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G05-1563 Manure Incorporation and Crop Residue Cover: *Part I: Reduction of Cover*

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NebGuide

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Manure Incorporation and Crop Residue Cover - *Part I: Reduction of Cover*

Residue cover reduction caused by soil-engaging components typically used with tank spreaders and towed hose systems to apply liquid or slurry manure.

David P. Shelton, Extension Agricultural Engineer

Manure incorporation represents a compromise between best management practices for soil erosion control and manure management. Manure should be incorporated into the soil for odor control, increased availability of nutrients, and control of potential manure runoff; however, disturbing the soil and crop residue may increase soil erosion and water runoff. This NebGuide summarizes the results of a field study to determine the influences on crop residue cover of common equipment used to simultaneously apply and incorporate manure.

Background

Manure management has become a focal point for many livestock producers because of environmental concerns such as water quality and odor control and an interest in capitalizing on its fertilizer value. A best management practice is to incorporate manure into the soil to maximize nutrient availability, especially nitrogen, and to minimize odors and potential degradation of surface water quality through manure runoff.

Maintaining crop residue on the soil surface is one of the most cost-effective soil erosion control practices. Compared to a cleanly tilled field, erosion can be reduced by 50 percent when just 20 percent of the soil surface is covered with residue. A best management practice for soil erosion control is to minimize soil and crop residue disturbance, thus leaving more crop residue on the soil surface. Today's livestock producer must balance these two best management practices.

Soil-Engaging Components for Manure Incorporation

Three general configurations of soil-engaging components are typically used with tank spreaders and towed hose systems to simultaneously apply and incorporate either liquid or slurry manure.

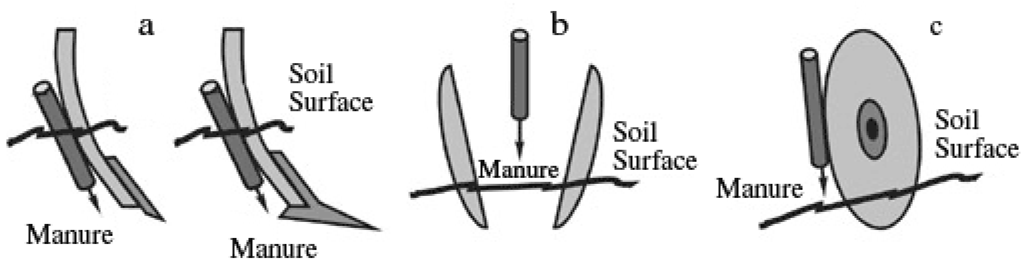

Figure 1. Typical soil-engaging components used for simultaneous application and incorporation of manure: a) chisel and sweep injectors; b) disk-type applicator; and c) coulter-type applicator.

Chisels and sweeps (*Figure 1-a*) are the most common and generally consist of a C-shaped shank, 2-3 inches wide, with either a chisel or sweep point attached. Shank spacing on the toolbar usually ranges from 20 to 60 inches. Chisel points are typically 2-3 inches wide and can be either straight or twisted. Sweeps are typically 7-24 inches wide. At least one manufacturer offers a combination chisel point and sweep as a single unit. Most manufacturers also offer coulters that can be mounted in front of the shanks to help cut the crop residue, allowing it to pass between and around the shanks. Operating depth of chisels and sweeps is usually 4-8 inches. Manure exits the supply tube below the soil surface, making these units true manure injectors.

Disk-type applicators (*Figure 1-b*) consist of two opposed concave disks, typically 14-22 inches in diameter, mounted on an angled shaft. Spacing between the centers of the individual disks is generally 12-32 inches. Because of the angled shaft, the disks are skewed relative to the direction of travel, giving a wider spacing between the disks at the front edges than at the rear. Manure exits slightly above the soil surface through the supply tube between the disks. Operating depth is generally 3-6 inches. As the applicator moves through the field, the disks throw loosened soil and crop residue inward and upward, mixing the soil and residue with the manure flowing from the supply tubes. Following application, the field often appears as strips of essentially undisturbed residue and soil alternated with strips of mixed soil, residue, and manure. The width of the undisturbed strip depends on the spacing between the two opposing disks and the spacing of the disk units along the toolbar (typically 15-60 inches).

Coulter-type applicators (*Figure 1-c*) consist of a large rolling coulter, typically 22-25 inches in diameter, a manure supply tube, and a closing or press wheel. The coulter is angled approximately 5 degrees compared to both the direction of travel and to vertical. As the applicator moves through the field, the soil and residue is cut by the coulter and a slot is wedged open. Manure is applied in this slot, which is closed by the press wheel. Operating depth is usually 4-8 inches. Coulter applicators are operated in pairs, with one skewed to the right and one skewed to the left, to eliminate implement side-draft.

Research on Residue Cover Reduction by the Components

Trials were conducted at the University of Nebraska Haskell Agricultural Laboratory near Concord in the spring and fall of 1996 and 1997 to study residue cover reduction by various components. Seven configurations of manure application/incorporation components were used in this study. A tandem disk also was included for comparison. Equipment descriptions are given in Table I. Evaluations were made in both irrigated and dryland corn residue (non-fragile) and in soybean and oat residue (fragile).

Table I. Summary of manure injection/application equipment components used in research on how manure application affected crop soil residue cover at the Haskell Agricultural Laboratory, Concord, in 1996-1997.

Chisel and Sweep Injectors
Balzer 20.5-inch wide sweeps with integral 2.25-inch wide straight chisel points; 30-inch spacing on toolbar
Balzer 20.5-inch wide sweeps with integral 2.25-inch wide straight chisel points and 17.5-inch diameter ripple coulter in front of each injector; 30-inch spacing on toolbar
Calumet 2-inch wide straight chisel points; 30-inch spacing on toolbar
Calumet 14-inch wide sweeps; 30-inch spacing on toolbar
Disk-type Applicators
Calumet disk applicator with 16-inch diameter disks spaced 16 inches at the center; 30-inch spacing on toolbar
Vittetoe disk applicator with 22-inch diameter disks spaced 31 inches at the center; 60-inch spacing on toolbar
Coulter-type Applicator
Sukup Manufacturing 25-inch diameter coulter applicator; 30-inch spacing on toolbar
Tandem Disk
John Deere model TO210; spring tooth harrow attachment
[a]Mention of brand names is for description only. Endorsement or exclusion of others is not intended or implied.

Residue cover reduction averaged 92 percent when chisel and sweep injectors were used in soybean and oat residue. In some instances, residue was reduced by as much as 98 percent. In corn residue, the average reduction was 52 percent with chisel and sweep injectors, with reductions ranging from 25 to 87 percent. Average residue cover reductions with the tandem disk were about the same as those from the chisel and sweep injectors in all four residues.

Average residue cover reduction by the disk-type applicator was 72 percent for soybean and oat residues and 45 percent for corn residue. Residue cover reduction by the disk applicators was not significantly different compared with the tandem disk in either irrigated or non-irrigated corn residue, but was significantly less in soybean and oat residues.

Residue cover reductions by the coulter-type applicator were significantly less than the reductions caused by all other components. When taken across year and season, mean residue cover reduction for the coulter applicator was 37 percent for soybean and oat residues and 11 percent for corn residue.

Estimating Percent Residue Cover Remaining

One objective of this study was to determine values for the amount of residue cover that could be expected to remain after using manure application/incorporation equipment. (Similar values are already available for many tillage and residue-disturbing operations.) Suggested ranges of values for both fragile and non-fragile residues are presented in *Table II*. These data can be used for planning if site and equipment-specific values are not available. [Note: The values in *Table II* are percentage of initial residue cover remaining, not percent residue reduction as previously discussed. Percentage cover remaining = (100 - percent reduction).]

Table II. Percentage of initial residue cover remaining after manure application/incorporation.

Application/ Incorporation Component	Percentage of Initial Residue Cover Retained	
	Soybean and Oat Residue (Fragile)	Corn Residue (Non-fragile)
Chisel and Sweep Injector	5-15	30-65
Disk-Type Applicator	15-40	40-65
Coulter-Type Applicator	65-80	80-95
Tandem Disk	5-25	35-60

The values in *Table II* can be multiplied by the percent residue cover present before manure application/incorporation to estimate the amount of cover that will remain after manure incorporation. For example, assume that a coulter-type applicator is used to apply manure in a recently combined soybean field having an average residue cover of 70 percent. Multiply 70 percent (after harvest cover) by 0.7 (estimated percentage of cover remaining for a coulter-type applicator used in soybean residue, expressed as a decimal) which gives about 50 percent residue cover following manure application. In contrast, if a chisel or sweep injector was used in the same soybean field, less than 10 percent cover would likely remain (70% x 0.1 = 7%). Likewise, in an irrigated corn field having an average residue cover of 95 percent, the expected percent cover following manure application/incorporation would be approximately 40 percent (95% x 0.45) if a chisel or sweep injector is used; slightly over 50 percent (95% x 0.55) if a disk-type applicator is used; and about 80 percent (95% x 0.85) if a coulter-type applicator is used.

As with tillage operations, the amount of residue cover remaining after manure incorporation is influenced by many factors, including component design, shank spacing on the toolbar, adjustments, field speed, depth of soil disturbance, previous residue disturbance, and soil and residue condition. Thus, the best procedure is to operate the manure incorporation equipment in a small, representative area of the field and then measure the amount of residue cover remaining (see University of Nebraska Extension NebGuide G93-1133, *Estimating Percent Residue Cover Using the Line-Transect Method*). Also, manure incorporation is only one operation within a series or system of operations performed in a field between harvest of one crop and planting of the next crop. Each soil and residue-disturbing operation must be considered when evaluating the amount of residue that will remain for erosion control. (For a more complete list of implements and the residue amounts remaining after their use, as well as more information about the influence of other factors, refer to University of Nebraska Extension NebGuide G93-1135, *Estimating Percent Residue Cover Using the Calculation Method*.)

Results of this study indicate that adequate residue cover can remain for effective erosion control with some configurations of manure injectors and applicators, particularly in corn or other non-fragile residue. Equipment must be selected, adjusted, and operated with the dual objectives of manure and residue management, rather than the objective of simply disposing of the manure. The companion NebGuide, *Manure Incorporation and Crop Residue Cover - Part II: Fine-Tuning the System* (G05-1564), discusses some of these considerations. With this information, livestock producers should be better able to select a manure management system that is also compatible with their soil erosion control objectives.

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