AGRONOMIC DESIGN

AGRONOMIC DESIGN INSIGHTS

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SOIL TILTH

Growers continually balance eight key agronomic needs: timeliness, crop residue management, soil tilth, seedbed conditions, seed placement accuracy, plant food availability, crop protection and harvest quality. **Soil tilth**, or "the physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergence and root penetration," is the subject of this paper.

Growers know good soil tilth when they see it, or when they feel the sponginess or "give" in their fields. They see large pore spaces, which allow for good air diffusion and water movement. Pore spaces help roots penetrate the soil to take up water and nutrients and enable seedlings to more easily emerge. Soil scientists, like Douglas Karlen, USDA Agricultural Research Service, have argued that the definition is more complex. He suggested that soil tilth be redefined as "tilth-forming processes."* This is because physical, chemical and biological processes combine to bond soil particles into aggregates that create specific tilth conditions.

Agronomic Needs for Successful Stands

* "Soil Tilth: A Review of Past Perceptions and Future Needs," *Soil Science Society of America Journal* (1990), Karlen (et al.)

WHAT'S INSIDE

Why Good Soil Tilth Matters 1-2

Recent Farming Practices Pose Soil Management Challenges 2-3

Adverse Effects of Poor Soil Tilth 3

Mitigating Adverse Factors 3-4

WHY GOOD SOIL TILTH MATTERS

By Tim Nix, Case IH Tillage Marketing Manager

Good soil tilth is important for a number of reasons. It affects all of the processes taking place in the soil matrix, the most important of which is movement of oxygen and water needed for crop growth.

Oxygen Diffusion

Good soil tilth allows for unrestricted movement of air. Oxygen diffusion into the plant's cells is how roots get oxygen for use in respiration. Respiration burns carbohydrates formed during photosynthesis, and produces energy for plant growth.

Good soil tilth promotes the exchange of O_2 and CO_2 between the atmosphere and the soil and roots. Without oxygen, plants cannot grow. This is why saturated soils are detrimental to root growth and why land prone to saturation is generally drained.

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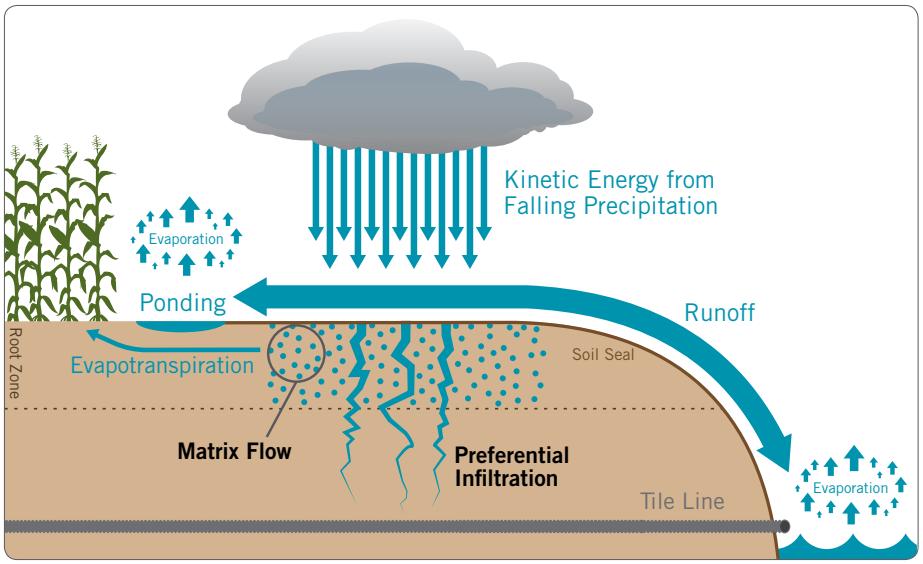
WHY GOOD SOIL TILTH MATTERS [CONT.]

J. Bornstein, agricultural engineer, University of Maine, reported that the exchange of O_2 and CO_2 provides additional benefits, including improved trafficability, lengthening of the growing season, the ability to get onto land safely soon after precipitation, and quicker warming of the soil in the spring.

Water Infiltration

Soil with good tilth has moisture spread throughout. A well-aggregated soil will resist soil sealing that can cause runoff. In compacted soil conditions, water perches above the compaction layer. This restricts proper dispersal of water throughout the root zone and creates anoxic rooting conditions that lose N and threaten plant cell respiration. Recharging the profile to field moisture capacity (when the tile stops running) is preferred. ■



During a rainfall event, some water will run off and some will infiltrate. There are two types of infiltration: preferential infiltration and matrix flow. With preferential infiltration, water will quickly flow down large cracks in the soil and will be lost out the tile line. Conversely, matrix flow is a relatively slow, even movement of water through the soil while sampling all pore spaces.

RECENT FARMING PRACTICES POSE SOIL MANAGEMENT CHALLENGES

By Dr. Rob Zemenchik, Case IH Global Marketing Manager, Agronomy

Agriculture has experienced tremendous growth over the last decade, with many new technologies resulting in record yields and improved efficiencies. At the same time, pressure to produce more food, fuel and fiber with finite natural resources and in weather extremes has resulted in farming practices and trends that pose challenges to soil tilth. But, there are also opportunities to maintain and improve soils with proper management.

Steady Yield Growth

Corn yields continue to trend up, with the U.S. Corn Belt currently averaging 168+ bushels per acre. To support high yields, growers must invest in the proper timing, placement and rates of fertilizer based on soil tests. In the presence of compaction, these test results lose meaning. With good soil tilth, soil test results are reliable because roots have the opportunity to intercept fertilizer as they explore the soil profile. Improved genetics make higher yields possible, but growers must "set the table" with good soil tilth and fertility for genetics to perform to their full potential.

Ultra-High Plant Populations

To maximize corn production, some growers are adopting populations of 36,000 to 40,000 plants per acre in 20-inch or even 15-inch rows. The soil very near the wheel or track path must now accommodate a row. More of the field must be "root friendly."

The Illinois Agronomy Handbook states, "Despite some questions about the yield response expected from narrowing the rows to less than 30 inches, some producers are investing in the equipment needed to make this change. Other benefits to narrower rows may include slightly more yield stability over a range of weather conditions, better suppression of early-emerging weeds, . . ."

Continuous Corn

The trend toward more corn-on-corn production has reduced the frequency of nitrogen-fixing legumes, like soybeans, in the rotation. As a result, the carbon-to-nitrogen ratio of the surface residue mass increases, and the short-term palatability of food sources for slugs, earthworms and ants, is diminished.

With lower life forms such as bacteria, fungi and nematodes, and other small species, crops may require mechanical sizing to achieve an adequate seedbed in northern latitudes in a timely manner.

Weather Extremes

The U.S. Midwest has seen extreme weather patterns of late with the drought of 2012, and the cold winter and spring of 2014.

"More frequent and intense precipitation events, elevated temperatures, drought, and other types of damaging weather are all expected to take tolls on crop yield and quality, making the challenge of feeding an estimated 9 billion people by 2050 exceedingly difficult," says *CSA News*, the monthly member magazine of the Crop

RECENT FARMING PRACTICES POSE SOIL MANAGEMENT CHALLENGES [CONT.]

Science Society of America, in its July 2011 coverage of a joint position on climate change published by The American Society of Agronomy, Crop Science Society of America and Soil Science Society of America.

Producers need more flexibility to maintain or increase soil productivity and adapt to challenging conditions rather than forcing current farm practices in adverse conditions. They need the equipment and technology options to maximize productivity when conditions are suitable. This will allow continued yield improvements and better return on investment from fertilizer seed, and soil preparation.

Renewed Interest in Cover Crops

Cover crops can help capture nutrients and provide ground-cover in the absence of crop residue, especially when residue may be harvested for a market, such as the emerging cellulosic ethanol industry. Deep-rooted cover crops increase water infiltration, reduce surface runoff and improve soil tilth. However, under certain conditions, caution must be taken as cover crops may compete for water or limit soils from warming by intercepting sunlight. ■

ADVERSE EFFECTS OF POOR SOIL TILTH

By Daniel Klein, Case IH Crop Production Marketing Manager

When soil tilth is degraded, aggregate stability is decreased and the risk for compaction increases. Soil particles are pressed together, squeezing out space for oxygen and water and making it difficult for plants to thrive. Too often, normal freeze/thaw cycles are relied upon to solve compaction. The effect is limited by the fact that for ice expansion to eliminate compaction, water must first enter into compacted soil, which is severely limited by the absence of pore space.

Compaction can be classified into three major types:

- ***Hydraulic compaction*** *occurs when soil moisture is at or near field capacity, so whenever possible, producers should avoid operating equipment on wet soil.*
- ***Surface compaction*** *occurs in approximately the top 8 inches of soil, and can be minimized with proper choice of tires, proper tire inflation (minimizing psi on the field), proper weighting and ballasting, as well as by minimizing the traffic loads in the field, covering more ground in a pass and taking fewer passes.*
- ***Deep or subsoil compaction,*** *which ranges from a depth of 12 to 20 or more inches, is the greatest concern because its true impact on yields can be permanent. Axle loads of more than 10 tons per axle can contribute to subsoil compaction.*

Surface Compaction

Deep or Subsoil Compaction

A Pennsylvania State University Extension summary of soil compaction studies in different countries in tilled soils showed first-year yield losses of approximately 15 percent after a severe compaction event. In the absence of re-compaction, yield loss went down to 3 percent. But, the final yield loss was assumed to be a result of subsoil compaction and was considered a permanent yield reduction. ■

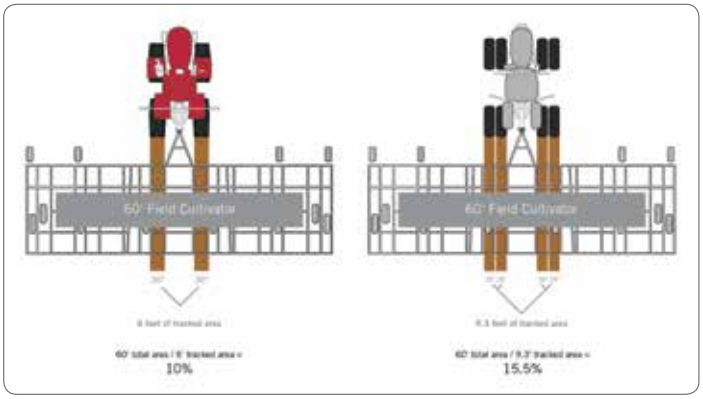
MITIGATING ADVERSE FACTORS

By Zach Hetterick, Case IH Tractor Marketing Manager

Growers can help maintain proper soil tilth, ensure good biological activity and help their crops thrive through proper selection and management of equipment. Agronomists recommend loads of no more than 10 tons per axle to avoid subsoil compaction, as well as spreading the load over more contact area to minimize psi. In addition, high plant populations and narrow windows of favorable weather require growers to consider and control traffic, covering more ground in a single pass and minimizing the number of passes required.

Consider this example:

To cover more ground in fewer passes, a grower purchases a 60-foot field cultivator. To determine which tractor to pull it with, he or she compares a Steiger 620 Quadtrac® to a wheeled tractor with 710/70 R42 duals. For each pass with a 60-foot cultivator, the trafficked area for a Quadtrac with 36-inch belts would be 6 feet, or 10 percent of the total area covered.



For the tractor with duals, it would be 9.3 feet, or 15.5 percent of the total area tilled. The Quadtrac traffics 5.5 percent less of the field, minimizing the potential area for compaction and associated yield loss. And that doesn't even take into account the lower psi associated with the wider footprint the Quadtrac delivers.

MITIGATING ADVERSE FACTORS [CONT.]

The unique Case IH Quadtrac-style track is now available for combines, row-crop and articulated 4WD tractors, delivering superior flotation and full power in turns for superior weight transfer and minimal berming. Each Quadtrac track uses five independent axles (two idler and three roller wheels) helping to better distribute the axle loads of increasingly larger equipment.

Case IH engineers understand the importance of creating a balanced footprint in the field even under load. Patriot® sprayers use a cab-forward, rear-engine design to ensure even weight balance, both when the tank is full and as it empties.

If sub-soil compaction is identified, the Ecolo-Tiger™ combination primary tillage tool's Tiger Points lift, twist and roll soil to fracture deep compaction.

Using Case IH AFS AccuGuide™ autoguidance technology, producers can repeat traffic patterns from year to year.

FIND OUT MORE: Visit **www.CaseIH.com/Agronomic Design** to learn more about agronomic considerations related to soil tilth.