UNIT- I

Irrigation

Definition :—

It is defined as the process of artificially supply water to the soil for raising crops.

It is a Science of planning and designing an efficient, low Cost, economic irrigation system. It also includes the study and design of works in Connection with river Control, drainage of water logged areas and generation of hydro-electric power.

Necessity of Irrigation :—

1. **Less Rainfall :—** when rainfall is insufficient for the crop artificial supply is necessary. In this Case Irrigation works may be Constructed at place where more water is more available and Convey water to the area where there is deficiency of water.

2. **Non uniform Rainfall :—**

when rainfall is not uniform over the ~~area~~ Crop period for a particular area. So with this non uniform rainfall, the yeild of crops will be less and some times crops may die. so by the Collection of water during excess rainfall period, water is supplied to the crop during the period, where there is no rainfall.

(3). **Growing a Number of crops during a year :—**

Some areas have rainfall to raise only one type of crop during the rainy season (i.e Kharif crops) there is no irrigation required. But beyond the season (kharif). Rabi season crops will be there, and irrigation has to be done.

4. Growing perinnial Crops :—

perinnial crops as sugarcane etc. which are needed through out the year, Can be raised only by (supplying water) irrigation in that area.

5. Commercial crops with additional water :—

Some of the crops are Commercial or Cash crops. So for their usual raise. (irrigation). Sufficient Quantity of water has to send.

6. Controlled water supply :—

By the Construction of proper distribution system, the yeild of the crop may be increased because of Controlled supply of water.

Principal crops and crop Seasons :—

Crops can be classified in following ways

a. Artificial classification

b. Classification based on crop Seasons

c. classification based on irrigation requirement.

a. Aggricultural classification :—

(i) field crops :— Such as wheat, rice, maize, barly, oats gram, pulses etc.

(ii) Commercial crops :— Such as Sugar Cane, Cotton, tobacco etc.,

(iii) oil seed crops :— Such as mastard, groundnut, Seasame, linseed etc.

(iv) plantation crops :— Such as Tea, Coffee, Cocunut, rubber etc.

(v) Horticulture crops :— Consist of various fruit crops. various vegitation crops and flower crops.

(vi) forage crops :— Remove fodder and gram etc.

(vii) Miscelleneous crops :— Medical crops, Aromatic crops, Sericultural crops, Condiments and spices.

b. Classification based on crop Season :—

(i) Rabi crops or winter crops :–

These are sown in Autumn (oct) and are harvested in spring (march) Such crops are gram, wheat, barely peas, mustard, tobacco, potato etc.,

(ii) Kharif crops or Monsoon crops :—

These are sown by the begining of South west manson and are havested in Autumn. Such crops are rice, maize spiked millet pulses, ground nut etc.

(2)

(ii) perennial crops :— These are the crops that require water for irrigation througout year.

(iii) Eight monsoon crops :— These are Cotton require irrigation water for 8 months.

③ classification based on irrigation Requirements :—

(i) dry crops :— Does not require water, only rain water is sufficient for their growth.

(ii) wet crops :— These are which Cannot grow without irrigation

(iii) Garden crops :— These are require irrigation througout the year.

(*) Crop Rotations :—

It implies that nature of crop shown in a particular field is changed year after year.

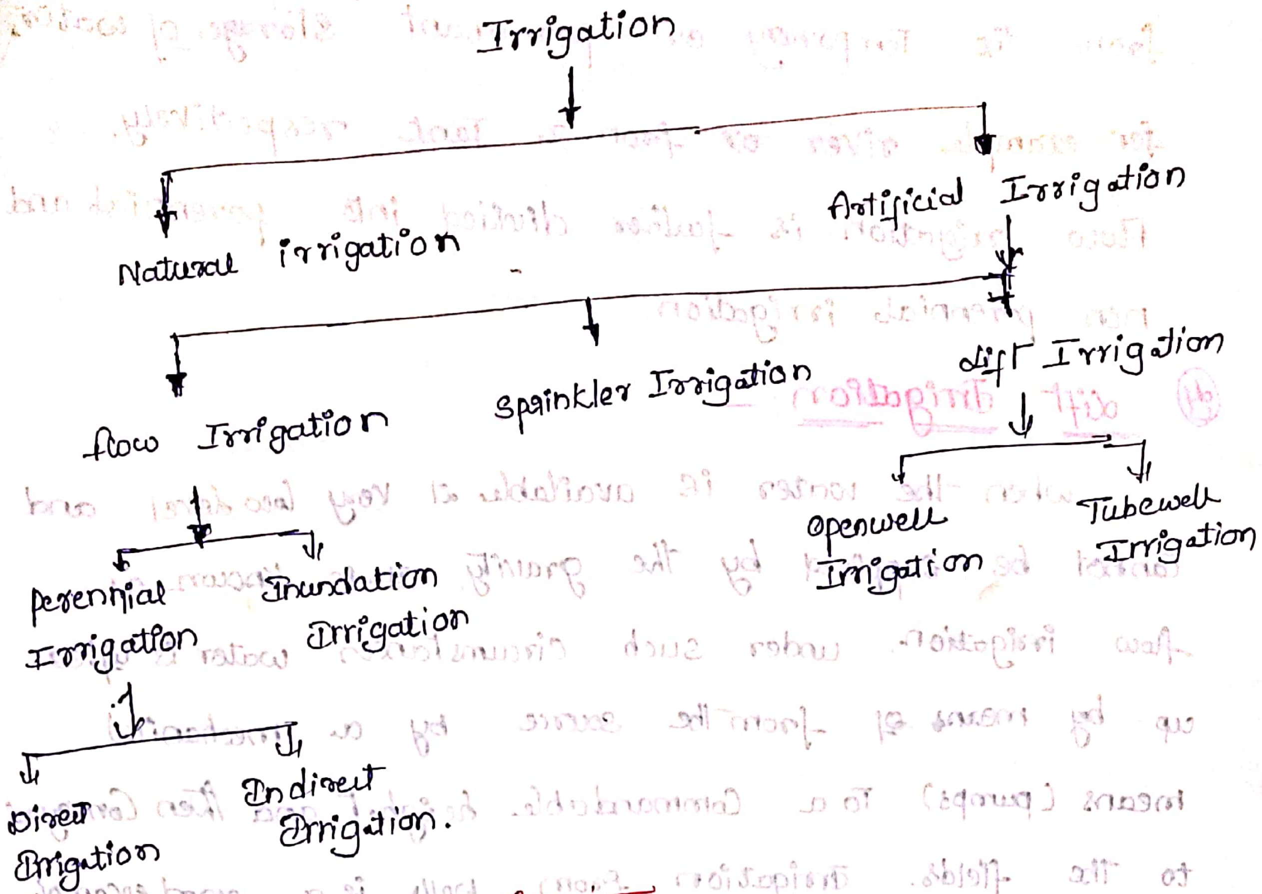
The necessity of rotation arises from the soil lose gradualy its fertility. if the same crop is sown every year and the field has to be allowed to gain its fertility. This regain of fertility is obtained by rotation of crops.

(*) Crop Seasons :— There are two main seasons

ⓐ Kharif Season :- known as mansoon crops. Sown in april month to harvested in September. ex. rice, maize

(b) Rabi Crop :— Called water crops : Sown in October and harvested in march. Ex wheat, Tobacco

Types of Irrigation :—



1. Natural Irrigation :—

In this Type of irrigation water is supplied to the fields without Constructing any Engineering work. In a very broadsense natural rainfall may be included in a natural Type of Irrigation.

2. Artificial Irrigation :—

In artificial irrigation fields are irrigated after constructing properly designed and located hydralic structure for example headworks outlets etc. It can be divided into flow irrigation, sprinkler irrigation and lift irrigation,

③ flow Irrigation :—

when the hydralic water can be conveyed to the land by the gravity is known as flow irrigation

 www.Jntufastupdates.com

In flow irrigation water flows in channels directly from the Temparary or permenant storage of water, for example river or from a Tank respectively. Flow irrigation is further divided into perennial and non perennial irrigation.

(4) Lift Irrigation:—

when the water is available at very low level and cannot be supplied by the gravity. ~~It is known as flow irrigation.~~ under such circumstances water is lifted up by ~~means of~~ from the source by a mechanical means (pumps) To a Commandable height and then Conveyed to the fields. Irrigation from wells is a good example of lift irrigation It can be further divided into

① open well irrigation ② Tube well Irrigation

In case of open well irrigation the diameter of well ranges from 12 to 16m and the water lifting divices erected on the surface of the ground. But in case of Tube well irrigation submergible pumps are kept below the ground level and diameter of the well ranges from 0.18 to 0.27 m.

(5) sprinkler Irrigation

The system by which water is sprayed over the fields by means of network of pipes fitted with spray nozzles at their open ends is Called over head or sprinkler irrigation. This system just like the rainfall created artificially.

⑥ Perennial irrigation :—

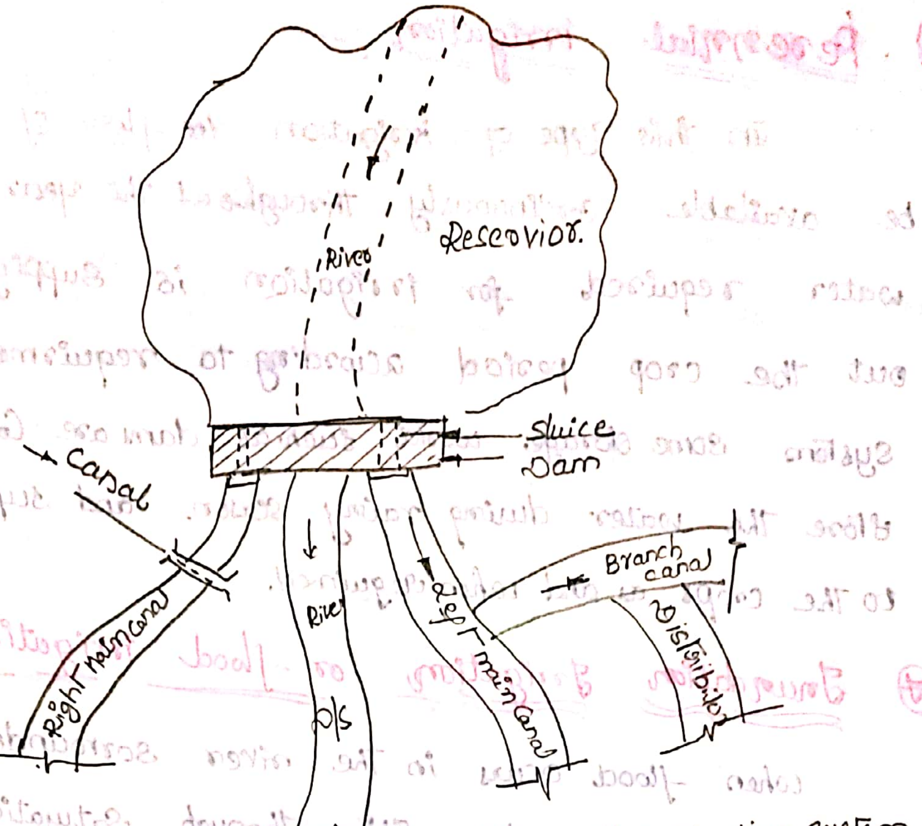
In this Type of irrigation the flow of water will be available continuously throughout the year. Hence the water required for irrigation is supplyed through out the crop period according to requirment. In this system some storage works such as dams are Constructed to store the water during rainy season. and supply the same to the crops as and when required.

⑦ Inundation Irrigation or flood irrigation

When flood occurs in the river sorrounding area is submerged under water. After through saturation the water is drained off before planting the crop. The moisture thus stored. If the soil is supplimented by rainfall occassional minor wetting which brings the crop to maturity. The method is also known as flood irrigation.

⑧ Indirect or storage Irrigation :—

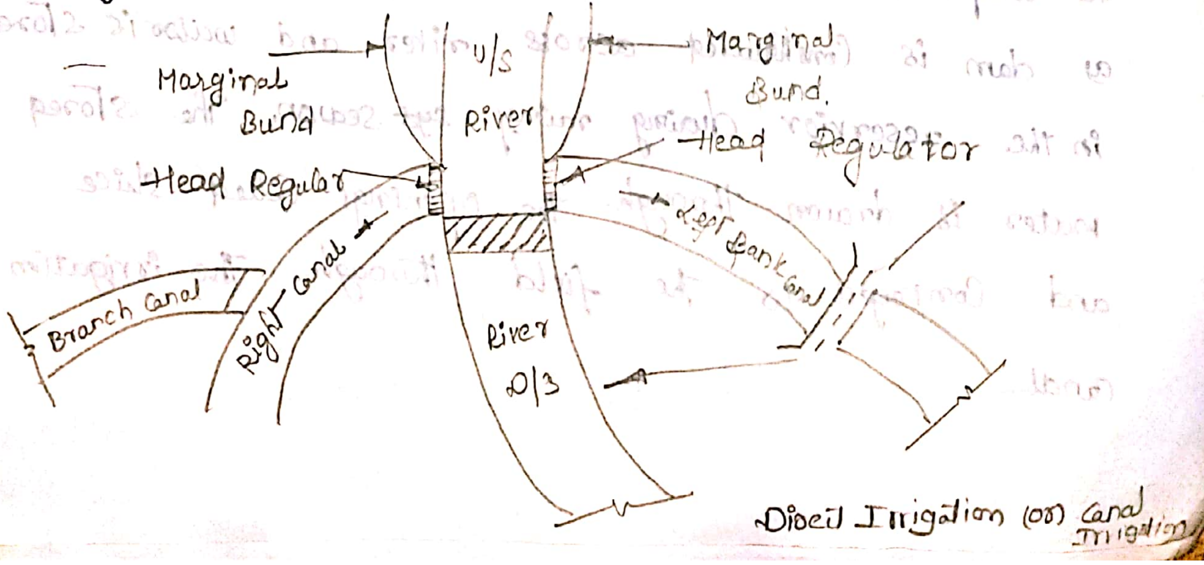
This Type of irrigation is also known as Tank irrigation when the flow of water is not available throughout the crop period this system of irrigation is adopted. In storage irrigation a solid barrier such as dam is Constructed across river and water is stored in the reserrior during rainy ~~sys~~ season. The stored water is drawn through the openings Called sluice and Conveyed to the field through the irrigation canal.



Storage Irrigation or Indirect Irrigation system.

① Direct Irrigation :-

It is also known as River Canal irrigation. In this system of irrigation a barrage or a weir is Constructed across the river which causes the rise in water level of the river. Then the water is Conveyed to the fields by canals Taking off directly from the river. When the flow of water in the river which is available throughout the crop period is always more then the requirements of the area to be irrigated then only direct irrigation is possible.



Direct Irrigation (or) Canal Irrigation

Methods of Irrigation :—

5

Methods of Irrigation

- Surface Irrigation
  - Flooding method
    - Natural Sub-Irrigation
    - Artifical Sub Irrigation
  - Furrow method
  - Contour farming
- Subsurface Irrigation
  - Natural Irrigation
  - Artifical Irrigation
- Overhead Irrigation
  - Fixed pipe
  - Portable sprinkler
- Drip Irrigation

- Flooding from field channels
- Border strip method
- Checks or Levees method
- Basin method.

① Surface Irrigation :—

In surface irrigation methods the irrigation water is applied by spreading it over the surface of the land to be irrigated. Different Quantities of water are allowed on the feilds at different times according to the crop requirements.

② Sub Surface Irrigation :—

In surface irrigation methods, The irrigation water is applied by spreading it over the surface of the land. to be irrigated. Different quantities of water is allowed on the feilds at different times according to the crop requirements.

③ Sprinkler Irrigation :—

In the sprinkler irrigation method, The irrigation water is applied to the land in the form of spray just like a rainfall. This method mainly Consists of a system of pipeline network with sprinkler heads which will supply the water to the crops in the form of natural rainfall.

(4) Drip Irrigation :—

In this method of irrigation, water is applied in the form of drops directly near the base of the plant. water is conveyed through a system of flexible pipelines operating at low pressure and is supplied to the plant through drip nozzles.

⇒ Surface Irrigation Methods :—

1. Flooding method :

In this method the water is applied to the fields by flooding the land. This method is again sub divided into

1. uncontrolled or wild flooding
2. Controlled flooding.

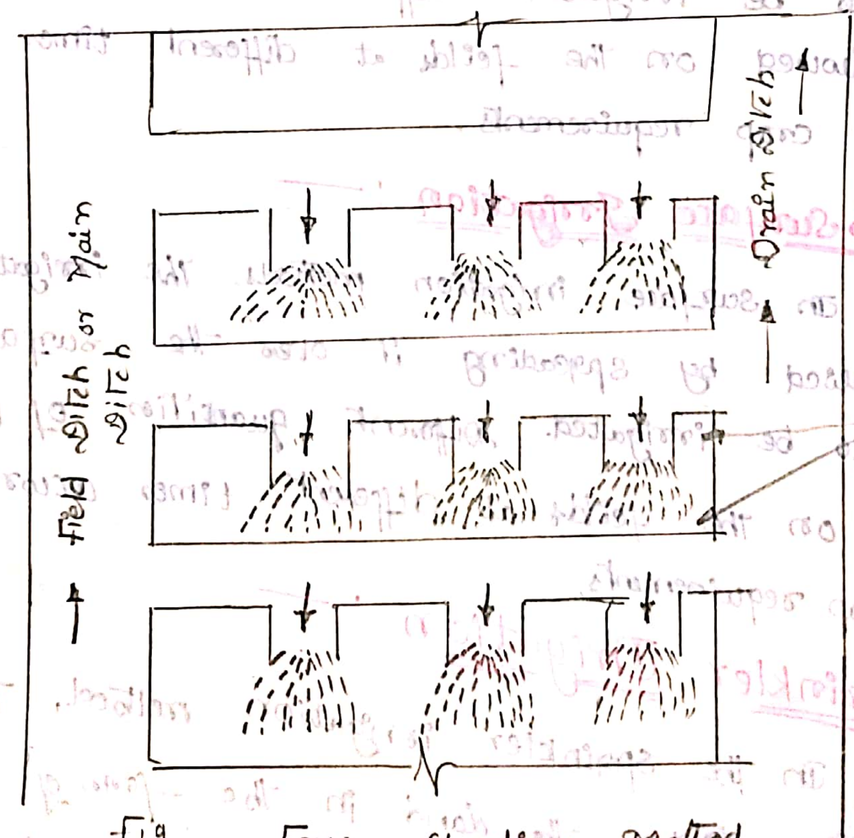


Fig. Free flooding Method

 www.Jntufastupdates.com Scanned by CamScanner

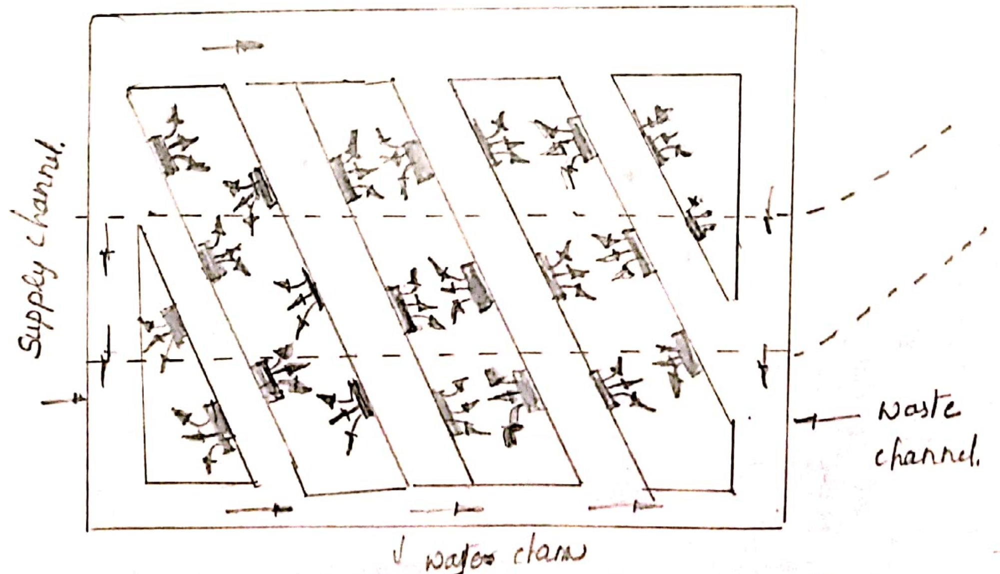
In this method water is spread or flooded on a smooth flat land without much Control or prior preparation. The water is allowed to flow on the natural slope of the ground without any control.

② Control flooding:-

In this method water is applied by spreading it over the field to be irrigated with proper Controlling arrangements. In this method prior preparation of the land essential. Controlled method can be subdivided into.

→ flooding from field channel:

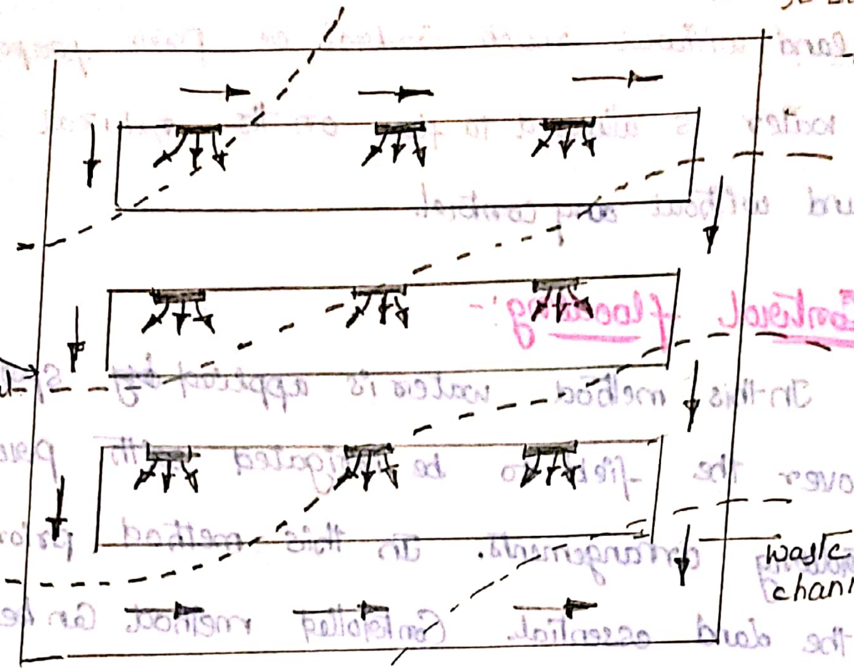
In this method a series of field channels divides the irrigated land into small strips. The water is supplied by a main channel to the field channel. The supply channels are aligned along the general slope of the field and are located at the higher edges of the field. The laterals may be aligned in three ways.



Field channels at Right angles to the Contour lines

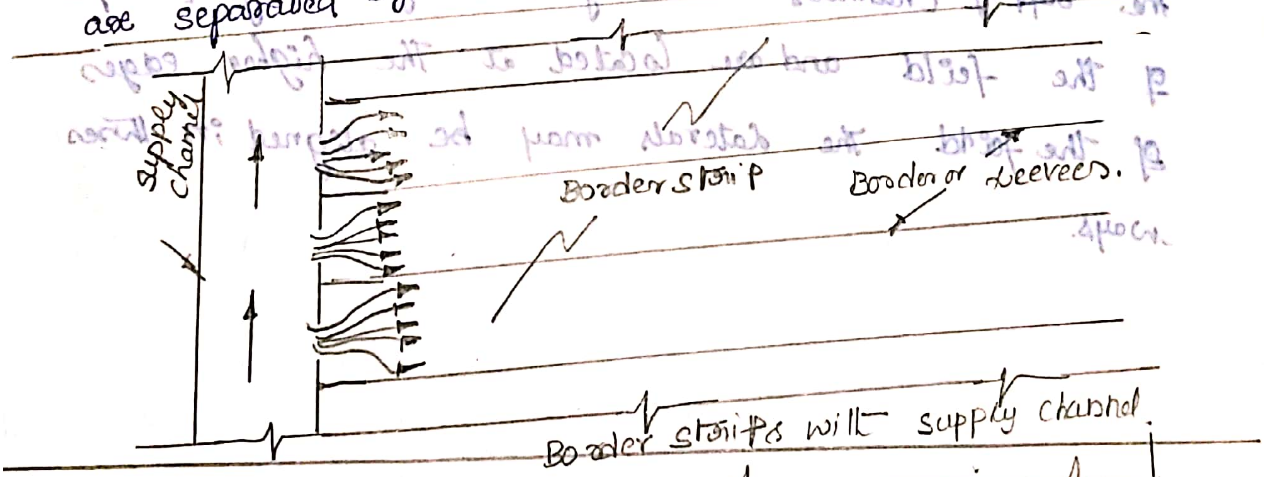
 www.Jntufastupdates.com Scanned by CamScanner

(c) Field channels at right angles to the sides of the field.

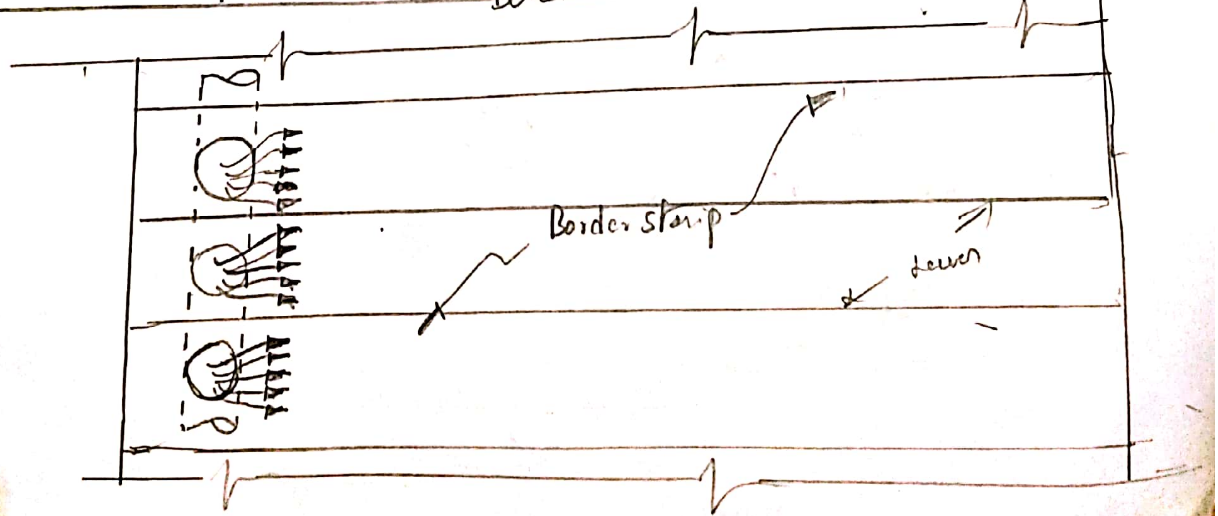


Border strip Method :-

In the boarder strip flooding method the entire flood is divided into a series of strips 10 to 20 metres wide. The length of the strip is 100 to 300 metres long. The strips are separated by low embankments or leeves.



Border strips with supply channel.

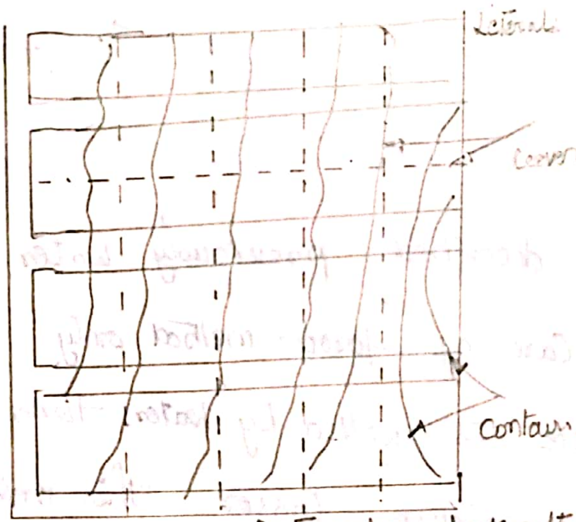


The water is diverted from the field channel into the strip. when the water is allowed through the field channel it flows towards lower and slowly and wetting the soil as it advances.

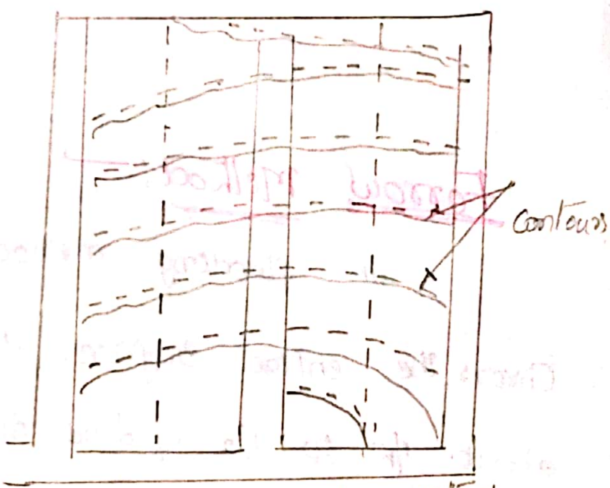
④ **check flooding :-**

This is the most common method of irrigation used in India. This method is also known as the method of irrigation by plots. In this method relatively level plots are enclosed by small levees or embankments. water enters the closed area and then floods it. This method is suitable for permeable soils because the water quickly spreads over the entire area and to prevent excessive percolation

ⓐ Rectangular checks :- In this system the checks or Levees are constructed to enclose the field in the form of rectangle



Rectangular checkmethod

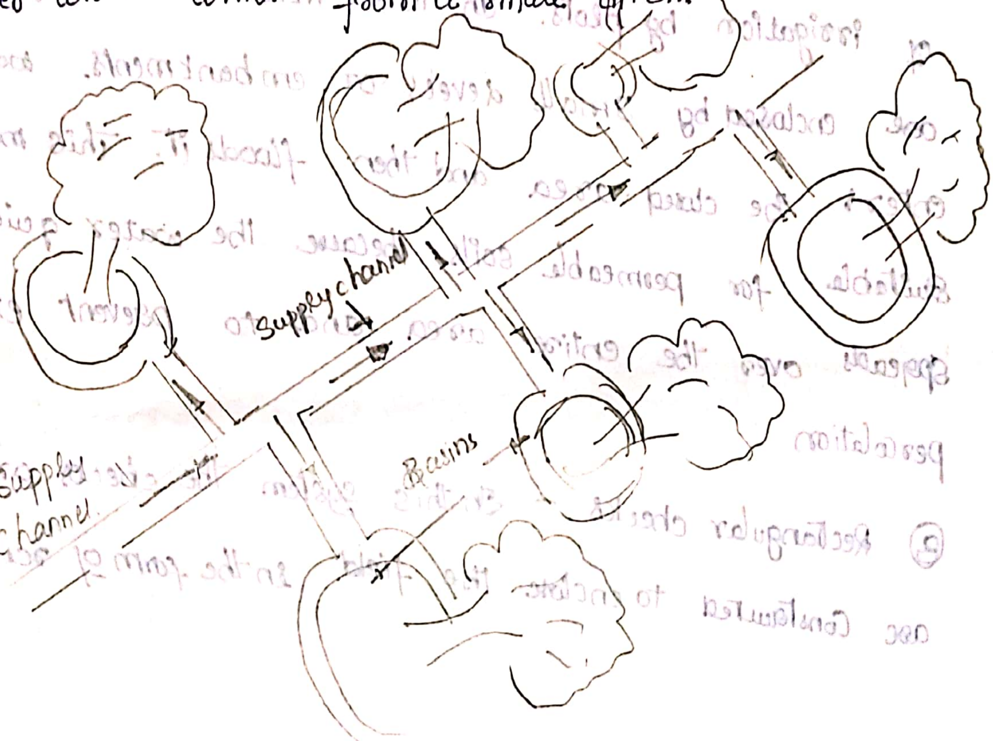


Contourcheck method

ⓑ **Contour checks :-** In contour checks system the levees are constructed along the contours. cross levees are at constructed sometimes at convenient places.

i) Basin Method: —

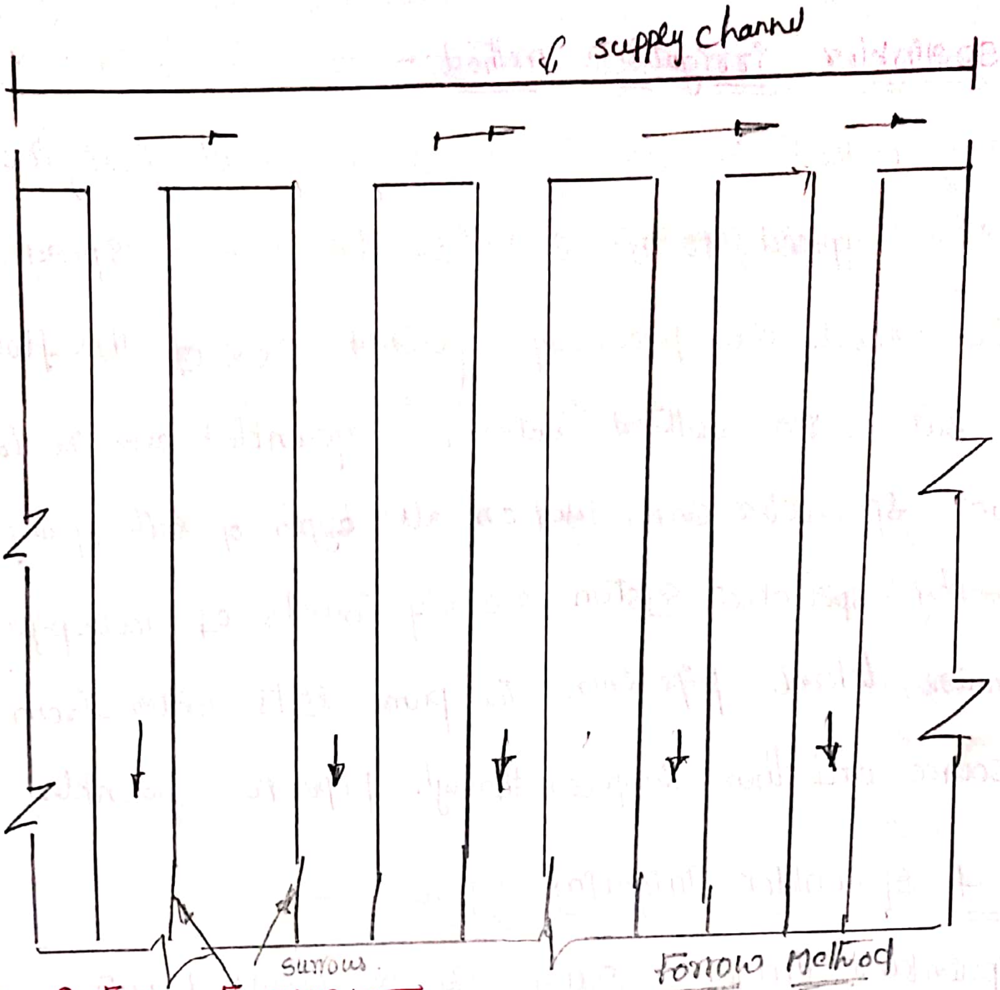
The Basin method of irrigation is nothing but a check method used for orchards (enclose with fruit) only. In this method each tree is provided with separate basin which is usally circular is shape and hence it is known as ring basin. Sometimes three or four trees may be included in one one basin. Each basin is flooded with water which comes from a small ditch.



ⓐ Basin ring

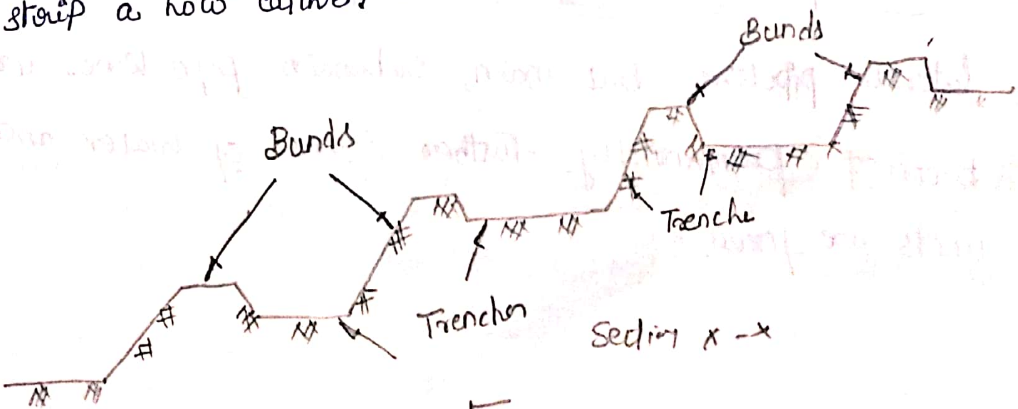
Forrow Method: —

In flooding methods described previously. water covers the entire surface. In case of forrow method only about 1/5 to 1/2 of land surface is wetted by water. Hence it results. in reducing the evaporation losses. this method the forrows are dug in the land at regular intervels. The water is supplied to farrows by openings in the supply channel or rubber hoses which are immersed in the ditch.



* Contour Farming:—

This method is adaptable for the lands having a steep slopes with quickly falling contour. In this method, the irrigated area is divided into longitudinal curved plots called terraces or benches. The bends of the plot follow the contours. These plots are having gentley sloping along their length to ensure efficient irrigation and disposal of excess water with low velocity. At the outer end of each strip a low earthen bund or dike is provided



Contour farming

=> Sprinkler irrigation method:-

This method is also known as overhead irrigation water is applied to the land in the form of spray All the methods are previously explained were of the flooding Type. But in this method water is sprinkled over the land surface. Sprinklers can be used on all types of soil of any Topography. sprinkler system mainly consists of mainpipe line submains, lateral pipe lines. The pump lifts water from the source and then supplies through pipes to sprinkler.

Types of sprinkler Irrigation system:—

Sprinkler Irrigation system can be classified into

① portable system:— This system defined to moved from one land to another land with all components namely mains, submains, and laterals, sprinkler and pumps unit.

② Semiportable system:— It is similar to that portable system except that the location of the water source and pumping units are fixed.

③ Semi permanent system:— It has the portable lateral pipeline but main, submain pipe lines are burried permanently. Further sources of water and pumps units are fixed.

Drip Irrigation or Trickle Irrigation

Drip Irrigation is one of the latest method of Irrigation. This method is suitable in areas where water scarcity and salt problems are existing. In this system of irrigation, water is applied in the form of drops directly near the base of the plant. Flexible system of pipe lines are laid parallel to row of the plants. water is carried and applied to the plants through nozzles. at low pressure. By maintaining a minimum soil moisture limit the Consumptive use of ~~mo~~ water is maximum thus results in saving water.

⊛ Quality of Irrigation Water: —

A good irrigation water is one which performs the above mentioned functions without any side effects which retard the plant growth. Irrigation water may be said to be unsatisfactory for its intended use of it Contains

(1) chemical Toxic to the plants

(2) unsatisfactory moisture characteristics

(3) Bacteria injurious to person or animals eating plants irrigated with the water.

Impurities in Irrigation water.

The quality of Irrigation water depends upon various Types of impurities present in water. The following being the prominent one.

① Concentration of sediments in water.
② Total Concentration of soluble salts
③ proportion of sodium ions to other Cation
④ Concentration of Toxic elements such as boron Concentrat
⑤ Concentration of biocarbonate in relation to the Concentration of Calcium of magnisium
⑥ Bacterial Concentration

(*) Soil Water plant Relationship :— (10)

Water is the most Significient Environmental factor. important Constituent of living organisms.

Soil plant water relationships are related to the properties of soil and plant that affects the movement and used of water.

Soil provides space for water, which is used by plants through their roots.

Soil characteristics :—

(i) – Soil Composition
(ii) Soil profile
(iii) Soil Texture
(iv) Soil structure.

Soil furnishes the following for plant life :—

(1) Anchor for its roots
(2) water for its Transpiration
(3) Mineral for its nutrition
(4) oxygen for its metabolism.

(1) classification according to age of formation

(a) youthfull :- It is fully pervious
(b) Mature : It has low permeability
(c) Senile :- It has little or no productivity. The soil becomes hard and of very low permeability.

(2) classification according to geological process of formation

(a) Residual soils : They are formed by disintegration of rock in place under various actions.

(b) Alluvial soils :- They are formed by deposition by water borne material

(c) Eolian soils :- These are formed by deposition by wind action

(d) colluvial soils :- These are formed by deposition by ~~glaciers~~ by rainwash below foot hills.

(e) Glacial soils :- These are formed by Transportation and deposition by glaciers.

(f) Volcanish ash :- They are ash deposits due to volcanic eruptions.

(3) Soil classification basis of particle size :-

A composite soil can be classified on the basis of particle sizes, soil particles are grouped in to gravel, sand, silt, and clay. The relative proportions are according to international soil classification.

Coarse sand 2 to 0.2 mm

Fine sand size particles — 0.2 to 0.05 mm

Silt size particles - 0.05 to 0.002mm

clay size particles - less then 0.002mm.

(4) Based on Structure :-

This refers to arrangement of soil particles and aggregates with respect to each other. soil structures is one of the most important properties of soil mass. It influences aeration, permeability water holding, capacity. this classification as follows.

(1) Type :- four types of primary structures - platy, prism, like block like and spheroidal.

(2) **class** :– Five Types (i) Very fine, fine, medium, Coarse and Very coarse.

(3) **Grade** :– Represents aggregation i.e is the proportion between aggregates and unaggregated material results when the aggregates are gently washed or disposed. Grades are termed as less, weak, moderate, strong and Very Strong depending on stability of aggregates when disturbed.

Classification of Soil Water :–

(1) **Hygroscopic Water** :– When a oven dried sample is kept open in the atmosphere, it absorbs some amount of water from the atmosphere. This is known as hygroscopic water and is not capable of movement by gravity or Capillary forces.

(2) **Capillary Water** :– Excess of hygroscopic water which exists in the pore space of the soil by molecular attraction. or which is water extracts from pores of soil.

(3) **Gravitational Water** :– It is the excess of hygroscopic and capillary water and Capillary Water which will move out or extract from soil if sufficient drainage is provided.

Soil Moisture Tension :–

It is force per unit area to extract water from soil is known as soil moisture Tension. and expressed as atmosphere (atm). and is also known as capillary potential, Capillary Tension or force of Suction. It is inversly proportional to moisture content. It is measured in laboratory with Centrifuge, Tensometre etc.,

Soil Moisture Stress :—

It is sum of soil moisture tension and osmotic pressure of soil solution.

Osmotic pressure is the increase in the force (or Tension) caused by the salts present in the soil solution. The growth of plant is a function of both soil moisture Tension and as well as osmotic pressure and function of soil moisture stress.

Soil Moisture Constants :

(1) Saturation capacity :—

This is also called as maximum holding capacity (or) Total capacity of water required to fill all the porespace between soil particles replacing all air held in pore spaces. If porosity of soil is known, Saturation capacity can be expressed as equivalent cm of water per meter of soil depth.

ex:- If porosity is 50% by volume, moisture in each metre of saturated soil is depth of 50cm.

(2) Feild capacity:

It is moisture content of soil after free drainage removed the most gravity water. The concept is extremely useful in arriving the amount of water available in (12)

the soil for plant use.

3. permanent wilting point:

Parmanent wilting coefficient is the water content at which plants no longer extract sufficient water from soil for its growth. This is the lower end of the available moisture range. If plant does not get sufficient water to meet its needs, it will wilt permanently. A plant is considered to be permanently wilted when it will not regain to its original size (or) strength (turbidity) even after being placed in a saturated atmosphere. However if water is added to soil. it will regain its turbidity

Temporary wilting point:

It takes place during hot windy-day, but plant will recover in the cooler portion of the day. no addition of water is required. takes place in hot summer day, even when soil moisture is higher than the wilting coefficient, because of increased transpiration rates.

ultimate wilting point:

It is slightly different from permanent wilting. when ultimating wilting occurs, plant will not regain its turbidity even after addition of sufficient water to the soil and the plant will die.

4. Available Water:

It is difference of water content b/w feild capacity and permanent wilting point is known as available water or available water content (Moisture).

5. Readily available Moisture:

It is portion of available moisture easily extracted by plants and is appox 75% of available moisture.

6. Moisture Equivalent

This is an artificial moisture property of soil and is used as an index of the natural properties. It is % of moisture retained in a small sample of wet soil 1cm deep when subjected to a centrifugal force 1000 times as great as gravity.

7. Soil Moisture deficiency:

It is the deficiency in the water required to bring soil moisture content of the soil to its feild capacity.

Depth of water stored in root zone and available to plants:

Let "d" be the depth of root zone (in meters)

'F_c' be the feild capacity (as ratio)

Let γ_d = dry unit weight of soil.

1 hect (10000 sq.m) area with a depth Δ metres. (4)

$= 1 \times 10,0000 \times \Delta$ cumes

No. of hectares then can be irrigated by 1 cumec flowing for B days.

$$= \frac{10 \times 60 \times 60 \times 24 \times B}{1 \times 10,000 \times \Delta} = \frac{8.64\,B}{\Delta}$$

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

* Factors affecting duty: —

(1) Rainfall
(2) evaporation
(3) Base period of crop
(4) soil characteristics
(5) Type of crop
(6) Depth in using water
(7) method of cultivation
(8) Quality of water
(9) skill of cultivator
(10) Topography of land
11. Basic principle

1. Methods and system of Irrigation: —

In the perennial Irrigation system, soil is continuously kept moist, and hence water required for initial saturation is less. Also due to the shallow depth of the water Table, deep percolation losses are less. In the inundation irrigation system has more duty than the inundation irrigation

2. Mode of Applying water: —

The flood irrigation system has lesser duty than the furrow system. sub-irrigation system gives still higher duty. The ring basin irrigation and uncontrolled flooding gives less duty.

3. Method of Cultivation: —

If the land is properly ploughed and made quite loose before irrigating the soil will have high water retention capacity in its unsaturated zone. Thus, the number of waterings can be reduced increasing the duty.

4. Time and frequency of tilling

Frequency of cultivation reduces the lose of moisture through weeds. soil structure affect the plant growth to a very great extent. A good structure is called good tilth of the soil. when the soil is in good tilth evaporation loses from the surface of the soil is less. soil becomes properly aerated. and hence yeild of crop is also better.

5. Type of crop:—

The duty varies from crop to crop.

6. Base period of the crop:—

If the base period of the crop is more, the amount of water required will be high. hence duty will be low. and vice-versa.

7. claimatic Conditions of the Area:—

The climatic Conditions which affect the duty are (i) Temparature (ii) wind (iii) humidity (iv) rainfall. Due to high Temparature and wind evaporation losses will be more and duty will be less. A humid Atmosphere reduces the loses

8. Quality of water:—

If the harmful salt Content and alkali Content of water is more, water will have to applied liberally so that the salts are leached off. This will, in turn

γ_w = unit wt. of water.

consider unit area (1 sq mt) of soil area then

$$F_c = \frac{\text{wt. of water retained in unit area}}{\text{wt. of soil of unit area.}}$$

$$F_c = \frac{\text{wt. of water retained in unit area}}{\gamma_d \times 1 \times d}$$

wt. of water retained in unit area = $F_c \cdot \gamma_d \cdot d$

Depth of water stored (in depth d) $= \frac{F_c \cdot \gamma_d \cdot d}{\gamma_w}$ metres. —(1)

A part of this depth of water will be availabe for evpo-transpiration.

Availabe moisture depth (d_w) is given

$$d_w = \frac{\gamma_d \cdot d}{\gamma_w} \left[\text{Field capacity} - \text{wilting coefficient} \right]$$

$$d_w = S_g \cdot d \; [F_c - W_c]$$

$\therefore S_g = \frac{\gamma_d}{\gamma_w}$ = Sp. gravity of soil.

* Consumptive use and Estimation of Consumptive use

Duty :— It is the total areas to be irrigated by a unit of water or irrigating capacity of unit water. It is relation between area of crop irrigated and Quantity of irrigation water required to supply is Termed as duty.

If 3 cumecs of water required for a crop in 3000 hectare

$$duty = \frac{3000}{3} = 1000 \text{ hect/cumec for entire base period.}$$

Delta :— It is the Total depth of water required by a crop during entire period and denoted by Δ

for ex:— If crop require 10 watering in an 10 days interval every watering requires 100 mm

Then $\Delta = 100 \times 10 = 1000$ mm or 1.0 m etc.

Crop period :— It is No. of days of Instant Sowing to the time harvesting.

Base period :— Repent entire period of cultivation from when irrigation water is applied from instant of first watering to before harvesting

Relation between Duty, Delta and Base period

let "D" be duty of water hect/cumec

Δ be the total depth of water supplied.

B be Base period in days.

1 cumec flowing for a base period 'B' days provides volume of water $= 1 \times 60 \times 60 \times 24 \times B \ m^3$

Quantity of water in cums required for flooding reduce the duty. More fertilizing matter in water will cause less consumption of water, and increase duty.

(9) Method of Assessment of water :—

Volumetric method of Assessment Always lead to a higher duty. This is because the farmer will use water economically. If however the method of Assessment is based on the area under cultivation

(10) Canal Conditions :—

If an earthen canal seepage and percolation losses will be high resulting in a low duty. If however the canal is lined, the losses will be less and the duty will high.

(11) character of soil and subsoil of the canal

If the canal is unlined if it flows through coarse grained, permeable soils the seepage and percolation losses will be high. If the canal flows through fine grained soil, such losses will be less, and hence the duty will be higher.

(12) character of soil and sub-soil of the irrigation field

If the soil and subsoil of the field is coarse grained percolation losses will be high. However if there is hard pan at depth 1 to 2 metre below surface the percolation losses reduces. the duty is also affected by the Topography of the land

Depth and frequency of Irrigation :—

The readily available moisture is that moisture which is easily extracted by the plants and approximately 75% of available moisture. At any time, therefore the moisture constant in soil should be between field capacity and lower limit (m_o) of the readily available moisture.

$$d_w = \frac{\gamma_d}{\gamma_w} d \left[F_c - m_o\right] m.$$

γ_d = dry unit weight of soil γ_w = unit weight of water

F_c & m_o are moisture constants

If C_u is daily consumptive use

$$f_w = \frac{d_w}{C_u} \text{ days.}$$

Time required to irrigate a certain Area :—

Let "t" be the time required to apply desired water depth d_w to bring water level in the soil from m_o to the field capacity F_c over an irrigation field of Area A.

If q is the discharge in the field channel in cumecs

$$t = \frac{A \cdot d_w}{q} \text{ Seconds}$$

where A is Sq. mt and d_w is depth of water applied

$$t = \frac{d_w}{q} \cdot A \times 10^4 \text{ Seconds}$$

$$= \frac{2.778 \, A d_w}{q} \text{ hours}$$

if A is expressed in hectors.

Irrigation Effeciencies :—

Effeciency is the ratio of water output to the water input and is expressed in percentage.

Types of Effeciencies :—

Water Conveyence Effeciency (η_c)

This takes in to account the Conveyence or Transit losses

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

η_c = Conveyence Effeciency

W_f = water delivered to form or irrigation plot

W_r = water supplied or delivered from river or reservior

Water application Effeciency :—

It is the ratio of Quantity stored in to the root zone of crops to the Quantity of water delivered to field.

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

Common sources of loss of irrigation water during water application are surface runoff (R_f), percolation D_f

$$W_f = W_s + R_f + D_f$$

$$\eta_a = \frac{W_f - (R_f + D_f)}{W_f} \times 100.$$

(3) Water use Efficiency (η_w) :—

Ratio of water beneficially used, including leaching water to quantity of water delivered.

$$\eta_w = \frac{W_u}{W_d} \times 100$$

(4) Water storage Efficiency :— (η_s) Ratio of Quantity of water stored in root zone during irrigation to the Quantity of water need to bring water content of the soil to field capacity.

$$\eta_s = \frac{W_s}{W_n} \times 100$$

(5) Consumptive use Efficiency (η_{cu}) :— Ratio of normal Consumptive use of water to the net amount of water depleted to the root zone.

$$\eta_{cu} = \left(\frac{W_{cu}}{W_d}\right) \times 100$$

Water logging :—

When Aggricultural land is said to be water logged when its productivity or fertility is affected by high water table and harmful to growth and subsidence of plant life depends on the height of capillary fringe which is the height to which the water will rise due to capillary action.

The depth of water Table adversely effects differently for different crops.

⊛ Effects of water logging :—

1. In habitating activity of soil bacteria
2. Decrease in availability Capillary water
3. Fall in Soil Temperature.
4. Defective air circulation
5. Rise of salt
6. Delay in cultivation operations.

⊛ Causes of water logging :—

1. Inadequate Surface drainage
2. Seepage from Canal system
3. over irrigation of rocks
4. obstruction of natural drainage.
5. obstruction to the flow of ground water.

Land Drainage :—

Benefits of drainage :—

1. Adequate drainage improves Soil structure and increase productivity of soil
2. Leads to early ploughing and planting.
3. Lengthens areas of crop growing seasons
4. Increase soil ventilation.
5. decreases Soil erosion ~~and gullying~~
6. excess of salts from soil Can be leached out

Land the

Types of drains :- or classification of drains :—

① open drains

It can be furtherly sub divided into

① Shallow surface drains (ii) open Deep Drains. (8)

(i) **Shallow surface drains :—**

It reduces percolation to ground water but is of no use if water has already permeated to the ground water Reservior. This drains excess irrigation water applied to the field and accelerates removal of storm water.

(ii) **Deep open drains :—**

causes ①

These can be used to reduce water logging without provision of the tile drains. These will then have to provided at a distance of 0.75Km or even less. They are also commonly as Common outlet drains for closed drains system.

(iii) **under Drains or Tile drains :—**

These are located a suitable depths below ground surface above the impervious clay stratum. The natural percolation of water. They are preferably placed in a medium or high permeability.

Objectives of Land Drainage :—

① Land drainage improves the soil structure and increase the productivity of soil.

② It keeps the soil warmer by maintaining higher soil Temparature

③ It makes the soil to grow large varieties of crop

④ It Control the weeds, malaria and improve the sanitary Conditions. of the area.

⑤ Aeration of upper soil layer and properly maintained by land drainage.

⑥ Land drainage extended the crop root zone due to which the soil moisture gets increase for crop growth

⑦ It provide tillage operation due to increase in soil tilt.

⑧ Land drainage removes the harmful salts present in soil and reclaim water logging land.

Requirements of Land drainage :—

① A drainage with Quick and unobstrucle flow are require from the Catchment.

2. The initial cost of construction and maintanance should be low

3. Discharge should be ~~too~~ high. So that it can spread over the section

4. The Condition of outfall Should be ideal for each land drainage

5. Land drainage require to admit all the flood discharge from the Catchment and carry with high capacity to the outfall

Ist unit problems

① Find the field capacity of a soil for the following data

Root zone depth = 2m

Existing water content = 5%

Dry density of soil = 15 kN/m²

Water applied to the soil = 500 m³

Water losses due to evaporation and deep percolation = 10%

Area of plot = 1000 sq.m.

Sol

Total water applied = 500 m³

Loss of water = 10% (100-10) = 90%

Water used in the soil = $500 \times \frac{90}{100}$ = 450 m³

Weight of water used = 450 × 9.81 = 4414.5 kN

Total dry weight of the soil = 1000 × 2 × 15 = 30000 kN

% of water added = $\frac{4414.5}{30000} \times 100$

= 14.72%

New water content added = 5% + 14.72%

= 19.72%

Field capacity = 19.72%

② After how many days will you supply water to soil in order to ensure efficient irrigation of the given crop

Field capacity of soil = 27%

Permenant wilting point = 14%

Dry density of soil = 15 kN/m²

Effective depth of root zone = 75 cm

Daily Consumptive use of water for the given crop = 11 cm

Sol Available moisture = field capacity − permanent wilting point

= 27 − 14 = 13%

Let the readily available moisture be 80% of the available moisture

Readily available moisture = 13 × 0.8 = 10.4%

m_0 = 27 − 10.4 = 16.6%.

Hence when irrigation water is applied, moisture raised from 16.6% to 27%.

Depth of water stored in root zone, during each water

$= \frac{\gamma_d . d}{\gamma_w}$ [field capacity − m_0] $= \frac{\gamma_d}{\gamma_w} d$ (0.27 − 0.166)

$= \frac{1.5 \times 0.75}{9.81} \times 0.104$ = 11.9 cm

Thus depth of water available for evapo-Transpiration

= 11.9 cm.

Daily Consumptive use of water = 11 cm

watering frequency = $\frac{11.9}{11}$ = 10.82 day

≃ 10 dy.

③. A water course has a cultivable commanded area of 1200 hectares. The intensity of irrigation for crop A is 40%. and for B is 35%. both the crops being Rabi crops. Crop A has a kor period of 20 days and crop B has kor period of 15 days. Calculate the discharge of water course if the kor depth for crop A is 10 cm and for B it is 16 cm.

Sol. Area under irrigation = 1200 × 0.40 = 480 hect

Kor period b = 20 days

Kor depth δ = 10 cm = 0.1 m

Duty = $\frac{8.64(b)}{\delta}$ = $\frac{8.64 \times 20}{0.1}$ = 1728 he/cumec

Hence discharge required = $\frac{\text{Area under irrigation}}{\text{outlet factor}}$

= $\frac{480}{1728}$ = 0.278 cum

For crop B

Area under irrigation = 1200 × 0.35 = 420 hect

Kor period b = 15 days

Kor depth δ = 16 cm = 0.16 m

Duty or outlet factor = $\frac{8.64 \, b}{\delta}$ = he

= $\frac{8.64 \times 15}{0.16}$ = 810 he/cu

Hence discharge required = $\frac{410}{810}$ = 0.519 cum

Thus the design discharge of water course

= 0.519 + 0.278 = 0.8 cumec

(4). Express a duty of 1800 hect/cumec for a base period of 120 days in hect/million cum

Given Data

Duty = 1800 hect/cumec for a base period 120 days

Quantity of water required for 1800 hectare for 120 days

= 120 × 24 × 60 × 60

= 1036800 cu. m

= 10.368 million cum

10.368 million cu. can irrigate 1800 hect

1 million cum = $\frac{1800}{10.37}$

= 173.6 hect

Duty = 173.6 hect

⑤. Express a duty of 1800 ha/cume for a base period of 120 days in ha/million cum.

Sol

Duty = 1800 ha/cume

Base period = 120 days

Quantity of water required for 1800 ha for 120 days

= 120 × 24 × 60 × 60

= 10368,000 cum

= 10.368 million cu.

10.368 million cum can irrigate 1800 ha

1 million cum can irrigate = $\frac{1800}{10.37}$ = 173.6 ha

Duty = 173.6 ha/million cum.