Deep Tillage (Acre) 324

DEFINITION

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

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following:

- Fracture restrictive soil layers.
- Bury or mix soil deposits from wind or water erosion or flood overwash.
- Reduce concentration of soil contaminants, which inhibit plant growth.

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 claypans, overwash or deposits from wind and water erosion or flooding, or contaminants in the root zone.

This practice includes tillage operations commonly referred to as deep plowing, subsoiling, ripping, row-till, zone tillage or para plowing, etc. performed from time to time below the normal tillage depth.

CRITERIA

General Criteria Applicable to all Purposes

Perform deep tillage operations when soil moisture is less than 30 percent of field capacity, according to the "feel test" or other acceptable method, at the maximum tillage depth needed to remove the root restricting soil layer. See NRCS Michigan Agronomy Conservation Sheet 324.1 – Soil Compaction Symptoms, Causes, Correction, and Prevention.

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.

Depending on the purpose, subsoiling is performed with a single or several shanked, subsoiling tool.

Perform deep tillage if compaction is deeper than 12 inches.

Additional Criteria to Fracture Restrictive Soil Layers

Tillage equipment such as chisels, subsoilers, bent-leg subsoilers, or rippers, with the ability to reach the required depth, shall be used.

Deep till a minimum of one inch 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*.

Complete fracturing of the restrictive layer is not required. The fractured zone, as a minimum, shall be sufficient to permit root penetration below the restrictive soil layer. The fractured zone does not need to extend to the row middles and should be limited to the area near the rows [in the case of crops broadcast-planted or drilled in narrow rows (less than 15 inches), the fractured zone may be disrupted completely].

The following soils in Michigan have naturally occurring cemented horizons or layers below 16 inches:

Baraga	Gogebic	Saugatuck
Champion	Iron River	Skanee
Channing	McBride	Stueben
Elo	Munising	Wakefield
Finch	Ogemaw	Yalmer

Fall tillage after deep tillage is not permitted.

Tilling after deep tillage will speed up sealing of the shattered area.

Additional Criteria to Bury or Mix Soil Deposits From Wind and Water Erosion or Flood Overwash

Tillage equipment such as moldboard plows, disk plows, or chisels with twisted points, with the ability to reach the required depth, shall be used.

The tillage operation shall uniformly mix soil 6 inches, or 2 times the depth of overwash, whichever is deeper, to achieve a desired available water-holding capacity (AWC) and to break the hydrologic barrier caused by overwash layer.

Additional Criteria to Reduce Concentration of Soil Contaminants Which Inhibit Plant Growth

Tillage equipment such as moldboard plows, disk plows, or chisels with twisted points, with the ability to reach the required depth, shall be used.

The tillage operation shall mix a sufficient amount of uncontaminated soil with the contaminated material so that the concentration of the contaminant is below the crop tolerance level. Crop tolerance levels shall be established in accordance with Land Grant University guidance and recommendations.

The soil contaminant shall be uniformly distributed throughout the deep-tilled layer.

As a minimum, it will require 3 times more uncontaminated soil to mix with the contaminated layer.

CONSIDERATIONS

Where restrictive layers are a concern, the effects of this practice can be enhanced by including deep-rooted crops in the rotation that are able to extend to and penetrate the restrictive layer.

Research on numerous crops has shown that tillage conducted excessively deeper than the compacted layer does not promote increased yields, requires excessive amounts of tillage energy, and promotes future compaction from nearby vehicle traffic.

Reduce or control equipment traffic during periods when soils are prone to compaction and formation of tillage pans. Reduce tillage *passes across* the field.

When infertile flood overwash 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, which maintain high levels of crop residues, such as no-till, can also accelerate this process.

Where the flood overwash layer is too thick to effectively mix with the pre-flood soil profile, redistribution of the overwash layer by smoothing or removal may be necessary. Generally, no more than about 6 inches of overwash can be uniformly mixed into the soil profile using commonly available equipment. Specialized equipment may be necessary where greater depths of overwash are to be incorporated.

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 would be brought to the surface by deep tillage operations.

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.

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.

Add organic matter to improve soil structure by growing more small grains, green manure crops (red and sweet clover), deep-rooted crops, or applying animal manure.

If application of this practice will impact cultural resources (archaeological, historic, historic landscape, or traditional cultural properties), follow NRCS national policy and state operating procedures for considering cultural resources.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the Criteria, Considerations, and Operation and Maintenance (O&M) described in this practice.

The minimum documentation for this practice as applied is:

- *Cultural Resource Evaluation completed first.*
- Location map.
- Time of year for deep tillage.
- Type of investigation to determine the need.
- Depth of deep tillage.
- Soil moisture conditions.
- O&M plan to prevent future soil compaction.

OPERATION AND MAINTENANCE

Deep tillage for reduction of soil compaction shall be performed whenever compaction reoccurs.

Investigate soil profile and observe symptoms.

When deep tillage has been performed to reduce the concentration of soil contaminants, the contaminant levels in the root zone shall be monitored to assist with determining when or if treatment will be reapplied.

Prevent recurrence of soil compaction.

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).

Michigan Electronic Field Office Technical Guide (eFOTG), Section IV, Conservation Sheets, Agronomy. 2007. Deep Tillage (324.2).

Michigan Electronic Field Office Technical Guide (eFOTG), Section I, Cultural Resources Information Contacts for Michigan.