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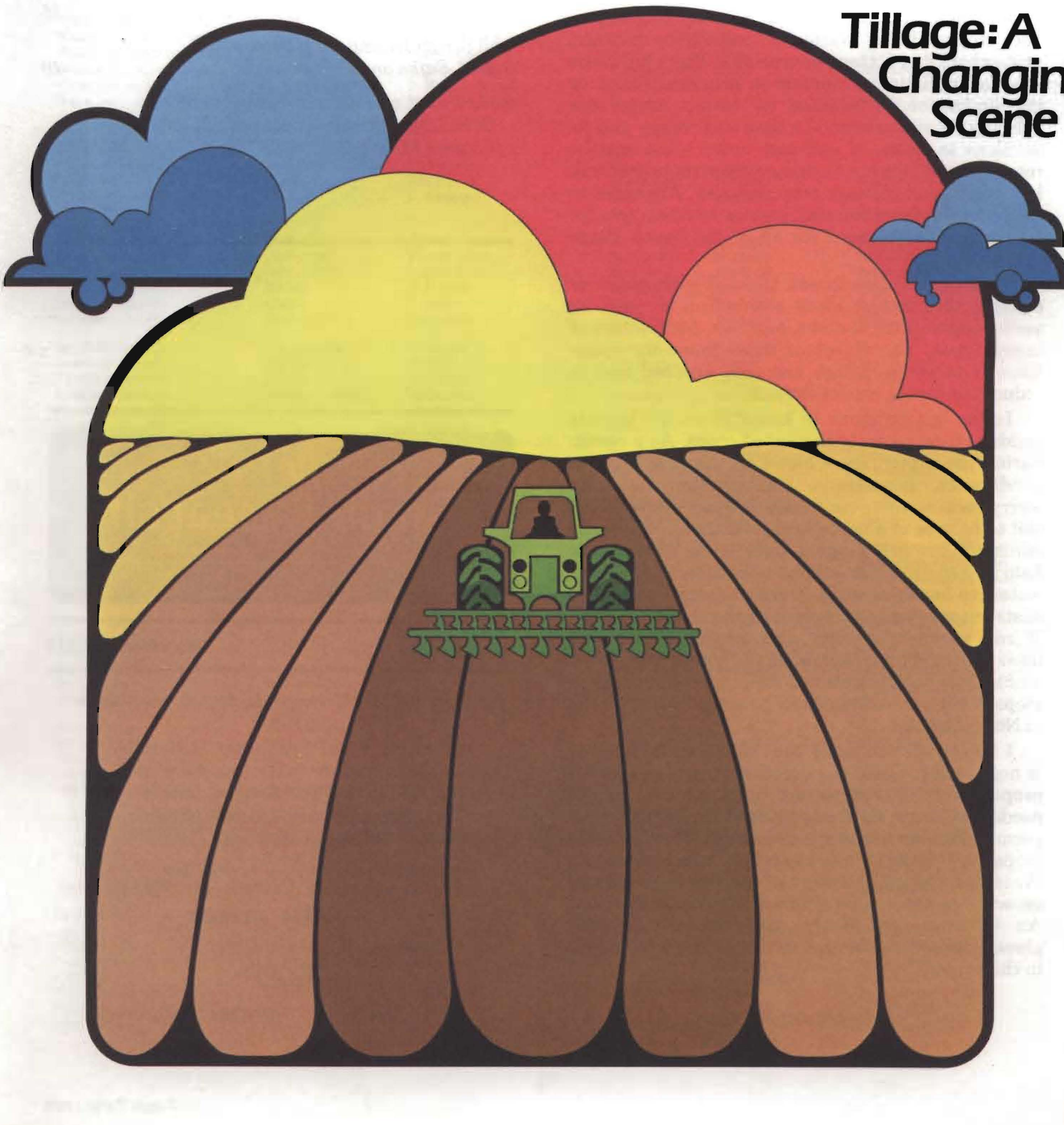
Tillage: A Changing Scene



Guest Column

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The amount and kind of tillage required to produce crops is being examined carefully by farmers, researchers and Extension workers. There are those who feel a distinct reduction in primary tillage, or its elimination, is justified for certain crops considering possible savings in time and energy and reductions in losses of soil and water. Customarily, reasons for tillage are to change the structure of soil, kill weeds, and manage crop residues. Advances in the technologies of farming provide valid choices for farmers as to the need for all of the usual tillage operations.

Traditionally, we loosen the soil with plows or sweeps, then reduce clods and refirm the soil by various operations of disks, harrows, and packers of many types. The object of these follow-up operations is to get a mellow but firm seedbed and to reduce the drying rate of the soil.

In the fall we hurry to knock down the stubble residues from recently harvested crops. As a result, during the winter, snow blows off the field into the windbreaks, farmsteads, and ditches. Then we worry because there isn't enough water stored in the soil to be sure of a successful crop the next year, so summerfallow is the logical thing to do. Because the field is then bare, it is subject to erosion by wind and water, to losses of water from evaporation, and to destruction of soil aggregates by the shearing action of rod weeders, sweeps, and similar implements used duirng summerfallow. If the soil is packed too much it is again loosened before seeding. These steps of tillage are applicable to many cropped soils in North Dakota.

I do not wish to imply that tillage is not good or is not needed. Quite the contrary, many soils have properties such that certain tillage operations are needed to insure good conditions for planting, seed germination, and subsequent growth of roots. Some crops may not be adapted to reduce tillage or no-till. Water infiltration and storage can also be restricted severely in some soils if loosening does not occur. An extreme case of this condition is the deep plowing of soils with pans as described in one paper in this issue.

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Decisions about how much tillage is needed should be based on the best information available. The effects of tillage are many. New research efforts are underway by North Dakota State University and U.S. Department of Agriculture Scientists with objectives to determine these effects and to define conditions causing them. A better basic understanding is needed of factors causing both the desirable and undesirable changes in soils which reflect different physical and chemical properties. With such information, and considering such pest problems as weeds, diseases and insects, farmers and their advisors will predict more correctly the need for various tillage operations and the expected results.

Present day practices of tillage vary from direct seeding of small grain into standing stubble with no prior cultivation by a few farmers and researchers to 12 or 15 operations before planting potatoes, in some cases. The objectives and needs vary for different crops, and conditions of soil and residues must be considered carefully. The possible detrimental effects of repeated wheel track compaction of moist soils cannot be overlooked. Subsequent loosening caused by plowing or chiseling is usually not deep enough to correct all of these problems. Also, what is the influence of a reduction of aggregate size and pore space on soil crusting and root extension? One paper in this issue relates to this question.

Management of crop residues is of major importance in farming where the water supply is not enough to produce crops each year. In many years snow trapped in tall stubble can add enough water to the soil to permit cropping the next year rather than summerfallowing. Longtime accepted procedures of fall tillage to partially incorporate residues and to cover crop and weed seeds may not be necessary or desirable from the viewpoint of available water supply for the next crop. However, many questions are only partly answered and studies are in progress in several areas of the state by researchers in the Department of Soils and at several Branch Experiment Stations. Snow management for improved available water supply is discussed in one paper in this issue.

Cropping systems involving minimum or no-till for certain crops, or that leave crop residues on or in the soil surface, will markedly reduce soil erosion. Other effects of residues on the surface are both positive and negative. These include lower soil temperatures in the seed zone, which may slow germination, but higher water content of the soil which can be a big advantage. In a wet spring seeding may be delayed because of slower drying of the soil. This might not, however, result in a disadvantage if a once-over no-till seeding operation can produce a satisfactory crop. Minimum or no-till can influence needed weed control practices. Research is underway in this area of concern. Minimum or no-till systems will change the placement and time of application options for fertilizers. Anhydrous ammonia injections in standing stubble may be more difficult and some tillage would result. Under conditions where urea nitrogen may be less efficient than other dry forms of N because of possible volatilization losses, application on undisturbed residues can accentuate the problem where incorporation into the soil cannot be done. Phosphorus placement will remain about the same if it is normally applied with the drill or planter. However, broadcast phosphorus followed by minimum tillage will result in residual P being confined to the shallow areas in the soil. Potassium is much the same although it can move into the soil somewhat more than phosphorus.

These observations point out the need for more research on the immediate and long time effects of reduced tillage on fertilization practices. In addition it has been known for many years that surface residues reduce the availability of N in the soil. How much of a factor this is can depend on the amount of residues left on the surfaces after planting. The orientation of residues, whether erect, flat or leaning will influence reflectance and subsequent temperature of the soil. Also, this orientation and degree of residue/soil contact after planting will influence the amount of nitrate nitrogen temporarily tied up in the process of decomposing straw. Many of these effects can be overcome by fertilizer additions and the advantages of less soil losses from a field may outweigh the added costs.

Some have argued in favor of minimum or no-till planting because of energy savings. This point is not as simple as merely evaluating the trips over a field. There will be added energy input into the farming sytem because of probable increased need for fertilizers. Also, herbicides may be enough different, or rates may be changed enough to have a net increase in energy demand. This applies as well to possible increases in disease and insect control activities with associated effects on yield.

The entire system of tillage needs careful evaluation as to the positive and negative effects. For some producers a savings of time by fewer opertions may be worth accepting a small reduction in yield. However, it is apparent that in many circumstances yield increases can result from greater efficiency of water storage and use. There may well be a need to modify the yield potential of plants genetically if residue and temperature effects can be shown as interacting with heritable characteristics.

The capability of farmers to modify tillage systems is much different now compared with a few years ago. Equipment, fertilizers, herbicides, crop varieties, understanding tillage and compaction effects, and concern for water and soil conservation contribute to a changing scene for tillage.

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BULK THIRD-CLASS

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Experiments	Crop	Cooperators	Location: Town	Location: County	Researchers
Coal Mine Reclamation Research***					
Lysimeters	NA	Falkirk Mining Co	Underwood	McLean	Pole-Brown-Brun
Water use-yields	Sp wheat	Falkirk Mining Co	Underwood	McLean	Pole-Brown
Microwatersheds-lysimeter	NA	North Am. Coal Co	Zap	Mercer	Gee-Mont. State U.-Pole
NP rates, placement	Sp wheat	Consolidation Coal	Stanton	Oliver	Gee-Pole
NP rates, placement	Corn	Consolidation Coal	Stanton	Oliver	Gee-Pole
NP rates, time	Grass	Baukol-Noonan	Center	Oliver	Gee-Pole
Pre-mine characterization	Mixed	Falkirk Mining Co	Underwood	McLean	Brown-Pole-Schroer
Runoff-water and soil	NA	North Am. Coal Co	Zap	Mercer	Gilley
Topsoil, P placement	Sp wheat	Knife River Coal	Beulah	Mercer	Gee-Pole
Topsoil, P placement	Corn	Knife River Coal	Beulah	Mercer	Gee-Pole
Water-neutron access tube network	Mixed	5 companies (above)	—	—	Gee-Brown-Pole

Numerous greenhouse, lab, and other expts. not associated with individual cooperators are not included.

NPKS: *nitrogen, phosphorus, potassium, sulfur fertilizers.*

* *Proprietary formulations.*

** *Experiments under irrigation monitored for water and nutrient with some instrumented for very detailed and precise measurements.*

SS: *Saline seep.*

*** *Greenhouse expts. on overburden also conducted at Mandan.*