SNS COLLEGE OF TECHNOLOGY

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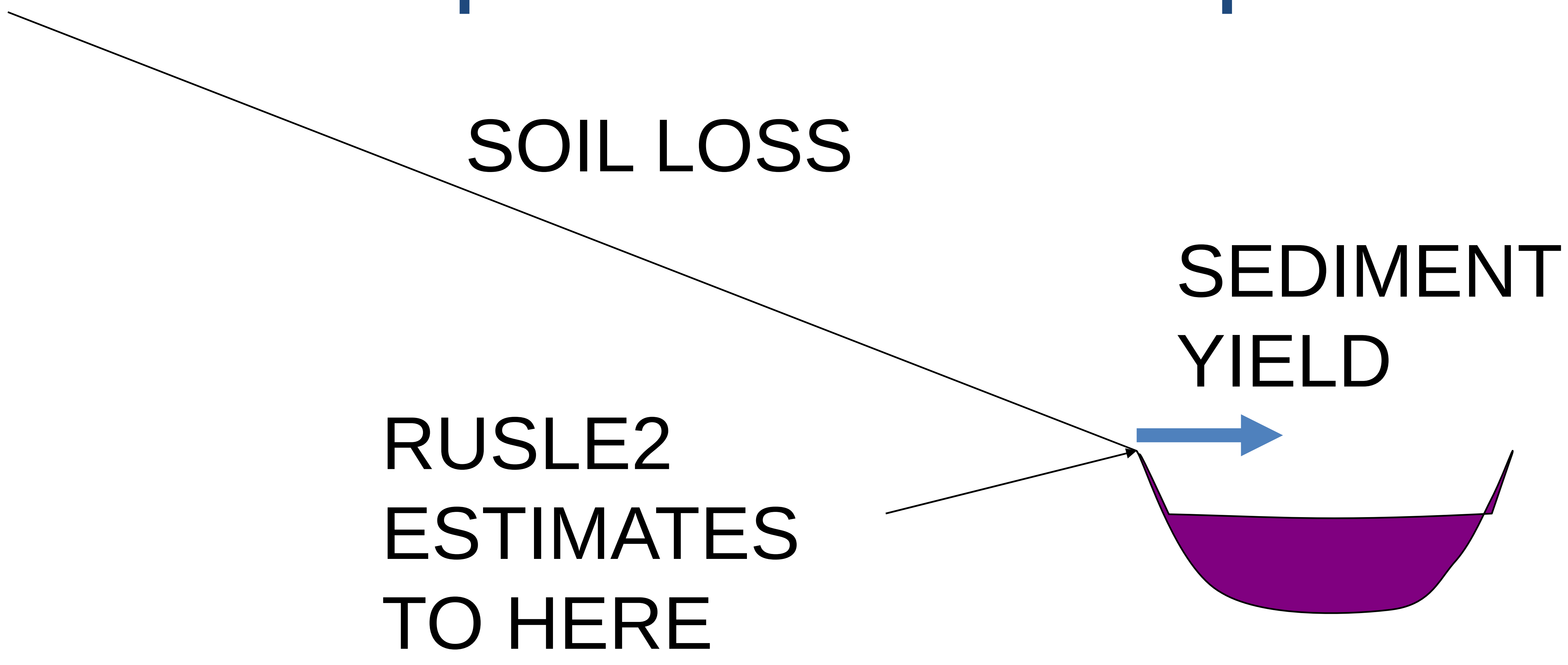
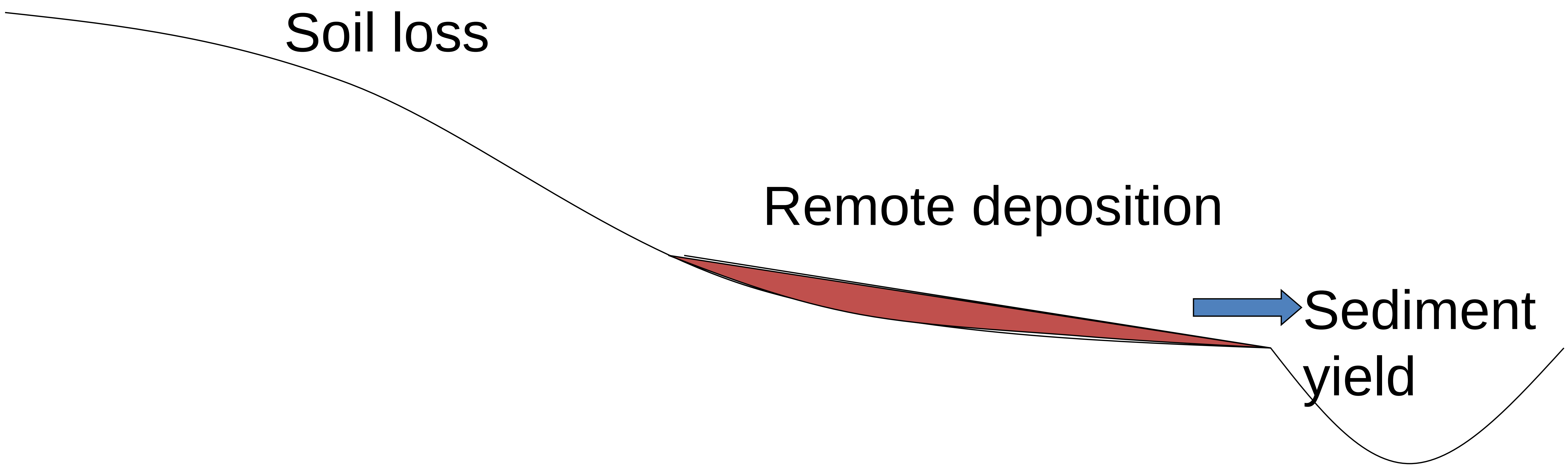
DEPARTMENT OF AGRICULTURAL ENGINEERING

19AGE308
WATERSHED PLANNING AND MANAGEMENT

Simple Uniform Slope

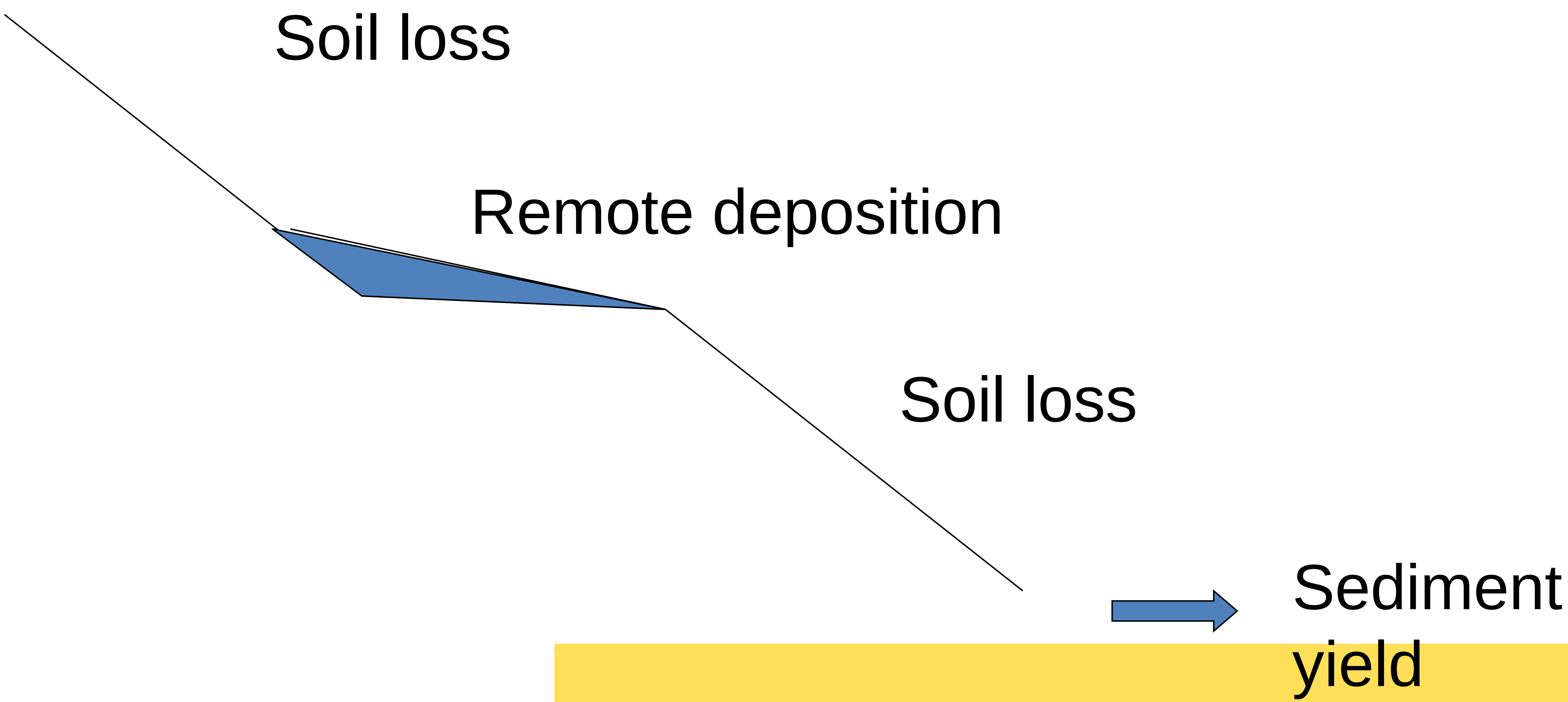


Complex Slope



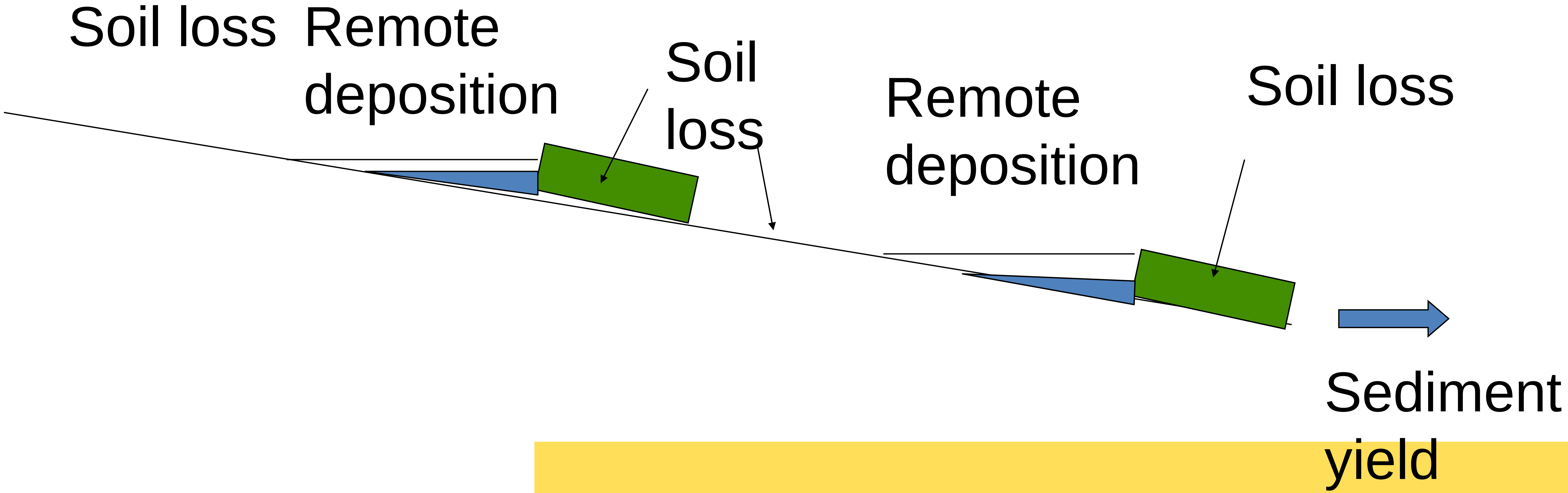
DEFINITIONS

Complex Slope

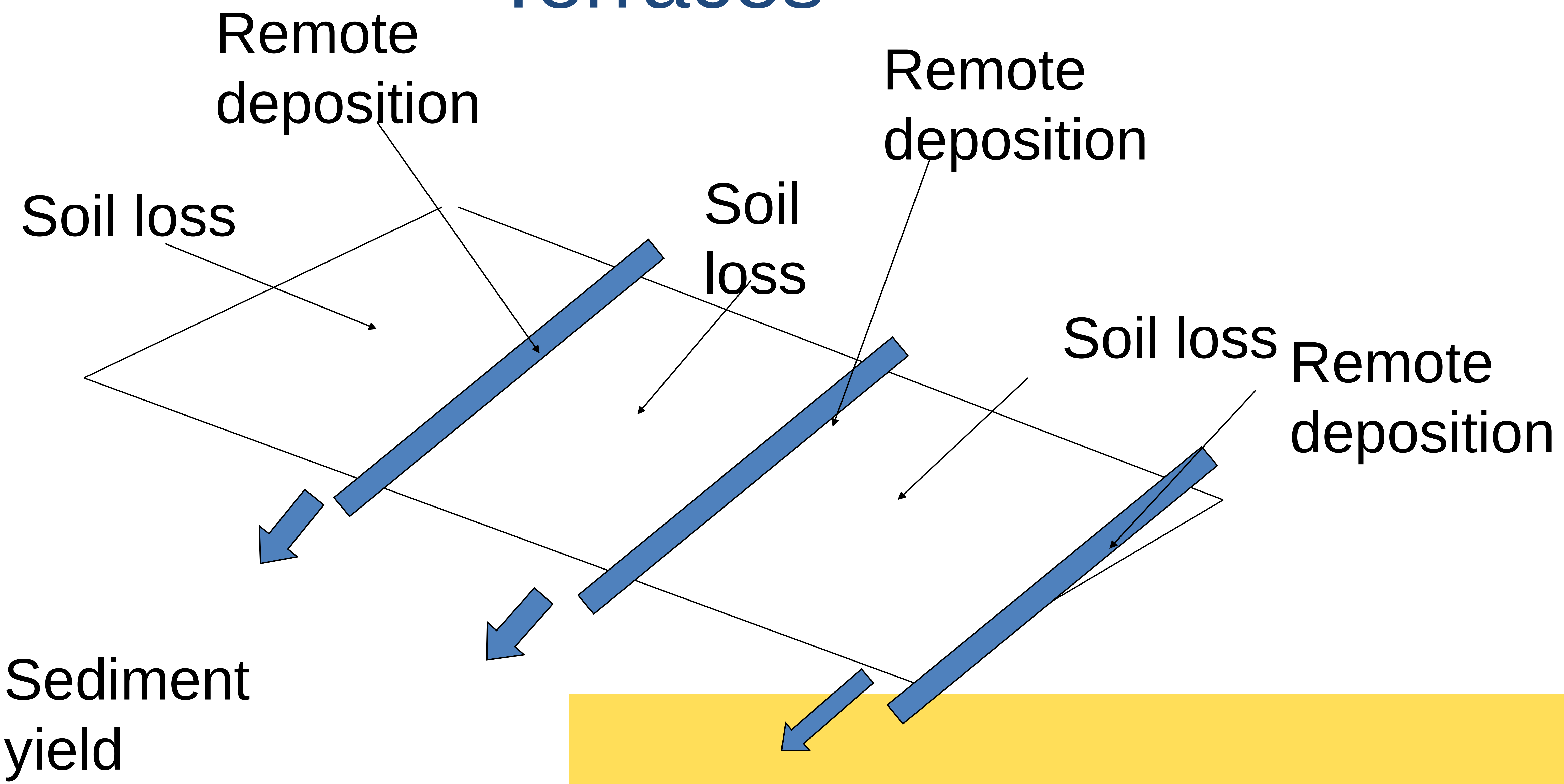


DEFINITIONS

Strips



Terraces


Remote deposition
Remote deposition
Soil loss
Soil loss
Soil loss
Remote deposition
Sediment yield

USLE (Universal soil loss equation)

Save slide

- USLE equation given by Wischmeier and Smith in 1965.
- This equation is used in sheet and rill erosion not gully erosion.
- It is used for water erosion not for wind erosion.
- It is compute average annual soil loss not sediment yield.
- It is a very simple and powerful tool for predicting the *average annual soil loss* .
- A is used to calculate long term average.

$$A = R*K*L*S*C*P$$

- Where,

A (>1)= Average annual soil loss, t/ha/y

R (>1)= Rainfall runoff erosivity factor, $\frac{t}{ha*y} * \frac{cm}{h}$

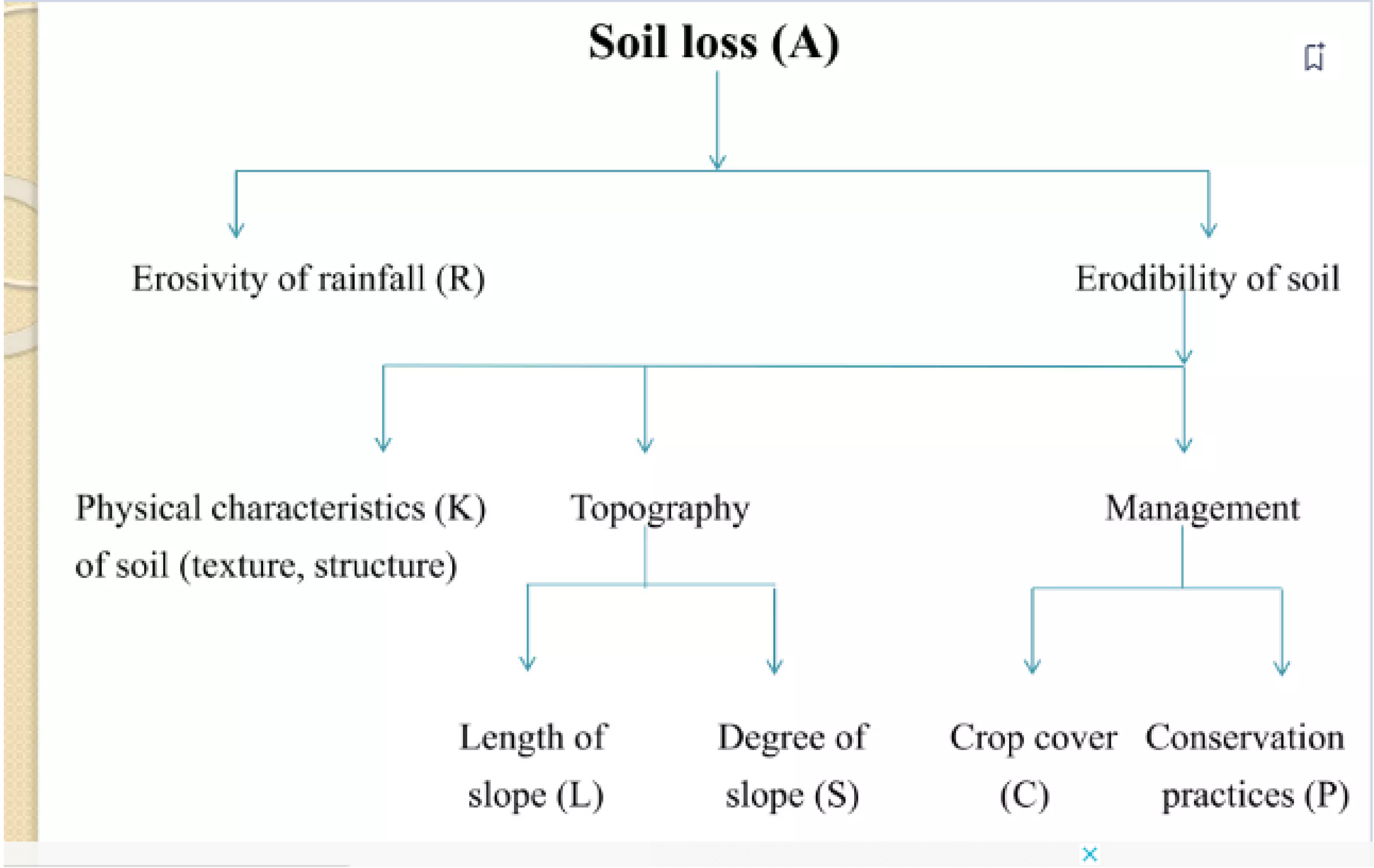
K (>1)= Soil erodibility factor, $\frac{t}{ha*y} * R$

L (>1)= Slope length factor

S (>1)= Slope steepness factor

C (<1)= Cover management factor

P (<1)= conservation practises.


Soil loss (A)
Erosivity of rainfall (R)
Erodibility of soil
Physical characteristics (K) of soil (texture, structure)
Topography
Management
Length of slope (L)
Degree of slope (S)
Crop cover (C)
Conservation practices (P)

- **Erosivity** It is defined as the potential ability of rainfall to cause erosion. It is rainfall factor it depends upon the physical characteristics of rainfall which include raindrop size, drop size distribution, kinetic energy, terminal velocity etc.
- **Erodibility** It is defined as the susceptibility of the soil to be eroded. It is the function of physical characteristics of the soil. It is a soil factor. The physical character includes the texture, structure, organic matter content.

- **R>1** – It represent the erosive potential of rain and it is related to the kinetic energy of the falling rain and its intensity. The product of kinetic energy and 30 minute maximum rainfall intensity is termed as rainfall erosivity factor.

$$R \text{ or } EI = \frac{\sum_{i=1}^{n} KE * I_{30}}{100}$$

Where,

EI= erosivity index

KE = kinetic energy of rainfall event,

I_{30} = rainfall intensity for maximum 30 minutes duration, and

n is the total number of rainfall event during a year.

$$KE = 210.3 + 89 * \log i$$

Where,

i = rainfall intensity, cm/h

- **K** – This factor is related to the various soil properties, by virtue of which particular soil becomes susceptible to get eroded by water or wind. Physical characteristics of soil (infiltration rate, permeability, soil texture, stability of soil structure, size, organic matter and soil depth) greatly influence the rate at which different soils are eroded.
- It is expressed as tonnes of soil loss per hectare per unit rainfall erosivity index from a field of 9% slope and slope length of 22.13 meters (72.6 ft.) for a continuously clean fallow land with up and down slope forming.
- Estimation of soil erodibility on the basis of runoff plot-

$$K = \frac{A_o}{S * \sum EI}$$

Where,

A_o = observed soil loss

S = slope factor

$\sum EI$ = total rainfall erosivity index.

K also be determined by using nomographic solution.

- **S** = it is defined as the ratio of soil loss from a given slope gradient to the soil loss from the slope of 9% under identical condition.

a. Slope length < 4 m

$$S = 3 * (\sin\theta)^{0.8} + 0.56$$

b. Slope length ≥ 4 m

i. Slope <9%

$$S = 10.8 \sin\theta + 0.03$$

ii. Slope ≥ 9%

$$S = 16.8 \sin\theta - 0.5$$

- Topographic factor (LS)

$$LS = \frac{\sqrt{L}}{100}(0.76 + 0.53 * S + 0.076 * S^2)$$

Where,

L = slope length, ft

S = % land slope

$$LS = \left(\frac{\lambda}{22.13}\right)^m [sin^2\theta + 4.58\ \sin\theta + 0.065]$$

Where,

L = slope length, meter

θ = slope angle

m = variable depend on the steepness of land slope

- C = It is defined as the ratio of soil loss from a field under known cropping system to the soil loss from a continuous clean fallow land under identical condition.

This factor combines the effect of crop type, crop rotation, length of growing season etc.

The erosion effectiveness of crop and cropping practice is evaluated on the basis of five recommended crop stages-

Period (F): Rough fallow: this include the summer ploughing or seed bed preparation

Period (1): Seed bed: It refers to the period from seeding to 1 month, thereafter

Period (2): Establishment: this is the time from 1 to 2 months after seeding,

Period (3): Growing period: It refers to the period from 2 to the period of crop harvesting and

Period (4): Residue or stubble: It refers to the period from crop harvesting to summer ploughing or new seed bed preparation.

Crop management factor is determined as the ratio of soil loss from cropped plot to the soil loss from a continuous fallow land for each of the above five crop stages separately.

- **P** = It is defined as the ratio of soil loss from a specific conservation practices to the soil loss from up and down slope forming under identical condition.

$$P = P_c * P_s * P_t$$

Where,

P_c = Contouring factor

P_s = Strip cropping factor

P_t = Terracing factor

Limitation of USLE -

1. It is empirical
2. It predict average annual soil loss
3. It does not compute gully erosion
4. It does not compute sediment yield.

Revised Universal Soil Loss Equation (RUSLE)

Over the last few decades, a co-operative effort between scientists and users to update the USLE has resulted in the development of RUSLE. The modifications incorporated in USLE to result the RUSLE are mentioned as under (Kenneth et.al. 1991):

- Computerizing the algorithms to assists the calculations.
- New rainfall-runoff erosivity term (R) in the Western US, based on more than 1200 gauge locations.
- Some revisions and additions for the Eastern US, including corrections for high R-factor areas with flat slopes to adjust splash erosion associated with raindrops falling on ponded water.
- Development of a seasonally variable soil erodibility term (K).
- A new approach for calculating the cover management term (C) with the sub-factors representing considerations of prior land use, crop canopy, surface cover and surface roughness
- New slope length and steepness (LS) algorithms reflecting rill to inter-rill erosion ratio
- The capacity to calculate LS products for the slopes of varying shapes
- New conservation practices value (P) for range lands, strip crop rotations, contour factor values and subsurface drainage.

- **Modified Universal Soil Loss Equation (MUSLE)**

USLE was modified by Williams in 1975 to MUSLE by replacing the rainfall energy factor (R) with another factor called as 'runoff factor'. The MUSLE is expressed as

$$Y = 11.8\left(Q \times q_p\right)^{0.56} K(LS)CP \; Y = 11.8\,(Q \times q_p)^{0.56} K(LS)CP \qquad (16.12)$$

where, Y = sediment yield from an individual storm (in metric tones), Q = storm runoff volume in m3 and qp = the peak rate of runoff in m3/s.
All other factors K, (LS), C and P have the same meaning as in USLE (equation 16.1). The values of Q and qp can be obtained by appropriate runoff models. In this model Q is considered to represent detachment process and qp is the sediment transport.