Arifur Rahman

Lec-1

Sir lecture note দিবেন

Irrigation

1) Introduction :

Artificial application of water for plant growth

2) Necessity :

HYV = High Yield Varities

3) Objective :

4) Advantage :

Leaching → salt water থাকলে salinity problem তৈরি হয়। এটা remove করার জন্য ও salt এর concentration কমানোর জন্যে প্রচুর পানি দিতে হয়, এটাই leaching

5) Direct benefit :

6) Disadvantage :

Restricted root system :

গাছ যদি ছোট থাকা অবস্থাতেই প্রয়োজনীয় সব উপাদান পায়, তবে এটার root system আর বাড়বে না। ফলে অল্প ঝড়েই সেটা uprooted হয়ে যাবে।

7) Irrigation : subset production system

8) Yield-water application interaction :

graph indicates → water দিলে production বাড়ে,
একটি নির্দিষ্ট water এর জন্য production
maximum. এর পর water দিলে
production কমতে থাকে।

9) Hydrologic Cycle :

Scanned by CamScanner

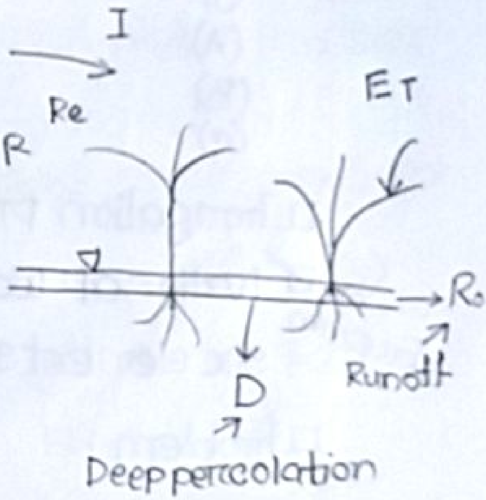
Lec-2

Importance of Irrigation

→ Law of Conservation of Mass:

E_t = Irrigation requirement

R_e = Effective rainfall
(loss বাদ দিয়ে rainfall এর remaining অংশ)



→ surface runoff
→ seepage
→ deep percolation
} এর মাধ্যমে irrigation এর পর Re এর অতিরিক্ত অংশ চলে যায়।

Water rights:

→ Irrigation Engineering:

→ Concept of Multipurpose Project:

- silt control না করলে, bridge pier ও other hydraulic structure এ siltation হয়, ফলে structure এর capacity কমে যায়। U/S এ sediment জমে ফলে backwater effect এর জন্য Flood হয়।

→ Considerations for development of W.R. project :

1.
2.
3.

☐ Type of irrigation Development :

(A)
(B)
(C)

☐ Irrigation practice in BD

(imp For exam) ☑ National Water Policy : (হুবহু লিখতে হবে exam এ আসলে)

six elements :

☐ Problem :

HTW → Heavy Tubewell Water
LLP → Low Lift pumps

☐ Categories :

STW = Shallow Tube well

→ Major canal + Traditional → use কমছে
অন্যগুলোর use বাড়ছে
NW → North-west

☐ Cropping Patterns

Q.(Ans) Rabi season এ irrigation এ খরচ বেশি, তবুও এই season
ফসল উৎপাদন ভাল হয়। কারণ,

Natural hazard (flood) হয় pre-monsoon and monsoon
এ। (+storm serge)

তাই যদি irrigation এর খরচ বাঁচাতে চাই; এই period এ crop
plant করি, natural hazard এর জন্য crop production ভাল
হবে না, crop নষ্ট হয়ে যাবে।

তাই rabi season এ irrigation এ খরচ হলেও crop production
ভাল হয় (ez, natural hazard নাই)।

II Social & Environmental aspects of irrigation and FCD :

Flood control

Lec-3

Soil Water Relationship

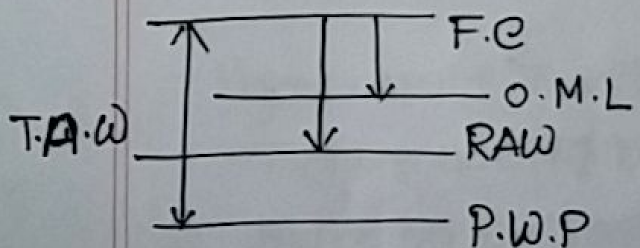
Q. Root zone depth কি?

→ saturation → 100% moisture content.

→ Field capacity → gravity এর জন্য water চলে যাবার পর যে moisture content

→ Field capacity এর 100% water plant use করতে পারে না।

→ permanent wilting point → গাছ নুয়ে পড়ে, এই অবস্থায় water দিলেও গাছ পূর্বের অবস্থায় ফেরত যাবে না, কিন্তু না কিছু ক্ষতি হতেই পারে।



T.A.W → Total available water

R.A.W → Readily available water.

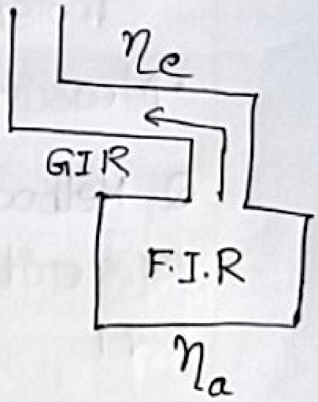
O.M.L → Optimum moisture level :
এই level এ water নেমে আসলে যদি irrigation দেয়া হয়, তবে plant আগের অবস্থায় ফিরে যাবে।

Q. Write short notes: Field capacity, PWP etc.

→ F.C:

→ P.W.P:

→ A.W:



FIR → Field irrigation Requirement

NIR → Net " "

GIR → Gross " "

→ Soil moisture content:

$$\theta_v = \frac{V_w}{V_b} \qquad \rho_w = \frac{M_w}{V_w} \qquad \rho_b = \frac{M_s}{V_b}$$

$$\Rightarrow \frac{d_w}{D_s} = \frac{M_w/\rho_w}{M_s/\rho_b}$$

$$= \frac{M_w}{M_s} \times \frac{\rho_b}{\rho_w}$$

$$= \theta_M \times \frac{\rho_b}{\rho_w}$$

d_w → কতটুকু depth of water apply করতে হবে

D_s → plant root zone depth.

$$\therefore \theta_v = \theta_M \times A_s$$

$$\therefore \frac{d_w}{D_s} = \theta_M \times A_s$$

$$\boxed{\therefore d_w = \theta_M \times A_s \times D_s}$$

$$\boxed{\rho_s = \rho_b(1+e)}$$

$$\boxed{\rho_b = \rho_s\left(1 - \frac{n}{100}\right)}$$

যদি $\rho_w = 1$ gm/cc,

then, $\theta_v = \theta_M \times A_s$

$$= \theta_M \times \frac{\rho_b}{\rho_w}$$

$$\boxed{\theta_v = \theta_M \times \rho_b}$$

এগুলোর প্রমাণ শিখতে হবে।

- Soil Moisture Tension :
  - Soil moisture characteristics :
    moisture extraction curve
  - Measurement of soil moisture :

Q. Method সম্পর্কে বললে →
এর merit, demerit & direct or indirect সেটা লিখতে হবে।

1. Direct ~~indirect~~ Method
2. Direct "
3. Resistance বেশি, moisture কম } Direct method
   " কম, " বেশি
4. Indirect Method
5.

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- Neutron Method :

→ soil এর Top surface এ moisture content বের করা যায় না।
→ expensive
→ needs calibration

- Flow of water through soil:

Darcy's principle অনুযায়ী → $V \propto i$ (Hydraulic gradient)

where, $i = \frac{h_L}{L} = \frac{\partial h}{\partial s}$

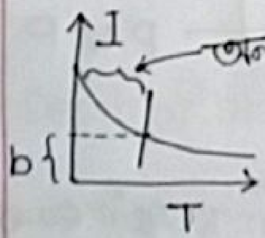
$V = ki$; K = permeability

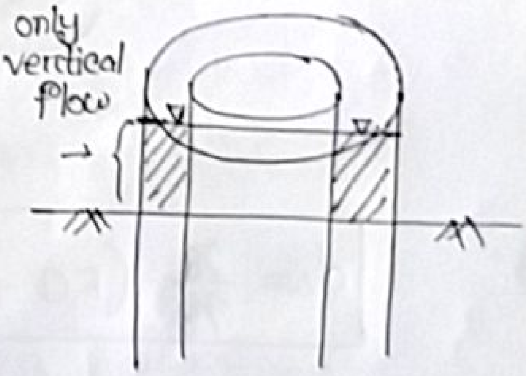
- Infiltration :

Intake rate → both radial + vertical flow of water through soil.

Infiltration → only vertical flow of water through soil.

- যত time যাবে, I কমবে।





১। ↓ , rate ↓
২। ↓ , " ↓
৩। potential difference ↑, rate ↑

Time ↑, I ↓

$V = ki$ (water)
$\approx I = ks \frac{\delta h}{\delta s}$ (soil)

- $I = a T^n$

অনেক সময়ের জন্য,

বেশি সময়ের জন্য, $I = b + aT^n$

• Longer period এর জন্য Intake rate constant

* Graph plot করে math করতে হবে।

Lec-5

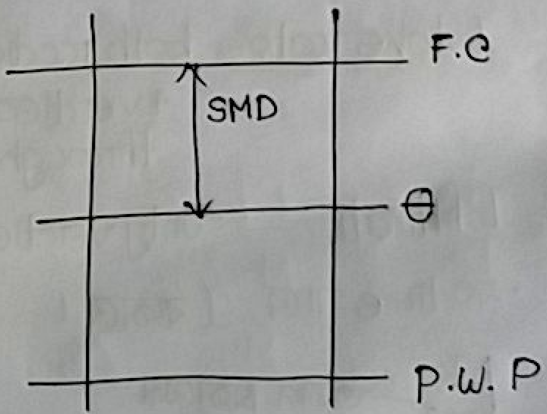
Example Problems

$\cdot\ d_\omega = \theta_m A_s D_s$

- f° না দেয়া থাকলে, $f^{\circ} = .5$ or 50%
- ধরা হয়, যখন 50% water কমে যায়, তখনই ~~wa~~ plant suffer করা শুরু করে।

$MAD = f^{\circ} \times TAW$

$\cdot\ SMD = (\theta_{FC} - \theta) \times Z$



$d_\omega = \theta_M A_s D_s \rightarrow Z$

$A_s = \frac{\gamma_d}{\gamma_\omega} = \frac{\rho_d}{\rho_\omega}$

$$d_\omega = \frac{\gamma_d}{\gamma_\omega}(F.C - PWP) \times D_s$$

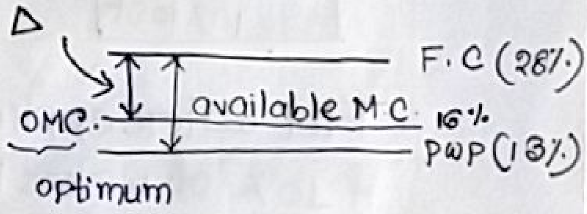
Net irrigation requirement

Lec-6

- $d_w = \frac{\gamma_d}{\gamma_w}(F.C - PWP) \times D_s = \frac{\rho_d \times g}{\rho_w \times g}(F.C - PWP) \times D_s$

Example problem 1 : (গার্গ এর বই)

Total available water = F.C − P.W.P
$= 28 - 13$
$= 15\% = TAW$



80% ← দেয়া থাকলে assume করে নিব 50 %

Readily available water (RAW) or (OMC. Level) = Δ

$= 15\% \times 80\% = 15\% \times 0.8$
$= 12\%$

$= 28 - 12$
$= 16\%$

Depth of stored water in the root zone

$= d_w = \frac{\gamma_d}{\gamma_w}(F.C - PWP) \times D_s$

$= \frac{\rho_d}{\rho_w}(28\% - OML) \times 0.7$

$= \frac{1.3}{1}(0.28 - 0.16) \times 0.7$

$d_w = 0.11\ m$

Days to supply water $= \frac{0.11}{\frac{12}{1000}} = 9.1$ days ≈ 9 days

Example 2:

F.C = ?

existing (8%)

1000 m^2
650 m^3
10% lost

Total water applied = 650 m^3

if 10% of water lost = $650 \times 0.1 = 65\ m^3$

Vol^m of water used to raise m/c from existing 8% to its F.C $= 650 - 65 = 585\ m^3$

∴ Depth of water used to raise m/c " " 8% to its F.C $= d_\omega = \frac{585}{1000} = 0.585\ m$

$$d_\omega = \frac{\gamma_d}{\gamma_\omega} (FC - PWP) \times Ds$$

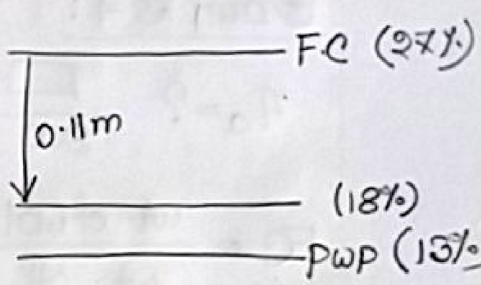
$\Rightarrow 0.585 = \frac{1450}{1000} \left(FC - \text{existing}\right) \times 1.8$

$\Rightarrow 585 = 1450\ (FC - 8\%) \times 1.8 \Rightarrow 585 = 1450 (FC - 0.08) \times 1.8$

$FC = 30.4\ \%$

Example 8

(i) Maximum depth of water stored in the root zone.



$$d_w = \frac{\gamma_d}{\gamma_w}(F.C - PWP) \times D_s$$

$$= \frac{14.72}{9.81}(0.27 - 0.13) \times 0.8$$

$$= \boxed{0.17m}$$

= net irrigation requirement (NIR)

(ii) Deficiency created before irrigation water is applied,

$$d_\omega = \frac{14.72}{9.81}(0.27 - 0.18) \times 0.8$$

$$= 0.11 m$$

This deficiency of water will be mitigated by irrigation water,

$$NIR = 0.11 m$$

$$FIR = \frac{NIR}{\eta_a} = \frac{0.11}{0.80} = 0.137 m$$

$$\text{Gross IR (GIR} = \frac{FIR}{\eta_e} = \frac{0.137}{0.85} = 0.162m = \boxed{16.2 cm}$$

Example 4:

100%

$\eta_a = ?$ $\frac{\square}{800}$

$$FC = \frac{\text{wt. of water contained in a certain vol}^m\text{ of soil}}{\text{wt. of the same vol}^m\text{ of soil}}$$

$$= \frac{\gamma_\omega \times V_v}{\gamma_d \times V_s} = \frac{\gamma_\omega}{\gamma_d} \times \frac{V_v}{V_s} = \frac{\gamma_\omega}{\gamma_d} \times n$$

porosity

$$\therefore \frac{\gamma_d}{\gamma_\omega} = \frac{n}{F.C} = \frac{0.4}{0.36} = 1.11$$

Maximum deficiency in between F.C & PWP

$$= d_\omega = \frac{\gamma_d}{\gamma_\omega}(FC - PWP) \times D_s$$

$$= 1.11(0.36 - 0.15) \times 0.60$$

$$= 0.14 \text{ m}$$

Deficiency created when soil moisture falls to 40%.

$$d_\omega = 0.14 \times 0.6$$

$$= 0.084 \text{ m}$$

vol^m of water needed to fill up this deficiency

$$= 0.084 \times 0.6 \times 10{,}000$$

$$= 504 \text{ m}^3$$

(moisture যখন 40%. এ নামে)

η_a = application efficiency = $\frac{504}{800} \times 100 = 63\%$

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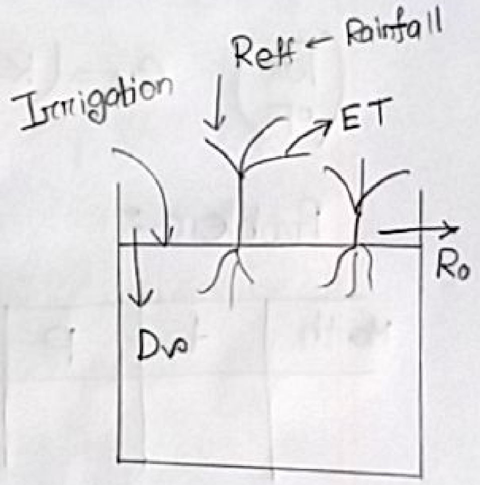
Consumptive use and Estimation of irrigation water requirement of crops:

(a) Transpiration

(b) Evaporation



(b) (Evaporation affected by) –

–
–
–
–

(a) Transpiration affected by →

* Direct measurement of CU / ET :

–
– non weighing percolation type
– weighing type

Σ Inflow = Σ Outflow

$I + Re = ET + \text{Runoff} (R_o) + D_r$

$\therefore$ $\boxed{ET = I + Re - R_o - D_r}$

$D_r \rightarrow$ Drainage / percolation loss

* Soil moisture depletion studies:

* Effective rainfall :

$Re = R - ~~ET~~ - R_o - D_r$

P

* Factors affecting Re :

* CIR

* Estimation of ET using empirical equation :
(সবগুলো eqⁿ মনে রাখতে হবে)

(a)
$$K = \frac{ET_c \text{ (practical crop এর)}}{ET_o \text{ (Standard crop এর)}} < 1$$

(For °F) $Cu = (K.P)/40\ [1.8t]$

Problem :

Month	t	P	Re

(b) Hargreaves class A pan evaporation method :
FAO Penman - Monteith equation : ← এই eqⁿ exam এ দেয়া থাকবে।

Lec-8

Irrigation Efficiencies:

Problem-1

Problem

Irrigation Scheduling

- Water requirement of a crop:
- crop period or base period:
- Duty and delta of a crop:

$$1 \text{ cumec} = \frac{1m^3}{1s}$$

$$Vol^m = 1 \times B(day) \ m^3/s$$
$$= 1 \times 60 \times 60 \times 24 \times m^3$$

$$depth = \frac{Vol^m}{area}$$

$$\Delta = 8.64 \frac{B}{D} \cdot m$$

- Importance of Duty
- Improvement of Duty

→ long canel এর জন্য 85% water conveyence এর জন্য loss হতে পারে for seepage.

17.12.17 →
C.T. Lec - 1 - 9
Chap - 1, 3, 4

Lec-9

- Crop season
- Cash crop
- Optimum utilization of irrigation water
- Gross command area (G.C.A)
- Cultivable area (C.C.A)
- Intensity of ~~Rai~~ irrigation (I.I)
- Net and Gross Sown Area
- Time Factor:

$\frac{144}{180}$ → Kharif Time Factor

- Capacity Factor:
- Kor depth:

Problem

Given, Gross command area = 6000 ha

C.C.A = 80% of 6000 = 4800 ha

for (Rabi) I.I = 50% of 4800 = 2400 ha

I.I for Kharif = 25% of 4800 = 1200 ha

Distributary for Rabi = 2000 ha/cumec

" " Kharif = 900 ha/cumec.

Discharge at head of the distributary $= \frac{A}{D}$

$\therefore$ for Rabi $= \frac{2400}{200} =$ **1·2 cumec**

for Kharif $=$, $Q = \frac{A}{D} = \frac{1200}{900} =$ **1·33 cumec**

↗ use → For design

Problem

C.C.A = 15,000 ha

I.I for Rabi = 40% of 15,000 = 6000 ha (wheat)

I.I " Kharif = 15% of 15,000 = 2250 ha (Rice)

Δ for Rabi = 37·5 cm

Δ " Kharif = 120 cm

(Rabi) $\Delta = 864 \times \frac{B}{D}$

$\Rightarrow 37.5 = 864 \times \frac{160}{D}$

$\therefore$ D(Rabi) = 3686·4 ha/cumec

$\Delta(\text{Kharif}) = 864 \times \frac{B}{D}$

$\Rightarrow 120 = 864 \times \frac{140}{D}$

$\therefore$ D(Kharif) = 1008 ha/cumec

$Q(\text{Rabi}) = \frac{A}{D} = \frac{6000}{3686.4} = 1.63$ (cumec = m^3/sec)

$Q(\text{Kharif}) = \frac{A}{D} = \frac{2250}{1008} =$ **2·23 cumec**

Design discharge

From avg. demand consideration.

From Peak Demand consideration,

Kor depth = Delta = Δ

For Rabi

$\Delta = 13.5cm$

B = 4 week = 28 days

$\Delta = 864 \times \frac{B}{D}$

$\therefore D = 1792$ ha/cumec

$Q = \frac{A}{D} = \frac{6000}{1792}$

$= 3.35$ cumec

For Kharif

$\Delta = 19$ cm

B = 2 week = 14 days

$\Delta = 864 \times \frac{B}{D}$

$\therefore D = 636.63$ ha/cumec

$Q = \frac{A}{D} = \frac{2250}{636.63}$

$= \boxed{3.53 \text{ cumec}}$

Design

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