TILLAGE FOR MIDSOUTH SOYBEAN PRODUCTION

Foreword

This article is meant to be informative rather than instructive; i.e., it contains facts and figures that can be used to make informed decisions about if, when, and how much tillage to use in a soybean production system.

Soybeans in Mississippi are grown on a variety of soil series, from sandy loam to clay. Each of these soils has unique properties and/or conditions that may benefit from some sort of tillage. There is no set rule for if, when, and how much of a particular type of tillage should be used to grow soybeans or any other crop on any of these soils.

In other words, there are published guidelines and recommendations that give specific instructions for control of weeds, insects, diseases, and nematodes in soybeans; soil sampling for nutrient analysis and amounts of nutrients to apply; and irrigation.

In contrast, there are no set recommendations for tillage management to produce soybeans. Consider these examples.

- A stale seedbed planting system is a viable option and may be preferred every year. However, harvesting in a wet fall may leave deep ruts that will interfere with next year's planting. Only tillage will remove the ruts, but soil may be not dry enough for remedial tillage until just prior to planting. Thus, tillage sometime prior to planting must be performed to create a suitable seedbed even though planting in a stale seedbed with little or no tillage prior to planting is the preferred option.
- A particular field or soil series may benefit from deep-tilling or subsoiling in the fall on an every-other-year or every-third-year rotation, but wet soil in the fall precludes effective deep tillage in a year the operation was planned. Thus, the planned tillage rotation is disrupted.
- Many producers prefer a no-till production system. However, the increasing occurrence of weeds that are resistant to herbicides that are used in a no-till system or heavy plant residue from a previous crop may require some level of preplant tillage to effectively manage these conditions in some years.

In each of the above examples, following rigid tillage or no-till guidelines would have resulted in an ineffective tillage operation or an undesirable production environment. Therefore, following a tillage "prescription" is not advisable. Rather, tillage should be used as an optional input to remedy or enhance a production environment on a case-by-case basis.

Definitions and Overview of Tillage Use

Tillage in soybean production systems is utilized to:

- Prepare a seedbed to ensure proper seed–soil contact;
- Remedy soil compaction, or disrupt soil layers that may restrict root development and/or water infiltration;
- Incorporate fertilizers and herbicides to facilitate their beneficial effects;
- Incorporate plant residues that may impede planting;
- Influence water movement both within and out of a production field; and
- Control problem weeds either before or after planting.

A tillage system is made up of operations that use a variety of implements to achieve a particular production environment and/or to remedy a defined problem that limits production potential.

Implements used to accomplish varied tillage goals differ in the fuel requirements for their use and result in varying amounts of soybean residue left on the soil surface following their use (**Table 1)**. Plus, the energy efficiency or output/input ratio (net energy output or energy in grain produced vs.

energy input per unit equivalent of grain produced) is affected by tillage (Wienhold et al. 2006). Thus, a tillage system directly affects the agronomic environment for soybean production and its economic potential.

The following definitions are based on the effect of a particular tillage operation on residue cover, soil loss, fuel consumption, and/or water runoff. These are major components that are affected by tillage and subsequently impact the economic and environmental sustainability of soybean production.

Conventional tillage system

This system is synonymous with clean tillage. Operations involve primary tillage with moldboard plows, heavy disks, and chisel plows. These operations are followed by one or more secondary tillage operations with a tandem disk harrow and/or field cultivator and/or spring-tooth cultivator at some time before planting to smooth the soil surface.

Clean tillage leaves essentially no plant residue on the soil surface; thus, soil is exposed to maximum water runoff and erosion (**Table 2**). A large amount of fuel is consumed in this system, the total cost for tillage is high (**Table 3**), and the total energy input is high (Wienhold et al. 2006).

Reduced tillage system

Tillage operations are conducted with secondary tillage implements that require less fuel than primary tillage implements (**Table 1**), and leave 15 to 30% of the soil covered with residue. This system can be termed a hybrid of the previously described conventional tillage system and the following conservation tillage system. It is the most flexible of the three systems in that limited tillage is used as needed to remedy an identified problem associated with continuous cropping of a site.

Using a reduced tillage system increases dependence on both pre- and post-planting chemical weed control, but does reduce erosion (**Table 2**) and fuel use (**Tables 1 & 3**).

An example of a reduced tillage system is the stale seedbed planting system used for soybean production in the Midsouth. The stale seedbed is described as "a seedbed that has received no seedbed preparation tillage just prior to planting. It may or may not have been tilled since harvest of the preceding crop. Any tillage conducted in the fall, winter, or early spring will have occurred sufficiently ahead of intended planting time to allow the seedbed to settle or become stale. A crop is planted in the unprepared seedbed, and weeds present before or at planting are killed with herbicides".

The stale seedbed planting system does not preclude tillage; rather, it is a minimum or reduced tillage concept where tillage is relegated to those times that will not result in delayed planting. This system has been adopted on a large acreage of the alluvial soils of the Midsouth that are normally saturated or nearly saturated in the spring.

Conservation tillage system

This category includes those systems commonly referred to as mulch-till, strip-till, ridge-till, and no-till. Definitions of these sometimes difficult-to-distinguish systems provide the nuances for their delineation (UWEX; CTIC). Fertilizer application and planting are done in narrow strips, with minimal soil disturbance outside the application and planting zone. More than 30% of the soil is covered by residue at any given time.

A no-till system, as the term implies, has the strictest criteria and is therefore the hardest to maintain on a continuing basis. Some form of rotational full-width tillage may be needed to disrupt surface and sub-surface soil consolidation and/or disturb or manage surface residues that accumulate in a continuous no-till system. This occasional tillage does not compromise the long-term goals of a no-till system.

Wortman and Blanco, in an article titled "Strategic Tillage for the Improvement of No-Till Cropping Systems" (Univ. of Nebraska-Lincoln, Jan. 2020), provide a summary of the concept of "Occasional Tillage" or OT that might be performed in no-till systems. Pertinent points from that article follow.

- OT may be required once in 5 to 10 years in a no-till system to aid in weed management, remedy a compaction layer in soil, incorporate a soil amendment, reduce vertical stratification of nutrient availability, move organic matter to a deeper soil depth, or reduce crop residue accumulation.
- To be beneficial, OT should be well-planned and conducted to address a specific problem or issue.
- Well-planned OT is a useful component of integrated weed management and soil compaction management.
- Maximum benefit from OT to fracture soil compaction layers is realized when the soil is dry, which is often in the fall.
- Findings from numerous studies where OT was applied show that negative effects from its conduct are highly unlikely, are generally less than 1-year duration, are of little agronomic significance, will generally not affect soil microbial biomass and activity, and will have little or no negative effect on crop yield.
- The negative effects of OT are its cost and the increased risk of erosion immediately following it.
- OT to address the above issues is not likely to be justified more frequently than once in 5 to 10 years, and this will not adversely affect no-till systems.

An article titled "A single tillage in a long-term no-till system on dryland crop performance" by Schlegel, Holman, and Assefa appears in Agron. J., Vol. 112:3174-3187 (2020) and provides supporting evidence that occasional or strategic tillage in a no-till system can be performed without compromising the benefits of the no-till system. Pertinent points from that article follow.

- It is documented that a no-till (NT) wheat-grain sorghum-fallow production system provides a yield benefit compared to a conventional tillage system in dryland environments.
- Research was conducted at Garden City and Tribune Kansas on sites with silt loam soil that had been in a no-till wheat-grain sorghum-fallow production system for >6 years.
- The research was initiated in 2013, and 2014 through 2016 data were analyzed to obtain results from the research.
- The objective of the research was to determine whether or not a single tillage operation will affect the benefits achieved with a continuous, long-term no-till production system.
- Three tillage treatments were: 1) a single tillage operation to a depth of about 4 in. in May or June during the fallow period (June tillage); 2) a single tillage operation following wheat harvest (July tillage); and 3) a complete NT system.
- Tillage treatment had no significant effect on either sorghum or wheat yield at both locations, and there was no trend favoring one tillage treatment over the others at either location.
- There were no significant differences among tillage treatments in available soil water at either planting or harvest of either crop.
- Tillage treatment did not influence water use of either crop at either location.
- This research showed that a single tillage treatment that was interjected into a no-till system does not negatively affect productivity of either grain sorghum or wheat grown in a dryland system.

A good summary of when and how to use strategic or occasional tillage is an article titled "Strategic tillage has it place in no-till agriculture" that appears in the Nov.-Dec. 2021 issue of Crops & Soils.

There is evidence that a strip-till system used in conjunction with precision guidance planting can be used as an alternative to no-till as a conservation tillage system to improve soil properties.

Research in Georgia comparing strip tillage (ST) with conventional tillage (CT) in cotton and peanut systems have been summarized in the Nov. 2015 issue of AgResearch Magazine. USDA-ARS scientists Dinku Endale, D.D. Bosch, T.L. Potter, and T.C. Strickland published the results providing these highlights in Vol. 57(6), pages 1611-1626 of the Transactions of the ASABE. Major results from this research that was conducted over the 10-year period of 2000-2009 follow.

- In a cotton-peanut biennial rotation, sediment loss from ST sites was reduced by 87% compared to loss from CT sites.
- Runoff from both rainfall and irrigation was 12% from ST and 20.5% from CT sites, a reduction of 41%.
- The allowable soil loss from the CT sites was exceeded in 3 of the 10 years, but was never exceeded from the ST sites.

Conservation tillage is frequently used with a narrow row spacing that precludes post-plant cultivation. This places total dependence on herbicides for both pre- and post-plant weed management; however, the fuel requirement for spraying herbicides is low (**Table 1**; Wienhold et al. 2006) and the energy input from their use is relatively small because of low fuel use and chemical application rates (Wienhold et al. 2006). Using a conservation tillage system results in soil and water conservation, reduced fuel consumption and fuel costs (**Tables 1, 2, and 3**), and a lower total energy input (Wienhold et al. 2006).

Deep tillage

This operation, sometimes termed "subsoiling" or "deep ripping", refers to primary tillage operations that affect soil deeper than 6 in. These operations are used to fracture or loosen deep soil barriers, improve rainfall infiltration, and mix residue and nutrients deep into the profile. Deep tillage can be part of a conservation tillage system if it minimally disturbs the soil surface and leaves more than 30% of the soil covered by plant residue.

The fuel requirement for deep tillage is high (essentially the same as for moldboard plowing–**Table 1**), so it should be strategically incorporated into a conservation tillage system only to remedy known subsurface soil problems.

Deep tillage results in increased yields (**Table 4**; Popp et al. 2001; Bauer et al. 1998; Wesley, Elmore, and Spurlock 2001, Henry et al 2018) and net returns (Wesley, Elmore, and Spurlock 2001) in some environments.

An Arkansas study conducted in 2013-2015 (Henry et al 2018) provides the following results.

- The objectives of the study were to examine the effects of deep tillage on soybean yield and water use efficiency (WUE).
- The study was conducted in the 2013-2015 seasons near Stuttgart Ark. on Stuttgart/Dewitt silt loam soils, which have a silt loam surface underlain by silty clay.
- Tillage factors were conventional (shallow surface tillage) and deep tillage (~16 in.).
- Irrigation treatments were full-season irrigation (scheduled with the Arkansas Irrigation Scheduler [AIS]), +1 and +2 deficit irrigations, and nonirrigated.
- Planting date was late May/early June.
- Soil penetration resistance readings showed that the deep tillage treatment had less resistance than the conventional treatment, indicating that deep tillage had a positive effect on compaction in the subsoil profile.
- The deep tillage treatment produced higher seed yield than did the conventional tillage treatment (**Table 4**) across all years of the study.
- Within the deep tillage treatment, the full-season and +1 deficit irrigation treatments resulted in similar seed yield, but the +1 deficit schedule for irrigations resulted in less

irrigation water being applied. This suggests that greater allowable deficits can be used when scheduling irrigation where deep tillage is employed, thus reducing irrigation water.
- The authors concluded that, when soybeans are grown in conditions similar to those in this study, the +1 deficit threshold can be used to schedule irrigations where deep tillage is used. Where conventional tillage is used, the AIS recommendations should be used to schedule irrigations.

Remember the below points when considering the use of deep tillage in the Midsouth.

- Yield increases resulting from deep tillage should be weighed against increased fuel and ownership costs associated with deep tillage.
- Net returns to deep tillage should frequently be evaluated against changing input and commodity prices.

Tillage, Fuel Use, and Cost

For a soybean tillage system to be sustainable, use of non-renewable fuel resources and associated costs must be minimized. Also, reducing fossil fuel consumption in soybean production will significantly improve air quality because of lowered emissions.

An online calculator for estimating fuel consumption and cost for various tillage systems is available on the United States Department of Agriculture's Natural Resources Conservation Service website (USDA-NRCS 2012).

Using the NRCS calculator, estimates of fuel use, costs, and savings associated with using different tillage systems at three Mississippi locations are shown in **Table 3**.

- As expected, using a conventional tillage system for soybean and corn production results in the greatest use of fuel and therefore the highest fuel cost.
- Using a no-till system results in more than a 50% reduction in fuel use and dollars spent for fuel.
- Using mulch-till reduced fuel use and cost below that for conventional tillage, but not as much as for the no-till system.
- The fuel cost savings with conservation tillage systems may be somewhat offset by higher herbicide costs.

Tillage, Plant Residue Cover, and Erosion

Residue cover resulting from conservation tillage is credited as the major factor for reducing soil loss. Erosion can be reduced by as much as 50% if 30% of the soil surface (compared to bare soil) is covered with residue (MU). Fuel consumption and cost are minimal (**Tables 1, 3**). Conservation tillage is recognized as one of the most important developments that has positively impacted crop production agriculture.

The values in **Table 1** are estimates (from the Midwestern US) of residue following the use of one implement one time. Tillage implements that are used multiple times or in combination will result in less remaining surface residue (**Table 5**) than the values shown in **Table 1**.

Calculations shown in **Table 5** give examples of estimated residue losses from fall harvest to after planting of corn and soybeans when various tillage implements are used in sequence. These calculated values are less than those for using individual implements one time (**Table 1**), and leave no doubt that using multiple tillage passes with various implements drastically reduces residue cover.

There are some interesting points that can be gleaned from the calculations in **Table 5**.

- Residue levels following soybean harvest may be sufficient to meet requirements to reduce erosion for highly erodible land, but winter decomposition and any fall or spring tillage–even the planting operation–destroys a significant portion.
- A no-till system for soybeans appears to be the

only one that leaves at least 30% residue cover.

- Using any of the tillage systems shown for corn following corn results in estimates of >30% residue cover after planting.
- Fall subsoiling more than doubles the fuel use per acre.

Some points about soybean vs. corn residue.

- Both soybean and corn produce a 1:1 ratio of residue to grain dry weight. Since soybean yields about 33% as much grain as corn, it follows that soybean residue is only about 33% that of corn.
- Soybean residue degrades quickly because of its high N content.
- The above factors–a small amount of residue following soybean and the fragility of that residue–may lead to increased soil erosion potential following a soybean crop, especially if any tillage is performed following harvest.

Calculation is a good way to get a rough estimate of remaining residue following tillage and relative differences resulting from using different tillage systems without making field measurements. However, it provides only a general guide and will not reflect the absolute conditions in any field because:

- Tractors and implements are different and perform differently.
- Field conditions such as soil moisture and topography will affect fuel use and residue stability.
- Irrigation vs. no irrigation will affect residue amounts.
- Residues in Midsouth crop fields will decompose faster than those in Midwestern fields. Thus, crop residues in Midsouth fields will be less than those in Midwest fields in the spring.

A more accurate way of estimating residue cover following harvest and tillage is to take field measurements. Two selected sources (UWEX; ISU) give detailed measurement instructions. These measurements can be made by a producer following any tillage operation or operations to determine their effect on the amount of plant residue remaining on the soil surface.

It is recognized that soil erosion in excess of soil production will lead to decreased agricultural potential (Montgomery 2007). Implementation of a no-till crop production system reduces water runoff and soil erosion (Rhoton, Shipitalo, and Lindbo 2002) by leaving increased amounts of residue on the soil surface. The reduction in soil loss can be dramatic (**Tables 2, 6**).

As mentioned above, soybean residue is fragile. Therefore, even light tillage, especially in the fall, can destroy a significant amount of the residue following harvest (UWEX). A no-till system for soybean may be the only one that meets the standard of 30% surface residue cover required for a conservation tillage system (**Table 2**; (UWEX). This is depicted in graphic fashion by UWEX.

Tillage and Yield

DeFelice, Carter, and Mitchell (2006) conducted an extensive review of the effect of tillage on soybean yields in the United States and found that:

- The national average difference in yield between no-tillage and conventional tillage soybean is small.
- No-till yields improve with continuous no-till. They concluded that soybean producers in most of the United States will not suffer a yield disadvantage when switching to a conservation tillage-based production system.

Results from other research conducted in Texas, Kansas, and the Corn Belt (CAST 2009) support this conclusion. This, coupled with the aforementioned reductions in erosion and water runoff and lower fuel use and fuel cost that result from using conservation tillage, strongly supports the premise that soybean produced with conservation tillage in any production system is more economically and environmentally sustainable. In fact, considering the generally accepted 30% minimum residue cover and the 3 to 5 tons/acre/year tolerable soil loss for a sustainable soybean production system, conservation tillage is the only system that appears to support sustainable soybean production from an environmental standpoint.

Final Thoughts

- A tillage operation may result in a yield increase only if there is a physical soil problem that only tillage will remedy. If a soil physical problem does not exist, then delete tillage from the production system.
- Do not till just to have a smooth seedbed. Today's planters and drills can plant in seedbeds previously thought to be too rough for planting.
- If you are subsoiling to fracture restrictive layers, the soil should be dry for best results.
- Subsoiling to promote increased water infiltration into the soil profile is best done in the fall with no subsequent tillage. The effects from this operation are relatively short-lived and will not override the effects of drought the following season.
- Fall subsoiling provides the most benefit when followed by early planting.
- In an irrigated production system, deep tillage may result in a decreased need for irrigation.
- There is increasing evidence that a strip tillage system can provide conservation benefits that are similar to those from a strict no-till system.
- Most of the calculated estimates for fuel use, residue, and erosion in this report rely on Midwestern numbers. There is little information of this sort relating to Midsouth soils and conditions.
- Click here for an NRCS Tillage Equipment Guide that defines and depicts the commonly used tillage implements for crop production.

The two most important things to remember about most tillage operations are 1) they are expensive, both in fuel and equipment costs, and 2) they will destroy plant residue and promote erosion.

Table 1. Approximate amount of diesel fuel required for indicated tillage operations and estimated range of soybean residue remaining after using an individual implement following corn and soybean harvest. Values are from the linked sources shown over each table column.

Tillage operation/ condition	Diesel fuel use		Residue (%)					
	ISU	NCAT	UWEX		MU		ISU	
	gal./acre		Corn	Soy	Corn	Soy	Corn	Soy
After harvest	---	---	75-95	65-90	80-95	70-80	90-95	80-90
After winter decomposition	---	---	80-95	70-80	---	---	80-90	70-80
Moldboard plow	1.70	1.68	0-10	0-5	0-10	0-5	0-5	0-5
Subsoiler/Ripper	1.70	---	70-90	60-70	70-90	60-80	---	---
Chisel plow–straight shank	1.10	1.10	60-80	40-60	60-80	40-60	50-60	30-40
Tandem disk	0.55	0.55	70-80	40-50	70-80	40-50	40-70	25-35
Field cultivate–sweeps	0.65	0.60	70-80	60-75	80-90	65-75	80-90	55-65
Spring tooth cultivator	---	0.40	70-90	50-70	60-70	35-50	---	---
Bedder/hipper	---	---	---	---	15-30	5-20	---	---
Planter–double-disk openers	0.55	0.50	85-95	75-85	90-95	85-95	80-90	80-90
No-till planter–fluted coulters	0.45	0.35	65-85	55-80	65-85	55-80	---	---
Rotary hoe	0.20	0.25	---	---	85-90	80-90	---	---
Sprayer	0.10	0.10	---	---	---	---	---	---
Cultivate–post plant	0.40	0.45	---	---	---	---	---	---

Table 2. Measured surface cover and soil loss for various tillage systems used for corn and soybean production in Kansas and Nebraska. Source: Heatherly and Elmore 2004

Residue type/tillage system	Residue cover	Erosion	Reduction from moldboard plow
	%	ton/acre	%
Corn residue[a]			
Moldboard plow, disk 2X, plant	7	7.8	--
Chisel plow, disk, plant	35	2.1	74
Disk 2X, plant	21	2.2	72
Rotary-till, plant	27	1.9	76
Till-plant	34	1.1	86
No-till, plant	39	0.7	92
Soybean residue[b]			
Moldboard plow, disk 2X, plant	2	14.3	--
Disk 2X, plant	5	14.3	0
Chisel plow, disk, plant	7	9.6	32
Disk, plant	9	10.6	26
Field cultivate, plant	18	7.6	46
No-till, plant	27	5.1	64

[a]After tillage and planting on a silt loam soil having a 10% slope and 2 in. water applied in 45 min.
[b]After tillage and planting on a silty clay loam soil having 5% slope and 2 in. water applied in 45 min.

Table 3. Estimated fuel use (FU) in gallons per acre and fuel cost (FC) in dollars per acre for various tillage systems used for soybean and corn production, and potential cost savings (CS) over conventional tillage in dollars per acre at three Mississippi locations (Greenville and Clarksdale have same values). Based on 1000 acres each of soybeans and corn, and diesel costs of $3.00 and $3.50/gallon. All estimates[a] will change with a change in acreage. Source: [USDA-NRCS 2012]()

	Conventional		Mulch-till			No-till		
Location—diesel cost	**FU***	**FC****	**FU**	**FC**	**CS**	**FU**	**FC**	**CS**
	Soybean							
Greenville--$3.50/gal.	5.24	$18.34	3.99	$13.96	$4.38	2.46	$8.61	$9.73
Greenville--$3.00/gal.		$15.72		$11.97	$3.75		$7.38	$8.34
Tupelo--$3.50/gal.	4.79	$16.76	1.96	$6.86	$9.90	2.65	$9.28	$7.48
Tupelo--$3.00/gal.		$14.37		$5.88	$8.49		$7.95	$6.42
Brooksville--$3.50/gal.	5.89	$20.62	5.02	$17.57	$3.05	2.47	$8.64	$11.98
Brooksville--$3.00/gal.		$17.67		$15.06	$2.61		$7.41	$10.26
	Corn							
Greenville--$3.50/gal.	6.74	$23.59	5.49	$19.22	$4.37	3.26	$11.41	$12.18
Greenville--$3.00/gal.		$20.22		$16.47	$3.75		$9.78	$10.44
Tupelo--$3.50/gal.	5.94	$20.79	3.59	$12.56	$8.23	3.32	$11.62	$9.17
Tupelo--$3.00/gal.		$17.82		$10.77	$7.05		$9.96	$7.86
Brooksville--$3.50/gal.	6.69	$23.41	5.82	$20.37	$3.04	3.42	$11.97	$11.44
Brooksville--$3.00/gal.		$20.07		$17.46	$2.61		$10.26	$9.81

[a]Different acreage and fuel cost assignments can be used to obtain results for a specific situation.
*Gal/acre.
**$/acre.

Table 4. Yield (bu/acre) of soybean grown in numerous tillage studies in the southern United States. Source: Heatherly and Elmore 2004 and Henry et al 2018, (Arkansas).

State	Soil series/texture	Tillage treatment[a]	Yield
Arkansas	Sharkey clay[b]	Conventional	40.4
		DT	48.1
Mississippi	Tunica silty clay[b]	Conventional	36.2
		DT	51.3
Mississippi	Sharkey clay[b]	Conventional	27.7
		DT	33.1
Mississippi	Sharkey clay[b]	Conventional	30.5
		DT	36.7
	Sharkey clay[c]	Conventional	24.6
		DT	26.6
Mississippi	Tunica silty clay[b]	Conventional	29.8
		DT	47.1
South Carolina	Eunola loamy sand[c]	No-till	32.1
		DT	35.9
Arkansas[d]	Stuttgart and Dewitt silt loams[c]	Conventional	46.0
		DT	54.9

[a]Conventional = shallow tillage (< 6 inches) with chisel plow, disk harrow, or spring-tooth cultivator; DT = deep-tilled to 15 to 18 inches depth.

[b]April-planted.

[c]May and later-planted (South Carolina study followed wheat harvest).

[d]Averaged across irrigated and nonirrigated treatments.

Table 5. Calculations of estimated residue losses and fuel use for indicated tillage systems from fall harvest to after planting using average UWEX residue values and ISU fuel use values from Table 1.			
Field operation/condition	% Residue remaining after each operation following:		Fuel use
	Corn	Soybean	gal./acre
After harvest	85	0.78	---
Fall–subsoil	x 0.80 = 68	x 0.65 = 51	1.70
Winter decomposition	x 0.88 = 60	x 0.75 = 38	---
Spring–disk	x 0.75 = 45	x 0.45 = 17	0.55
Spring–spring tooth cultivator	x 0.80 = 36	x 0.60 = 10	0.40
Plant double disk openers	x 0.90 = 32	x 0.80 = 8	0.50
Totals	32	8	3.15
After harvest	0.85	0.78	---
Fall–disk	x 0.75 = 64	x 0.45 = 35	0.55
Winter decomposition	x 0.88 = 56	x 0.75 = 25	---
Spring–spring tooth cultivator	x 0.80 = 45	x 0.60 = 15	0.40
Plant double disk openers	x 0.90 = 40	x 0.80 = 12	0.55
Totals	40	12	1.50
After harvest	0.85	0.78	---
Fall-disk	x 0.75 = 64	x 0.45 = 35	0.55
Fall–spring tooth cultivator	x 0.80 = 51	x 0.60 = 21	0.40
Winter decomposition	x 0.88 = 45	x 0.75 = 16	---
Plant double disk openers	x 0.90 = 40	x 0.80 = 13	0.55
Totals	40	13	1.50
After harvest	0.85	0.78	---
Winter decomposition	x 0.88 = 75	x 0.75 = 58	---
Spring–disk	x 0.75 = 56	x 0.45 = 26	0.55
Spring–spring tooth cultivator	x 0.80 = 45	x 0.60 = 16	0.40
Plant double disk openers	x 0.90 = 40	x 0.80 = 13	0.55
Totals	40	13	1.50
After harvest	0.85	0.78	---
Winter decomposition	x 0.88 = 75	x 0.75 = 58	---
Plant no-till	x 0.75 = 56	x 0.68 = 40	0.45
Totals	56	40	0.45

Table 6. Annual soil loss from plots with 5% slope in the brown loam soil region of Mississippi. Source: Heatherly and Elmore 2004				
	Conventional till soil loss/year		No-till soil loss/year	
Crop	C Factor[a]	ton/acre	C factor[a]	ton/acre
Sorghum	0.04	4.2	0.005	0.6
Corn (grain)	0.09	7.2	0.005	0.4
Corn (silage)	0.14	11.2	0.003	0.3
Soybean	0.12	21.1	0.006	1.2
Soybean	0.10	19.6	0.008	1.4
Cotton	0.31	31.2	0.053	5.4

[a]Factor used in the Universal Soil Loss Equation to reflect influence of soil management and cropping methods on water erosion. Kind and time of tillage, implements used, time of planting, crops planted, postemergence cultivation, crop sequence, residue cover on the soil surface, and changes in soil organic matter all affect C factor.

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