IS SOIL COMPACTION FROM ANIMAL TRAFFIC A PROBLEM IN PASTURES

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SOIL COMPACTION DEFINED

Compression of the soil from an applied force that first re-arranges and then destroys aggregates increasing bulk density and reducing porosity

- Wheel traffic from field operations
- Tillage
- Livestock
COMPACTION IS A PROCESS
Soil compacts when load-bearing strength of soil is less than load being applied.
WHICH IS WORSE - PRESSURE OR LOAD?

High PSI, but small load  
Low PSI, but large load

THE LARGER THE LOAD  
THE DEEPER THE COMPACTION EFFECT
“COMPACTABILITY” INFLUENCED BY WATER CONTENT

- VARIES BY SOIL
- MAXIMUM NEAR FIELD CAPACITY
- DRY SOIL HAS MORE STRENGTH
- SATURATED SOIL NOT COMPACTABLE
WHEEL-TRAFFIC COMPACTION IS AN ISSUE

- Larger equipment
- Earlier field operations
- Loss of forage in rotation
- Operations on wet soils
- Time management
- Uncontrolled traffic
- Brain cramps
QUANTIFYING COMPACTION

- Crop and Soil Symptoms
- Penetration Resistance
  - Moisture Dependent
  - No Absolute Value
  - Note Depth and Relative Force
  - Compare Good and Bad Areas
- Bulk Density
  - Mass per Volume
  - Inversely Related to Porosity
  - Texture Dependent
“Cloddy” soil following corn silage harvest
Stunted, uneven growth is often the first symptom
"Pancake" root mass
Many pastures are converted cropland and may have a plow layer.
The shovel is an excellent diagnostic tool.
MEASURING PENETRATION RESISTANCE

Hand-held penetrometer

Soil probe
CONSTANT-RATE RECORDING PENETROMETER
Wheel traffic compaction is a problem in forage production.
## EFFECT OF COMPACTION ON SOIL BULK DENSITY OF A SILT LOAM SOIL

<table>
<thead>
<tr>
<th>DEPTH (in)</th>
<th>COMPACTION</th>
<th>1991 (g/cc)</th>
<th>1992 (g/cc)</th>
<th>1993 (g/cc)</th>
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</thead>
<tbody>
<tr>
<td>0-6</td>
<td>NONE</td>
<td>1.19</td>
<td>1.30</td>
<td>1.32</td>
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<tr>
<td></td>
<td>14 t</td>
<td>1.36</td>
<td>1.41</td>
<td>1.40</td>
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<tr>
<td>6-12</td>
<td>NONE</td>
<td>1.31</td>
<td>1.33</td>
<td>1.31</td>
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<tr>
<td></td>
<td>14 t</td>
<td>1.59</td>
<td>1.50</td>
<td>1.52</td>
</tr>
<tr>
<td>12-18</td>
<td>NONE</td>
<td>1.19</td>
<td>1.35</td>
<td>1.33</td>
</tr>
<tr>
<td></td>
<td>14 t</td>
<td>1.45</td>
<td>1.44</td>
<td>1.33</td>
</tr>
<tr>
<td>18-24</td>
<td>NONE</td>
<td>1.36</td>
<td>1.35</td>
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<tr>
<td></td>
<td>14 t</td>
<td>1.40</td>
<td>1.34</td>
<td>1.33</td>
</tr>
</tbody>
</table>

Compacted April 1991 and seeded to alfalfa
K SOIL TEST AND ALFALFA YIELD ON A COMPACTED SOIL (sum of 3 yrs.)

Arlington, Wis., 1994
DON'T COUNT ON MOTHER NATURE TO CORRECT COMPACTION
WADSWORTH TRAIL, MINNESOTA

Sharratt et al., 1998

SOIL BULK DENSITY (g/cc)

RUTS

OUTSIDE

10-12 in
8-10 in
6-8 in
4-6 in
2-4 in
0-2 in
WHAT FACTORS AFFECT SOIL COMPACTION IN PASTURES

• ANIMAL TYPE
• STOCKING RATE
• SOIL TYPE
• SOIL MOISTURE AND DRAINAGE
• TRAFFIC PATTERNS
• FORAGE TYPE
• AREAS OF CONCENTRATION
• PLANT DAMAGE
Compaction and soil degradation in riparian areas increase P loss to surface water.
MALWEG PASTURE STUDY - 2004

• FIVE SITES (SO FAR)
• GPS GRID CREATED OVER FIELD
  - APPROX. 20 SAMPLE POINTS PER FIELD
  - SOIL SAMPLE 0-1, 1-6 in.
  - BULK DENSITY
  - PENETROMETER RESISTANCE
EXAMPLE DATA FROM A DANE COUNTY FARM

- PASTURE FOR THE PAST 10 YEARS
- SOUTH AND NORTH PASTURES
- NORTH NOT GRAZED PRIOR TO SAMPLING
  - WAS CUT FOR HAY IN JULY
- NORTH SAMPLED IN SEPTEMBER
  - WEST 1/3 WAS GRAZED THE DAY BEFORE
  - 6 HOURS, 80 HOLSTEIN COWS
- SOUTH ALSO SAMPLED AT THIS TIME
CLOSE-UP VIEW OF AN ORCHARD GRASS PASTURE FOLLOWING 6 HR. GRAZING BY 80 HOLSTEIN COWS

DOES THIS LEVEL OF GRAZING PRESENT AN EROSION RISK?
# Soil Test Levels in Two Southern Wisconsin Pastures

<table>
<thead>
<tr>
<th>SITE</th>
<th>DEPTH</th>
<th>pH</th>
<th>O.M.</th>
<th>P</th>
<th>K</th>
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</thead>
<tbody>
<tr>
<td>NORTH</td>
<td>0-1</td>
<td>6.2</td>
<td>5.8</td>
<td>47</td>
<td>156</td>
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<td>1-6</td>
<td>6.5</td>
<td>3.0</td>
<td>14</td>
<td>82</td>
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<tr>
<td>SOUTH</td>
<td>0-1</td>
<td>5.7</td>
<td>6.8</td>
<td>45</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>1-6</td>
<td>6.2</td>
<td>3.6</td>
<td>19</td>
<td>64</td>
</tr>
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### Field Average Bulk Density, Porosity, and Water Content

<table>
<thead>
<tr>
<th>Depth</th>
<th>Bulk Density</th>
<th>Porosity</th>
<th>Water Content</th>
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</thead>
<tbody>
<tr>
<td>0-4 in.</td>
<td>1.27 g/cc</td>
<td>52 %</td>
<td>35 %</td>
</tr>
<tr>
<td>4-8 in.</td>
<td>1.34 g/cc</td>
<td>50 %</td>
<td>33 %</td>
</tr>
</tbody>
</table>

*South pasture*
COMPARISON OF GRAZED vs. UNGRAZED CONDITION

UNGRAZED
North pasture

GRAZED
PENETROMETER RESISTANCE FOLLOWING 6 HOURS OF GRAZING BY 80 HOLSTEIN COWS
**PENETROMETER RESISTANCE (MPa) AT 4 cm AS AFFECTED BY GRAZING**

<table>
<thead>
<tr>
<th>UNGRAZED</th>
<th>GRAZED</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.15</td>
<td>1.76</td>
</tr>
<tr>
<td>1.23</td>
<td>1.33</td>
</tr>
<tr>
<td>1.16</td>
<td>1.24</td>
</tr>
<tr>
<td>0.81</td>
<td>1.37</td>
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</table>

*North pasture (each value is the mean of three probes)*
# PENETROMETER RESISTANCE (MPa) AT 8 cm AS AFFECTED BY GRAZING

<table>
<thead>
<tr>
<th></th>
<th>UNGRAZED</th>
<th>GRAZED</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.98</td>
<td>1.90</td>
<td>2.54</td>
</tr>
<tr>
<td>1.34</td>
<td>2.09</td>
<td>1.78</td>
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<tr>
<td>1.85</td>
<td>1.30</td>
<td>1.69</td>
</tr>
<tr>
<td>2.03</td>
<td>2.45</td>
<td>1.90</td>
</tr>
</tbody>
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North pasture (each value is the mean of three probes)
GUIDELINES FOR MANAGING SOIL COMPACTION IN PASTURES

• Minimize Stocking Time on Wet Soils
• Evaluate and Monitor Crops and Soil
• Soil Test to Assure Adequate Fertility
• Use a Reasonable Rotation Scheme
• Control Heavy Vehicle Traffic
• Address Compaction Issues When They Occur
I've got plenty of common sense!

I just choose to ignore it.