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NEW MEXICO AGRONOMY TECHNICAL NOTE NO. 53

SUBJECT: ECS – SOIL QUALITY RESOURCE CONCERNS: MANAGING CONSERVATION TILLAGE

Purpose: To distribute Agronomy Technical Note No. 53.

Effective Date: When contents have been noted.

Filing Instructions: File in the Agronomy Technical Note binder.

Explanation:

The director of the Soil Quality Institute sent out to all offices Soil Quality-Agronomy Technical Note No. 9, *Managing Conservation Tillage*. The attached copy is to be filed with this notice in the FOTG Agronomy Technical Notes.

Please read through this note because it has some negative points you may not know about conservation tillage. If you have any questions please call Mike Sporcic at (505)761-4424.

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Attachment

ASTC/FO (2)
DC – 1 ea
TSO 1 ea
Los Lunas PMC – 1 ea
SOS – 1 (route – notice only)
NMSO, Official TG – 1 ea
NMSO, ENG – 12
Director, ECS, NHQ, Washington, DC – 1 ea
Adjoining States – AZ, CO, OK, TX, UT 1 ea (notice only)
BIA, Division of Resource Development, Albuquerque Area Office, Code 380, Box 26567, Albuquerque, NM 87125-6567 (notice only)
BIA, Laguna Agency, PO Box 1448, Laguna, NM 87026
Range Conservationist, BIA, PO Box 1750, Crownpoint, NM 87313
Field Director, NM State Land Office, PO Box 1148, Santa Fe, NM 87501-1148 (notice only)
Reclamation Specialist, Office of Surface Mining, OSMRE, Suite 1200, 505 Marquette NW, Albuquerque, NM 87102

SOIL QUALITY-AGRONOMY
Technical Note No. 9

Managing Conservation Tillage

United States
Department of
Agriculture

Natural
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This is the ninth note in a series of Soil Quality-Agronomy technical notes on the effects of land management on soil quality. This information is general and covers broad application.

Conservation tillage or residue management is a conservation practice that gives efficient, effective control to erosion and can improve soil properties and soil quality. However, crop response to conservation tillage can be widely variable. Leaving residue from a cover crop or previous crop changes the soil environment and may alter the crop response. This technical note will discuss improvements of soil quality and potential problems in conservation tillage such as: (1) improving organic matter content and soil aggregation; (2) reduced soil temperature and lack of germination; (3) root and plant diseases; (4) increased soil density/compaction.

Improving Organic Matter and Aggregation

The moldboard plow inverts soil and places crop residue deep into the soil. The resulting changes in the soil surface increase soil temperature and oxidation rates, thus accelerating organic matter decay throughout the plow layer. It is estimated that many soils have lost from 20 to 50 percent of the soil carbon content of the surface layer since cultivation began (Lal et al., 1998). On the other hand, conservation tillage leaves crop residues on the soil surface. The organic matter below the surface, including the previous crop's roots, is left undisturbed and is not subject to accelerated decay. This combination of adding organic residues to the soil surface, while not disturbing the existing organic matter stocks below the surface, can result in increases organic matter in the upper few inches of the soil. The amount of time to increase organic matter is determined mainly by climate (moisture and temperature), and the amount of crop biomass produced and left on the soil surface.

A study in Indiana (Griffith et al., 1992) showed an increase in organic matter with no-till continuous corn after seven years in two soil types (Table 1). The increase in organic matter was largest near the surface but increased slightly below four inches.

Table 1. Comparison of organic matter and distribution with plow and no-till systems

	Tracey sandy loam		Chalmers silty clay loam	
Tillage System	Depth (inches)	OM (%)	Depth (inches)	OM (%)
Plow	0-4	1.5	0-3	4.1
	4-8	1.5	3-6	4.1

	8-12	0.8	6-9	3.7
No-till	0-4	1.9	0-3	4.8
	4-8	1.7	3-6	4.2
	8-12	0.9	6-9	3.8

Organic matter (OM)

In the South, Wood and Edwards (1992) also found increases in organic matter at the surface using conservation tillage (Table 2).

Table 2. Soil organic matter as affected by 10 years of tillage management in Crossville, AL

Hartsells fine sandy loam

Tillage System	Depth (inches)	OM (%)
Plow	0-2	1.0
	2-4	1.0
	4-8	1.0
No-till	0-2	1.8
	2-4	1.7
	4-8	1.0

Data is for all crop rotations: corn-wheat cover crop, soybean-wheat cover crop, and corn-wheat cover crop, soybean and wheat cover crop.

Similar findings were found in Kentucky on a silt loam after five years of continuous corn. The top two inches of soil had 4.1 % organic matter with no-till and 2.8 % with the plow system (Griffith et al., 1992).

As soil organic matter increases, soil aggregation is improved because soil particles are glued together into larger, more stable aggregates. This increase in overall aggregation and in the stability of the aggregates, has the following beneficial effects:

- Resistance of soil dispersion
- Less susceptibility to compaction
- Improved soil aeration
- Better soil drainage
- Improved infiltration
- Less susceptibility to soil erosion
- Plant emergence

An Indiana study (Griffith et al., 1992) showed after five years of continuous corn that aggregation in the top 2 inches was increased by 120 % for no-till and

35 % for ridge-till systems, compared to moldboard plowing. After five years, the field was plowed and the aggregation index returned to its original level.

Increasing organic matter levels, along with the lack of soil disturbance from plowing, can also increase the number, kinds, and activity of soil organisms. Adopting conservation tillage systems can result in equivalent or higher yields and can improve soil quality. However, conservation tillage increases moisture, reduces temperature and may leave soils at planting more dense, which can result in management challenges.

Problems with Temperature/Lack of Germination

Cool temperatures, increased diseases, and lack of germination (alleopathy, which results from placing seed under or near decaying residue) can affect early season crop growth. Bacteria from decaying residue can inhibit the growth of a crop. In field conditions, it is difficult to separate temperature effects from alleopathy.

Maintaining residue on the soil surface slows soil warming in the early spring compared to a plow-tilled seedbed. This is especially true in northern climates and during the first month after planting. The type, distribution, and amount of residue on the soil surface influences soil warming. Residue from wheat, rye and corn will prevent warming more than soybean residue that produces fewer residues and decomposes more quickly. Another factor is the crop being grown. Corn is more susceptible to cool temperatures than soybean because the growing point of corn remains below the soil surface until about the sixth-leaf stage. Slower growth results in delayed maturity. Cotton is especially sensitive to cool temperatures. Cold weather, anytime from April to harvest is hard on cotton. Early season cool wet temperatures delay harvest, often into adverse fall weather.

When dealing with wetter soils and cooler temperatures, adjustments will need to be considered to prevent delayed early season growth rates. Soil temperatures of at least 50° F are needed for germination of most corn hybrids and above 60° F for cotton. Excessive moisture also inhibits soil warming. Delayed planting and clearing residues in the row or raised beds are methods used to influence warming of the soil. However, delayed planting can sometimes lead to yield reductions as with other tillage systems (Griffith et al., 1992). Soil in raised-worked strip- beds (strip-cropping) warms faster than between rows.

Adjusting to a modified form of conservation tillage may involve residue removal from the row area with flat disks, sweeps, and fluted coulters. In an Iowa study (Griffith et al., 1992) removing approximately 4 inches residue in the row for corn resulted in:

- Increased corn height
- Decreased days to emergence by 50%

- Decreased days to tassel by 50%
- Increased yield by 5 bushels/acre

Fine tuning ridge-till and no-till systems to individual fields increases the range of adaptability for conservation systems in conditions that result in cool temperatures (northern climate and or wetter soils).

Choosing a tillage system depends on local soils, climate and rotation. Many states (e.g. Ohio and Indiana) have classified soils into tillage management groups for crops like corn and soybean. Your local state agronomic specialists will be able to provide guidance on tillage system selections and planting strategies where temperature and lack of germination are problems with conservation tillage systems.

Problems with Disease

Conservation tillage systems leave more residues on the soil surfaces thus providing a wetter and cooler environment for crop growth conditions. These conditions may increase, decrease, or not affect plant diseases, depending on the disease. Diseases that thrive in wet and cooler conditions may become more of a problem in conservation tillage compared to plow-tillage.

Pathogens that survive in infected crop residue left on the soil surface are another variable that may increase the potential for diseases in conservation tillage systems. These diseases include stem rot, stem and stalk rots, and foliar diseases. With many of these diseases, continuous cropping in a conservation cropping system usually increases of frequency incidence (Scott et al., 1992).

Diseases become a problem when you have three variables present. They are the host, pathogen, and correct environmental conditions. If these conditions remain favorable for an extended amount of time, the disease severity increases. Maintaining favorable conditions for plant growth alters disease potentials. Some weeds and insects are vectors, or provide a favorable environment for pathogens. Some agronomic management practices that eliminate or reduce disease conditions (Scott et al., 1992) are:

- Crop rotation
- Selection of resistant varieties
- Use of recommended fungicides at planting
- Date of planting (delay if possible during wet and cool conditions)
- Insect and weed control
- Maintain adequate soil fertility

Problems with Density/Compaction

Untilled soils usually have higher bulk densities (less pore space) than tilled soils. Tilled soil will settle with rainfall during the growing season, and by harvest, will equal that of conservation tillage. Additional compaction results from mechanical forces from wheel traffic, animals and tillage operations under moist conditions.

Reduced yields will result from attempting to adopt a conservation tillage system in soils already compacted without trying to remediate the problem. Many soils that have been previously conventionally farmed have poor structure prior to adoption of conservation tillage. Because of the poor structure, yields will probably be reduced as a result of using conservation tillage.

With continued use of conservation tillage, changes occur in the soil, which may improve root growth in a denser soil. As organic matter increases near the surface, aggregation and air movement improves. Earthworm burrows and old root channels remain for roots to find growth pathways.

Even though conservation tillage will reverse some of the degradation of soil properties caused by tillage, yields may be reduced too substantially to proceed with conservation tillage prior to alleviating the compacted soil. In-row subsoiling (strip-tillage) below the restrictive layer (usually below 10 inches) will result in equal or improved yields using conservation tillage on sandy soils in the Coastal Plain. Tables 3 and 4 illustrate the effects of in-row subsoiling on cotton lint yields and bulk density, respectively (Raper et al., 1994).

Table 3. Tillage Treatments on Cotton Lint yield on a Coastal Plain soil (sandy loam)

Tillage System	Traffic (yield in lbs/A)	No-Traffic (yield in lbs/A)
Disk, field cultivate and plant	815	955
In-row subsoil and plant	974	957

Table 4. Tillage Treatments on Bulk Density at 0-3 inches depth on a Coastal Plain soil (sandy loam)

Tillage System	Traffic (Bulk density in g/cm^3)	No-Traffic (Bulk density in g/cm^3)
Disk, field cultivate and plant	1.57	1.42
In-row subsoil and plant	1.41	1.28

Another management practice that reduces compaction is to avoid field operations when soil is wet. If it is too wet to plant in a conventional tillage system, it is also too wet to plant in a conservation tillage system.

Controlled traffic, keeping wheel traffic in the same row middles and planting in last year's rows, may improve root growth. This practice is especially effective when all crops are in rows. When crops or rotations have different wheel spacing, adjustments may be necessary. Using Crop rotations, especially sod-base rotations and cover crops also reduces the effects of compaction.

Conclusion

Crop response to conservation tillage (elimination of full-width tillage) is widely variable depending on climatic factors, soils, and cropping sequence. Conservation tillage may enhance soil quality by increasing organic matter levels, and improving soil structure, aeration, and infiltration. Soil biological activity is also often enhanced. In addition, it can provide an effective solution to reducing erosion. More residues left on the surface can result in a cooler and wetter conditions that may cause growth problems due to lack of germination or delayed growth as a result of cool temperatures and diseases. Adoption of conservation tillage may result in a more dense soil; especially in soils that have been previously degraded by inappropriate tillage and cropping. Adjustments in planting dates, tillage systems, cropping sequence, knowledge of soil response to different tillage systems, and the use of non-inversion tillage, i.e., subsoiling or bent leg plows like paratill, can aid in the success of a conservation tillage system. Cover crops and sod-base rotations also reduce soil compaction.

This technical note discusses only a few conditions that can be detrimental to crop growth. See your state's agronomic specialists for ways to improve crop management regardless of the tillage system.

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