Engineering Functions of Plants

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Relative strengths of various plant categories

Engineering Function	Trees	Woody Shrubs	Bamboos	Clumping Grasses	Non-woody Grasses	Other herbs
Catch	*	***	***	**	*	–
Armour	*	*	*	***	***	*
Reinforce	**	***	*	**	*	–
Anchor	***	**	***	–	–	–
Support	***	**	***	–	–	–
Drain	–	–	–	***	*	–

*** Excellent
** Good
* Moderately useful
– Not useful at all

Hydrological functions

S.No.	Functions	Effect
1	Leaves intercept raindrops before they hit the ground	Good
2	Water evaporates from the leaf surface	Good
3	Water is stored in the canopy and stems	Good
4	Large or localized water droplets fall from the leaves	Bad
5	Surface runoff is slowed by stems and grass leaves	Good
6	Roots increase the permeability of the soil leading to infiltration	Site dependent
7	Roots extract moisture from the soil, which is then released to the atmosphere through transpiration	Weather and site dependent

Mechanical functions

S.No.	Functions	Effect
1	Stems and trunks trap materials that are moving down the slope	Good
2	Roots bind soil particles to the ground surface and reduce their chances of erosion (i. e. Root Cohesion)	Good
3	Roots penetrating through the soil cause it to resist deformation (Root Anchor)	Good
4	Woody roots bind fragmented rocks together	Good
5	Woody roots may open the rock joints due to thickening as they grow	Bad
6	Root cylinder of trees holds up the slope above through buttressing and arching	Good
7	Tap roots pin down the overlaying materials to firmer stratum below	Good
8	Vegetation exposed to wind transmits dynamic forces into the slope	Bad

Hydraulic functions

S.No.	Functions	Effect
1	Stems and grass increase the roughness of the surface	Good
2	Increase in permeability leads to chances of seepage	Bad
3	Fully developed bioengineering techniques help in the formation of natural terraces with gentle slopes	Good
4	Closely lined grasses are most suitable for proper channelization of surface flow	Good

Tap roots and Lateral roots

- Tap roots are those growing vertically downwards;
- Tap roots provide the function of anchoring;
- Woody plants produced grown from seed usually develop best roots for anchorage;

Tap roots and Lateral roots

- Lateral roots are those growing sideways;
- Lateral roots provide the function of reinforcement (i. e. soil cohesion);
- Woody plants propagated from cuttings will produce the best shallow rooting system;
- Clumping grass usually develop a dense network of lateral roots;

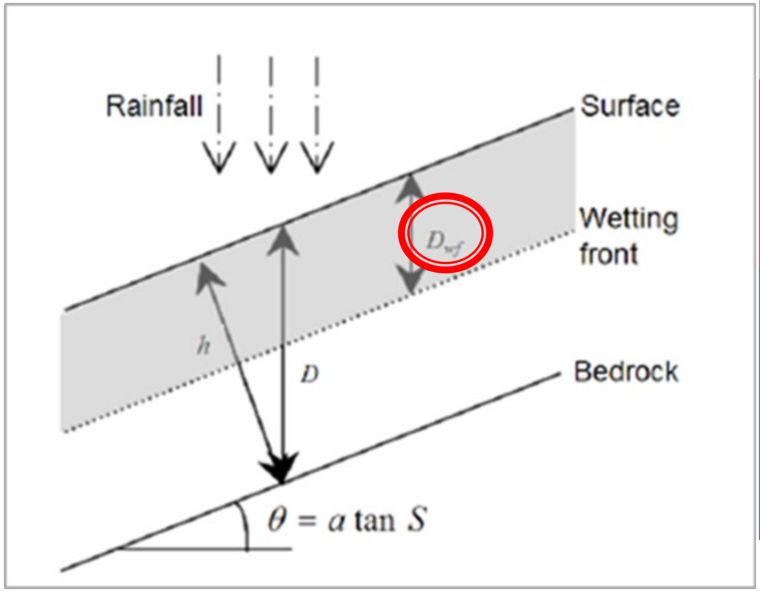
Effective depth of roots

Plant type	Local name (Example)	Max. effective rooting depth
Small grass	Burmuda Grass (*Cynodon dactylon*)	100 mm
Large grass	Guinea Grass (*Anicum maximum*), Gamba Grass (*Andropogon gayanus*), Napier (*Pennisetum Purpureum*), Para Grass (*Brachiaria mutica*), Congosignal Grass (*Brachiaria ruziziensis*)	0.5 to 1 m
Large bamboo	Mula (*Bambusa bambos*)	1 m
Shrubs	Kadal cherry (), Muttamaram (), Oorakam (), Kattooram ()	1.5 m
Trees	Ashokam (*Saraca ashoca*), Rubber (), Kanikkonna (*Cassia fistula*)	2 m
Vetiver Grass		~3 m

Slope instability & Root Contribution:

Physically based infinite slope stability model (Chae et al. 2015) for LSM:

$$FS = \frac{(c_s + c_r) + \cos^2\theta[A]\tan\phi}{D\rho_t g\sin\theta\cos\theta}$$



where,

$$A = [\rho_t g(D - D_{wf}) + (\rho_t g - \rho_w g)D_{wf}]$$

'c_r' is the plant roots cohesion (N/m^2), 'c_s' is the soil cohesion (N/m^2), 'θ' is the slope gradient (^{0}), 'ρ_t' is the soil density (kg/m^3), 'ρ_w' is the density of water (kg/m^3), 'g' is the acceleration due to gravity (9.81m/s^2), D is the depth of the soil layer (m), 'D_{wf}' is the vertical height of the water table (m) and 'ϕ' is the internal friction angle of the soil (^{0}).