UNIT - III

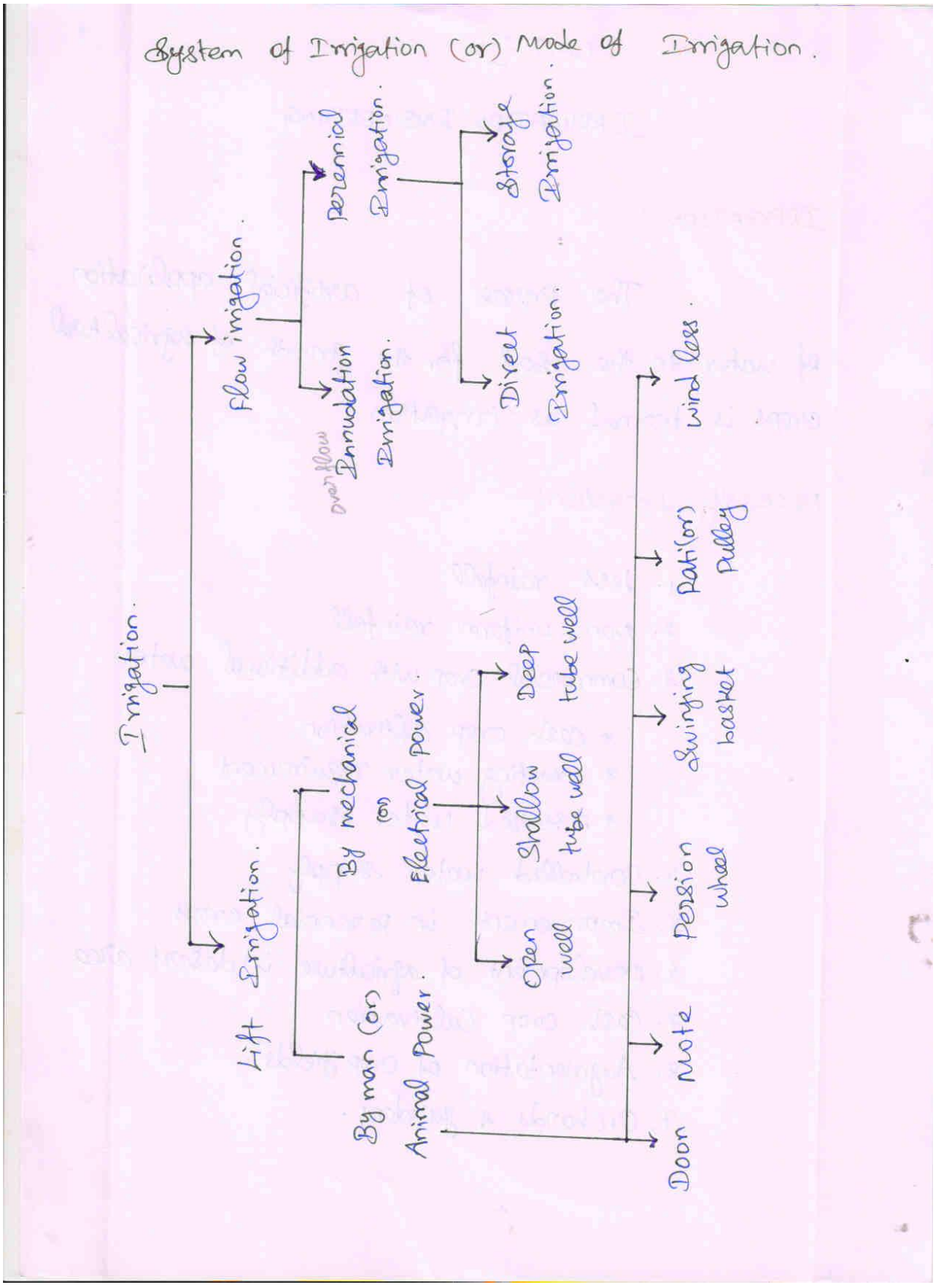
IRRIGATION ENGINEERING

IRRIGATION : -

The process of artificial application of water to the soil for the growth of agricultural crops is termed as irrigation.

Necessity Irrigation : -

1. Less rainfall
2. Non - uniform rainfall.
3. Commercial crop with additional water.
   * Cash crop cultivation.
   * Exacting water requirement.
   * Assured water supply.
4. Controlled water supply.
5. Improvement in perennial crops.
6. Development of agriculture in desert area.
7. Cash crop Cultivation.
8. Augmentation of crop fields.
9. Orchards & gardens.


System of Irrigation (or) Mode of Irrigation.
Irrigation.
Flow irrigation.
Perennial Irrigation.
Inundation Irrigation.
overflow
Storage Irrigation.
Direct Irrigation.
Lift Irrigation.
By man (or) Animal Power.
By mechanical (or) Electrical power.
Open well
Shallow tube well
Deep tube well
Door Mote
Pension wheel
Swinging basket
Pah(or) Pulley
wind legs.

Merits of Irrigation :-

Increasing food production.
Production from famine
Cultivation of Cash crops.
Addition of the wealth of the country.
Increase the in economical of people.
yield of crops.
Generation of hydro electric power.
Domestic and industrial water supply.
Navigation.
Improvement of communication.
Improvement in ground water storage.
Development of fishery.
Source of Revenue.

Demerits of Irrigation :-

Breeding places for mosquitoes.
water logging.
Damp climate.
Rising the water table.
Losses of valuable lands.

Scope of Irrigation:-

It deals with all aspect and problems extending from water shed to agricultural farms.

It deals with design and construction of all works such dams weirs and head regulator in connection with the storage are diversion of water as well as the problem of sub soil drainage and water - soil - Crop relationship.

Scope of Irrigation may be divided into two heads.

1. Engineering Aspect:-

Storage, diversion or lifting of water.
Conveyence of water to the agricultural field.
Application of water to the agricultural fields.
Drainage & Relieving water logging.
Development of water power.

2. Agricultural Aspects:-

Basic Definition:-

(1) Gross Command Area:- (GCA)

The hole area enclosed between an

imaginary boundary line which can be included in an irrigation project for supplying water to agricultural land by the network of canals is known as GCA.

It include both the culturable & unculturable area.

2. Un-culturable Area :-

The area were the agriculture cannot be done and crop cannot be grown is known as un-culturable area.

Ex :- Marshy land, Barren land, Lakes, forest, village.

3. Culturable Area :-

The area were the agriculture can be done satisfactorily or is known as culturable area.

4. Culturable Command Area (CCA) :-

The total area with in on irrigation project were cultivation can be done and crop can be grown is known as culturable command area.

Again CCA may be of 2 categories.

(a) Culturable cultivated Area :-

It is the area with in CCA were the cultivation has been actually done at present

(b) Culturable uncultivated area :-

It is the area with in CCA were cultivation is possible but it is not being cultivated at present due to some reasons.

(5) Intensity of Irrigation :-

It is defined as the ratio of cultivated land for a particular crop to be total culturable command area.

(6) Crop Ratio :-

It is defined as the ratio of the area of 2 main crop season.

Ex : Kharif & Rabi

The crop ratio should be so selected that the discharge of the canal for supplying water to kharif & rabi season may be nearly equal.

7. Crop Season :-

The period during which some particular types of crop can be grown every year on the same land is known as crop season.

The following are the main crop season.

* Kharif
* Rabi

Kharif Season :-

This season range from June to october. The crops are shown in the very beginning of monsoon & harvesting at the end of the autumn.

The major Kharif crops

Rice
Millet
Maize
Jute.
Ground nut, etc...

Rabi Season :-

The season ranges from october to march. The crops are shown in the very beginning of winter and harvested at the end of spring.

The major rabi crops.

* Wheat
* Gram
* mustard
* Rape seed
* Linseed
* Pulses, Onion, etc.

8. Cash Crop :-

The crops which are cultivated by the farmers to sell in the market to meet their current financial requirement are known as cash crops.

Ex :- vegetables, fruits, etc.

9. Crop Rotation :-

The process of changing the type of crop for the cultivation on the same land is known as crop rotation.

1. Rice - Gram.
2. Wheat - Millet - Gram.
3. Rice - Gram - Wheat.

10. Crop Period :-

It is defined as the total period from the time of sowing a crop to the time of harvesting it.

11. Overlap Allowance :- 5

Sometimes a crop of one season may overlap the next crop season by a few days more which it requires to mature.

During this period of overlapping, the irrigation water is to be supplied simultaneously to the crops of both the seasons.

Due to the extra demand of water during this period, the discharge of the canal has to be increased. So, for the purpose of canal design, a provision should be made for this extra demand. This provision is termed as overlap allowance.

12. Time factor :-

The ratio of the number of days the canal has actually been kept open to the number of days the canal was designed to remain open during the base period is known as Time factor.

$$T.F = \frac{\text{No of days the canal practically kept open}}{\text{No of days the canal was designed to keep open.}}$$

$$= \frac{\text{Actual discharge}}{\text{Designed discharge.}}$$

13. Cumec Day :-

The quantity of water flowing continuously for one day at the rate of one cumec is known as cumec-day.

$$1 \text{ cumec day} = \frac{1 m^3}{\text{secs}} \times 24 \times 60 \times 60 \text{ secs}$$

$$= 24 \times 60 \times 60 \times m^3$$

$$= \frac{24 \times 60 \times 60}{10000} \, m \quad (1 \text{ hectare} = 10000 \, m^2)$$

$$= 8.64 \text{ hec. metre}$$

~~14.~~ Capacity factor.

Base Period :-

It is defined as the period from first to last watering of the crop just before the its maturity. It is denoted by "B" & expressed in no of days.

Crop		Base in days.
Rice	–	120
wheat	–	120
maize	–	100
cotton	–	200
Sugarance	–	320.

Delta :-

Each crop require certain amount of water per hectare for it maturity.

If the total amound of water supply to the crop is stored in the land without any losses.

This depth of water layer is known as delta for the crop. It is denoted as delta (Δ).

Duty :-

The duty of water is defined as no. of hectare that can be irrigated by constant supply of water at the rate of 1 cumec throughout the base period & is denoted as "D".

Factors affecting Duty :-

1. Kinds of crop grown
2. Nature of soil.
3. Cultivation methods.
4. Methods of water application
5. Irrigation system.
6. water quality.
7. Climate & season.
8. Rainfall.

9. Base Period
10. Method of Assessment
11. Canal Section
12. Topography of Land.

Methods of Improving Duty :-

1. Proper Ploughing.
2. Methods of supplying water
   - Furrow method
   - Contour method
   - Basin method
   - Flooding methods.
3. Canal lining.
4. Transmission loss.
5. Crop rotation.
6. Implementation of Tax.

Irrigation Efficiency :-

The ratio of amount of water available (output) to the amount of water supply (input) is known as irrigation efficiency.

It is expressed in percentage. It is denoted as η.

(7)

Types of Irrigation Efficiency :-

(1) water Conveyence Efficiency (η_c) :-

$$\eta_c = \frac{W_e}{W_r} \times 100$$

where, W_e - Amount of water apply to land.
W_r - Amount of water supply from reservoir.

(2) water Application Efficiency (η_a) :-

$$\eta_a = \frac{W_z}{W_f} \times 100.$$

where, W_z - Amt of water stored in root zone.

(3) water Use Efficiency (η_u) :-

$$\eta_u = \frac{W_u}{W_f} \times 100$$

where W_u - water used.
W_f - water apply.

(4) Consumptive use Efficiency : (η_{cu})

$$\eta_{cu} = \frac{C_u}{W_p} \times 100.$$

where,
C_u - Consumptive use of water.
W_p - Amout of water depleted from root zone.

(3)(a) Crop water Use Efficiency :-

It is the ratio of yield of crop to the amount of water depleated by crop in evapotranspiration.

(b) Field water Use Efficiency :-

It is the ratio of yield of crop to the total amount of water used in the field.

(5) water Storage Efficiency (or) water Storage Factor :-

It is defined as the ratio of water stored in the root depth by irrigation to the water needed in the root depth to bring it to the field capacity.

$$E_s = \frac{W_s}{W_w} \times 100$$

where, W_s - water store in the root depth.

(6) water Distribution Efficiency :-

It is the expression for distribution efficiency to evaluate the extent to which the water is uniformly distributed.

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

where, d - Avg deviation in depth of water stored from avg depth store during irrigation.

D - Avg depth of water stored along the run during irrigation.

Consumptive use of water (or) Evapotranspiration :- 8

It is defined as the total quantity of water used for the growth of plant is lost by transpiration & evaporation.

It is expressed in m.

(i) Transpiration :-

water entiring the plant roots and used to build plant tissue (or) being passed through leaves of the plant into atmosphere.

(ii) Evaporation :-

water evaporating from the adjacent soil water surface (or) from the surface leaves of the plant.

Reasons :-

Consumptive used various with temperature, humility, used wind velocity, soil topography, sunlight hours, available moisture, precipitation, irrigation water (or) natural ground water, methods of irrigation, depth of water applied for irrigation, cropping pattern, season and mean monthly temperature.

(i) Optimum Consumptive use of water :-

It is the consumpitive use which produces a maximum crop yield.

(ii) Seasonal Consumptive use of water :-

Depth of water consumed by evapotranspiration during crop growth till maturity including water used by accompanying weed growth.

Consumptive Irrigation Requirements :- (CIR)

It is the amount of irrigation water required to meet the consumptive use of crop during the growth period.

It is the same as consumptive use exclusion of effective precipitation stored soil moisture (or) ground water.

$$CIR = Cu - Re$$

Where

Cu - Consumptive use.

Re - Rainfall effective.

Net Irrigation Requirements [NIR] :-

Dt is the amount of irrigation water require to meet the evapotranspiration need of crop as also other needs such as leaching

$$NIR = Cu - Re + Le.$$

where

Le → water lossed at percolation

Methods of Determining Consumptive use of water :-

(1) Direct Measurement :-

Lysimeter method
Field experimeter method.
Soil moisture study method.

$$Dr = \frac{Pwd}{100}$$

where,

Dr - Depth of water remove
P - % of water content
w - specific gravity of soil.
d - depth of soil in meter.

(ii) Empirical Formula :-

* Lowry - Johnson Method :-

Consumptive use

$$U = 0.00015\,H + 0.9$$

Where

H → Accumulated degree days during the growing season computed from the maximum temperature above 32°c.

* Blaney-criddle Method :-

$$C_u = \frac{K_p}{40}(1.8t + 32) = KF$$

Where C_u - Monthly Consumptive use.

K - Empirical co-efficient

P - Monthly present of annual day light hours.

t - Mean monthly temperature degree Celsius.

F - Sum of monthly consumptive use factor for the period.

* Hargreaves, class A pan evaporation Method:- 10

$$C_v = K E_p$$

where

C_u - Consumptive use of water co-efficient.

K - Empirical co-efficient

E_p - Class A pan evaporation.

$$E_p = 0.459 R \, C_t \cdot C_w \cdot C_h \cdot C_s \cdot C_e(C_m)$$

where

R = Extra - terrestrial radiation (cm(or)mm)

C_t = Co efficient of temperature

$$C_t = 0.393 + 0.02796 T_c + 0.0001189 T_c^2$$

where

T_c - mean temperature in °c

C_w - wind velocity co-efficient

$$C_w = 0.708 + 0.0024 w - 0.0000038 w^2.$$

where:

w - mean wind velocity in km/day at 0.5m above ground surface.

C_h - Co efficient of relative humidity.

$$C_h = 1.25 - 0.0087 H + 0.75 \times 10^{-4} H^2 - 0.83 \times 10^{-8} H^4$$

where

H = mean % relative humidity at noon (or) average relative humidity for 11 to 18 hours.

C_s - co efficient for percent of possible sunshine

$$C_s = 0.542 + 0.0083 - 0.78 \times 10^{-4} s^2 + 0.62 \times 10^{-6} s^3$$

where.

S - mean sunshine percentage.

Ce - Coefficient of elevation.

$$Ce - 0.97 + 0.00984E$$

where E = Elevation in 100m.

Types of Soil :-

Alluvial Soil
Black Soil.
Red Soil.
Laterite Soil.

Types of Soil water :-

Gravitational water.
Capillary water.
Hygroo
Hydroscopic water.
Field Capacity.
Permanent wilting point.

11

Relation b/w Base, Delta & Duty :-

Let
D - Duty of water in hectare/cumec.
B - Base in days.
Δ - Delta in meter.

From definition 1 cumec of water flow in continuously for "B" days gives a depth of water Delta "Δ" over an area "D" hectare.

ie,
1 cumec for "B" days gives "Δ" over "D" hectare
(or)
1 cumec for 1 day gives "Δ" over $\frac{D}{B}$ hectares.
(or)
1 cumec for 1 day = $\frac{D}{B} \times \Delta$ hectare meter.
(or)
1 cumec day = $\frac{D}{B} \times \Delta$ hectare meter. — (1)

Again 1 cumec day = $1 \times 24 \times 60 \times 60$
$= 86400 m^3$.
$= 8.64$ hec-meter.

($\because$ 1 hec = $10000 m^2$) — (2)

From eqn (1) & (2)

$$\frac{D}{B} \times \Delta = 8.64$$

$$\Delta = \frac{8.64 \times B}{D} \text{ in meter}$$

Water Requirement of crop :-

optimum water requirement of a crop is the quantity of water require during its growth period that results in maximum yield. The optimum quantity of water include water supply by precepitation as well as water deliver by irrigation.

The supply of water more than optimum requirement may not result in increase in yield of most crop but also decrease the quality of the product.

Needs :-

If the supply of water to the crop is more or loss than its optimum requirement it will adversely affected the crop of yield supply.

Supply of loss water will cause the plant to spend extra energy to get moisture

from the soil which would otherwise has been used in it growth. 12

Supply of surplus water will expel the air from the soil porous and will prevent free circulation of fresh air which is essentially for food preparation of the plant.

Factors affecting crop water Requirements:-

Depth of water table.
Slope of the ground.
Climate condition of the region.
Intensity of irrigation.
Texture & structure of soil.
Moisture storage capacity of the soil.
Type & quantity applied to the field.
System of irrigation used.