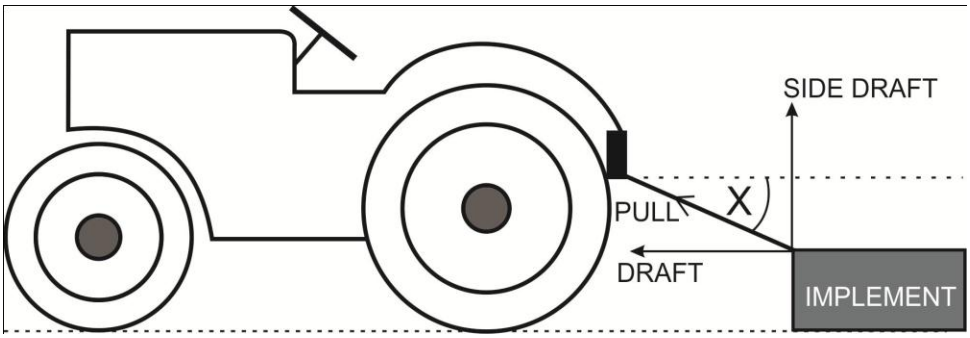
2. Soil dynamics for tillage

Some definitions related to tillage

Pull – The total force exerted upon the implement by the tractor. Generally at some angle above the horizontal may or may not be parallel to the line of motion.



Draft – Horizontal component of pull parallel to the line of motion

Side Draft – Vertical component of the pull perpendicular to the line of motion

Specific Draft – Draft per unit area of tilled cross section.

Usually in N/cm2

Draw bar power (DBP) – Power actually required to pull the implement at uniform speed.

Forces acting upon a tillage tool

A tillage implement moving at a constant speed is subjected to three main forces that must be in equilibrium.

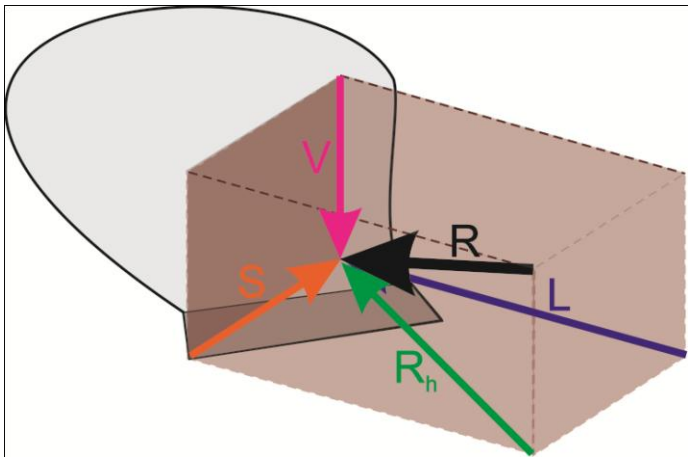
1. Force of gravity acting upon the implement
2. Forces acting between the implement and the tractor
3. The soil forces acting upon the implement

<u>Soil forces</u>

- Useful soil forces
- Parasitic soil forces

Useful soil forces – tool must overcome the forces in cutting, lifting, breaking or pulverizing and turning the soil

Parasitic forces – Frictional and rolling resistant forces that act upon stabilizing such as land side and sole of a plow or upon supporting wheels.



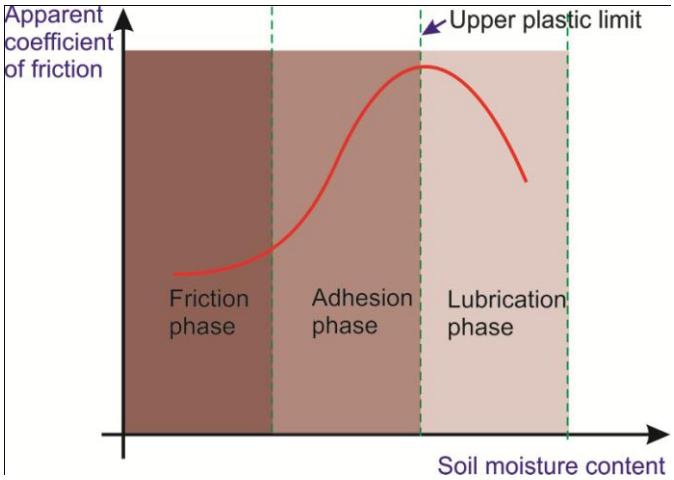
R – Resultant of all soil forces acting upon the tool
L – Longitudinal or directional component of R
S – Lateral component of R
V – Vertical component of R
R_h – Resultant of L and S

All tillage tools consist of inclined planes for applying pressure to the soil.
Frictional forces are involved due to sliding action of soil.
Frictional forces due to sliding soil on soil

$\mu = F/N$

μ – coefficient of friction
F – Frictional force tangent to the surface
N – Normal reaction (Normal force)
Frictional forces due to movement of soil on metal (adhesive forces)

As adhesive forces are due to moisture films, magnitude varies with the moisture content.



In adhesive phase moisture films develops between metal and soil particles: μ increases
With the addition of more water, water acts as a lubricant: μ decreases

Soil characteristics that effects abrasiveness are,

- Hardness
- Shape and size of soil particles
- Moisture content of soil

Abrasive resistant of the tool depend on

- composition of materials

Hardness
Strength
Toughness

A layer of special abrasive resistance alloy (non ferrous chromium- cobolt – tungstant or high carbon iron based alloy containing chromium, tungsten, manganese, silicon and molybdenum) is used on cutting edges of tillage tools to reduce wear rates. (Hard facing or hard surfacing)

Factors effecting draft of a plow

Soil type
Soil condition (MC and BD)
Plowing speed
Plow bottom shape
Depth of plowing
Width of cut
Types of attachments to the plow
Plow adjustments

Specific draft – sandy soil 1.4 – 2 N/m^2
Silt soil 2 -5 N/m^2
Clay loam and clay 4 – 8 N/m^2