TEXAS NRCS AGRONOMY TECHNICAL NOTE TX-8

SOIL CONDITION RATING SYSTEM

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Introduction

The Soil Condition Rating System (SCRS) discussed in this technical note is a numerical rating system consisting of three components that can affect long-term cropland productivity. They are as follows: Residue and organic matter (OM); Field Operations; and Erosion (Lightle, D.T. and M. S. Argabright 1997). The subfactors are weighted, as follows, according to their predicted influence on soil condition based on an analysis of known systems in Texas (Franzluebbers et al. 1995, and Laws, W.D. 1961). The residue and OM subfactor of a cropping system accounts for 70% of the Soil Condition Rating (SCR); the field operation subfactor accounts for 20% of the SCR; and the erosion subfactor accounts for 10% of the SCR. A fourth component climate, primarily rainfall, is also considered because of its affect on the production and decomposition of biomass needed to maintain soil condition (King, A.D. et al, 1987). An SCR of greater than 0.0 is assumed to depict an increase in soil condition, and an SCR value of less than 0.0 is assumed to depict a decline in soil condition.

The SCRS is intended to be used as a tool to help clients analyze and compare various cropping systems and their effects (either + or -) on soil condition. Even though the numbers are relative, they reflect proven effects of various rotation, tillage, and management systems on soil condition in Texas and around the country. **The SCRS should be used on cropland when soil condition is a concern of the client, or it is a concern within the local Common Resource Area (CRA).**

Minimum Residue Needed For Soil Maintenance

The residue amounts in Table 1 are based on the work of Laws, 1961. He determined that for the rotation and tillage he studied at Renner, Texas an average of 3600 lb/ac or more above ground residue had to be produced annually to maintain soil organic matter (SOM). The values for the 35 - 40 inch rainfall area reflect Laws' conclusion. The values for lower rainfall areas have been reduced, since lower rainfall areas have less natural potential for biomass production, and the values for the wetter rainfall area has been increased due to its higher potential for biomass production.

The fibrous rooted vs. tap rooted difference is due to the fact that fibrous rooted crops generally produce more root mass than tap rooted crops, and their above ground residue generally persists for a longer period of time than that of tap rooted crops (King, A.D. et al, 1987. Soil Condition Indices of the Southeast).

Weighted Residue and O.M. Subfactor Value

The residue and organic matter subfactor value is a ratio of the estimated dry above ground residue produced annually by crops in rotation, as well as, the amount of dry residue supplied annually by cover crops, and/or other organic matter (manure, gin trash, etc.) added to a crop rotation vs. the minimum annual residue needed for soil maintenance (see Table 1 values). It is calculated by the following equation: (Residue produced) minus (Maintenance amount) divided by (Maintenance amount). The subfactor is then weighted by multiplying it by 0.70. The crop residue subfactor calculation section of the Soil Condition Rating Worksheet is used to calculate crop residue subfactors, when needed, or the appropriate pre-calculated crop subfactors in Table 3 may be used. Table 4 is used to select the appropriate subfactors for perennial crops in rotation, and subfactors for OM additions are in Table 5. Once a residue subfactor is known for each crop in the rotation, and/or cover crop, and other OM addition, Section 1 of the Soil Condition Rating Worksheet is used to calculate the weighted residue subfactor for the rotation.

Soil Disturbance Ratings and Weighted Field Operations Subfactors

Soil disturbance rating (SDR) values were initially developed by USDA/NRCS personnel at the National Soil Survey Center in Lincoln, Nebraska, and by the USDA/NRCS Soil Quality Institute. Those values have been adjusted for Texas based on the two studies previously mentioned; the Texas values appear in Table 6. An SDR value from Table 6 is recorded in Section 2 of the Soil Condition Rating Worksheet for every field operation for each crop in the rotation. An average SDR for the system is calculated. The weighted field operation subfactor corresponding to the average SDR is then selected from Table 7 and recorded in Section 2 of the Soil Condition Rating Worksheet.

Weighted Erosion Subfactor

The weighted erosion subfactor is selected from Table 8 based on the erosion rate for the fields in each cropping system. Erosion estimates made during the planning process will be used to select the weighted erosion subfactor from Table 8. The selected weighted erosion subfactor is recorded in Section 3 of the Soil Condition Rating Worksheet.

Calculating the Soil Condition Rating for Cropping Systems

The weighted residue and OM subfactor, the weighted field operations subfactor, and the weighted erosion subfactor for each system to be evaluated are recorded in Section 3 of the Soil Condition Rating Worksheet. The three weighted subfactors are added together to determine the Soil Condition Rating for a system. An SCR of greater than 0.0 is assumed to depict an improvement in soil condition, and a SCR of less than 0.0 is assumed to depict a decline in soil condition. See Appendix 1 for example and worksheet.

Background

Tillage and Rotation Effects

There is abundant evidence that intensive tillage and low residue cropping systems reduce soil condition and associated productivity. Odell (1984) compared the soil organic matter (SOM) levels of plots that had been conventionally tilled and cropped for over 100 years with the SOM of adjoining grassland that had never been farmed. The grass plot had more than 6 percent SOM. The tilled and cropped plots ranged from about 2.25 percent SOM to 3.75 percent SOM depending on the rotation.

In another long term study Haas and Evans (1957) showed a decline in soil nitrogen of over 50 percent during 35 years of farming a conventionally tilled wheat fallow rotation. Reicosky and

Lindstrom (1993) determined that in just 19 days after plowing wheat stubble, more SOM was oxidized than was produced annually by the wheat residue and roots.

At the Hoblitzelle Agricultural Laboratory Texas Research Foundation near Dallas, Texas, a comparison of nine conventionally tilled rotation and fertility combinations resulted in only two combinations that did not reduce soil carbon (the primary element in SOM) over time. One was continuous wheat with annual fertilization, and the other was a cotton, grain sorghum, wheat rotation annually fertilized with commercial fertilizer and with 5 tons per acre of manure applied each year.

As a result of the loss of SOM over time, Laws and Evans (1950) observed the deterioration of soil structure, decreases in moisture infiltration and water holding capacity, and other negative effects.

Residue and Climate Effects

Intensive inversion tillage is not the only input adversely affecting soil condition. Soil condition is also affected by the amount of residue produced each season, and by the annual amount of erosion by wind and water. Climate plays an important role in these two factors, it affects crop production potential, SOM decomposition rates, and erosion rates.

Stewart (1993) noted that decomposition of SOM increases with rising temperatures. He concludes, "under somewhat equal moisture conditions, the amount of SOM in cool regions is significantly greater than that of soils in the tropics. Furthermore, under somewhat equal temperature conditions, SOM levels are greater in humid areas than in arid areas, because there is much more vegetation produced to eventually form SOM".

For years, the assumption of many agronomists and agricultural producers was that little could be done about the downward trend in soil condition, especially in warm humid and warm arid climates. Laws (1961) was one of the first to recognize that there were ways to maintain or increase SOM in warm humid climates. The work he conducted near Dallas, Texas in the 1950's and 1960's is the basis for the minimum residue needs used by NRCS in the Soil Condition Rating System. Laws' long term studies determined that SOM could be maintained at his site as long as at least 3600 lb of crop residue was returned to the soil annually. Treatments that produced less than 3600 lb of residue annually resulted in a decline of SOM, and those that produced more than 3600 lb resulted in a slight increase in SOM over time.

The effects of erosion on soil organic matter and productivity were quantified by Bauer and Black (1994) on three sites in North Dakota. Each ton of SOM was calculated to be equivalent to 31 lb of grain sorghum production per acre. If soil erosion was 10 tons per acre per year over a 50 year period the resulting erosion would total 500 tons. If the soil contained 4 percent SOM, then 20 tons of SOM would be lost to erosion over the 50 year period. The corresponding loss in soil productivity would be 20 (tons SOM) multiplied by 31 lb of grain per ton of SOM, or 620 lb of grain per acre.

Lyles (1975) summarized a number of studies of the effects of erosion on crop yields. The yield reductions varied according to soil, climate, and crop species. Wheat yields were decreased by 2 to 9.5 percent per inch of topsoil eroded; corn yields decreased by 4.3 to 8.7 percent per inch of topsoil eroded; and grain sorghum yields were reduced by 4.1 to 5.7 percent per inch of topsoil eroded.

Benefits of Improving Soil Condition

In recent years, crop varieties have been improved to increase yield potential and in some cases the amount of residue produced. New herbicides and tillage equipment have been developed making conservation tillage, strip tillage, and no-till viable alternatives to inversion tillage systems. Cover crops and manure applications have been promoted to increase residue cover to meet the erosion criteria of farm programs and improve nutrient cycling. All these improvements have resulted in opportunities to maintain or improve soil condition.

Hunt (1994) conducted a long term study on the sandy coastal plains of South Carolina, using a rotation of corn, cotton, soybean, and wheat in 2 different tillage systems: conservation tillage with minimal soil disturbance, and traditional tillage in which the soil was disked several times. After 14 years, carbon in the top 6 inches of the conservation tillage plots had nearly doubled. The traditional tillage plots exhibited no increase.

In the Brazos River Bottom, Franzluebbers, Hons, and Zuberer (1994) determined that over a 10 year period cropping in a no-till wheat/soybean double crop system increased SOM by nearly 50 percent in the top 3 inches of the soil. Franzluebbers, Hons, and Saladino (1995) determined that over an 11 year period sorghum, and wheat/soybean double crop yielded better in rotation than in continuous systems.

In 1991 Bernard King, farming in the Blackland Prairie of Mississippi, converted from clean till cotton (2 trips with a disk, one trip with a chisel plow, one trip to row it up, and one trip with a drag before planting) to no-till cotton (spray and plant) on 1100 acres. The SOM in some fields doubled in 4 years, and yields increased to average 2 plus bales per acre.

Increased SOM is accompanied by increases in soil structure and infiltration (Bruce and Langdale, 1992). On a Southern Piedmont watershed, annual runoff was reduced from an average of 10 inches (conventional tillage) to 0.5 inch (conservation tillage) over a 10 year period, Mills (1988).

Unger and Weise (1979) determined the effect of tillage method on several parameters in a winter wheat, grain sorghum, fallow rotation at Bushland, Texas. The study showed that more precipitation was stored as soil water and higher sorghum yields were attained with a no-till system, compared to more intensive tillage methods.

Musick (1977) in another study at Bushland, determined the effect of tillage method on irrigated winter wheat followed by irrigated grain sorghum. The results were that about 70 percent more precipitation was stored as soil moisture during fallow, and the infiltration depth of irrigation water was nearly doubled in the no-till plots vs. the disked plots. The no-till sorghum yields were 25 percent higher than the disked plots.

Unfortunately, maintaining or improving soil condition does not always translate into noticeable short term gains in productivity; however, it is of major importance to long term productivity and sustainability of the cropland resource. The advances in crop production technology mentioned earlier combined with additions of commercial fertilizers mask the negative effects of declining soil condition. It is usually only in times of stress, like drought or excessive wetness, that these negatives become more obvious to the casual observer. Soil condition will become more important as world demand for food and fiber increases with increasing world population, and as the acreage of highly productive farm land is reduced by conversion to other uses.

Most people have probably noticed a strip at the edge of a crop field that has been missed by the annual fertilizer application; that area usually produces a stunted crop, if it produces anything at all. That stunted crop should serve as a reminder that soil condition has been affected by our farming practices, and that our present cropland management systems are not sustainable without several outside inputs.

TABLE 1 - Minimum Residue Needed for Soil Maintenance
Adapted f rom King, A.D. et al, 1987

Annual Rainfall* (Inches)	Fibrous Rooted (lb./ac.)	Tap Rooted (lb./ac.)
< 20	1500	2000
20 - 25	2000	2500
25 - 30	2500	3000
30 - 35	3000	3500
35 - 40	3500	4000
> 40	4000	4500

*Where irrigation is used, the minimum residue should be determined by adding inches of irrigation to the annual rainfall, then refer to the table.

TABLE 2 - Estimated Residue Production and Root Types of Common Agronomic Crops.

Crop	Unit	Conversion Factors	Fibrous Rooted	Tap Rooted
Corn	bu.	56	X	
Grain Sorghum	lb.	1.0	X	
Peanut	lb.	1.3		X
Soybean	bu.	90		X
Cotton Dry	lb.	4.5		X
Cotton Irr.	lb.	6.0		X
Wheat	bu.	102	X	
Barley	bu.	72	X	
Oat	bu.	64	X	
Rye	bu.	101	X	
Rice	lb.	2.3	X	
Sunflower	lb.	2.2		X

Residue conversion factors are from Revised USLE, SWCS Version 1.04, 1992. For crops not listed in the above table use the RUSLE residue yield ratios in Version 1.04, or documented field data. Actual amounts of residue vary by climate, variety, etc. Site specific data should be used when available.

TABLE 3 - Residue Subfactors For Selected Yields of Annual Field Crops
< 20 Inch Rainfall

Crop	Yield	Unit	Estimated Residue	Residue Subfactor
corn				
low	50	bu	2800	0.87
med	80	bu	4480	
med high	110	bu	6160	3.11
high	140	bu	7840	4.23
cotton dry				
low	250	lb	1125	-0.44
med	500	lb	2250	0.13
med high	750	lb	3375	0.69
high	1000	lb		
cotton irr				
low	500	lb	3000	0.50
med	750	lb	4500	1.25
med high	1000	lb		
high	1250	lb	7500	2.75
grain sorghum				
low	1500	lb	1500	0.00
med	3000	lb	3000	1.00
med high	4500	lb		2.00
high	6000	lb	6000	3.00
peanut				
low	1000	lb	1300	-0.35
med	2000	lb		
med high	3000	lb		
high	4000	lb	5200	
soybean				
low	15	bu	1350	-0.33
med	25	bu	2250	
med high	35	bu	3150	
high	45	bu	4050	
wheat				
low	25	bu	2550	0.70
med	35	bu	3570	1.38
med high	45	bu	4590	
high	55	bu	5610	2.74
forage sorghum				
residue left	500	lb	500	-0.67

To calculate residue subfactors for other estimated residue amounts, subtract the maintenance residue amount from the estimated residue produced and divide by the maintenance amount. For double crop situations, add individual crop subfactors together .

TABLE 3 - Residue Subfactors For Selected Yields of Annual Field Crops
20 - 25 Inch Rainfall

Crop	Yield	Unit	Estimated Residue	Residue Subfactor
corn				
low	50	bu	2800	0.40
med	80	bu	4480	1.24
med high	110	bu	6160	2.08
high	140	bu	7840	2.92
cotton dry				
low	250	lb	1125	-0.55
med	500	lb	2250	-0.10
med high	750	lb	3375	
high	1000	lb	4500	0.80
cotton irr				
low	500	lb	3000	0.20
med	750	lb	4500	
med high	1000	lb	6000	1.40
high	1250	lb	7500	2.00
grain sorghum				
low	1500	lb	1500	-0.25
med	3000	lb	3000	0.50
med high	4500	lb	4500	1.25
high	6000	lb	6000	2.00
peanut				
low	1000	lb	1300	-0.48
med	2000	lb	2600	0.04
med high	3000	lb	3900	0.56
high	4000	lb	5200	1.08
soybean				
low	15	bu	1350	-0.46
med	25	bu	2250	-0.10
med high	35	bu	3150	0.26
high	45	bu	4050	0.62
wheat				
low	25	bu	2550	0.28
med	35	bu	3570	0.79
med high	45	bu	4590	1.30
high	55	bu	5610	1.81
forage sorghum				
residue left	500	lb	500	-0.75

To calculate residue subfactors for other estimated residue amounts, subtract the maintenance residue amount from the estimated residue produced and divide by the maintenance amount. For double crop situations, add individual crop subfactors together.

TABLE 3 - Residue Subfactors For Selected Yields of Annual Field Crops
25 - 30 Inch Rainfall

Crop	Yield	Unit	Estimated Residue	Residue Subfactor
corn				
low	50	bu	2800	0.12
med	80	bu	4480	0.79
med high	110	bu	6160	1.46
high	140	bu	7840	2.14
cotton dry				
low	250	lb	1125	-0.63
med	500	lb	2250	-0.25
med high	750	lb	3375	0.13
high	1000	lb	4500	0.50
cotton irr				
low	500	lb	3000	0.00
med	750	lb	4500	0.50
med high	1000	lb	6000	1.00
high	1250	lb	7500	1.50
grain sorghum				
low	1500	lb	1500	-0.40
med	3000	lb	3000	0.20
med high	4500	lb	4500	0.80
high	6000	lb	6000	1.40
peanut				
low	1000	lb	1300	-0.57
med	2000	lb	2600	-0.13
med high	3000	lb	3900	0.30
high	4000	lb	5200	0.73
soybean				
low	15	bu	1350	-0.55
med	25	bu	2250	-0.25
med high	35	bu	3150	0.05
high	45	bu	4050	0.35
wheat				
low	25	bu	2550	0.02
med	35	bu	3570	0.43
med high	45	bu	4590	0.84
high	55	bu	5610	1.24
forage sorghum				
residue left	500	lb	500	-0.80

To calculate residue subfactors for other estimated residue amounts, subtract the maintenance residue amount from the estimated residue produced and divide by the maintenance amount. For double crop situations, add individual crop subfactors together.

TABLE 3 - Residue Subfactors For Selected Yields of Annual Field Crops
30 - 35 Inch Rainfall

Crop	Yield	Unit	Estimated Residue	Residue Subfactor
corn				
low	50	bu	2800	-0.07
med	80	bu	4480	0.49
med high	110	bu		
high	140	bu	7840	
cotton dry				
low	250	lb	1125	-0.68
med	500	lb		
med high	750	lb	3375	-0.04
high	1000	lb	4500	0.29
cotton irr				
low	500	lb	3000	-0.14
med	750	lb	4500	
med high	1000	lb	6000	
high	1250	lb	7500	1.14
grain sorghum				
low	1500	lb	1500	-0.50
med	3000	lb		
med high	4500	lb	4500	0.50
high	6000	lb	6000	1.00
peanut				
low	1000	lb	1300	-0.63
med	2000	lb	2600	-0.26
med high	3000	lb	3900	0.11
high	4000	lb	5200	0.49
soybean				
low	15	bu	1350	-0.61
med	25	bu	2250	-0.36
med high	35	bu	3150	-0.10
high	45	bu	4050	
wheat				
low	25	bu	2550	-0.15
med	35	bu	3570	0.19
med high	45	bu	4590	0.53
high	55	bu	5610	0.87
forage sorghum				
residue left	500	lb	500	-0.83

To calculate residue subfactors for other estimated residue amounts, subtract the maintenance residue amount from the estimated residue produced and divide by the maintenance amount. For double crop situations, add individual crop subfactors together.

TABLE 3 - Residue Subfactors For Selected Yields of Annual Field Crops
35 - 40 Inch Rainfall

Crop	Yield	Unit	Estimated Residue	Residue Subfactor
corn				
low	50	bu	2800	-0.20
med	80	bu	4480	0.28
med high	110	bu	6160	0.76
high	140	bu	7840	1.24
cotton dry				
low	250	lb	1125	-0.72
med	500	lb	2250	-0.44
med high	750	lb	3375	-0.16
high	1000	lb	4500	
cotton irr				
low	500	lb	3000	-0.25
med	750	lb	4500	0.13
med high	1000	lb	6000	0.50
high	1250	lb	7500	0.88
grain sorghum				
low	1500	lb	1500	-0.57
med	3000	lb	3000	-0.14
med high	4500	lb	4500	
high	6000	lb	6000	0.71
peanut				
low	1000	lb	1300	-0.68
med	2000	lb	2600	-0.35
med high	3000	lb	3900	-0.03
high	4000	lb	5200	
rice				
low	2000	lb	4600	0.31
med	4000	lb	9200	1.63
med high	6000	lb	13800	2.94
high	8000	lb	18400	4.26
soybean				
low	15	bu	1350	-0.66
med	25	bu	2250	-0.44
med high	35	bu	3150	-0.21
high	45	bu	4050	0.01
wheat				
low	25	bu	2550	-0.27
med	35	bu	3570	0.02
med high	45	bu	4590	0.31
high	55	bu	5610	0.60
forage sorghum				
residue left	500	lb	500	-0.86

To calculate residue subfactors for other estimated residue amounts, subtract the maintenance residue amount from the estimated residue produced and divide by the maintenance amount. For double crop situations, add individual crop subfactors together.

TABLE 3 - Residue Subfactors For Selected Yields of Annual Field Crops > 40 Inch Rainfall

Crop corn	Yield	Unit	Estimated Residue	Residue Subfactor
low	50	bu	2800	-0.30
med	80	bu	4480	
med high	110	bu	6160	0.54
high	140	bu	7840	0.96
cotton dry				
low	250	lb	1125	-0.75
med	500	lb	2250	-0.50
med high	750	lb	3375	-0.25
high	1000	lb	4500	0.00
cotton irr				
low	500	lb	3000	-0.33
med	750	lb	4500	0.00
med high	1000	lb	6000	0.33
high	1250	lb	7500	0.67
grain sorghum				
low	1500	lb	1500	-0.63
med	3000	lb	3000	-0.25
med high	4500	lb		
high	6000	lb		
peanut				
low	1000	lb	1300	-0.71
med	2000	lb		
med high	3000	lb	3900	-0.13
high	4000	lb	5200	0.16
rice				
low	2000	lb	4600	0.15
med	4000	lb	9200	1.30
med high	6000	lb	13800	2.45
high	8000	lb	18400	3.60
soybean				
low	15	bu	1350	-0.70
med	25	bu	2250	-0.50
med high	35	bu	3150	-0.30
high	45	bu	4050	-0.10
wheat				
low	25	bu	2550	-0.36
med	35	bu	3570	
med high	45	bu	4590	0.15
high	55	bu	5610	0.40
forage sorghum				
residue left	500	lb	500	-0.88

To calculate residue subfactors for other estimated residue amounts, subtract the maintenance residue amount from the estimated residue produced and divide by the maintenance amount. For double crop situations, add individual crop subfactors together.

TABLE 4 - Residue Subfactors For Perennial Crops in Crop Rotation.
Adapted from Texas USDA, SCS Agronomy Tech. Note TX-8, 1987, and from Arkansas and Louisiana USDA, NRCS Soil Condition Indices.

Duration of Perennial Crops in Rotation	Weighted Residue Subfactors for Perennial Crops Harvested as Hay, Silage, or Green Chop.		
	Grass	Legume	Grass and Legume
1 Year	+0.80	+0.80	+0.80
2 Year	+2.40	+2.00	+2.40
3 Year	+3.20	+2.40	+3.20
4 Year	+3.60	+2.80	+3.60
5 Year	+4.00	+3.00	+4.00
> 5 Years	Add 0.16 for each additional year.		

Reduce the above figures by the following percentages based on annual rainfall : for 35 - 40 inch reduce by 12.5%; 30 - 35 inch reduce by 25.0%; 25 - 30 inch reduce by 37.5%; 20 - 25 inch reduce by 50.0%; and for <20 inch reduce by 62.5%.

TABLE 5 - Weighted Residue Subfactor For Manure and Other O.M. Additions.
Adapted from Arkansas and Louisiana USDA, NRCS Soil Condition Indices.

Material	Weighted O.M. Subfactor (per ton dry material)
Cow Manure	0.56
Sheep Manure	0.64
Poultry Manure (litter)	0.72
Gin Trash	0.40
Straw or grass hay	0.40

Reduce the above figures by the following percentages based on annual rainfall : for 35 - 40 inch reduce by 12.5%; 30 - 35 inch reduce by 25.0%; 25 - 30 inch reduce by 37.5%; 20 - 25 inch reduce by 50.0%; and for <20 inch reduce by 62.5%.

TABLE 6 - Soil Disturbance Ratings

Adapted from Lightle, D.T. and M.S. Argabright, 1997.

Field Operations	Soil Disturbing Operations						Soil Disturbance Rating
	Invert	Mix	Lift	Shatter	Aerate	Compact	
PRIMARY AND SECONDARY TILLAGE							
Plow, moldboard, complete inversion	5	5	5	5	5	4	**29**
Plow, moldboard, incomplete inversion	4	5	5	5	5	4	**28**
Plow, deep chisel, twisted point	4	4	5	5	5	2	**25**
Plow, deep chisel, straight point	3	4	4	4	5	2	**22**
Plow, chisel, twisted point	3	4	5	5	5	2	**24**
Plow, chisel, straight point	2	3	4	4	4	2	**19**
Plow, chisel, sweeps	2	3	5	4	4	3	**21**
Plow, disk plow	4	5	5	5	5	4	**28**
Disk, offset	4	5	4	5	5	4	**27**
Disk, Tandem, primary (>6" deep)	4	5	4	4	5	4	**26**
Power rotary tiller	5	5	5	5	5	4	**29**
Ground driven rotary tiller	4	5	5	5	5	4	**28**
Paratill / paraplow	0	0	5	5	3	2	**15**
Undercutter (8 - 12" sweeps)	0	0	5	5	4	3	**17**
V-blade	0	0	5	5	3	3	**16**
Vee ripper/subsoiler	3	3	4	5	5	2	**22**
Bedder - ridger	3	3	3	3	3	2	**18**
Rebed	2	2	1	2	2	1	**10**
Disk, Tandem finishing (<6" deep)	2	3	4	3	5	4	**21**
Field cultivator, straight point	1	2	2	2	2	1	**10**
Field cultivator, duckfoot	1	2	2	2	2	1	**10**
Field cultivator, sweep	1	1	2	3	2	2	**11**
Harrow, ridge spike	1	1	0	3	1	2	**8**
Harrow, spring tooth	1	2	0	2	2	2	**9**
Harrow, flexible tine	1	2	0	2	2	2	**9**
Rod weeder, plain	1	2	0	3	3	1	**10**
Roller harrow	1	2	1	1	1	2	**8**
Packer roller	0	0	0	0	0	4	**4**
PLANTER AND DRILLS, > 20" ROW SPACING							
Runner shoe	0	0	0	0	0	1	**1**
Single disk	0	0	0	1	1	1	**3**
Double disk	1	0	0	0	1	1	**3**
Fluted coulter < 2"	1	0	0	0	1	1	**3**
Fluted coulter > 2"	1	1	0	1	1	1	**5**
Row cleaner < 1" deep	1	2	1	1	1	1	**7**
Row cleaner > 1" deep	1	2	1	2	2	1	**9**
Ridge till planter	2	2	1	2	1	1	**9**
PLANTERS AND DRILLS 10 - 20" ROW SPACING							
Single disk	0	0	0	1	1	1	**3**
Double disk	0	0	0	1	1	1	**3**
Fluted coulter < 2"	0	0	0	1	2	1	**4**
Fluted coulter > 2"	1	1	0	2	2	1	**7**
Row cleaner < 1" deep	2	2	1	2	2	1	**10**
Row cleaner > 1" deep	2	3	1	3	3	1	**13**

TABLE 6 - Soil Disturbance Ratings

Adapted from Lightle, D.T. and M.S. Argabright, 1997.

Field Operations	Soil Disturbing Operations						Soil Disturbance Rating
	Invert	Mix	Lift	Shatter	Aerate	Compact	
PLANTERS AND DRILLS, < 10" SPACING							
Single disk	0	0	0	1	0	1	**2**
Double disk	1	1	0	1	2	1	**6**
Fluted coulter < 2"	1	1	0	1	2	1	**6**
Fluted coulter > 2"	1	2	0	2	2	1	**8**
Hoe opener	2	1	1	2	2	1	**9**
Chisel opener	2	1	1	2	2	1	**9**
Sweep opener	2	1	2	3	3	1	**12**
ROW CROP CULTIVATION							
Spring tooth	2	1	1	2	3	1	**10**
Single sweep	2	1	1	2	2	1	**9**
Multiple sweep	2	1	1	2	3	1	**10**
Rotary fingers	1	1	1	1	1	1	**6**
Ridge till	2	2	2	3	3	1	**13**
Rotary hoe	1	1	1	1	1	1	**6**
NUTRIENT INJECTION							
Knife (wide)	1	1	1	1	2	1	**7**
Knife with coulter	0	0	1	1	1	1	**4**
Spike point	0	0	0	0	0	0	**0**
Manure injection	1	1	2	2	2	2	**10**
MISCELLANEOUS FIELD OPERATIONS							
Harvest (combine, truck, grain wagon)	0	0	0	0	0	5	**5**
Harvest, digger root crops)	1	2	3	2	2	2	**12**
Fertilizer buggy	0	0	0	0	0	5	**5**
Manure, surface applied	0	0	0	0	0	5	**5**
Spraying, mowing, baling, stalk shredding, broadcast seeding, etc.	0	0	0	0	0	3	**3**

TABLE 7 - Weighted Field Operations Subfactors

Adapted from Lightle, D.T. and M.S. Argabright, 1997.

Average Annual Disturbance Rating	Subfactor Value	Weighted Subfactor Value
0 - 1	+1.00	+0.20
2 - 6	+0.95	+0.19
7 - 10	+0.90	+0.18
11 - 15	+0.85	+0.17
16 - 19	+0.80	+0.16
20 - 24	+0.75	+0.15
25 - 28	+0.70	+0.14
29 - 33	+0.65	+0.13
34 - 37	+0.60	+0.12
38 - 42	+0.55	+0.11
43 - 46	+0.50	+0.10
47 - 51	+0.45	+0.09
52 - 55	+0.40	+0.08
56 - 60	+0.35	+0.07
61 - 64	+0.30	+0.06
65 - 69	+0.25	+0.05
70 - 73	+0.20	+0.04
74 - 78	+0.15	+0.03
79 - 82	+0.10	+0.02
83 - 87	+0.05	+0.01
88 - 91	0.00	0.00
92 - 97	-0.05	-0.01
98 - 102	-0.10	-0.02
103 - 108	-0.15	-0.03
109 - 113	-0.20	-0.04
114 - 119	-0.25	-0.05
120 - 124	-0.30	-0.06
125 - 130	-0.35	-0.07
131 - 135	-0.40	-0.08
136 - 141	-0.45	-0.09
142 - 146	-0.50	-0.10
147 - 152	-0.55	-0.11
153 - 157	-0.60	-0.12
158 - 163	-0.65	-0.13
164 - 168	-0.70	-0.14
169 - 174	-0.75	-0.15
175 - 179	-0.80	-0.16
180 - 185	-0.85	-0.17
186 - 190	-0.90	-0.18
191 - 196	-0.95	-0.19
197 - 201	-1.00	-0.20

TABLE 8 - Erosion Subfactors by Erosion Rate

Wind and / or Water Erosion Rate (T/A/Yr)	Erosion Subfactor	**Weighted Erosion Subfactor**
0 - 0.9	+1.00	**+0.10**
1 - 1.9	+0.75	**+0.08**
2 - 2.9	+0.40	**+0.04**
3 - 3.9	+0.10	**+0.01**
4 - 4.9	0.00	**0.00**
5 - 5.9	-0.20	**-0.02**
6 - 6.9	-0.35	**-0.04**
7 - 7.9	-0.55	**-0.06**
8 - 8.9	-0.70	**-0.07**
9 - 9.9	-0.90	**-0.09**
10 - 10.9	-1.10	**-0.11**
11 - 11.9	-1.20	**-0.12**
12 - 12.9	-1.40	**-0.14**
13 - 13.9	-1.60	**-0.16**
14 - 14.9	-1.80	**-0.18**
15 - 19.9	-2.00	**-0.20**
> 20.0	-2.50	**-0.25**

Adapted from Arkansas and Louisiana Soil Condition Indices.

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Example Calculation of Soil Condition Rating for Three Cropping and Tillage Systems.

Fields 1, 2, and 3 are terraced and planted on the contour.

The major portion of the three fields has a slope of 3 percent and a length of 110 feet.

The yearly average rainfall in the county is 33 inches.

<u>System 1</u>, (Present system) -

2 year rotation : Cotton (375 lb/ac yield)
Grain Sorghum (4500 lb/ac yield)

Conventional Tillage, wide rows, 4 - 6 inch beds, RUSLE estimated erosion 5.9 tons/ac/yr.

<u>System 2</u>, (Alternative system) -

2 year rotation : Cotton (375 lb/ac yield)
Grain Sorghum (4500 lb/ac yield)

Conventional Tillage, row cotton and drilled grain sorghum, RUSLE estimated erosion 5.6 tons/ac/yr.

<u>System 3</u>, (Alternative system) -

3 year rotation : Cotton (375 lb/ac yield)
Grain Sorghum (4500 lb/ac yield)
Grain Sorghum (4500 lb/ac yield)

Conventional Tillage, year row cotton and 2 years drilled grain sorghum, RUSLE estimated erosion 4.8 tons/ac/yr.

Appendix 1

SOIL CONDITION RATING WORKSHEET

SECTION 1 - RESIDUE AND O.M. SUBFACTOR DATA

County Avg. Annual Rainfall (Inches) __33__ System No. ___1___

Producer EXAMPLE________________ Field No. ______1 - 6_________

Residue and O.M. Subfactor Data

1	2	3	4	5	6
Crop or Cover Crop	*Avg. Yield	O.M. Additions Type and Dry Tons / Ac	O.M. Addition Subfactor (Table 5) x Dry Tons/Ac	Residue Subfactor (Tables 3 - 4) or Calculated	Total Residue and O.M. Subfactor Col. 4 + Col. 5
COTTON	375 LB	NONE	0	-0.52	-0.52
G. SORG.	4500 LB	NONE	0	+0.50	+0.50
				Column 6 Total	-0.02
				Avg. Residue and OM Subfactor for the Rotation (Total ÷ Years in Rotation	-0.01
				Weighted Residue and OM Subfactor (Avg. Subfactor x 0.70)	0

* For cover crops use the estimated dry weight of the above ground portion of the cover crop.

Crop Residue Subfactor Calculated From Yield

System No. 1

Residue Needed Fibrous Rooted Crop (Table 1) 3000

Residue Needed Tap Rooted Crop (Table 1) 3500

1	2	3	4	5	6
Crop	Yield	Residue Conversion Factor (Table 2)	Estimated Residue lb./ac. (col. 2 x col. 3)	Maintenance Residue Needed (Table 1)	Residue Subfactor (Col. 4 - Col. 5) ÷ (Col. 5)
COTTON	375 LB	4.5	1688	35OO	-0.52

SOIL CONDITION RATING WORKSHEET

SECTION 2 - FIELD OPERATIONS SUBFACTOR DATA

System No. ____1____ Field No. ______1 - 6

1	2	3	4	5	6
Crop COTTON		Crop ROW G. SORG.		Crop ____________	
Field Operations	Soil Disturbance Rating (Table 6)	Field Operations	Soil Disturbance Rating (Table 6)	Field Operations	Soil Disturbance Rating (Table 6)
T. DISK >6”	26	SAME AS			
T. DISK <6”	21	COTTON			
BED	18				
REBED	10				
PLANTER	3				
3 ROW CULT. MULTI	3X10				
HARVEST	5				
SHRED	3				
Total 1	116	Total 2	116	Total 3	

Total Soil Disturbance Rating (SDR) For Rotation (Total 1 + Total 2 + Total 3)*	232
Avg. Soil Disturbance Rating for Rotation (Total SDR ÷ Years in Rotation)	116
Weighted Field Operation Subfactor (Table 7)	-0.05

Use additional sheets for longer rotations.

SECTION 3 - SOIL CONDITION RATING

1	2	3	4	5
System No.	Weighted Residue and O.M. Subfactor (Section 1)	Weighted Field Operation Subfactor (Section 2)	Weighted Erosion Subfactor (Table 8)	Soil Condition Rating (Col. 2 + Col. 3 + Col. 4)
1	0	-0.05	-0.02	-0.07

SOIL CONDITION RATING WORKSHEET

SECTION 1 - RESIDUE AND O.M. SUBFACTOR DATA

County Avg. Annual Rainfall (Inches) __33__ **System No. ___2____**

Producer _EXAMPLE__________________ **Field No. ____1 - 6**

Residue and O.M. Subfactor Data

1	2	3	4	5	6
Crop or Cover Crop	*Avg. Yield	O.M. Additions Type and Dry Tons / Ac	O.M. Addition Subfactor (Table 5) x Dry Tons/Ac	Residue Subfactor (Tables 3 - 4) or Calculated	Total Residue and O.M. Subfactor Col. 4 + Col. 5
COTTON	375 LB	0	0	-0.52	-0.52
G. SORG.	4500 LB	0	0	+0.50	+0.50

Column 6 Total	-0.02
Avg. Residue and OM Subfactor for the Rotation (Total ÷ Years in Rotation	-0.01
Weighted Residue and OM Subfactor (Avg. Subfactor x 0.70)	0

* For cover crops use the estimated dry weight of the above ground portion of the cover crop.

Crop Residue Subfactor Calculated From Yield

System No.

Residue Needed Fibrous Rooted Crop (Table 1)

Residue Needed Tap Rooted Crop (Table 1)

1	2	3	4	5	6
Crop	Yield	Residue Conversion Factor (Table 2)	Estimated Residue lb./ac. (col. 2 x col. 3)	Maintenance Residue Needed (Table 1)	Residue Subfactor (Col. 4 - Col. 5) ÷ (Col. 5)

SOIL CONDITION RATING WORKSHEET

SECTION 2 - FIELD OPERATIONS SUBFACTOR DATA

System No. ____2____ Field No. _____1 - 6______________

1	2	3	4	5	6
Crop COTTON		Crop DRILLED G. SORG		Crop ____________	
Field Operations	Soil Disturbance Rating (Table 6)	Field Operations	Soil Disturbance Rating (Table 6)	Field Operations	Soil Disturbance Rating (Table 6)
SAME AS		T. DISK >6”	26		
SYS. 1		T. DISK <6”	21		
		DRILL	3		
		HARVEST	5		
		SHRED	3		
Total 1	116	Total 2	58	Total 3	

Total Soil Disturbance Rating (SDR) For Rotation (Total 1 + Total 2 + Total 3)*	174
Avg. Soil Disturbance Rating for Rotation (Total SDR ÷ Years in Rotation)	87
Weighted Field Operation Subfactor (Table 7)	+0.01

* Use additional sheets for longer rotations.

SECTION 3 - SOIL CONDITION RATING

1	2	3	4	5
System No.	Weighted Residue and O.M. Subfactor (Section 1)	Weighted Field Operation Subfactor (Section 2)	Weighted Erosion Subfactor (Table 8)	Soil Condition Rating (Col. 2 + Col. 3 + Col. 4)
2	0	+0.01	-0.02	-0.01

SOIL CONDITION RATING WORKSHEET

SECTION 1 - RESIDUE AND O.M. SUBFACTOR DATA

County Avg. Annual Rainfall (Inches) __33__ System No. ___3____

Producer EXAMPLE________________ Field No. 1 - 6

Residue and O.M. Subfactor Data

1	2	3	4	5	6
Crop or Cover Crop	*Avg. Yield	O.M. Additions Type and Dry Tons / Ac	O.M. Addition Subfactor (Table 5) x Dry Tons/Ac	Residue Subfactor (Tables 3 - 4) or Calculated	Total Residue and O.M. Subfactor Col. 4 + Col. 5
COTTON	375 LB	0	0	-0.52	-0.52
SORGHUM	4500	0	0	+0.50	+0.50
SORGHUM	4500	0	0	+0.50	+0.50
				Column 6 Total	+0.48
				Avg. Residue and OM Subfactor for the Rotation (Total ÷ Years in Rotation	+0.16
				Weighted Residue and OM Subfactor (Avg. Subfactor x 0.70)	+0.11

* For cover crops use the estimated dry weight of the above ground portion of the cover crop.

Crop Residue Subfactor Calculated From Yield

System No. _______

Residue Needed Fibrous Rooted Crop (Table 1)

Residue Needed Tap Rooted Crop (Table 1)

1	2	3	4	5	6
Crop	Yield	Residue Conversion Factor (Table 2)	Estimated Residue lb./ac. (col. 2 x col. 3)	Maintenance Residue Needed (Table 1)	Residue Subfactor (Col. 4 - Col. 5) ÷ (Col. 5)

Appendix 1

SOIL CONDITION RATING WORKSHEET

SECTION 2 - FIELD OPERATIONS SUBFACTOR DATA

System No. ___3_____ **Field No.** ____ - 6

1	2	3	4	5	6
Crop COTTON		Crop DRILLED G. SORG.		Crop DRILLED G. SORG.	
Field Operations	Soil Disturbance Rating (Table 6)	Field Operations	Soil Disturbance Rating (Table 6)	Field Operations	Soil Disturbance Rating (Table 6)
SAME AS		SAME AS		SAME AS	
SYS. 2		SYS. 2		SYS. 2	
Total 1	116	Total 2	58	Total 3	58

Total Soil Disturbance Rating (SDR) For Rotation (Total 1 + Total 2 + Total 3)*	232
Avg. Soil Disturbance Rating for Rotation (Total SDR ÷ Years in Rotation)	77
Weighted Field Operation Subfactor (Table 7)	+0.03

* Use additional sheets for longer rotations.

SECTION 3 - SOIL CONDITION RATING

1	2	3	4	5
System No.	Weighted Residue and O.M. Subfactor (Section 1)	Weighted Field Operation Subfactor (Section 2)	Weighted Erosion Subfactor (Table 8)	Soil Condition Rating (Col. 2 + Col. 3 + Col. 4)
1	0	-0.05	-0.02	-0.07
2	0	+0.01	-0.02	-0.01
3	+0.11	+0.03	0	+0.14