hibbing	1.5a	Maumee	5c
Ahmeek	3a-a	Chelsea	5a	Hillsdale	3a	McBride	3a
Alcona	3a-s	Cheneaux	4b	Hodunk	3a	McGregor	3/5b-c
Alger	3a	Coldwater	3b	Houghton	Mc	Melita	5/2a
Allendale	4/1b	Coloma	4a	Hoytville	1c	Menominee	4/2a
Amasa	3/5a-a	Colwood	2.5c-s	Huron	1a	Metamora	3/2b
Angelica	2.5c	Conover	2.5b	Huronville	1a	Metea	4/2a
Antrim	4a	Coupee	3/5a	Ingalls	4/2b	Miami	2.5a
Arenac	5/2b	Coral	3b	Ionia	3/5a	Minoa	3b-s
Arkport	3a-s	Corunna	3/2c	Iosco	4/2b	Missaukee	3b
Aubarque	2.5b-cd	Coventry	3/5a	Iron River	3a-a	Monico	3b-a
AuGres	5b	Crivitz	4a-a	Isabella	2.5a	Monitor	2.5b
Aurelius	M/mc	Crosby	2.5b	Jeddo	1.5c	Montcalm	4a
AuTrain	5a-h	Crosier	2.5b	Johnswood	3a	Morley	1.5a
Avoca	4/2b	Croswell	5a	Kalamazoo	3/5a	Morocco	5b
Bach	2.5c-cs	Dafter	3/1b	Kalkaska	5a	Moye	4b
Bad Axe	3/2b-d	Deford	4c	Karlin	4a	Munising	3a-a
Barker	1.5a	Del Rey	1.5b	Kawkawlin	1.5b	Munuscong	3/1c
Barry	3c	Dighton	2.5a	Kendallville	3/2a	Mussey	4c
Belding	3/2b	Dixboro	3b-s	Kent	1a	Nappanee	1b
Bellefontaine	3/5a&4a	Dowagiac	3/5a	Keweenaw	4a-a	Nester	1.5a
Belleville	4/2c	Dresden	3/5a	Kibbie	2.5b-s	Newaygo	3/5a
Bentley	4a	Dryburg	3/1a	Kidder	2.5a	Newton	5c
Bergland	0c	Dryden	3a	Kilmanagh	2.5c-d	Nisula	1b
Berrien	5/2a	East Lake	5a	Kinde	2.5a-d	Nunica	1.5a
Berville	3/2c	Echo	5a	Kingsville	4c	Oakville	5a
Bibon	5/2a	Edmore	4c	Kinross	5c-a	Ockley	2.5a
Bixby	3/5a	Edwards	M/mc	Kiva	4a	Ocqueoc	4/2a
Blount	1.5b	Elmdale	3a	Kokomo	2.5c	Ogden	M/1c
Blue Lake	4a	Elo	2.5a-a	Lacota	3c	Ogemaw	5b-h
Bohemian	2.5a-s	Emmet	3a	Lake Linden	1.5a	Ogontz	3/2c
Bono	1c	Ensley	3c	Lamson	3c-s	Omena	3a
Bowers	1.5b	Epoufette	4c	Lapeer	3a	Onaway	2.5a
Boyer	4a	Essexville	4/2c-c	Latty	1c	Ontonagon	0a
Brady	4b	Fabius	4b	Leelanau	4a	Orienta	5/2b
Breckenridge	3/2c	Fox	3/5a	Lenawee	1.5c	Oshtemo	4a
Brems	5b	Froberg	1a	Linwood	M/3c	Otisco	4b
Brevort	4/2c	Fulton	1b	Locke	3b	Ottawa	5/2a
Brimley	2.5b-s	Gaastra	2.5b	Londo	2.5b	Ottokee	4a
Bronson	4a	Gagetown	2.5a-cs	London	2.5b	Owosso	3/2a
Brookston	2.5c	Gay	3c	Longlois	2.5a	Padus	3a-a
Bruce	2.5c-s	Gilchrist	4a	Loxley	Mc-a	Palms	M/3c
Burleigh	4/2c	Gilford	4c	Lucas	1a	Palo	3/5b
Cadmus	3/2a	Gladwin	4b	Lupton	Mc	Parkhill	2.5c
Capac	2.5b	Glynwood	1.5b	Mackinac	2.5b	Paulding	0c
Carbondale	Mc	Gogebic	3a-a	Macomb	3/2b	Pelkie	L-2c
Carlisle	Mc	Goodman	2.5a	Mancelona	4a	Pella	2.5c-s
Casco	4a	Granby	5c	Manistee	4/1a	Pence	4a-a
Cathro	M/3c	Graycalm	5a	Marenisco	4a-a	Perrin	4a
Celina	2.5a	Grindstone	2.5a-d	Markey	M/4c	Pert	1b
Champion	3a-a	Guelph	2.5a	Marlette	2.5a	Perth	1b
Channing	5b-h	Hartwick	5a	Martinsville	2.5a	Pewamo	1.5c
Charity	1c-c	Hettinger	1.5c	Martisco	M/mc	Pickford	1c

***Modifying symbols used after dash in soil management groups:**

a — Naturally very strongly acid soils.
c — Soils which are calcareous (limy) at or near the surface.
d — Dense or compact till within 48" of the surface.
h — Subsoils which are hardened and cemented.
s — Stratified with fine sands and silts.

Continued

Table 2. Soil management group designation for soil series used for corn production in Michigan (continued).

Soil Series	Soil Mgm't Group	Soil Series	Soil Mgm't Group	Soil Series	Soil Mgm't Group	Soil Series	Soil Mgm't Group
Pinconning	4/1c	Sanilac	2.5b-cs	Sumner	4a	Twining	1.5b
Plainfield	5a	Saugatuck	5b-h	Sunfield	3/5a	Ubly	3/2a
Pleine	3c	Saverine	3/2b	Superior	1a	Volinia	3/5a
Porcupine	4a	Sebewa	3/5c	Tacoosh	M/3c	Wainola	4b
Posen	3a	Selfridge	4/2b	Tappan	2.5c-c	Wakefield	2.5a-a
Poy	3/5c	Selkirk	1b	Tawas	M/4c	Wallace	5a-h
Poygan	1.5c	Seney	5a	Teasdale	3b	Warners	M/mc
Randville	4a-a	Seward	3/1a	Tedrow	5b	Warsaw	3/5a
Richter	3b-s	Shebeon	2.5b-d	Thackery	2.5a	Wasepi	4b
Riddles	2.5a	Shinnock	1.5a	Thetford	4b	Watton	1.5a
Rifle	Mc	Sigma	4b	Thomas	1.5c-c	Wauseon	3/1c
Rimer	3/1b	Sims	1.5c	Thomastown	4b	Wea	2.5a
Rollin	M/mc	Sisson	2.5a-s	Tobico	5c-c	Weare	5a
Ronald	3/5c	Skanee	3b-a	Toledo	1c	Westland	2.5c
Rondeau	M/mc	Sleeth	2.5b	Tonkey	3c-s	Wexford	5a
Roscommon	5c	Sparta	5a	Tracy	3a-a	Wheatley	5c
Roselawn	5.3a&4a	Spinks	4a	Traunik	5b	Willette	M/1c
Roselms	0b	Spirit	2.5b	Traverse	3b	Winegars	4b
Rousseau	4a	Stambaugh	3/5a-a	Trenary	3a	Wisner	1.5c-c
Rubicon	5.3a	St. Clair	1a	Trout Lake	5b-h	Witbeck	3c
Rudyard	0b	Steuben	3a-a	Tula	3b	Yalmer	4a-a
Saganing	4c	Strongs	5a	Tuscola	2.5a-s	Ypsi	3/1b

***Modifying symbols used after dash in soil management groups:**

a — Naturally very strongly acid soils.
c — Soils which are calcareous (limy) at or near the surface.
d — Dense or compact till within 48" of the surface.
h — Subsoils which are hardened and cemented.
s — Stratified with fine sands and silts.

The finer-textured soils (Groups 0, 1 and 1.5) naturally tend to be compact and to crust. On such soils, this is likely to be a problem every year with no-till methods. If field operations occur at high moisture levels, the amount of compaction increases, thus reducing opportunities for success. Yields will commonly be less than reported in Table 3.

Natural Drainage

In general, the naturally somewhat poorly drained "b" soils and the poorly drained "c" soils should be tiled and (or) ditch drained before no-till methods are attempted. The high soil moisture problem may be intensified where large volumes of crop residues on the soil surface retard evaporation rates. As with other tillage methods, no-till should not be considered as a substitute for artificial drainage in these groups.

Other soils on occasions may remain too wet for field operations when seasons are late and planting is delayed. Obviously, less time is involved in no-till planting than with methods that include plowing. No-till could be an advantage on large farms with many acres to plant. Sod crops and cover crops become important during such wet seasons because while growing they use water and speed the drying process.

Organic Matter

Success with no-till depends upon the effective use of herbicides. Successful herbicide treatment is closely related to the colloidal content (clay and organic matter) of the soil. To date, herbicides have been less successful on the poorly and very poorly drained "c" soils, both mineral and organic, primarily because such soils have relatively high organic matter levels. Increased rates of herbicides or different kinds than normally considered are commonly needed for control of weeds on such soils.

Even though success of no-till methods is related to organic matter content, most corn producers do not have their soils tested for this property. Thus, average soil organic matter levels for several soil management groups where corn is most frequently grown are shown in Table 5 (9). In using this table, recognize that the average may represent a relatively wide range. In the absence of a test for organic matter, the levels shown in Table 5 can be used as a guide for determining how much, and what kind, of herbicide to use.

Summary

Soils differ in their suitability to no-till methods. The use of the soil management group and unit concept is an aid in predicting where high or low levels of success are likely. Soils best-suited to no-till methods are those that are sandy loam or loam textured and well drained. Production problems are usually greater on naturally poorly and very poorly drained soils, on those which contain relatively large amounts of clay or organic matter, and on those soils that are steeply sloping (in excess of 18 percent).

Table 3. Longtime average corn yields with minimum tillage methods as related to soil management groups (with good management including adequate drainage, but without irrigation).

Soil Management Group	MORE THAN 140 FROST-FREE DAYS		FEWER THAN 140 FROST-FREE DAYS	
	Silage T/A	Grain Bu/A	Silage T/A	Grain Bu/A
Fine clays (over 60%)				
0a	13	80	11	60
0b	14	85	11	65
0c	15	90	12	70
Clays (40-60%)				
1a	16	95	12	75
1b	17	110	13	80
1c	18	120	14	85
Clay loams				
1.5a	17	105	13	80
1.5b	18	115	14	85
1.5c	19	125	15	90
Loams				
2.5a	17	110	15	90
2.5b	18	120	15	90
2.5c	20	130	16	95
Sandy loam over clay or loam				
3/1a or 3/2a	17	105	13	80
3/1b or 3/2b	18	115	14	85
3/1c or 3/2c	18	120	15	90
Sandy loams				
3a	16	95	12	75
3b	17	105	13	80
3c	17	110	14	85
Loamy sands over clay or loam				
4/2a-4/1a	16	95	11	70
4/2b - 4/1b	16	100	13	80
4/2c - 4/1c	17	105	13	80
Loamy sands				
4a	13	75	11	70
4b	13	80	11	70
4c	15	90	12	75
Sand to loamy sand over loam to clay				
5/2	12	65	10	60
Sands				
5a	10	50	9	50
5b	11	60	10	55
5c	13	80	11	70
Organic				
Mc	Frost an unpredictable problem		Frost a perpetual problem	

Table 4. Opportunities for success with no-till corn in Michigan as related to soil management units.

Key to Slope

A = 0-2%, For fine textured soils, consider other minimum tillage
B = 0-6%, Use no-till methods where soil is suitable
C and D = 6-18%, Use only no-till methods
E and F = 18% +. Don't grow corn

Dominant Profile Texture	Symbols	NATURAL DRAINAGE CLASSES		
		Well and Moderately Well-Drained	Somewhat Poorly Drained	Poorly and Very Poorly Drained
		a	b	c
			Opportunity for Success*	
Fine clays (over 60%)	0	Poor (1)	Poor (1,4)	Poor (1,4,7)
Clays (40-60%)	1	Poor to fair (1)	Poor (1,4)	Poor (1,4,7)
Clay loam and silty clay loam	1.5	Good to poor (2,5)	Poor (2,4)	Poor (1,4,7)
Loam and silt loam	2.5	Good to fair (2,5)	Poor (2,4)	Poor (4,7)
Sandy loam, 20-40" over loam to silty clay loam	3/2	Good (5)	Fair (3,4)	Poor (4,7)
Sandy loam, 20-40" over sand and gravel	3/5	Good (6)	Fair (3,4)	Poor (4,7
Sandy loam	3	Good (6)	Fair (3,4)	Poor (4,7)
Loamy sand, 14-40" over clay	4/1	Good (6)	Fair (3,4)	Poor (4,7)
Loamy sand, 20-40" over loam to silty clay loam	4/2	Good (6)	Fair (3,4)	Poor (4,7)
Loamy sand	4	Good (6)	Fair (3,4)	Poor (4,7)
Sand to loamy sand, 40-60" over loam to clay	5/2	Good (6)	Fair (4,6)	Poor (4,7)
Sand	5	Good (6)	Fair (4,6)	Poor (4,7)
Organic 16" +	M	---	---	Poor (4,7)

***KEY TO PROBLEMS WITH NO-TILL CORN:**

1. Soils are naturally compact. A problem with all minimum tillage methods.
2. Some soils are naturally compact. An unpredictable problem with no-till.
3. Some soils are cool and wet without drainage.
4. All soils are too wet without tile and (or) surface drainage.
5. Variable soil conditions due in part to erosion. Variable soil moisture levels. When surface soil is a sand, loamy sand, sandy loam, or loam, opportunities for successful no-till corn are improved.
6. Irrigation may be needed for satisfactory yields with any minimum tillage method.
7. Weeds cause problems if herbicides are ineffective due to high soil organic matter levels.

Table 5. Average percent organic matter levels as related to soil management groups.

Dominant Profile Texture	Symbols	NATURAL DRAINAGE CLASSES		
		Well and Moderately Well-Drained	Somewhat Poorly Drained	Poorly and Very Poorly Drained
		a	b	c
		%	%	%
Clay (40-60%)	1	2.0	3.5	3.7
Clay loam and silty clay loam	1.5	1.8	2.5	3.7
Loam and silt loam	2.5	1.6	2.2	2.8
Sandy loam, 20-40" over loam to silty clay loam	3/2		1.8	
Sandy loam	3	2.0	2.8	5.9
Loamy sand, 14-40" over clay	4/1		1.6	
Loamy sand, 20-40" over loam to silty clay loam	4/2	2.8	2.3	
Loamy sand	4	1.3	2.4	5.3
Sand to loamy sand, 40-60" over loam to clay	5/2	3.3		
Sand	5	1.1	3.7	5.0
Organic 16" +	M			56.1

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Corn planted no-till in sod. When soil in slot fails to make close contact with seed, germination is slow. In extreme conditions germination percentages may be greatly reduced. Note that corn is missing in slot (at left of arrow).

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