(1) History of Agriculture

→

* Agriculture = Agric/Ager + ~~Cultura~~ Cultura
  - Agric/Ager → Soil
  - ~~Cultura~~ Cultura (Latin) → Cultivation

* Agronomy = Agros + nomos → Greek
  - Agros → Field
  - nomos → to manage

* Difference -

Agriculture	Agronomy.
Study human activities related to use of soil.	Management of field to provide favourable environ^{t} to the crop for higher productivity.

* Father of Agronomy → Peter Decresenzi.
* Jethrotull → (1) seed drill and Horse Drawn cultivator were developed.
  (2) Firstly used words - 'weed' and 'zero tillage'.
* Scientific cultivation in India started with the commercialisⁿ of sugarcane, cotton & tobacco.
* A joint dept of agriculture, revenue & commerce :-
  - Estd. by Lord Mayo (27th April, 1871)
* A separate central dept. of agriculture - 1881
  - (Due to the direction issued by Famine commiⁿ in 1880)

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→ Organisations :-

① IARI → 1) Imperial Agricultural Research Institute estd. in 1905 at Pusa. (Bengal, now Bihar)
(viceroy → Lord Curzon)

2) 1936 - Transfered to Pusa Road, New Delhi.

3) Renamed after 1947 - 'Indian' Agricultural Research Institute.

4) 1958 - status of deemed university.

② ICAR → 1) Imperial Council of Agricultural Research.

- estd. on 16th July 1929.
- on the recomm^n of Royal Commi^n Report, 1928.

2) First president - Md. Habibullah.

Secretary - S. A. Hydari.

3) March 1946 - Renamed - 'Indian' CAR.

4) 1966 - Autonomous body.

5) First Director general → Dr. B. P. Pal.

③ First Agriculture University - 1960 - Pantnagar (उत्तराखंड, erstwhile उत्तरप्रदेश)

→ The then Chief minister of UP → Pt. Govind Ballabh Pant.

→ Recomm^ → First Educ^ comm^ (1949) - Radhakrishnan.

→ 1st & 2nd Indo American Teams.

④ IRRI → International Rice Research Institute -

→ Manila (Philipines) - 1960.

⑤ CIMMYT → Mexican word denotes - International centre for Maize & Wheat improvement at Mexico (1966).

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→ Revolutions -

* Green Revolⁿ - 1965-66
* White — Milk
  Blue - Fisheries
  Round - Potato
  Silver - Eggs
  Brown - Fertilizer.
* Agriculture includes grains, livestocks, forest resources and Fisheries.

→ Institutes in Maharashtra -

① CIFE - Central Institute of Fisheries Education.
- वर्सोवा, मुंबई.

② CICR - Central Institute of Cotton Research, नागपूर

③ CIRCT - Central Institute for Research on Cotton Technology., माटुंगा - मुंबई.

④ NBSSLUP - National Bureau of Soil Survey and Land Use Planning, नागपूर.

→ Agricultural Universities in Maharashtra -

① Dr. Panjabrao Deshmukh Krishi V., Akola.
② Dr. Balasaheb Sawant Konkan K.V., Dapoli
③ Mahatma Phule K.V., Rahuri
④ Marathwada Agricultural Uni., Parbhani.
⑤ Maharashtra Animal sciences & Fisheries university, Nagpur.

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③ Dryland Agriculture.

→ Meaning - cultivation of crops entirely under rainfed condition.

→ Classific^{n} -

Basis - Rainfall.

	Dry farming	Dryland f.	Rainfed f.
①	< 750 mm	1150 mm > Rainfall > 750 mm	> 1150 mm < Rf.
②	Crop failures due to dry spells	Dry spells may occur, but crop failure - less frequent	less chances of crop failures due to dry spells.
③	Arid regions	semi-arid regions	Humid regions.

→ Characteristics of dryfarming -

① Inadequacy & uncertainty of rainfall.
② Late onset & early cessation of rains.
③ Prolonged dry spells.
④ Low moisture retention capacity.
⑤ Poor soil fertility condition.
⑥ Socio-economic constraints - small & marginal farmers.
⑦ Technological & developmental constraints
⑧ Limited infrastr^{o} development
⑨ Improper & untimely availability of credit & i/ps.

→ 3 types of agriculture possible in dryland areas.

① Crop production
② Animal husbandry with pastures management.
③ Agro forestry.

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→ Drought and Agricultural Drought.

IMD, Pune defined -

Drought – when annual rainfall is < 75% of normal.

Severe drought - when deficiency of rainfall is above 50%.

Drought areas - drought occured 20% of years.

Chronic drought areas - drought occured in >40% years.

→ Institutes -

① ICRISAT – International Crop Research Institute for the Semi-Arid Tropics.
- Estd. 11 Oct' 1972
- Hyderabad (Patancheru) - Telangana.

② ICARDA – International centre for Agl. Research in Dry Areas.
- Estd. 1977 at Aleppo (Syria)

→ Indexes -

① Moisture Availability Index.

$$MAI = \frac{\text{Rainfall at 50\% probability}}{PET}$$

② Aridity Index (A.I.)

$$Ia = \frac{WD}{PET} \times 100$$

where,
WD = Water Deficit
PET = Potential Evapotranspir?

③ Moisture Deficit Index. (MDI)

$$Im = \frac{P - PET}{PET} \times 100$$

where,
P = Precipitation.

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④ Thornthwaite Moisture Index (TMI)

$$Im\ a = \frac{AE}{PET}$$

where, AE ⇒ Percent probability of Actual evopar^n.

★ Ima is much superior to Im in explaining the variability in crop yields from year to year.

→ Watershed Management.

★ Watershed means an area of land whose runoff drains to a common point i.e. in the river or waterpool.

★ catchment area (water collecting area) is larger but the area of watershed is comparatively smaller.

→ ★ Watershed Management Programme launched by GOI in 7th five year plan. (1983 - Assistance of world bank)

★ Features of watershed Manag^t Progr^m -

① Soil & water conservation Measures.
② Scientific Dry Farming.
③ Forestry & develop^t of pasture.
④ Animal husbandry and develop^t of dairy.

★ Aims & objectives of watershed management -

① Protect, conserve and improve the land resources for efficient and sustained prod^n
② To protect & enhance water resource, moderate floods & reduce silting up of tanks, increase irrig^n & conserve rainwater for crops - mitigate droughts.
③ To utilise the natural local resources - improve agriculture & allied activities - improve socio-eco condition of local residents.

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→ Water Harvesting.

- The term first used by Myers.
- 3 types of techniques in India -
  1. Inter row water harvesting
  2. Inter plot or microplot water harvesting
  3. Water harvesting in farm ponds and Reservoirs.

→ Chemical treatment to increase runoff -

1. Asphalt compounds – Impermeable catchments
   - cover ground surface for water collection.
   - control seepage loss.
2. Bentonite – sealing properties.
3. Jalshakti – Chemical – when applied (mixed) in soil, improves the aeration, infiltra^n & waterholding capacity of the soil.

→ Evapo-transpiration (ET).

- Evapor^n from the soil surface and transpir^n from the plant surface.
- Can be reduced by – 1) Mulches 2) Antitranspirants. 3) wind breaks 4) weed control.

* Antitranspirants -

- Applied to plant surface to reduce water loss.
- 4 types - 1. Stomata closing type – Atrazine, Phenyl mercuric acetate (PMA), ABA, CO_2
  2. Film forming type – Mobilcat, silicone, hexadecanol, oils, waxes.

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③ Reflecting type - celite & Kaolin.

Applic^{n} of 5% Kaolin reduces transpir^{n} loss.

④ Growth retardants. - cycocel (CCC)

→ Antitranspirants reduce photosynthesis - Therefore the use is limited - use in nurseries & horticulture.

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④ Erosion & soil conservⁿ

* Soil erosion → Process of removal of soil particles from parent body & transportⁿ by wind &/or water.

→ Runoff – The excess water from precipitaⁿ that moves out of field & finds its way to river, lakes and oceans etc.

* Factors Affecting Runoff –
  - (A) Climatic – Snowfall, ET, etc.
  - (B) Physiographic – Watershed characteristics, etc.
  - (C) Geological – Lithological, structural, etc.

* Rainfall intensity of more than 5 cm/hr is considered as severe.

→ Soil Loss Equation due to Water Erosion –

$$A = RKLSCP$$

where, A ⇒ Predicted soil loss (t/acre/year)
R → Rainfall & runoff
K → Erodibility
L → Slope length
S → Steepness
C → Soil cover & management.
P → Erosion control Practice.

→ Soil Loss Eqⁿ due to Wind Erosion.

$$E = IRKFCWDB$$

where,
E ⇒ Soil loss by wind erosion.
I → Soil cloddiness factor.
R → Surface cover factor.
K → Surface roughness factor.
F ⇒ Soil textural class factor
C → Local wind factor
W → Field width factor
D → Wind direction factor
B → Wind Barrier factor.

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→ Soil conservⁿ Measures -

(A) Agronomic Measures → where slope is less than 2%.

1) Contour cultivation - (1) conserve soil, water, soil fertility
(2) Increase crop yield.
(3) less power required.
(4) less wear & tear of implementⁿ
less time.

2) Mulching - Material applied on the soil surface.
to check evaporⁿ & improve soil water.
- Types - (1) soil mulch / dust mulch.
(2) stubble mulch - wheat straw, cotton stalks, etc.
(3) Straw mulch
(4) Plastic mulch. - PVC, etc.
(5) Vertide mulching - coffee gardens.

3) Dense growing crops - provide maxᵐ cover to soil.
e.g. cowpea & moong.

4) Strip cropping - 2/more crops grown simultaneously in strips.
- controls runoff erosion & maintains the soil fertility
- 4 types - (1) Contour Strip Cropping
(2) Field-strip cropping
(3) Wind-strip cropping
(4) Permanent / Temporary Buffer Strip Cropping.

★. Strip cropping is another form of rotation.
Not adopted in India on a large scale due to small size holdings.

5) Cropping systems like crop rotation, strip cropping, etc.

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(B) Mechanical Measures - slope is more than 2%

1) Basin-Listing - mild slopes.

2) Sub-soiling -

Extensive use in India.

3) Contour bunding - ① Arid & semi-arid areas
② slope of about 6%
③ spacing - vertical - 150 cm
Horizontal - 67.5 cm

4) Graded bunding / channel terraces.
- ① where, rainwater is not readily absorbed.
② Rainfall > 800 mm irrespective of soil textures, but
In clay soil even < 800 mm.
③ Tractor farming → Broad based bunding.
④ Slopes 2-10%.

5) Broad bed and furrow (BBF) system.
- Suitable for black soils where surface drainage during monsoon is problem.

6) Bench terracing. - ① slope 16-33% on steep
② sloping & undulating land.
③ Intensive farming is possible only with bench terracing.

7) Zing terracing - ① 9-10% slope
② Medium to deep soils
③ Moderate to high rainfall areas.
④ cut down from upper area for the benefit of crops in lower side.
- Ensure adequate drainage during heavy rainfall.

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© Conserv^ measures for Hilly slopes -

1) Contour Trenching and Afforestation.

- ① Both on hill slopes & on degraded and bare waste lands.
② Not advisable when slope is more than 20%.
③ Used in both high rainfall & low rainfall conditions.

2) Bench Terracing -

- ① Suitable & common measure in hilly areas for the conserv^ of soil and water.
② H.P., J&K, Uttarakhand, Assam.
③ Slope - 15 - 33 %
④ Possible only where depth of soil is more.

3) Stone Terracing / Stone Wall Terraces -

① Small embankments constructed with stones across the slopes.
② Adopted on any slope with spacing from 10 to 30 m depending upon slope.

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⑤ Water Management. (Irrigation & Drainage)

→ **Definitions**

① **Free energy** - ~~Related to~~ of saturated soil is zero.
of unsaturated soil is < 0, hence - ve.

② **Matric Potential** - Negative pressure potential, results from capillary and adsorptive forces.

③ **Capillary potential** - Energy with which water is held by soil.

④ **Gravitational potential** - Due to gravitational force field and is dependent on the elevation.

⑤ **Seepage** - Horizontal flow of water in channel.
- Main cause of water loss from irrig^n canal.

⑥ **Percolation** - Vertical movement of water in the soil.
- downward flow.

⑦ **Infiltra^n** - Downward movement of water from upper layer. Occurs in unsaturated soil.

⑧ **Leaching** - Downward movement of nutrients & salts from the root zone with water.

→ **p^F value** -

- Means potenz meaning power at 10.
- It is like p^H through which we measure the force with which water is retained, in capillary or soil.
- Exponential expression of a free energy difference.
- $p^F = \log 10^h$ where h = soil moisture in cm of water.

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1 atm = 1036 cm of water. or 76.39 cm of Hg.

1 bar = 1023 cm of water column = 10^6 dynes/cm^2

1 millibar = 10^{-3} bar.

1 cubic metre = 1000 litre.

★ FC ≅ ME in medium textured soil.

FC > ME in sandy soil.

FC < ME in clayey soil.

[∵ FC ⇒ Field capacity, ME → Moisture Equivalent]

★ Wilting coefficient.

$$WC = \frac{\text{Hygroscopic coeff.}}{0.68} = \frac{\text{Moisture equivalent}}{1.8}$$

★ Moisture movement under saturated conditions.

ⓐ Poisseuille's Law - Expresses the flow of water in narrow tube.

Sandy > loam > clay.

ⓑ Darcy's law - Expresses water movement in soil.

Considering both the laws,

The conductivity of water does not depend upon the total amount of pore spaces.

→★ Measurement of soil moisture content -

→ Direct measurement → ① gravimetric method.

② Infra-red moisture balance method.

→ Indirect → ① Look at the soil & feel it

② Neutron scattering method.

③ Tensiometer.

④ Electrical resistance method.

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→ Potential Evapo-transpiration (PET) - (measurment by Lysimeters)

* It is evapo-transpiration from a large vegetation covered land surface with adequate moisture at all times.

* Evapor^n is a function of the diff^{ce} in the vapour pressure of the water and the vapour pressure of air.

$$E = f(V.P_{water} - V.P_{air})$$

* Solar energy arrives at the upper limit of the earth's atmosphere at about 2 calories/minute/m^2

→ Consumptive Use of water -

* CU = ET + water used in metabolic activities.

* $$\frac{Moisture_{FC} - Moisture_{WP}}{100} \times B.D.(g/cc) \times Depth\ of\ soil\ (cm)$$

where, $Moisture_{FC}$ ⇒ Moisture content at field capacity

$Moisture_{WP}$ → " at wilting point.

B.D. → Bulk Density.

→ Water use efficiency -

* The water utilisation by the crop → water use efficiency (kg/ha-cm) or q/ha.cm

(a) Crop water use efficiency -

$$WUE = \frac{Y}{ET}$$

[∵ Y is yield, ET is amt. of water depleted.]

(b) Field water use efficiency -

$$WUE = \frac{Y}{WR}$$

where WR → water required or used.

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★ Irrigation Efficiency-

$$(E_i) = \frac{\text{Water stored in the soil for crop growth}}{\text{water applied as irrigation.}} \times 100$$

★ Water Distribution efficiency.

$$(E_d) = \left(1 - \frac{\bar{y}}{\bar{d}}\right) \times 100$$

where, $\bar{d}$ = Average depth of water stored.

$\bar{y}$ = Avg. numerical deviation from $\bar{d}$.

★ Irrigation period = $\frac{\text{Net irrigation requirement.}}{\text{Peak use rate.}}$

★ Intensity of Irrigation → The area proposed to be irrigated every year/every season. Expressed as percentage of total cultivable area.

★ Crop ratio → The ratio of area under different crops of a particular canal or entire project.

★ Moisture Regime → The percentage of moisture in the soil at atmospheric pressure.

★ Duty of water → Quantity of water required for irrig^n to bring a crop to maturity.

★ Base → Period of irrig^n which crop requires for maturity.

★ Delta → Total depth of water required by a crop during the entire period the crop is in the field.

$$\text{Duty of water} = \frac{8.64 \times \text{Base}}{\text{Delta } (\Delta)}$$

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★ Weirs - Used to measure the flow in an irrig^n channel or the discharge of a well or canal outlet at source.

- May be rectangular, trapezoidal (cipoletti weirs) or triangular (90° - V notch)
- 'V' notch weir is commonly used to measure small & medium size streams.

★ Parshall flume (Venturi flume) - To measure water flow.

→ Methods of Irrigation.

Ⓐ Surface Irrig^: 1) Flooding (lowland rice)

2) Check Basin Method.

↓

→ Advantage - water applic^ uniformly.

→ Disadvantage - labour requir^t, wastage of land, cultivation is difficult.

3) Ring basin method. (fruit trees)

4) Border strip method. (close growing crops. Not suitable for sandy soils.)

5) Furrow method - (crops grown with ridges. e.g. sorghum, maize, cotton, etc.)

Merits - Intercultiv^n is possible & labour req^t is less.

6) Surge Irrig^ - series of 'on' & 'off' modes of constant / variable time spans.

7) Cablegation - gated pipe system.

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(B) Subsurface / Subsoil Irrigⁿ.

* underground perforated pipes.

Merits → ET less, Less weed, Deep trenches for drainage, suitable for shallow table.

Demerits → Deep percolation; Maintainance of pipe is difficᵗ.

* Practiced in Kerala – coconut gardens.
Kashmir – vegetables.

(C) Sprinkler Irrigⁿ.

* Applied as a spray or as rain over the crop.

Merits → 1) Loss of water → 15-20% in well-irrigated areas.
30-35% in canal & tank irrigᵗᵈ areas.
2) Uniform applicⁿ of water.
3) 1.5-2 times increase in Irrigable area.
4) Saving of water → 25-30%
5) Saving of land 10-16%
6) No risk of runoff, erosion, inudaⁿ.
7) Suitable for – sandy, shallow soils, steep slopes, rolling topography, undulating land.
- water & labour scarcity areas.
- saline soils to leach salts.

& Sprinkling before frost → maintain higher temp.
minimize frost damage.

Demerits → 1) Not used under high wind velocity.
2) Not suitable for areas with hot dry winds.
3) High requirement of power.
4) High initial cost.
5) More spreading of diseases.

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(D) Drip / Trickle Irrigⁿ.

- Discovered in Israel.
- consist of main pipeline, submains, laterals & emitters.
- Irrigⁿ interval is 1-4 days. Saves 50-70% water.

* Merits - 1) Well suited to acute water shortage area.
2) Percolⁿ, runoff, ET losses are minᵐ.
3) Water is maintained at field capacity all through.
4) High moisture. → less salt concentⁿ.
5) No need of land leveling.
6) Herbigation & Fertigation.
7) Less energy reqᵗ.
8) Less disease & weed infestation.

* Demerits → 1) Clogging of emitters
2) Damage to lateral system due to animals.
3) Salt accumulation near plants.
4) Inadequate root devᵗ.
5) Frequent installⁿ & retrieval of system for annual crops.
6) High initial cost.

- Suitable for widely spaced crops, orchard trees and vegetables.
- Typhoon system of Drip irrigⁿ.
  - For sugarcane.
  - uses less than 50% of water needed.
  - used in Hawaiian sugar plantations.

→ * Pudding → Irrigation before sowing of crop is known as pudding.

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⑥ Rocks and its Weathering.

→ 3 main classes - ① Igneous rock
② Sedimentary rocks
③ Metamorphic rocks.

① Igneous rock ⇒

- The original molten material solidified.
- Ex: Granite, basalt, diorite, gabbro, syenite, Granodiorite, Periodotite.
- 2 types. (mode of form^n)

Plutonic	Volcanic
★ Solidific^n of magma inside the earth	Cooling of lava on the surface of earth.
★ Very slow cooling large crystals. Crystalline	Rapid cooling glassy structure.
★ eg. Diorite, granite, syenite, Gabbro	eg. andesite, trachyte, basalt.

② Sedimentary rocks →

Limestone, Dolomite, Sandstone, Shale, Conglomerate.

- Derived from igneous rocks.
- cover 4/5th of the extent of rocks on earth surface.

③ Metamorphic rocks.

Gneiss, marble, schist, slate, calcite & quartzite.

- Formed from Igneous or Sedimentary rocks. (by the action of intense heat and high pressure or both)

★ granite ~~from~~ gneiss
quartzite ~~from~~ quartz / sandstone
marble ~~from~~ Limestone
slate ~~from~~ shale.

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* The acid rocks give rise to sandier types of soils. and Basic rocks to the clayey types of soils.

→ Sources of plant nutrients.

	Nutrient	Source.
1>	N	Organic matter (O.M.)
2>	C	Carbamate
3>	P	Apatite, Fe/Al Phosphate, O.M.
4>	K	Micas, Feldspar, Orthoclase, Microline.
5>	Mg	Dolomite

→ Primary & Secondary Minerals

	Primary	Secondary.
①	Coarser Fractions of soil viz. sands, stone.	Fine materials. viz. clays
②	eg. Quartz, Muscovite, Augite, etc.	- Geothite, Dolomite, calcite, gypsum, etc.

→ classific^{n} of rocks on the basis of silica content.

① Acid rocks - 65-70% silica. eg. Sandstone, granite.

② Basic rocks - 40-45% eg. limestone, Basalt, gabbro.

③ Intermediate rocks - 55-65% eg. diorite, andesite.

→ Weathering of Rocks.

3 types -

A) Physical weathering. - ① Heat and cold
② Freezing & Thawing
③ Glaciers
④ Erosion by streams, waves, winds.

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B) Chemical weathering -- ① Simple solution
② Carbonation
③ Oxidation
④ Reduction
⑤ Hydration
⑥ Deposition
⑦ Hydrolysis

c) Biological weathering - Plants like mosses & lickens.
- roots of plants

→ Chemical composition of earths crust.

Element	Percentage.
1) Oxygen	49.2 %
2) Si	25.67 %.
3) Al	7.5 %.
4) Fe	4.71 %
5) Ca	3.39 %
6) Mg	1.93 %

→ Additional -

① Weathering : 1) Most resistant - Quartz (primary)
2) Least resistant - Calcite (secondary)

② Basic igneous rocks weather more than acid igneous rocks.

③ Sedimentary rocks are more resistant to weathering than igneous and metamorphic.

④ Limestone weathers more easily than sandstone.

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⑦ Soil Formation.

→ Factors of soil formation.

$$S = f(cl, o, r, p, t, \ldots)$$

S = Soil formation

cl = climate
o = organisms } Active factors

r = relief / topography
p = parent material } Passive factors

t = time or age of land } Neutral factors.

→ Soil forming Processes.

1) Humification - Formation of humus.

2) Eluviation - Washing out, removal of constituents from the upper layers to lower layers.

3) Illuviation - Washing in, deposition of soil materials in the lower layers.

4) Horizonation - Development of all the horizons in soil.

★ Specific Pedogenic Processes.

ⓐ Zonal

5) Calcification and gypsification — deposition of ~~soil~~ $CaCO_3$ in soil profile. In arid & semi arid regions.

6) Decalcification - Removal of $CaCO_3$ from soil by leaching.

7) Podzolization - Humus and sesquioxides (Fe & Al) become mobile, leach out from the upper horizons and are deposited in lower horizons.

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8) Laterization -

- contrast to podzolization.
- Removes silica, instead of sesquioxides from upper layers there by leaving sesquioxides to concentrate in the soil.
- Used for shifting agriculture, low intensity grazing and plantation of coffee, banana, pine apple and coconut.

(b) Intrazonal.

- Influenced by certain local conditions.
- occured in arid & semi arid regions. (Except gleiz^{n})

9) Gleization - Develop^{t} of glei (blue/grey/green clay) in the lower part of soil. Also called hydromorphic soil.

10) Salination - Accumulation of soluble salts in soil.

11) Solonization / Alkanization - Accumulation of high exchangeable Na^{+} ions. Called black alkali soils.

12) Solodization or Dealkalization -

Removal of Na^{+} ions from the soil.

13) Pedoturbation - Process of mixing of soils.

↓

3 type → (1) Faunal

(2) Floral

(3) Argillipedoturbation.

- in vertisols (i.e deep black cotton soils of central India)

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③ Soil and its properties (Physical)

→ 1> Pedology = Pedon + logos = greek word.
↓ ↓
Soil/earth study

(Study) of
- Classific^{n} and description of soil is pedology.
- Useful to highway and construction engineers.

→ Edaphology = Edaphos + logos = greek.
↓ ↓
Soil/ground study.

- To study the soil from the stand point of higher plants.
- Main objective - food and fibre production.

→ Regolith - loose earth material above solid rocks
- ~~with~~ weathered material may be inherent product or deposited by wind, water, etc.

→ Regosol - Any soil without definite genetic horizons
- soft mineral deposites - sands, loess, etc.

→ Organic soil - Having organic matter.

→ Mineral soil - weathered upper portion of regolith.
- less than 20% organic matter.

→ Soil = mineral soil, organic soil, Air, water.
(components)
Solid space Pore space.

→ Law of minimum - Von Liebig (1840)
सर्व घटक present असूनही, पिकासाठी अत्यावश्यक असणारा एक घटक absent असेल तर अशा जमिनीत ते पीक येत नाही.

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→ Soil profile - A vertical section of soil through horizons.

O, A, E, B & C

O → organic, in forest areas

A → Topmost, darker than others.

E/A_2 → Max^m Eluviation of clay, Fe & Al oxides.

AE / EB → Transition layer bet^n A and B

B → Max^m accumulation (Illuviation) of Fe & Al oxides

C → least weathering, accumul^n of Ca, Mg

→ Physical properties of soil.

* Soil texture - concerned with size of mineral particles. Relative proportion of sand, silt & clay.

* soil structure - Arrangement of soil particles into certain defined pattern.

* Fragments - Sand — 0.2 - 2 mm

Fine sand — 0.02 - 0.2 mm

Silt — 0.02 - 0.002 mm

Clay — < 0.002 mm

* Factors affecting soil structure.

1. Soil management.
2. Absorbed cations
3. Micro organisms
4. Variation of soil moisture.
5. Influence of O.M.

* Particle Density - Mass / weight of a unit volume of soil solids.

P.D. of O.M. is 1.1 — 1.4 g/cm^3

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★ Bulk Density (B.D) = $\frac{\text{Weight of soil}}{\text{volume of solids \& pores.}}$

★ Soil colour - (Yellow colour indicates more moist soils than red colour.)

Black / dark grey → Organic matter.

Red, Brown, Yellow → Iron compounds.

light, white, grey → Silica lime & other salts.

★ Soil Air -

Plant growth suffers at 40×10^{-8} g/cm² per minute ODR

Root growth is ceased at 20×10^{-8} "

(∵ ODR → Oxygen Diffusion Rate)

★ soil temperature - Root develop^{t} → 10 - 27° C

Crop root devel^{t} → 15 - 45° C

★ soil water :-

A] Physical classific^{n}

① Hygroscopic water → Held at hygroscopic coefficient

Tension - 31 - 10,000 atm.

② capillary water → Held betn field capacity and hygroscopic coeff.^{t}

Tension - $\frac{1}{3}$ (or 0.1) - 31 atm.

③ Gravitational water → Drainage water.

-ve tension of 0.3 atm.

B] Biological classification of water.

① Super fluous water - tension $\leq \frac{1}{3}$ atm.

- Held at field capacity.
- Higher plants साठी उपयुक्त नाही.
- पाणत साठवास Harmful.

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② Available water - lying between Field capacity ($\frac{1}{3}$ atm) and wilting coefficient (15 atm)

③ Unavailable water - Held in soil at the permanent wilting point.
- Hygroscopic water removed too slowly by plants to prevent wilting.

* Optm growth of plants at tension 1 bar or less.

④ Field capacity - When macropores drain their water and are filled by air but micropores are still filled with water then soil is called at field capacity.

Tension 0.1 - 0.3 atm.

⑤ Permanent wilting Percentage -
Although plants not dead but now in a permanentlly wilted condin and will die if water is not added.

Tension is 15 atm.

⑥ Hygroscopic coefft - Tension - 31 atm.
Moisture held at the point after the removal of liquid water completely from micropores.

⑦ Moisture Equivalent -

$$W.P. = \frac{\text{Moisture Equivt}}{1.84}$$

- M.E. represents moisture held under field capacity.

- Maximum capillary capacity (MCC)
= Water holding capacity - Hygroscopic coefft.

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