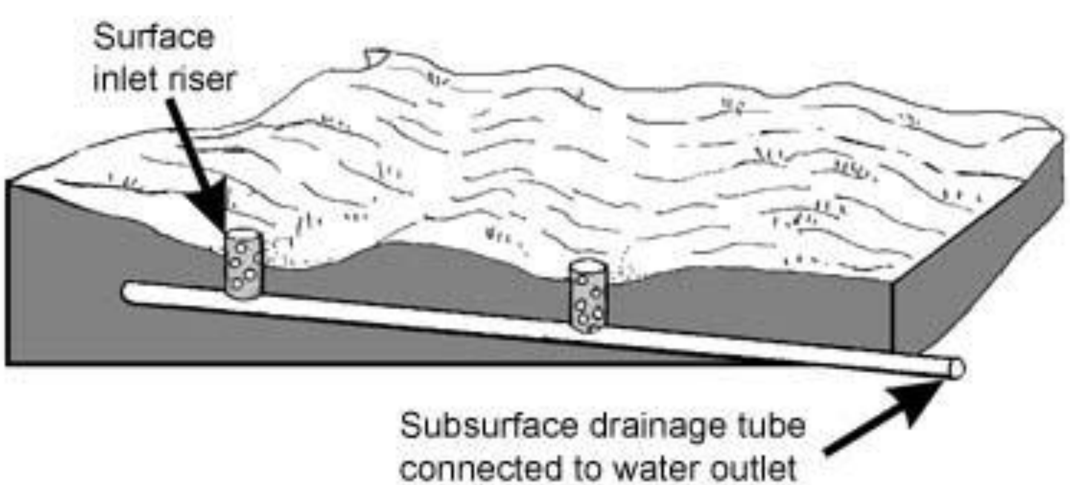
Other Forms of Terraces

- Subsurface outlet terraces
  - Used in combination with tile drainage systems
  - Holds water long enough to let sediment settle but not so long as to cause crop damage.



http://www.agry.purdue.edu/soils_judging/new_manual/ch3-water.html

Flat Top Terraces

- Used on steep slopes to gain arable land

http://lrc.salemstate.edu/pictures/ipc2011/imagepages/image51.htm

General Design Requirements For Terraces

- Spacing:
  - Maximum spacing is that which will reduce soil erosion to below soil loss tolerance (T value).
- Channel Length:
  - Must be short enough to prevent excess concentration and velocity at outlet
- Channel Grade:
  - Water velocity must be low enough to prevent channel erosion but fast enough to prevent water logging or delay in field activities
- Channel Capacity:
  - Sufficient to control runoff from a 10 year frequency 24 hour storm

Terrace Spacing

- Calculate soil loss using RUSLE or the WEPP hill slope erosion model for 30 year average (RUSLE is currently used by NRCS)
  - If above T value, terraces are warranted.
  - Spacing is equal to slope length at which soil loss is below T
- NRCS also uses an empirical equation to determine spacing

$$VI = X*S*Y$$

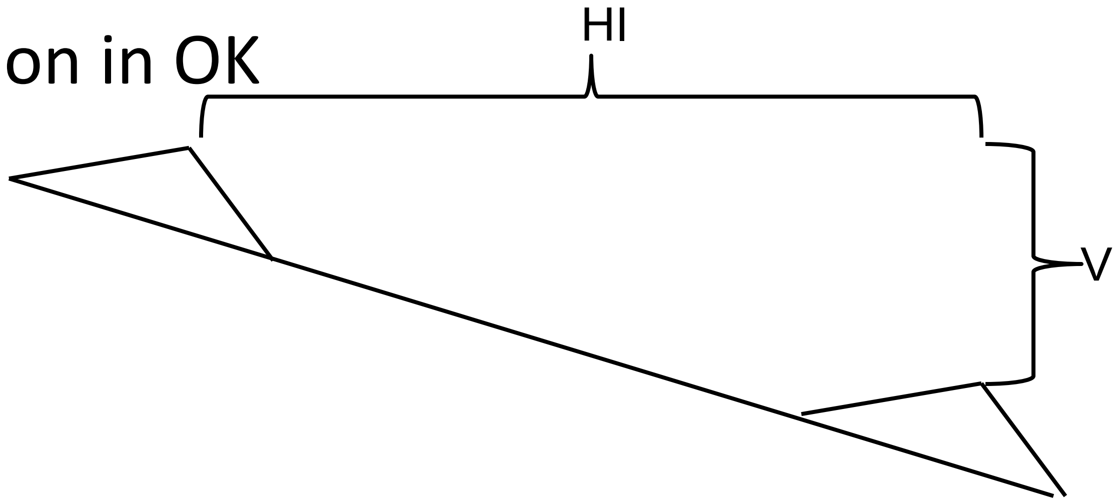
$$HI = \frac{(X*S+Y)100}{S}$$

VI=Vertical interval
HI=Horizontal interval

X=is based on geographical location
Y=soil condition
S=slope (%)

Vertical and Horizontal Interval

- HI must be used for parallel terraces
  - May be used on steep slopes were narrow base terraces are needed
  - Facilitate field activities
- VI is used for terraces that follow slope
  - Most common in OK



X Values

- Dependent on the quantity and intensity of Rainfall

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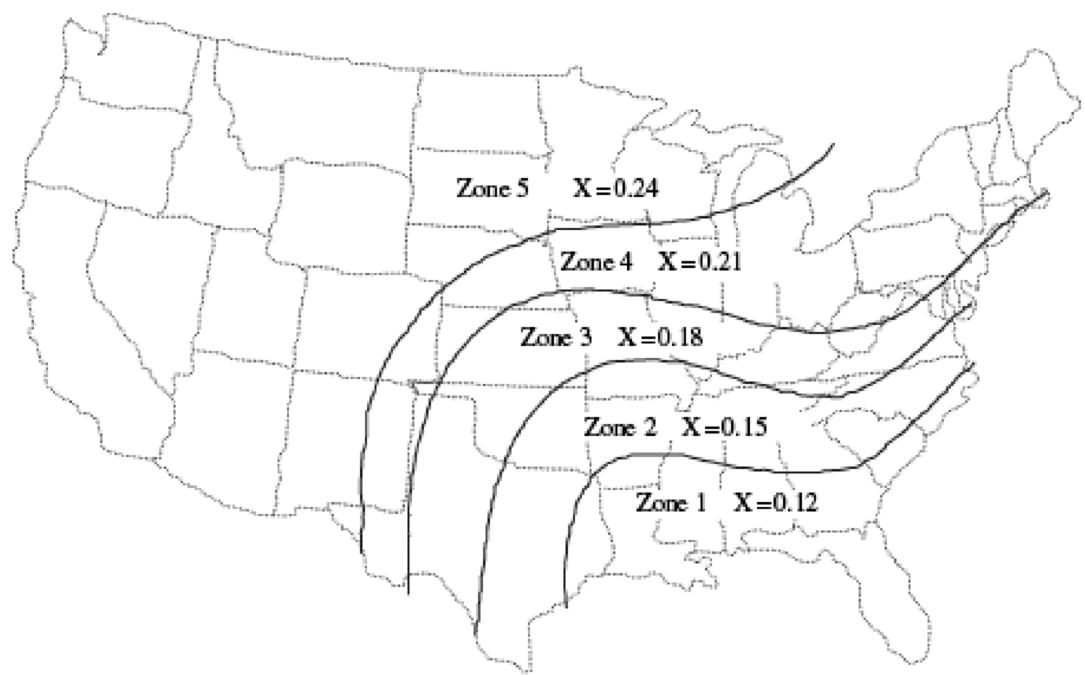


Fig. 11.15 Values for geographical location (X) in Eq. (11.7) for the USA (After ASAE, 2003)

This figure is for calculation of HI in meters
For HI in ft x=0.4, 0.5, 0.6, 0.7 and 0.8

Y Values

- Dependent on soil erodibility and ground cover
- Combined with slope this replaces the need to estimate erosion

Table 2			
Y			
Ground Cover	Soil Erodibility Factor (K)		
	0-0.20	0.20-0.28	0.28-0.64
10% 40% 80%	2.5 3.25 4.0	1.75 2.5 3.25	1.0 1.75 2.5

Terrace Grade

- Must be sufficient to prevent damage to crops yet not cause channel erosion
- At the upper part of the terrace, grade can be as high as 1.5 to 2 %
- The grade may decrease as the terrace becomes longer to prevent excessive water velocity

Terrace Length

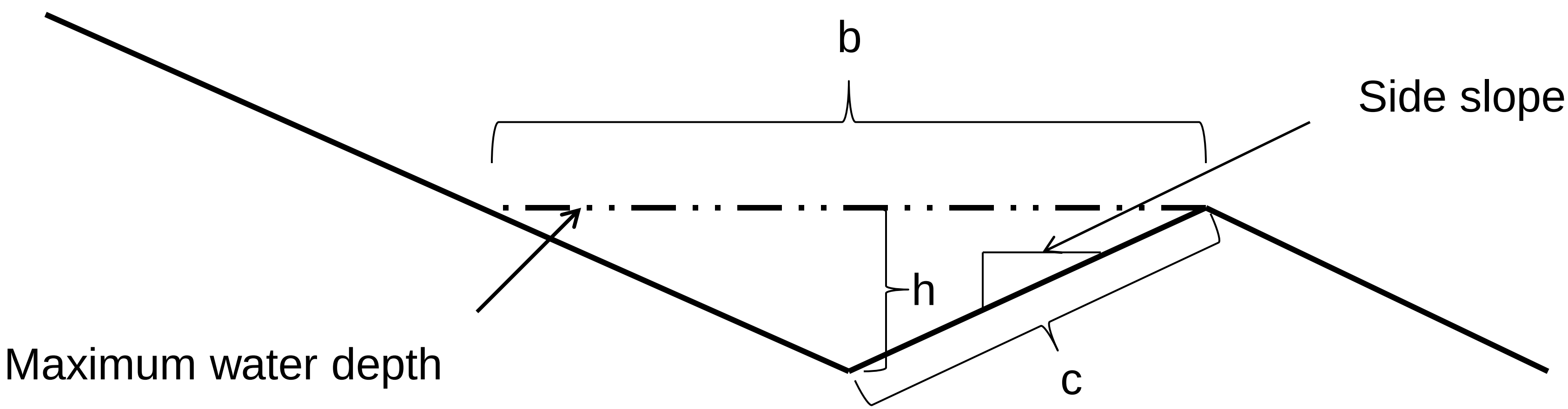
- As the terrace length increases the water velocity will increase
- 1800-2000 ft is the maximum distance that a terrace should drain in one direction.
  - Distances longer than this will require very shallow grades to reduce velocity
    - Can cause problems with drainage near outlet

Channel Capacity

- Terrace channel must be designed to control (graded terraces) or contain (flat channel) a 10 year 24 hour rainstorm event.
- Graded terraces should be designed to carry the water at low velocities

Cross Sectional

- Side slopes (h/(0.5b) will influence water velocity
  - Shallow side slopes decrease velocity
  - This allows terrace grade to be increased
    - Providing better drainage



Manning's Equation

$$V = \frac{R^{2/3} * S^{1/2}}{n}$$

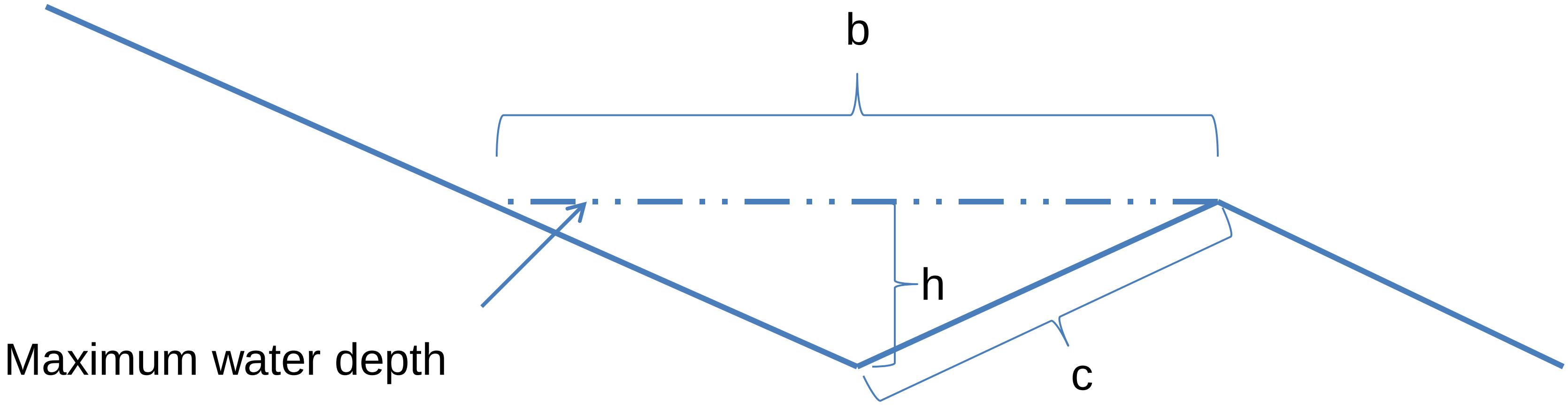
Continuity Equation

$$Q = A * V$$

- R=hydraulic radius of water way (m)=cross sectional area/wetted perimeter
- S=Waterway slope
- n= manning's coefficient of roughness
- Q=Flow rate (m^3/s) [peak discharge]
- A=cross sectional area of water way (m^2)
- V=velocity of runoff (m/s)
  - To prevent channel erosion the following velocities should be used:
    - 0.8 m/s for clays, 0.6 m/s for loamy soils and 0.45 m/s for sandy soils.

Cross Sectional Area

- Most commonly, broad based terraces should have the following dimensions:
- h=0.3m (1ft) this includes free board
- b=10m (32 ft)



Removing Terraces

- Dramatically increases water velocity in terrace channel
  - Can cause scouring
- Increased probability over topping terraces
  - Can result in Gullies
- No-till will simply reduce maintenance and reduce damage from large events

Terrace Maintenance

- Maintenance is needed to remove sediment from channel and maintain height
- Can be done with a moldboard plow or grading equipment
- Must also evaluate terrace outlet to determine if sediment accumulation is obstructing flow
- Channel grade may also need to be corrected

Sedimentation of Channel

- Approximately 4 inches of sediment from 2011-12 wheat crop year
- Rill erosion off hill slope

Sediment Removal

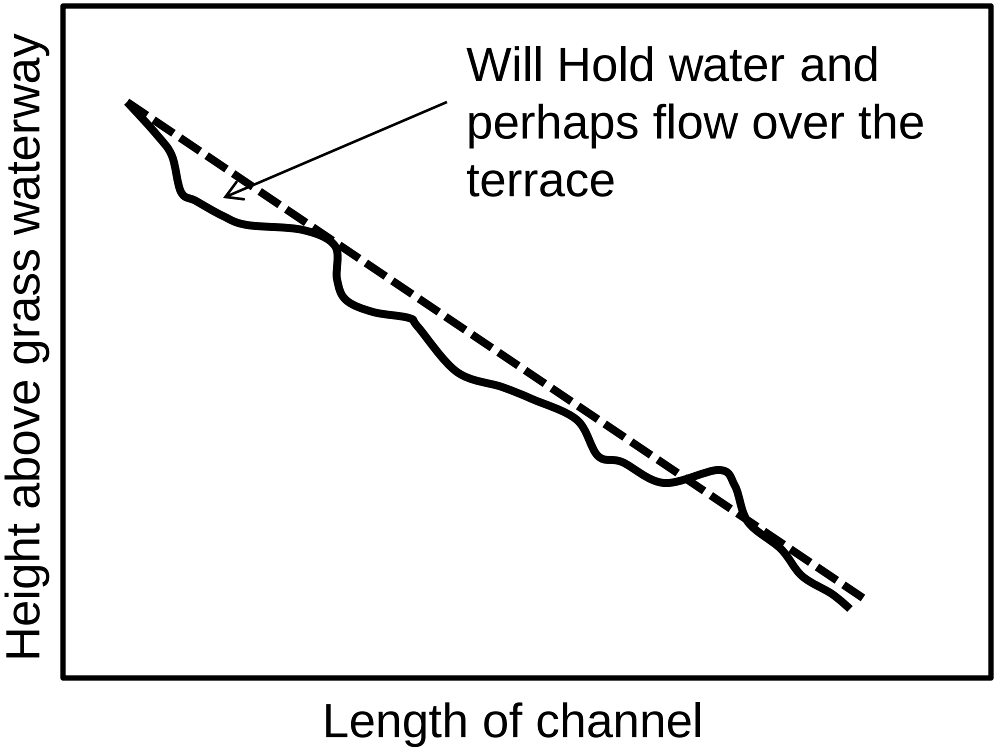
- Most often achieved with a MoldBoard
- Will not correct channel grade

Terrace Maintenance

- New RTK guided technology is also being used
  - Initial developed for construction
  - Then adapted to use in rice production
  - Can be adapted to grade terraces

Terrace Maintenance

- Biggest problem with terraces is improper channel grade



Improper drainage

- Water log conditions
  - Restrict field operations and reduce yield

Crop Damage is very Common

- Zero yield near outlet

Crop Damage is very Common

RTK system

- Dr. Taylor Video