CHAPTER 10 - IRRIGATION
IRRIGATION

Irrigation is the artificial application of water to the soil to supplement the rainfall and groundwater contribution to assist the crop production.

Sustainable development and efficient management of water is an increasingly complex challenge in India. Increasing population, growing urbanization, and rapid industrialization combined with the need for raising agricultural production generates competing claims for water. There is a growing perception of a sense of an impending water crisis in the country.

Some manifestations of this crisis are:

(a) There is hardly any city which receives a 24-hour supply of drinking water. Besides in many rural habitations there are pockets where arsenic, nitrate, and fluoride concentration in drinking water are posing a serious health hazard.

(b) Increasing costs of developing new water resource – Many major and medium irrigation projects seem to remain under execution forever as they slip from one plan to the other with escalating cost and time overruns.

(c) Siltation of reservoirs and owing to lack of maintenance, the capacity of the older irrigation systems seems to be going down.

(d) Declining groundwater table due to over-exploitation imposing an increasing financial burden on farmers who need to deepen their wells and replace their pump sets and on State Governments whose subsidy burden for electricity supplies rises.

(e) Water pollution and degradation of water-related ecosystems - Water in most parts of rivers is not fit for bathing, let alone drinking. Untreated or partially treated sewage from towns and cities is being dumped into the rivers. Untreated or inadequately treated industrial effluents pollute water bodies and also contaminate groundwater,
(f) Wasteful use of already developed water supplies, often encouraged by the subsidies and distorted incentives that influence water use,

(g) Rise in water-logging and salinity resulting in degradation of soils in irrigated areas,

(h) Increasing water conflicts about water rights between upper and lower riparian states in a river, conflicts about quality of water, people’s right for rainwater harvesting in a watershed against downstream users, industrial use of groundwater and its impact on water tables and conflicts between urban and rural users etc.

(i) The gross irrigated area does not seem to be rising in a manner that it should be, given the investment in irrigation. The difference between potential created and area actually irrigated remains large. Unless we bridge the gap, significant increase in agricultural production will be difficult to realize.

India with 2.4% of the world’s total area has 16% of the world’s population; but has only 4% of the total available fresh water. This clearly indicates the need for water resource development, conservation, and optimum use.

◇ Objectives /Importance of Irrigation

“Irrigation in many countries including India is an age-old art – as old as civilization – but for the whole world it is a modern science – science of survival”.

The broad objectives of irrigation are as follows:

a) To increase crop production on sustainable basis where water is a limitation
   - To increase national income/national cash-flow
   - To increase labour employment
   - To increase standard of living

b) Modification of soil & climatic environment
   - For leaching of salts
   - For reclamation of sodic soils
   - For frost protection
c) **To mitigate i.e., lessen the risk of catastrophes caused by drought**
   - To overcome food shortages
   - To protect high value crops/trees

d) **To increase population of arid and sparsely populated areas**
   - For national defense
   - For population re-distribution

e) **National security i.e., self-sufficiency in food grain production**
   1) To supply the moisture essential for plant growth.
   2) For better utilization of production factors. (Nutrients)
   3) To provide crop insurance against short spells of drought.
   4) To dilute/washout soluble salts
   5) To soften tillage pans
   6) Intensive cropping is made possible
   7) Timely seedbed preparation and timely sowing.
   8) To create favorable microclimate for crop growth.
   9) Higher yields as well as stability in production

◇ **Method of irrigation**

Depending on soil type, slope, source of irrigation water, nature of crop methods differs.

1. **Surface methods of irrigation**
2. Sub-surface methods
4. Drip/trickle irrigation.
5. Quantity of irrigation water depends on rooting depth and water holding capacity of soil.
6. Irrigation water can be quantified through weirs, flumes, orifices, water meters etc.

1. Surface irrigation: Water is applied directly to the soil from channel located at upper ridge of the field proper land preparation adequate control of water is necessary for uniform distribution of water border. The entire field is divided into strips separated by low ridge of the strip to lower in form of sheet guided by the low ridges. Border should have uniform gentle slope in direction of irrigation. Each strip is independently by turning stream of water at upper ridge. Suitability suitable for close growing crops some row crop & orchards under favourable soil & topographic condition. Not recommended for extremely low or extremely high infiltration rate soils.

Advantage:

(i) Easy construct & operate
(ii) Person can irrigation more compares to check basin.
(iii) If properly designed use uniform distribution & high water use efficiency.
(iv) Large streams can be effectively used.
(v) If can provide excellent drainage (surface) if have proper outlet facility at the lower end.

Disadvantages:

(i) Required precise land levelling
(ii) Required large irrigation streams.

**Border Strip Method**

- In this method the field is divided into number of strips, which are separated by ridges.
- Soils with slope of 0.5-1% are suitable for this method
- Suitable for all close growing crops on medium to heavy texture soils.
- Not suitable for sandy soils.
**Flooding Method**

- Water is applied to the crop by flooding it on the soil surface.
- This method is practiced where irrigation water is abundant
- Mostly adopted in wetland rice
- Useful in uniform surface soils with good water holding capacity.

**Corrugations**

- Small and shallow furrow are known as corrugations
- Suitable for close growing crops like wheat, ground nut, etc
Check Basin

- Most common among surface methods
- Suitable for close growing crops (groundnut, pearl millet, etc)
- It consists in running water in to relatively level basins surrounded by small ridges
- Field with slope up to three percent can be irrigated by using this method
- It has too many ridges which occupy large area of land and require too much labour to formed beds.

Ridge and Furrow Method

- Used to irrigate row crops and vegetables and is suited to soils in which infiltration rates are between 0.5-2.5 cm/hour
- It is ideal for slopes varying from 0.2-0.5 %
- The length of the furrows may vary from 30 m for sandy soils at lesser slope to 300 m for heavy soils at greater slope
- Suitable to most type of soils except sands that have very high infiltration rate
- Suitable for root and tuber crops.

**Ring Basin**

- Suitable for fruit crops.

2. **Subsurface Irrigation**

Various sources of irrigation in India are canals, tanks, tube wells and other wells with tube wells and canals accounting for about 70% of total irrigation. Water is applied into a series of filed ditches through underground pipe lines. It is generally followed in Western Countries.

Practiced in Kerala for coconut garden and in Gujarat and Kashmir on sandy loam soils for vegetables. Water is applied below the ground surface by maintaining artificial water table at some depth depends upon the soil characteristic & root zone of crop. Water moves through capillaries within soil to meet plant requirement deep trenches & underground piper are the two ways for subsurface irrigation.

3. **Sprinklers System**

In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high pressure sprinklers or guns. A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed.
Risers is often referred to as a solid-set irrigation system. Higher pressure sprinklers that rotate are called rotors and are driven by a ball drive, gear drive, or impact mechanism. Guns are used not only for irrigation, but also for industrial applications such as dust suppression and logging. Sprinklers can also be mounted on moving platforms connected to the water source by a hose. Automatically moving wheeled systems known as traveling sprinklers may irrigate areas such as small farms, sports fields, parks, pastures, and cemeteries unattended.

- Suitable for undulating topography and sandy soils
- Saving of water from 25-50% for different crops.
- Water use efficiency is high
- Can be used to protect crops against frost and high temperature

![Sprinkler irrigation](image)

**Fig. 6.6. Sprinkler irrigation**

4. Drip/Trickle Irrigation

Drip or trickle irrigation is one of the latest methods irrigation which is becoming increasingly popular in areas with water scarcity and salt problems. This irrigation is defined as the precise but slow application of water as discrete drops or continuous drops through mechanical devices, called emitters located at selected points along water delivering lines. This system involves the slow application of water, drop by drop to the root zone of a crop. In this method water is used very economically, since losses due to deep percolation and surface evaporation are reducing to the minimum. Drip irrigation is best suited in water scarcity area where water quality is marginal, topography is undulating or steep, soil depth is restricted, labour is expensive and crop value is high.
- Suitable for water scarcity area water saving 50-70% as compare to surface.
- Fertilizer or other chemical amendment can be efficiently applied to individual or separate plants.
- Discharge rate of water per dripper is generally 1-8 lit/hr. at 1.52.5kg/cm² pressure.
- Fertilizers (Fertigation) and herbicides (Herbigation) also possible to apply with drip.
- Most suitable for widely spaced crops, orchard trees and in green houses (protected cultivation of vegetables & flowers).

◆ **Water Requirement of Crop:**

Water requirement of crop is the quantity of water regardless of source, needed for normal crop growth and yield in a period of time at a place and may be supplied by precipitation or by irrigation or by both.

Water is needed mainly to meet the demands of evaporation (E), transpiration (T) and metabolic needs of the plants, all together is known as consumptive use (CU). Since water used in the metabolic activities of plant is negligible, being only less than one percent of quantity of water passing through the plant, evaporation (E) and transpiration (T), i.e. ET is directly considered as equal to consumptive use (CU). In addition to ET, water requirement (WR) includes losses during the application of irrigation water to field (percolation, seepage, and run
off) and water required for special operation such as land preparation, transplanting, leaching etc.

WR = CU + application losses + water needed for special operations.

Water requirement (WR) is therefore, demand and the supply would consist of contribution from irrigation, effective rainfall and soil profile contribution including that from shallow water tables (S) WR = IR + ER + S

Under field conditions, it is difficult to determine evaporation and transpiration separately. They are estimated together as evapotranspiration (ET). IR is the irrigation requirement.

◆ Factors influencing Evapotranspiration (ET): ET is influenced by atmospheric, soil, plant and water factors.

A) Atmospheric factors:
   1. Precipitation
   2. Sunshine
   3. Wind velocity
   4. Temperature
   5. Relative humidity

B) Soil factors:
   1. Depth of water table
   2. Available soil moisture
   3. Amount of vegetative cover on soil surface.

C) Plant factors:
   1. Plant morphology
   2. Crop geometry
   3. Plant cover
   4. Stomatal destiny
   5. Root depth
D) Water factors:

1. Frequency of irrigation
2. Quality of water ET

Water requirement of any crop depends on crop factors such as variety, growth stage, and duration of plant, plant population and growing season. Soil factors such as temperature, relative humidity, wind velocity and crop management practices such as tillage, fertilization, weeding, etc. Water requirement of crops vary from area to area and even field to field in a farm depending on the above-mentioned factors.

Estimation of Evapotranspiration (ET):

Climate is the most important decides the rate of ET. Several empirical formulas are available to estimate ET from climate date. FAO expert group of scientists has recommended four methods for adoption of different regions of world.

1. Blaney and Criddle method
2. Radiation method
3. Pan evaporation method
4. Modified penman method

(NOTE: The formulas of above Methods are not very important from examination point of view. Formulas are discussed below)

Estimation of ET Involves Three Important Steps:

1. Estimation of PET or evapotranspiration (ET) by any four above methods.
2. Estimation of crop co-efficient (KC) and
3. Making suitable adjustments to local growing conditions.

Reference Evapotranspiration (ETO): ETO can be defined as the rate of evapotranspiration of an extended surface of an 8 to 15 cm tall, green cover, actively growing completely shading the ground and not short of water.
Selection of a method for estimation of ETO depends on availability of metrological data and amount of accuracy needed. Among four methods for estimation of ETO, modified Blaney-Criddle method is simple, easy to calculate and requires data on sunshine (S.S.) hours, wind velocity (WV), relative humidity (RH) in addition to temperature (T).

Among these methods, modified penman method is more reliable with a possible error of 10% only. The possible errors for other methods are 15, 20 and 25% of pan evaporation, radiation and modified Blaney-Criddle methods respectively.

- **Modified Blaney method:**

  \[ ETO = C \times (P \times (0.46 \times T + 8)) \text{ mm/day} \]

  Where \( ETO \) = Reference crop ET in mm/day for the month considered

  \( T \) = Mean daily temperature in °C over the month considered

  \( P \) = Mean daily percentage of total annual day time hours of a given month and latitude (from standard table)

  \( C \) = Adjustment factor depends on minimum R.H., Sunshine hours and day time wind estimates.

- **Pan evaporation method:**

  \[ ETO = K_p \times \text{Epan} \]

  Where \( K_p \) = Crop factor

  \( \text{Epan} \) = mean pan evaporation (Epan pan evaporation)

- **Modified penman method:**

  \[ ETO = C \times [W \times R_n + (1-w) \times f(U) \times (ea - ed)] \]

  Where \( R_n \) = Net radiation in equivalent evaporation expressed as mm/day

  \( W \) = temperature of altitude related factor
F (U) = Wind related function

Ea – ed = Vapour pressure deficit (mili bar)

C = the adjustment factor (ratio of U day to U night)

Rn (0.75-Rns)

Ea = Saturated vapour pressure (m.bar)

Ed = Mean actual vapour pressure of the air (m.bar)

♦ **Crop Coefficient:**

Crop coefficient is the ratio between evapotranspiration of crop (Etc) and potential evapotranspiration and expressed as T (crop) = Kc X ETo

♦ **Irrigation requirement:**

Irrigation requirement is the total quantity of water applied to the land surface in supplement to the water supplied through rainfall and soil profile to meet the water needs of crops for optimum growth.

IR = WR – (ER + S)

♦ **Net irrigation requirement:**

The net irrigation requirement is the amount of irrigation water just required to bring the soil moisture content in the root zone depth of the crops to field capacity. Thus, net irrigation requirement is the difference between the field capacity and soil moisture content in the root zone before application of irrigation water.

♦ **Gross irrigation requirement:** The total amount of water inclusive of water in the field applied through irrigation is termed as gross irrigation requirement, which in other words is net irrigation requirement plus application and other losses.

♦ **Water conservation Techniques**
Primary source of water in India is south-west and north-east monsoons. Monsoon, however, is erratic and as you have already studied the duration and the amount of rain fall is highly variable in different parts of our country. Hence, surface runoff needs be conserved. The techniques for conservation of surface water are:

(a) **Conservation by surface water storage**

Storage of water by construction of various water reservoirs have been one of the oldest measures of water conservation. The scope of storage varies from region to region depending on water availability and topographic condition. The environmental impact of such storage also needs to be examined for developing environment friendly strategies.

(b) **Conservation of rain water**

Rain water has been conserved and used for agriculture in several parts of our country since ancient times. The infrequent rain if harvested over a large area can yield considerable amount of water. Contour farming is an example of such harvesting technique involving water and moisture control at a very simple level. It often consists of rows of rocks placed along the contour of steps. Runoff captured by these barriers also allows for retention of soil, thereby serving as erosion control measure on gentle slopes. This technique is especially suitable for areas having rainfall of considerable intensity, spread over large part i.e. in Himalayan area, north east states and Andaman and Nicobar Islands. In areas where rainfall is scanty and for a short duration, it is worth attempting these techniques, which will induce surface runoff, which can then be stored.

(c) **Ground water conservation - Attributes of groundwater**

- There is more groundwater than surface water.
- Groundwater is less expensive and economic resource and available almost everywhere.
- Groundwater is sustainable and reliable source of water supply.
- Groundwater is relatively less vulnerable to pollution.
- Groundwater is a free of pathogenic organisms.
- Groundwater needs little treatment before use.
- There is no *conveyance losses* in underground based water supplies.
• Groundwater has low vulnerability to drought.
• Groundwater is the key to life in arid and semi-arid regions.
• Groundwater is source of dry weather flow in some rivers and streams.

As highlighted earlier, out of total 4000 BCM (billion cubic meters) precipitation that occurs in India, about 45 mhan (million hectares meters) percolates as ground water flow. It may not be possible to tap the entire ground water resources. The ground water potential is only 490 BCM. As we have limited ground water available, it is very important that we use it economically and judiciously and conserve it to the maximum. Some of the techniques of ground water management and conservation are described below.

(i) Artificial recharge

In water scarce areas, there is an increased dependence on ground water. The water table declines quickly due to low and erratic rainfall. The only alternative is to replenish the ground water by artificial means. As you have studied in the previous lesson, there are various techniques to develop and manage ground water artificially. In one of the methods, water is spread over ground to increase area and length of time for water to remain in contact with soil. So as to allow maximum possible opportunity for water to enter into the ground. Try to recollect the other methods of recharging ground water.

(ii) Percolation tank method

Percolation tanks are constructed across the water course for artificial recharge. The studies conducted in Maharashtra indicates that on an average, area of influence of percolation of 1.2 km², the average ground water rise was of the order of 2.5 m and the annual artificial recharge to ground water from each tanks was 1.5 hec m.

(ii) Catchment area protection (CAP)

Catchment protection plans are usually called watershed protection or management plans. These form are an important measure to conserve and protect the quality of water in a watershed. It helps in withholding runoff water albeit temporarily by a check bund

Constructed across the streams in hilly terrains to delay the run off so that greater time is available for water to seep underground. Such methods are in use in north-east states, in hilly areas of tribal belts. This technique also helps in soil conservation. Afforestation in the catchment area is also adopted for water and soil conservation.
(iii) Inter-basin transfer of water

A broad analysis of water and land resources and population statistics of various river basins in our country reveals that areas in western and peninsular regions have comparatively low water resources/cultivable land ratio. Northern and eastern region which are drained by Ganga and Brahmaputra have substantial water resources. Hence, the scheme of diverting water from region with surplus water to water deficit region can be adopted Ganga- Cauveri link would enable to transfer of vast quantities of Ganga basin flood water running out to sea, to west and south west India. The transfer of the surplus Ganga water would make up for the periodical shortage in Sone, Narmada, Godaveri, Krishna and Cauveri. The National Grid Commission envisages diversion of part of the surplus discharge in the Ganga near Patna during the high flood period.

(iv) Adoption of drip sprinkler irrigation

Surface irrigation methods, which are traditionally used in our country, are unsuitable for water scarce areas, as large amount of water is lost through evaporation and percolation. Drip irrigation is an efficient method of irrigation in which a limited area near the plant is irrigated by dripping water. It is suitable method for any area and especially for water scarce areas. This method is particularly useful in row crop. Similarly sprinkler method is also suitable for such water scarce areas. About 80% water consumption can be reduced by this method, whereas the drip irrigation can reduce water consumption by 50 to 70%.

(v) Management of growing pattern of crops

In water scarce areas, the crop selection should be based on efficiency of the crop to utilize the water.

Some of the plants suitable for water scarce areas are

(i) Plants with shorter growth period;
(ii) High yielding plants that require no increase in water supply;
(iii) Plants with deep and well trenched roots and
(iv) Plants which cannot tolerate surface irrigation.
(vi) Reducing evapotranspiration

Evapotranspiration losses can be reduced by reducing the evaporation from soil surface and transpiration from the plants, in arid zones, considerable amount of water is lost in evaporation from soil surface. This can be prevented by placing water tight moisture barriers or water tight mulches on the soil surface. Non-porous materials like papers, asphalt, plastic foils or metal foils can also be used for preventing evaporation losses. Transpiration losses can be reduced by reducing air movement over a crop by putting wind breaks and evolving such types of crops which possess xerophytic adaptations.

(a) Reducing evaporation from various water bodies

The quantity of water lost through evaporation is very high in many areas in our country. It is estimated that 10000 hectares of land loses about 160mm³ of water each year. The water losses through evaporation from storage tanks, reservoirs, irrigation tanks, rivers and canals reduce the water available for various uses. The methods that reduce evaporation from water bodies are- installing wind breaks, reducing energy available for evaporation, constructing artificial aquifers, minimizing exposed surface through reservoir regulation, reducing ratio of area/volume of water bodies, locating reservoirs at higher altitudes and applying monomolecular films.

(b) Recycling of water

The wastewater from industrial or domestic sources can be used after proper treatment, for irrigation, recharging ground water, and even for industrial or municipal use. If agricultural lands are available close to cities, municipal waste water can be easily used for irrigation.

◆ Micro Irrigation

Drip irrigation, also known as trickle irrigation or micro irrigation, functions as its name suggests. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water-efficient method of irrigation, if managed properly, since evaporation and runoff are minimized. In modern agriculture, drip irrigation is often combined with plastic mulch, further reducing evaporation, and is also the means of delivery of fertilizer.

**Major, Medium, Minor Irrigation**

Irrigation works have been classified as major, medium and minor, depending on their culturable command area.
1. Major Irrigation:
Culturable command area (CCA) more than 10,000 hectares.

2. Medium Irrigation:
Culturable command area more than 2,000 hectares but less than 10,000 hectares.

3. Minor Irrigation:
Culturable command area up to 2,000 hectares.

All groundwater and surface water schemes having culturable command area up to 2000 ha individually are classified as minor irrigation schemes. Minor surface water flow irrigation projects comprising storage, diversion works and surface lift irrigation schemes occupy a prominent place in the scheme of irrigated agriculture particularly in the undulating areas south of the Vindhyas and the hilly regions. Minor Irrigation Schemes are labour intensive, provide employment to rural population and check their migration to urban areas. They also help in raising the standards of living of rural population and bring them above the poverty line. Such schemes are quick maturing and the benefit from the schemes starts flowing with a very small gestation period. Generally, the schemes are installed in a maximum of two to three years.

The minor irrigation schemes are funded from plan funds, institutional finance and private investments by the farmers. It is generally considered as a people’s programme as the plan funds form only a small portion of the total investment for its development.

◆ Minor Irrigation Development Scenario

The 1st Plan started in 1951 with an irrigation potential of only 22.60 mHa of which contribution of Minor Irrigation was 12.90 mHa i.e. 57% (surface water 6.40 mHa and Groundwater 6.50 Mha). From then onwards over successive plan periods, irrigation potential increased steadily in surface water schemes. If VI Plan is taken as the mid-level to assess the complete plan-wise development for the six decades till the end of XI Plan, it is observed that, at the start of VI Plan(in 1980), irrigation potential created in surface water (MI) was 8.00 mHa and groundwater 22.00 mHa respectively. There was reportedly no potential gap between creation and utilization till that period. The total potential created at (30 Mha) in 1980 points that the growth was modest, more so, for surface water schemes. The momentum picked up in irrigation potential created after 1980 was particularly by groundwater schemes which were popularly adopted due to rural electrification and green revolution technologies. The growth is apparently plateauing in VIII, IX and X Plan performances. For the minor irrigation scenario as a whole, the potential created by the end of X Plan is 60.10 mHa and the potential utilized at 52.42 mHa only. However, with access to new technologies in drilling, pump sets and irrigation...
systems, noticeable acceleration in irrigation potential created was observed in groundwater sector. Irrigation potential created and utilized in groundwater sector played a vital role giving a boost to the food production and socio-economic status of farmers in various parts of the country. On the financial front, unit cost of irrigation potential created in minor irrigation sector especially in groundwater remain low compared to major, medium & minor surface irrigation projects. The expenditure incurred in minor irrigation sector during 1st Plan was Rs 65.6 crore, about 14.84% of the total plan outlay of Rs 441.8 crore in irrigation sector. The Plan investment steadily increased up to Rs 8,634.99 crore during IX Plan and further onto Rs 14,140.70 crore during X Plan. Salient details of the growth in surface and groundwater potential and investments made over different Plan periods till XI Plan are given in Table 2.1. Though Plan investments increased steadily in water sector in Major, Medium and Minor surface irrigation in successive plans, however focus on investments by the central & state governments in groundwater irrigation sector remain meager (up to the extent of giving subsidy / loans) leaving largely responsibility of the private sector. It is pertinent to state that majority of investments made in groundwater sector in irrigation was by the farmers themselves and was not suitably projected as part of investments in irrigation WORKING GROUP: MINOR IRRIGATION AND WATERSHED MANAGEMENT Page 66 of 110 sector. A major credit of achieving self-reliance in food production of the country goes to farmers’ investments in groundwater sector.

The salient features of Minor Irrigation Programme are:

- To ensure adequate provision of funds for the externally aided projects according to the schedule of disbursement;
- To ensure prioritization for on-going schemes;
- Stepping up the institutional investment to the extent possible including subsidy to small & marginal farmers and other weaker sections;
- Stepping up ground water development, especially in the Eastern and North- Eastern States;
- Encouraging minor irrigation programme for tribal, backward, drought-prone areas and areas having pre-dominantly scheduled caste and scheduled tribe farmers by establishing effective coordination as well as by dovetailing if possible all ongoing programmes/schemes like employment generation schemes etc. under various Ministries.
- Encouraging schemes utilizing non-conventional sources of energy like hydrams etc.,
- In water scarce and drought prone areas, the use of sprinkler/drip irrigation system as a water saving device as well as for efficient use of water for productivity should be encouraged.
- To improve the utilization of public tube wells and their rehabilitation along with turning over to beneficiary farmers for O&M.
Whereas major and medium irrigation works are meant for tapping surface water (e.g., rivers), minor irrigation mainly involves ground water development, e.g., tube-wells, boring works, etc.

Drainage: Removal of excess water from the surface or below the surface of the soil so as to create favorable conditions for plant growth.

- **Causes of Water Logging**
  - Intensive rains
  - Floods
  - Soil slope
  - Bunds
  - Defective irrigation
  - Seepage from unlined canals.

- **Effects of ill drained conditions**
  
  a. Lack of accretion of soil.
  b. Restricted root growth and lodging problems
  c. Difficulty in tillage.
  d. Increase in salinity in top layers of soil.

**Benefits of drainage**

1. Helps in soil ventilation/accretion
2. Facilitates timely tillage operations.
4. Favors growth of soil microorganism (better mineralization)
5. Warming up for optimum soil temperature maintenance.
6. Promotes leaching and reduce logging.
7. Improves anchorage and reduce lodging.
8. Improves soil structure and decrease soil erosion.
9. Improves sanitary and health conditions and makes rural life happy.
Definitions & Terms used in Irrigation

- **Hydroscopic Water**: That water is adsorbed from an atmosphere of water vapour because of attractive forces in the surface of particles.
- **Hysteresis**: It is the log of in one of the two associated process or phenomena during reversion.
- **Indicator Plant**: It is the plant, which reflects specific growing condition by its presence or character of growth.
- **Infiltration Rate**: It is the maximum rate at which a soil under given condition and at given time can absorb water when there is no divergent flow at borders.
- **Intake Rate or Infiltration Velocity**: It is the rate of water entry into the soil expressed as a depth of water per unit area applicable or divergence of flow in the soil.
- **Irrigation Requirement**: It refers to the quantity of water, exclusive of precipitation, required for crop production. This amounts to net irrigation requirement plus other economically avoidable losses. It is usually expressed in depth for given time.
- **Leaching**: It is removal of soluble material by the passage of water through the soil.
- **Leaching Requirement**: It is the fraction of water entering the soil that must pass through the root zone in order to prevent soil salinity from exceeding a specific value.
- **Oasis effect**: It is the exchange of heat whereby air over crop is cooled to supply heat for evaporation.
- **Percolation**: It is the down word movement of water through the soil.
- **Permanent Wilting Point (PWP)**: Permanent wilting point is the moisture content in percentage of soil at which nearly all plants wilt and do not recover in a humid dark chamber unless water is added from an outside source. This is lower limit of available moisture range for plant growth ceases completely. The force with which moisture is held by dry soil this point corresponds to 15 atmospheres.
- **Permeability**: Permeability is the property of a porous medium to transmit fluids. It is a broad term and can be further specified as hydraulic conductivity and intrinsic permeability.
- **PF**: It is the logarithm of height in cm of column of water which represents the total stress with which water is held by soil.
- **PH**: It is the negative logarithm of hydrogen ion concentration.
- **Potential Evaporation**: It represents evaporation from a large body of free water surface. It is assumed that, there is no effect of addictive energy. It is primarily a function of evaporative demand of climate.
- **Potential Evapo-transpiration**: It is the amount of water evaporated in a unit time from short uniform green crop growing actively and covering an extended surface and never short of water. Penman prefers the term potential transpiration.
- **Seepage**: It is the water escaped through the soil under gravitational forces.
• **Agricultural Drainage:** It is removal of excess water known as free or gravitational water from the surface or below the surface of farm land to create favorable condition for proper growth and development of the plot.
• **Surface Drainage:** when the excess water saturates the pores spaces removal of water of water by downward flow through the soil is called subsurface drainage.