Why do we till soils?

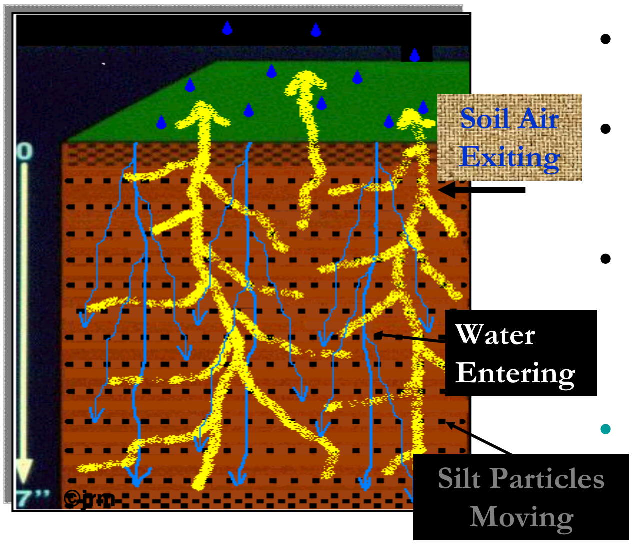
Do any of these tillage, including no-tillage, strategies do the job?

Why do we till agricultural soils? This next series of discussion slides are designed to specifically help us understand the real reasons behind tillage. We have very typically looked at tillage as something necessary to control weeds, resize or even bury plant material, provide a seedbed for successful planting operations or some other cosmetic features achieved by tilling.

Over the years with the experiences I have had using the soil aerator technology that began in New Zealand in the 1970s, I have come to the point of redefining tillage in my own mind. And I want to share it here with you.

I have concluded that what constitutes tillage has absolutely nothing to do with the physical appearance after I have performed the tillage operation. My hope is that you will be able to share in the understanding and the vision which I have for redefining tillage in the years ahead. The result of this changed perception has been nothing short of amazing for nearly all who have received the vision for what can be achieved..

Thank God It Rains…..But When it Does, it Changes Things



- Conventional tillage performed
- Soil silt particles evenly distributed
- Rapid diffusion of water throughout the plow-payer
- **Deep, purging of soil air**

©jrm

One of the things which most farmers and helping professionals have noticed is that over time which, hopefully includes rainfall, our agricultural soil's seem to change in their ability to transport water. Of course, many of us have attributed this to a hard surface. And we have rightfully attributed the hardening of the surface to traffic from machines and cattle and the hammering of the raindrops themselves.

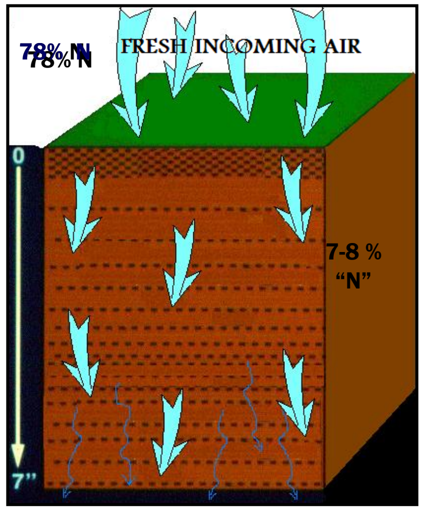
All of these contributing factors are true enough. However, I have been privileged to observe through the experiences with clients over many years that soils are effected in their ability to transport water by something else which operates internally rather than on the surface.

The cumulative effects of this resistance to water movement can be seen in perennial forage crops where low areas produce early death of certain plant species. In annual crops such as corn and small grains certain areas of the field may retain large amounts of water apparent on the surface for longer periods of time and result in shorter straw in those areas.

Whatever it is that we are effectively doing with what we have come to know as conventional tillage techniques, recreates the capacity of soils to take water in quickly, move it uniformly and efficiently through the topsoil while purging air which is high in waste gases and refresh the soil with new air from above the ground atmosphere.

When the Rain Stops….

- Free water continues downward- IDEALLY
- Leaves partial pressure behind or above
- Atmospheric pressure pushes “fresh air” into soil
- Brings a “Breath of Life” to all the good guys



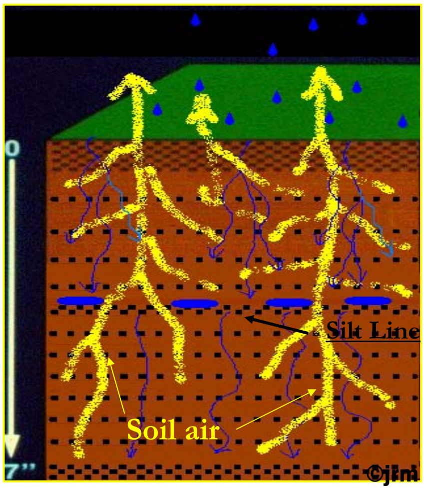
The fundamental purpose for all water movement is the changing of soil air. The fact that the technology that we are presenting in this context is called soil aeration however, is a misnomer. The air movement is strictly a result of preceding water movement.

Think of the difference between the concentration of nitrogen in above ground atmosphere and the normal soil atmosphere of soil. Above ground atmosphere is nearly 78% elemental nitrogen. Whereas, a normal soil at rest will contain between 7% and 8% nitrogen in the soil atmosphere.

As the water follows passageways through macro pores in the soil it is purging low concentration nitrogen soil atmosphere from the topsoil profile. In its wake the partial pressure created allows air containing high concentrations of CO_2 and nitrogen to enter the soil profile.

These are the required gaseous nutrients for the reproduction of soil microbes and fungi. And this is the foundation of all natural fertility arising from a healthy and growing mycorrhiza. This process is the foundation of soil nitrogen mineralization. Our tillage practices set a pattern for this mineralization rate.

And Then it Rains Some More- We Hope



- Silt particles travel with the free-water <u>**DOWNWARD**</u>
- Where water speed <u>**drops**</u> so does the <u>**silt**</u>
- <u>**Water**</u> percolation rate through silt is reduced
- <u>**Air**</u> purging from below the silt line is reduced

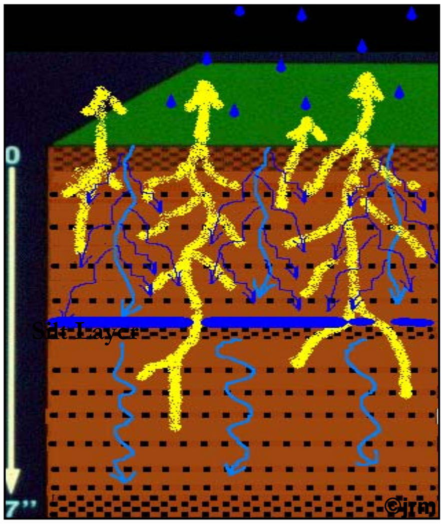
Now as this water movement continues through subsequent precipitation events, the soil experiences a particle size separation or centrifuging action due to the density of the water and the density of the soil particles contained in the plow layer.

This is observable quite readily in the study of streambed formation. The only real difference between streambed formation and silt migration and accumulation phenomenon in topsoil is the orientation of the process. Streambed formation takes place in a horizontal plane whereas soil aging takes place vertically.

Since silt sized soil particles are almost identical in density to water, when the water moves downward, silt particles move with the water. When the water speed is reduced the silt particles drop from the water. The resulting structural change is called here silt layering or line formation. Each time a rain or precipitation event occurs additional silt is transported and dropped in normally the same location.

For as long as the silt accumulation is relatively minor deep air changes take place and relatively small amounts of water are held or suspended on the density layer composed of the silt particles.

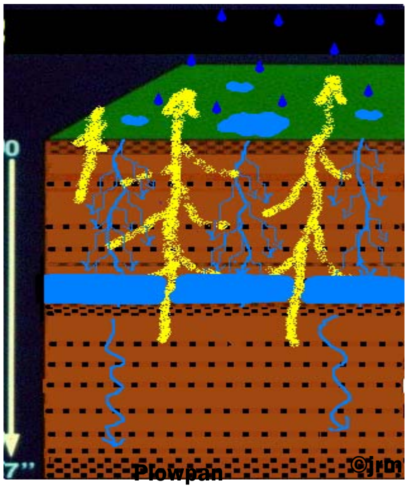
Then We Hope it Doesn't Rain Too Much



- The free-water keeps on moving more silt to the same location
- The pore spaces are getting fewer and smaller
- Less field capacity; slower percolation
- Less soil air purged
- Less incoming fresh air and slower rate of air exchange
- Straight-jacket time**

As time goes on and additional precipitation moves increasing amounts of silt producing a more continuous formation of silt, the air exchange and water movement below this line are restricted. The pore spaces which normally would make for rapid air and water exchange are being slowly but inevitably filled with silt particles. The direct result of that is what I call the straitjacket syndrome. Instead of breathing freely and deeply, now the soil begins to take very shallow breaths.

Now we start to See the Problem…

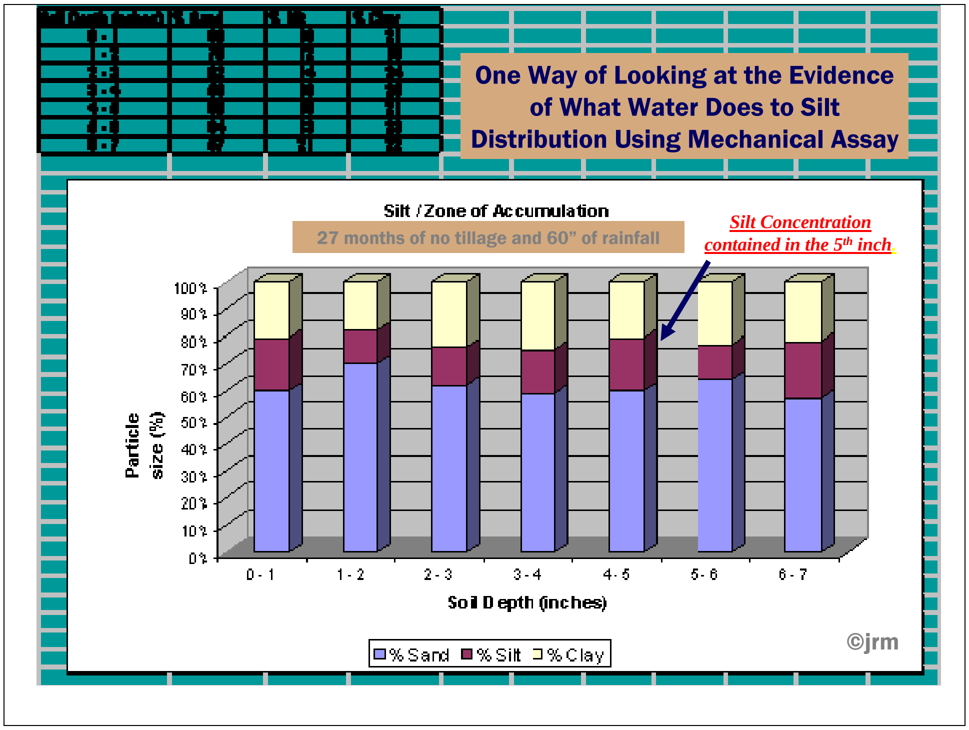


- Surface ponding appears
- Greatly restricted water percolation at silt line
- Little air exchange under silt line
- Soil spends more time anaerobic
- Field depressions become wet-holes
- The silt density layer is still only a fraction of an inch thick

Now as we approach approximately 60 cm of precipitation, the internal condition of the top soil profile becomes apparent. Some of the first signs will be water accumulation on the surface in low-lying areas of the field. Other indications are wheel tracks that have water sitting in them.

Now unfortunately the silt accumulation has progressed to the point where water is accumulating above and air is restricted underneath the layer so that the two cannot exchange places. Anaerobic soil conditions occur now on a regular basis whenever precipitation occurs. In certain species of plants death begins to occur. Other species begin to encroach which are more well suited to having wet feet or grow better in soil which is producing products from anaerobic microbial respiration.

The result will be that before long the field will need to be tilled.



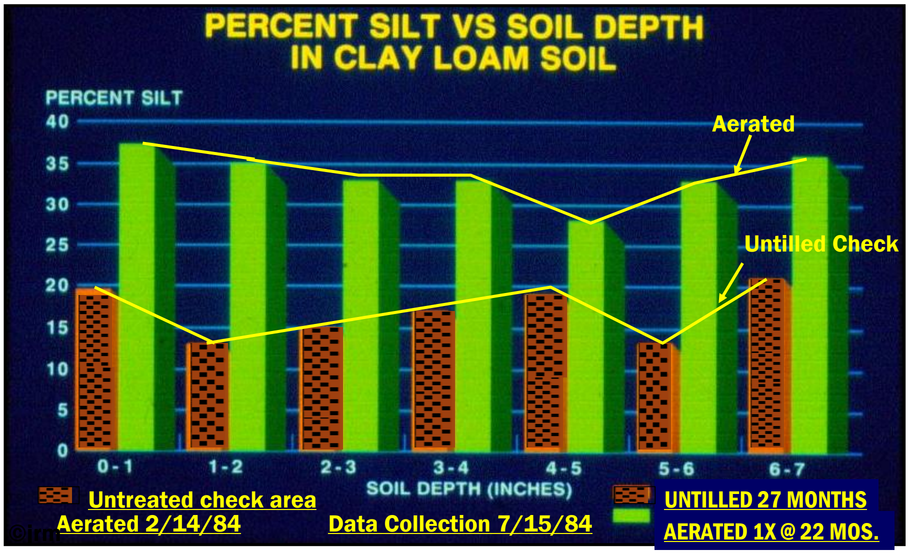
Now back to the story where we began with standing water on an alfalfa field that was not yet two year old. My friend Donald was certainly not ready to see up to 35% of his field destroyed by water that just would not percolate into his soil. So in a desperate move, though insightful move, he determined that if he merely produced a hole through the surface into the profile he could evacuate the water and rescue the alfalfa plants.

Everything you have heard me discussing at this point concerning silt migration and accumulation was developed from a very simple procedure known as a mechanical assay. What you see displayed here are the results of doing a mechanical assay for each 2 cm of topsoil down to the plow layer at approximately 14 cm. The purple band in the bars indicates the percentage of silt found in each inch.

I wish I had had had the financial resources necessary to evaluate each half centimeter or even 3 mm depth. Restricting the amount of soil evaluated for silt percentage would, in my estimation, have identified the layer much more exactly and demonstrated a huge increase in the percentage of silt found in the specimen. This particular set of analyses were performed on soils that were not mechanically disturbed during the February experience. The samples were taken from the area of the field we called the untilled check.

Bear in mind that, more than likely the layer of silt identified in the troubled core, was probably only a fraction of a millimeter thick.

FIVE MONTHS PLUS SPRINGTIME RAINFALL (8 TO 10 INCHES) CHANGED THINGS



In this chart we have diagrammed only the percent silk found in each sample. What we have displayed however also shows the results of samples taken from the treated and check areas of the field.

The result will indicate to you that the silt was redistributed when the tillage procedure was performed. The brown bars indicate the data from the previous display. Interestingly those areas of the field which were treated did not accumulate any evidence of standing water phenomenon for another year of production.

The variation in the percent silt shown here in the chart merely relates to the normal distribution differences within the field area.

Foundational Knowledge

- The physical location of silt-sized soil particles changes with transport of water
- Collected silt soil particles produce a barrier to air and water transport/exchange
- All forms of tillage must be deep enough address this silt barrier or they are not effective
- Doing **no tillage** fails to address the problem in anyway

So to summarize what we've learned from that experience and from some good simple agronomic analyses is that tillage does not necessarily have anything fundamentally to do with what a field looks like once we've completed the operation.

So in my mind I have redefine tillage. It no longer has any relationship to appearance. Tillage to me now means that I have effectively in the process of tilling restored the soil's ability to exchange air and water.

To effectively perform tillage I must address the silt accumulation phenomenon. That means that my operation called tillage must be deep enough, must be frequent enough, and be of sufficient other characteristics that the soil will be restored to normal water and air movement.

I want to caution my audience now, that every tool that says it is or looks like it is a soil aerator REALLY is one. Simply making a hole in the soil that is deep enough and doing it often enough does not necessarily constitute tillage that meets the requirements of the new definition which I have offered here. Beware.