DEEP TILLAGE (AC.) 324

DEFINITION
Performing tillage operations below the normal tillage depth to modify the adverse physical or chemical properties of a soil.

PURPOSES
This practice supports one or more of the following:

- Bury or mix soil deposits from wind or water erosion or flood over wash – Resource concern (DEGRADED PLANT CONDITION – Undesirable plant productivity and health).
- Fracture restrictive soil layers – Resource concern (SOIL QUALITY DEGRADATION – Compaction).

CONDITIONS WHERE PRACTICE APPLIES
This practice applies to land having adverse soil conditions which inhibit plant growth, such as compacted layers formed by field operations, restrictive layers such as cemented hardpans (duripans) in the root zone, over wash or deposits from wind and water erosion or flooding.

This practice does not apply to normal field methods for planned crop production.

CRITERIA

General Criteria Applicable to all Purposes
Perform deep tillage operations when soil moisture is less than 30-50 percent of field capacity, according to the “feel test” or other acceptable method, at the maximum tillage depth to which the tillage will be done. See NRCS Michigan Agronomy 324.1 – Soil Compaction Symptoms, Causes, Correction, and Prevention. And Deep Tillage (324.2) for a description of the “feel test” to determine soil moisture.

Additional Criteria to Fracture Restrictive Soil Layers
Deep till a minimum of 1” deeper than the depth of the bottom of the restrictive layer. Carefully set tillage depth and periodically check that the desired depth is fracturing the tillage pan.

The following agriculturally important soils in Michigan have naturally occurring cemented or dense till horizons or layers below 16 inches:
- Aubarque
- McBride
- Elo

The horizontal extent of the fractured layer, at a minimum, shall be sufficient to permit root penetration below the restrictive soil layer.

Additional Criteria to Bury or Mix Soil Deposits From Wind and Water Erosion or Flood Overwash
Deep tillage operations to invert and mix soil deposits shall be at a depth needed to meet planning objectives.

Soil deposits shall be inverted and mixed a minimum of (2x) the depth of the deposited material.

CONSIDERATIONS
Include deep-rooted (bio till) crops in the rotation that can penetrate the restrictive layer and mimic the effects of deep tillage.

Reduce or control equipment traffic during periods when soils are prone to compaction and formation of tillage pans. Exercise caution when excessively heavy equipment is used on soils that are prone to compaction. Equipment loads greater than 6 tons/axle can cause compaction to depths of approximately 16 inches deeper than normal tillage and may cause yield reductions for several years. (especially on soils with high clay content)

Reducing contact pressure between the load and the soil may be helpful to reduce compaction. Typical bias-ply tires require excessive inflation pressures which can concentrate the loads on the soil surface and cause excessive soil compaction. Radial tires offer superior soil compaction and traction characteristics when properly inflated to the manufacturer’s specifications. Other methods that can be used to further spread the load and potentially reduce soil compaction include using dual tires or tracks beneath tractors, grain wagons, slurry tanks,
etc. Research on numerous crops has shown that tillage conducted deeper than the compacted layer:

1. does not increase yields
2. requires excessive amounts of tillage energy
3. promotes future compaction from nearby vehicle traffic.
4. increases Carbon Dioxide and Nitrogen Oxide emissions
5. decreases soil organic matter

To reduce development of compacted restrictive layers, conduct normal tillage operations when soil moisture is less than 50 percent of field capacity. Avoid harvest operations when soil moisture is greater than 50 percent of field capacity. Limit field harvest haul traffic to end rows or haul roads. Compaction zones between rows can assist in supporting vehicle traffic, limit rutting and soil compaction beneath the row.

To help reduce compaction, it is desirable to conduct normal tillage operations when soil moisture is less than 30 percent of field capacity. Moisture content has the greatest influence on the amount of compaction produced by a given axle load pressure.

Improve drainage with surface and subsurface drainage to improve soil moisture content and increase the number of days for field operation with minimal compaction.

Consider using triple tires when soil moisture content is between 26-30 percent moisture capacity on Michigan soil management groups 2.5, 1.5, 1, and 0 to minimize economic yield loss. Yield loss from soil compaction with triple tires starts showing up at 34 percent soil moisture capacity. Consider using dual tires when soil moisture content is 19-25 percent moisture capacity on Michigan soil management groups 2.5, 1.5, 1, and 0 to minimize economic yield loss. Yield loss from soil compaction with dual tires starts showing up at 26 percent moisture capacity.

Consider using single tires when soil moisture content is 18 percent moisture capacity or less on Michigan soil management groups 2.5, 1.5, 1, and 0 to minimize economic yield loss. Yield loss from soil compaction with a single tire starts showing up at 18 percent moisture capacity.

Reduce surface soil pressure with wider tires and duals.

When possible, harvest operations should be avoided when soil moisture is greater than 50 percent of field capacity. Field harvest haul traffic should be limited to head lands or haul roads. Compacted regions between crop rows that are not fractured can assist in supporting vehicle traffic, limiting rutting and soil compaction beneath the row. Substitute lighter equipment for heavier equipment for any operation.

Freezing and thawing do not correct deep compaction immediately. It may take as long as 3-5 years on some soils.

When infertile flood over wash is mixed with the pre-flood soil profile, the soil rebuilding process can be enhanced by additions of organic matter, such as manure or cover crops. Crop rotations, tillage and planting systems, such as no-till, that maintain high levels of crop residues, can accelerate this process.

Where the flood overwash layer is too thick to effectively mix with the pre-flood soil profile, thin the over wash layer by smoothing or removing with heavy equipment. Generally, about 6 inches of over wash can be uniformly mixed into the soil profile using commonly available equipment. To incorporate greater depths of over wash, specialized equipment may be needed.

Do not use deep tillage where unfavorable soil materials such as high sodium, calcium, gypsum, or other undesirable materials are within anticipated deep tillage depth and brought to the surface by deep tillage.

Transport of sediment-borne pollutant(s) offsite can be reduced when this practice is used in a conservation management system by reducing the concentration of pollutants in the surface layer.

Moldboard plows and large tandem disks, when used to bury and mix soil deposits can have a destructive effect on soil physical characteristics. These implements create conditions ideal for soil compaction to occur. Chisels with twisted points have a slightly less destructive impact.

Disruption of the soil surface is not desired and should be minimized where possible through proper selection of shanks. Excessive disturbance of the soil surface can cover plant residues which should be maintained on the soil surface to intercept rainfall and impede surface runoff.

NRCS Michigan
October 2014
Add organic matter to improve soil structure and improve soil bearing capacity and water infiltration by growing more small grains, green manure crops (red and sweet clover), deep-rooted crops, applying animal manure or adopting no till.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the selected conservation practice purposes, criteria and condition and considerations in this conservation practice standard.

Record practice design using approved Implementation Requirements document

OPERATION AND MAINTENANCE

On fields with subsurface drainage, deep tillage can damage shallow tile lines. Try to maintain a minimum of 1 foot between the tip of the deep till equipment and the top of the tile lines to keep from fracturing or crushing tile.

Evaluate effectiveness of deep tillage field operations applied for fracturing restrictive layers or mixing soil deposits and adjust plan if needed and reapply deep tillage when these field conditions reoccur.

REFERENCES


USDA, NRCS. 1996. Soil Quality Information Sheet: Sediment deposition on cropland.


ELECTRONIC REFERENCES

http://www.nrcs.usda.gov/technical/efotg/

Michigan, Electronic Field Office Technical Guide (eFOTG), Section IV, Conservation Sheets, Agronomy. 2007. Soil Compaction Symptoms, Causes, Correction, and Prevention, (324.1); Deep Tillage (324.2);

Michigan, Electronic Field Office Technical Guide (eFOTG), Section I, References, Technical Notes:
- Agronomy 41; Narrow Strip-cropping
- Agronomy 42; Effect of Controlled Released Nitrogen on Corn in Narrow Strip-cropping
- Agronomy 50, Radish Cover Crop
- Agronomy 51, Radishes, a New Cover Crop

USDA, NRCS. October 2014