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# Tillage Systems in Southwest and West Central Minnesota



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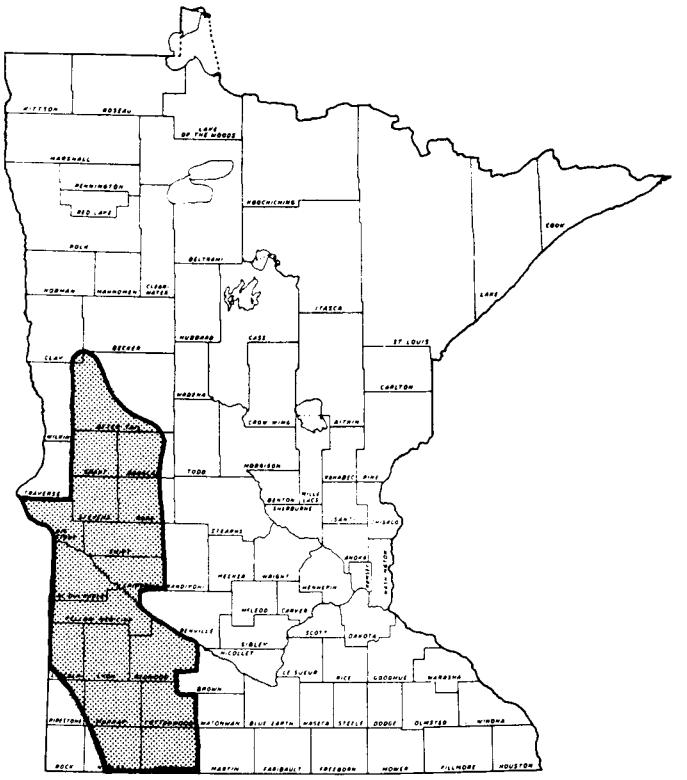
The medium to moderately fine-textured Prairie and Prairie Border Soils of southwest and west central Minnesota include the Barnes, Aastad, Flom, Buse, Pierce, Waukon, Winger, and McIntosh series and related associations. Other series commonly occurring in this region are Clarion, Nicollet, Webster, and Storden. Tillable land is typically undulating to gently sloping with loam, silt loam, or clay loam textured surface soil. Soils are dark colored and range from well to poorly drained. Principal crops grown in this region are corn, soybeans, sunflowers, and small grains. Rainfall between April and August averages 16.7 inches. The average annual precipitation is 25.4 inches. The tillage system traditionally used to prepare these soils for spring planting includes fall plowing, spring disking and dragging.

Tillage has become a commonly spoken word in Minnesota's agricultural community. In the most practical sense, tillage is the mechanical process of preparing a seedbed. However, there are many other reasons why a farm operator selects a specific farm implement to till his land. Tillage can be used to reduce and minimize soil loss due to water and wind erosion, increase rainfall intake, promote warming and drying of the soil, control weeds and pests, and increase crop yields. In southwest and west central Minnesota (Figure 1) a number of tillage systems are being used to successfully grow crops and minimize soil, water, and energy loss.

**Figure 1. Southwest and west central Minnesota—shaded region has traditionally been managed with fall moldboard plowing, spring disking, harrowing and planting.**



During the past fifteen years extensive research has been conducted at Lamberton and Morris to identify successful tillage systems for corn, soybeans, and small grains. Most studies at these locations show that some tillage is necessary in the fall to prepare the soil for secondary spring tillage and/or planting.

## TILLAGE AFFECTS SOIL MOISTURE

Soil conditions seldom remain stable between crop harvesting and planting the following spring. Usually the soil is dry at harvest because most of the water in the soil has been removed by the preceding crop. Fall and spring rain plus melting snow often replenish the soil moisture supply. When combined with summer rainfall, sufficient water is available to support a crop of corn, soybeans, sunflowers or small grains. Occasionally the soil is relatively wet following harvest. In such years, less of the fall and little of the spring rain and melting snow may be stored.

Some degree of fall tillage may be appropriate for both of these situations in southwest and west central Minnesota. Fall tillage can be managed to minimize the time required and problems encountered in seedbed preparation on wet soils or to maximize soil water storage. Thus fall tillage can make the difference between too much and too little moisture the following year. Increases in corn yields from fall moldboard plowing compared to spring plowing are frequently observed on less well drained, finer-textured soils in the northern corn belt. Ohio results show that fall plowing raised corn yields about 10 bushels an acre on some dark-colored, poorly drained soils. In six years at the Lamberton Experiment Station, corn yields on a Nicollet clay loam averaged 83 bushels per acre for fall plowing versus 73 bushels per acre for spring plowing. In three years at the Waseca Experiment Station on a poorly drained Webster clay loam where corn followed soybeans, fall plowed treatments outyielded spring plowed treatments by 11 percent.

Fall chisel plowing has some special advantages over moldboard plowing in this region during years when the soil is quite dry following crop harvest. This is especially true on the more rolling area but can also be beneficial on the flatter slopes with medium and moderately fine-textured soils. Chisel plowing leaves both a rough, uneven surface and some crop residue on the surface during the winter.

Crop residue on a rough, uneven soil surface does several beneficial things: retards soil sealing and crusting, helps maintain infiltration at a relatively high rate, minimizes wind speed and erosion, traps and holds snow, and conserves moisture and prevents soil drying.

These effects may significantly increase the amount of moisture stored in the soil profile between fall chisel plowing and secondary spring tillage. Research has shown that in years of soil moisture deficiency, one extra inch of water during the crop season may increase corn grain yields as much as eight bushels per acre in southwest and west central Minnesota. In addition, some crop residue on the soil surface will decrease runoff and erosion by wind and water. In relatively dry years, chisel plowing may be the best method to successfully reduce populations of perennial weeds and grasses.

Conventional fall moldboard plowing modifies the overwinter soil heat balance and also increases spring soil tem-

peratures. This method of primary tillage is often the best system on somewhat poorly and poorly drained soils which tend to be wetter than desirable for spring moldboard plowing. At planting time, the plow layer in the fall plowed ground is drier and is composed of relatively small aggregates. This provides greater seed-soil contact and more rapid water and nutrient movement to the seed and plant roots.

In addition, fall moldboard plowed land is usually drier at the surface in the spring than land which is untilled in the fall or where surface residues cover an appreciable part of the surface. Shortening the time required for spring tillage is important especially in wet springs because early planting of corn increases yields. Rough moldboard plowing provides a temporary increase in infiltration and protection against runoff. However, fall moldboard plowing generally will not provide protection against erosion the following spring and is not effective in increasing infiltration the following spring due to overwinter weathering which seals the soil surface.

## TILLAGE AFFECTS CROP YIELDS

Most differences in crop yields in tillage studies are related to soil water differences caused by tillage. Average corn and soybean yields for 1974 to 1978 from fall moldboard and chisel plow plots at Lamberton and Morris are shown in Figure 2. During this study period, average crop yields were approximately the same from the two fall tillage systems.

Other tillage practices have been studied at these same locations. No tillage and till-plant practices have been compared with moldboard plow and chisel plow practices between 1974 and 1978. Average corn grain yields from four tillage systems

**Figure 2. Average corn and soybean yields 1974-78 at Lamberton and Morris, MN. Secondary spring tillage included disk, drag, and plant. Primary tillage performed in preceeding fall: m=moldboard, c=chisel plow.**

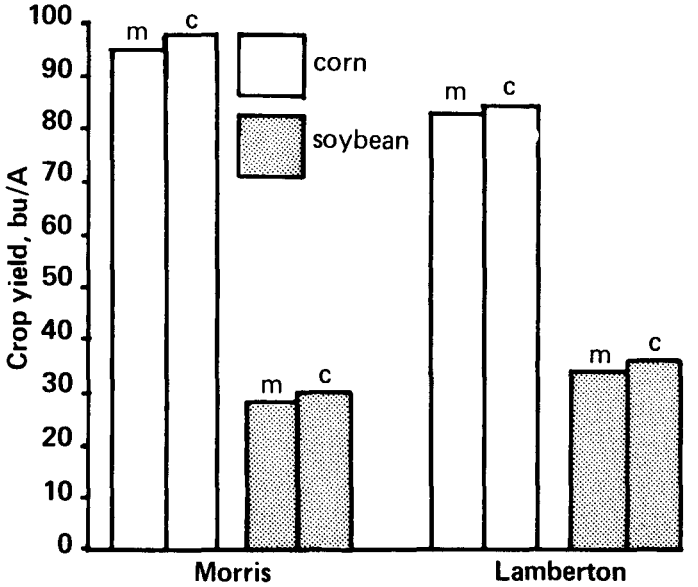
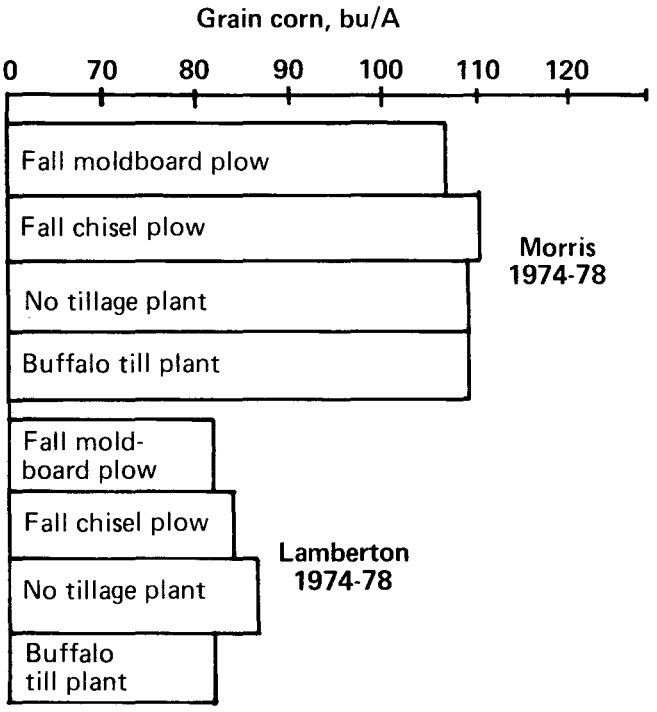



**Figure 3. Average corn yields 1974-78 following soybean at Lamberton and Morris, MN. Secondary spring tillage included disk, drag, and plant. Primary tillage performed in fall.**

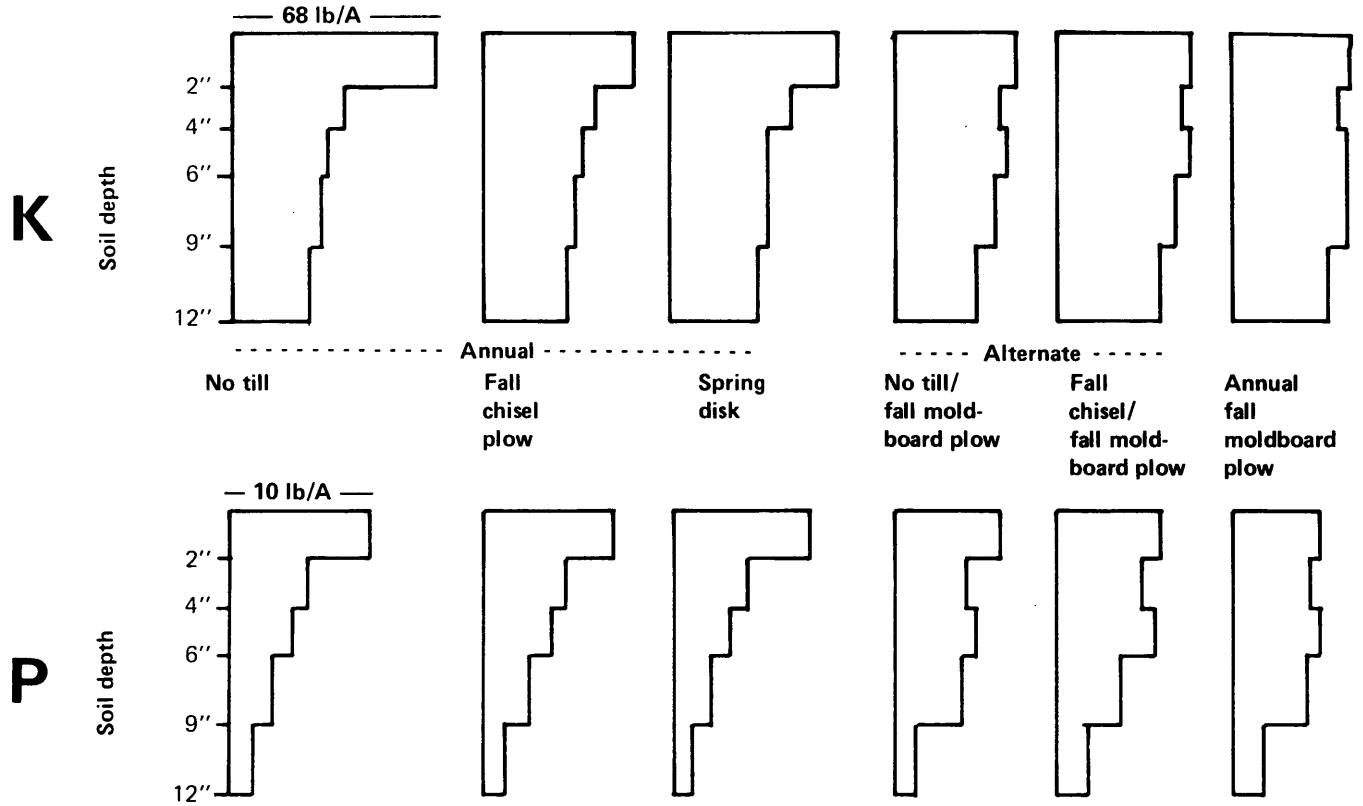



are shown in Figure 3. Corn yields at Morris were approximately the same for all four tillage practices compared. During this same period the surface soil was adequately dry to allow planting to be done on all plots at the same time. Consequently no advantage was recognized on the fall moldboard plowed plots. In a relatively wet spring it would be anticipated that the plots moldboard plowed in the fall would be sufficiently dry for planting before other tillage treatments. At Lamberton, the highest average corn yields occurred on no tillage plots. During this relatively dry study period, no tillage provided some additional stored soil water each spring which contributed to a slight yield increase on no tillage plots.

## TILLAGE AFFECTS FERTILIZER DISTRIBUTION

Several studies have shown that tillage practices strongly affect the distribution of fertilizer in the plow layer. In turn, fertilizer distribution may affect availability of fertilizer to the crop, plant nutrition, and subsequent yield. Research has shown that both phosphorus (P) and potassium (K) distribution in the soil is affected by tillage practices. Figure 4 illustrates the distribution of P and K in Webster clay loam soil at Waseca following three years of tillage in a corn-soybean rotation. With continuous no till, P and K accumulated in the top two inches of soil. This resulted from both minimal mixing of the applied fertilizer and little incorporation of P and K which was being brought to the surface by plant roots. Consequently, much of the fertilizer P and K was unavailable to the growing crop when the surface soil dried below the moisture content at which roots could take up nutrients.

Figure 4. Soil P and K distribution (0-12") as affected by primary tillage treatment in a corn-soybean sequence on Webster clay loam at Waseca, Minnesota.




Other tillage practices which provided little incorporation of P and K were continuous fall chiseling, continuous spring disking and various combinations of these two practices in rotation with no till. Phosphorus and potassium were incorporated and mixed to a depth of 10 to 12 inches when moldboard plowing was practiced in rotation with reduced tillage or chisel plowing. Such practices as fall plowing corn residue in rotation with no till or chisel plowing soybean residue provided good nutrient distribution. Thus periodic plowing to maintain the entire plow layer in the high P and K range should prevent positional unavailability of P and K. Other methods of deep incorporation may also be used on a periodic basis.

## TILLAGE AFFECTS EROSION

Where wind and water erosion is a hazard, the advantages of incorporating surface residue below the soil surface must be balanced against potential increased erosion. A rough surface is initially effective in decreasing runoff. After sealing of the surface due to overwinter freezing and thawing, the roughness is no longer effective in decreasing runoff. Once such a surface has sealed, spring secondary tillage such as disking is of little benefit in increasing infiltration. However, the same result occurs with any bare surface following overwinter weathering except where sizable ridges and furrows are left on the contour. To solve these problems, conservation measures such as chisel plowing and terracing should be considered. Chisel plowing should be done in the fall when the soil is dry and more apt to benefit from the shattering action of the chisel. By mid to late October, the top foot of soil on many moderately fine-textured soils in southern Minnesota is frequently near field capacity. Shattering action is drastically reduced at this water content. Soils in spring in Minnesota are frequently too wet to shatter satisfactorily.

## CONCLUSIONS AND RECOMMENDATIONS

In most years, some fall tillage is necessary on somewhat poorly to poorly drained soils in southwest and west central Minnesota. Tillage practices need to be altered in accordance with post-harvest soil moisture conditions, previous crop yields, plant nutrient distribution in the soil, and the soil erosion hazard. In corn-soybean rotations, chisel plowing will help conserve moisture overwinter when soils are relatively dry following harvest. When soils are relatively wet in the fall and generally wet in the spring, fall moldboard plowing will cause soils to dry and warm faster in the spring. Fall chisel plowing successfully minimizes the potential for erosion on many soils. However, periodic moldboard plowing may be necessary to insure adequate incorporation and distribution of P and K fertilizer. In years with springtime dry soil conditions on well drained soils, no tillage and till planting may provide corn and soybean yields equal to those where moldboard plowing has been practiced.

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