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DEFINITION OF IRRIGATION:

- Irrigation is defined as the systematic process of artificially supplying water to land for raising crops. It is the profession, science of planning and designing an efficient, economic system to fit natural conditions.

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NECESSITY OF IRRIGATION IN INDIA:

- India being an agricultural country, as such all the resources depends on the agricultural output.
- The yield of an agricultural land depends on number of factors, however moist vital need is adequate quantities of water at various stages of the growth of the plants, but such conditions are rarely satisfied by natural rains.
- Hence the necessity of irrigation are as follows:

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Less Rainfall:

- When the rainfall is less than 100cm i.e. less than needed for the crop, artificial supply is necessary.
- Hence irrigation work may be constructed at places where adequate quantities of water is available and convey the same to places of necessity.

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Non – Uniformity of Rainfall:

- The rainfall over a particular area may be sufficient but not uniform over the crop period.
- In other words more water is supplied during the monsoon months, there is acute requirement of irrigation in other periods.

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Commercial Crops with addition Water:

- The rainfall in a particular area may be sufficient to raise the regular crops, but large quantities of water may be necessary for raising commercial and cash crops like sugar cane etc.

Controlled Water Supply:

- By constructing a proper distribution system, crop yield can be substantially increased.

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BENEFITS AND ILL EFFECT OF IRRIGATION:

- Irrigation project are designed in such a way that, they give both direct and indirect benefits.

Direct Benefits or Advantages:

- **Increase in Food Production:** this is achieved by controlled and timely supply of optimum quantity of water to the crop.
- **Protection from Famine:** irrigation projects can save the places of famine in two ways: during construction employment opportunities are provided to the local people and after construction continuous supply is assured even during drought period.

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BENEFITS AND ILL EFFECT OF IRRIGATION:

Direct Benefits or Advantages:

- **Cultivation of Cash Crops:** due to irrigation, it is possible to grow cash crops such as sugarcane, tobacco, cotton etc.
- **Addition to the Wealth of the Country:** irrigation projects are so designed that they bring some revenue to the country in the form of tax, bumper crops and hence saves importing of food crops from other countries.

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BENEFITS AND ILL EFFECT OF IRRIGATION:

Direct Benefits or Advantages:

- **Increase in Prosperity of People:** as continuous water supply is assured from an irrigation project, two or more superior crops can be grown, plus the value of the agricultural lands increases, thereby increasing the prosperity of people.
- **Hydro – Electric Power Generation:** major project are designed in such a way that power generation can be done together with irrigation.

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BENEFITS AND ILL EFFECT OF IRRIGATION:

Direct Benefits or Advantages:

- **Domestic and Industrial Water Supply:** water from irrigation canals can be used for domestic and industrial water supply.
- **Improvements of Communication:** as all the canals are provided with inspection roads, which can be metalled and hence can be used as means of communication.
- **Canal Plantation:** the area along the canal is always damp and hence canal plantation is possible, which in turn increases the wealth of the country and also minimizes soil erosion.

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BENEFITS AND ILL EFFECT OF IRRIGATION:

Direct Benefits or Advantages:

- **Improvement in the Ground Water Storage:** due to constant percolation and seepage of water, the ground water table raises, which is beneficial for better growth of the crop.
- **Aid in Civilization:** due to the improvement of irrigation projects there will be increase in the yield, the standard of living of the framer gets improved and becomes more civilized.

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BENEFITS AND ILL EFFECT OF IRRIGATION:

Indirect Benefits or Disadvantages:

- Climate becomes damp and cold, giving rise to malaria.
- Excess irrigation with poor drainage may results in water logging and causes salt efflorescence, resulting in drastic reduction of crop yield.
- Land revenue decreases in places where irrigation is extended as a protective measure.
- Excessive seepage from unlined canals would lead water logging of adjacent lands.

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SYSTEM OF IRRIGATION:

Various systems of irrigation are broadly classified as follows:

- **Flow Irrigation or Gravity Irrigation:** the water is supplied to the fields by gravity only, through a network of canals. This system is further subdivided into perennial irrigation and flood or inundation irrigation.
- **Lift Irrigation or Pumped Irrigation:** water is lifted with the help of pumps and discharged into lift canal. The source of supply can be from a river or canal and from ground surface.

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SYSTEM OF IRRIGATION:

Flow Irrigation:

Flow irrigation is that type of irrigation in which the irrigation water is supplied to a field by gravity. Flow irrigation is divided into two classes:

- Perennial Irrigation System
- Inundation or Flood Irrigation System

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SYSTEM OF IRRIGATION:

Flow Irrigation:

- **Perennial Irrigation System:** the water necessary for irrigation is supplied in accordance with the crop requirements throughout the crop period. Hence, for such a system some storage works such as dams, weirs or barrages are necessary to store excess water during floods and release it to the crops at the time of necessity.
- **Inundation or Flood Irrigation System:** water is flooded, till the land gets thoroughly saturated. Irrigation is carried out after draining the water.

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SYSTEM OF IRRIGATION:

Direct Irrigation:

- A weir or barrage is constructed across a river, so that the water can be diverted into the canal, such a system is also known as river canal irrigation.
- In this method water is not stored.
- Hence water level in the canal varies according to the water level in the river.
- Sarda canal system and Ganga canal system of UP are examples of this system of irrigation.

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SYSTEM OF IRRIGATION:

Storage Irrigation:

- In this system water is impounded in the form of a reservoir by the construction of a dam or a weir and this water is used for irrigation through a network of canals.
- Generally in order to achieve economy the project may be multipurpose, meaning the water can be used for number of purposes.
- This system is used when the monsoon are heavy during part of the year, but for most of the months in the year the discharge is not sufficient to meet the demand of the canals.

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SYSTEM OF IRRIGATION:

Bandhara Irrigation System:

- Bandhara irrigation is a special type of irrigation and is essentially a diversion irrigation scheme on non – perennial streams.
- This system is practiced in some parts of Maharashtra and Karnataka.
- The bandhara system was developed by late Sir M Visvesvaraya.

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SYSTEM OF IRRIGATION:

Bandhara Irrigation System:

- A bandhara is a masonry diversion weir of small height of about 1.2m to 4.5m, constructed across the stream and the water from the upstream side of such a structure being diverted into small canals.
- It is the cheapest and most economical type of irrigation.
- Bandharas can be constructed in series and irrigation can be carried out on both the sides of the canals.

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SYSTEM OF IRRIGATION:

Bandhara Irrigation System:

- The capacity of each bandhara can vary from few hectares to few hundred of hectares, depending on the volume of water available.
- Generally the length of a bandhara canal should not be more than 8km.

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SYSTEM OF IRRIGATION:

Location of Bandharas:

- The rivers should preferably be perennial in nature.
- Good foundation should be available for constructing the bandhara.
- The section at the site should be straight, narrow and well defined.
- The command of the canal should be fairly good and fertile.
- The cost of construction should be less or economical.

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SYSTEM OF IRRIGATION:

Advantages:

- The system of irrigation has a low initial cost.
- Losses in the canal are less, therefore duty of water is more.
- Small quantities of water which would have otherwise gone water is utilized to maximum in this system.
- As the lengths of the main canal and the distribution system being small, seepage and evaporation losses are very less.

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SYSTEM OF IRRIGATION:

Disadvantages:

- When excess water is available, it goes waste, since the area to be irrigated is small and fixed.
- Water supply in the canal depends on the nature of the river.
- As the water resources upstream of the bandhara depends on the nature of the stream, water may not be available for domestic purposes during dry seasons.

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SYSTEM OF IRRIGATION:

Tank Irrigation:

- Tank irrigation is a storage on the upstream which utilizes the water stored on the upstream side of a smaller (less than 12m height) earth dam or a bund.
- The reservoir or storage so formed upstream of such a bund is known as a tank.
- Tank irrigation method is very much popular in South India.

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SYSTEM OF IRRIGATION:

Tank Irrigation:

- Generally tank bunds are provided with sluices or outlets for discharging water from the tank for the tank for the purpose of irrigation.
- Excess water can be discharged from a surplus escape weir provided in the body or at one end of the tank bund.
- When a tank neither receives water from an upper tank nor discharges its own surplus into a lower tank, it is called an isolated tank.

SYSTEM OF IRRIGATION:

Tank Irrigation:

- When a number of tanks are connected in series, such that any tank either receives the surplus water into the lower tank or do both, they are known as tanks in series or group of tanks.
- The storage capacity of a tank can be computed by using the contour plan of the area of the water spread, the total capacity will be sum of the capacities between successive contours.
- When the contour plan is not available and if only the area of the tank at full tank level FTL multiplied by one third of the vertical distance between the FTL and the deepest bed level of the tank or the level of the silt of the lowest sluice whichever is higher of the two.

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SYSTEM OF IRRIGATION:

Lift Irrigation:

Lift Irrigation from Surface Source: the water is lifted with the help of pump and discharged into lift canals. The water source may be river or gravity canal. The water so lifted flows to the fields through a network of gravity canals.

Lift Irrigation from Ground Source: the water is lifted by means of tube wells or open wells. The water from such wells are pumped into the network of canals, leading to the place of necessity.

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SYSTEM OF IRRIGATION:

Methods of Lifting Water from Shallow Wells:

Persian Wheel:

- This method is used for lifting water from wells which are 10 to 20 m deep.
- This is very common in western UP and Punjab.
- It consists of a big framed wooden wheel fixed in a vertical position above the top of the well.

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SYSTEM OF IRRIGATION:

Methods of Lifting Water from Shallow Wells:

Persian Wheel:

- At the end of the axel of this wheel, another vertical wooden wheel of smaller diameter is fitted, this smaller wheel is rotated by a gear mechanism, which in turn is driven by a pair of bullock.
- As the bullocks move round all the wheels rotate and the metallic buckets filled with water start coming to the upstream end of the field canal, through which water flows to the land.

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SYSTEM OF IRRIGATION:

Methods of Lifting Water from Shallow Wells:

Doon:

- This method is used to lift waters up to 1.2m closed at upstream end and open on the downstream side.
- This chute is supported at its centre on a horizontal rod on which it rocks.
- The closed upstream end of the chute is connected by a rope on one side and a counter weight mechanism to the other side.

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SYSTEM OF IRRIGATION:

Methods of Lifting Water from Shallow Wells:

Doon:

- A wooden platform is fixed in the channel near its berm such that the top of platform is above the water level in the channel.
- The farmer stands on the platform who can operate the chute to lift the irrigation water from the channel to the irrigation fields.

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SYSTEM OF IRRIGATION:

Methods of Lifting Water from Shallow Wells:

Wind Lass:

- This methods is employed for lifting small quantity of water for irrigation or for drinking.
- In this method two wheels each having four or six projecting arms are joined together to from a cylindrical wooden frame.
- This cylinder is rested on top of the well.
- The bucket is tied to one of the rope while the other end of it is fixed to the axle of the frame.

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SYSTEM OF IRRIGATION:

Methods of Lifting Water from Shallow Wells:

Wind Lass:

- For lifting the water the wooden cylinder is rotated in one direction so that the bucket is lowered into the well and when it is full the cylinder is rotated in the opposite direction till the bucket rises to the top of the well so that the water can be discharged into the canal.
- This process is repeated as per requirements.

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SYSTEM OF IRRIGATION:

Comparison of Lift Irrigation and Canal Irrigation:

- In lift irrigation, pumping device are essential, while in the canal irrigation no such devices are required.
- In the case of lift irrigation, the farmer can irrigate his fields as per his requirements, while in the canal irrigation he has to wait for his turn.
- In lift irrigation pumping of water reduces the possibility of water logging, but in the case of canal irrigation water logging is possible.

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SYSTEM OF IRRIGATION:

Comparison of Lift Irrigation and Canal Irrigation:

- In the case of lift irrigation, water supply gets disrupted due to repair or due to power failure.
- Lift irrigation can be implemented anywhere and everywhere, but canal irrigation is possible in places where water can flow by gravity only.
- Due to the absence of slit in well water, its manorial value will be low, but in case of canal water, silt content is more meaning relatively high manorial value. This is an added advantage of canal irrigation.

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SYSTEM OF IRRIGATION:

Comparison of Lift Irrigation and Canal Irrigation:

- The area under irrigation in the case of lift irrigation will be relatively small compared to the canal irrigation.
- Lift irrigation water is used economically when compared to the canal irrigation.
- Lift irrigation is possible at all times even in draughts, but irrigation becomes more difficult when the rains fail.
- Staff requirement for lift irrigation is small compared to the canal irrigation.

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SYSTEM OF IRRIGATION:

Tube Well Irrigation:

- The maximum discharge from ordinary open well vary between 4 to 5 liters/sec, hence their usage is limited to small locality or dwellings, also it may not be economical to install pumps in such wells.
- In order to get more yield, tube wells are commonly used.
- These wells consist of blind pipes and strainer pipes driven into water bearing strata.
- The maximum yield of such a well will be about 200 lps and the depth may vary from 50 to 500m.

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DEFINITIONS:

Delta (Δ): it may be defined as the total volume of water delivered by the area over which it has been spread.

Duty: it denotes the irrigating capacity of a unit water. It is usually defined as the area of land in hectares which can be irrigated for growing any crop if one cumec or 1 m^3/sec of water is continuously supplied to the land for the entire base period of the crop.

Gross Duty: it is the duty of water measured at the source of diversion of irrigation supplies.

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DEFINITIONS:

Nominal Duty: it is the duty sanctioned as per schedule of the irrigation department.

Economic Water Duty: it is the duty of water which results in the maximum yield.

Designed Duty: it is the duty of water assumed in an irrigation project for designing the capacity of a channel.

Farm Duty or Net Duty: it is the duty measured in the farm.

Flow Duty: it is the duty determined at the head of a channel.

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DEFINITIONS:

Quantity Duty: it is the duty expressed in terms of the volume of water stored, and is expressed as hectares/million cubic meters of water available.

High Duty: when small amounts of water matures comparatively small area under crop the duty is said to be high.

Low Duty: when large amounts of water matures comparatively small areas under a crop the duty is said to be low.

Base Period: it is the period from the first to the last watering of the crop just before its maturity. It is expressed in number of days.

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DEFINITIONS:

Base of Duty of Water: it is defined as the period to which the stated duty of water has reference. When the duty of water is expressed for the entire base period and if the base is not mentioned it is evident that the duty refers to the entire base period.

Outlet Factor: the duty of water at the outlet or at the head of a field channel is known as the outlet factor.

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DEFINITIONS:

Cumec Day: the total quantity of water flowing continuously for one day at the rate of one cumec is known as cumec day.

1 cumec day = 1 x 24 x 60 x 60 = 8.64 x 10^4 m^3 = 8.64 Hectare – meters.

Consumptive Use of Evapo Transpiration: it is defined as the total quantity of water used by the vegetative growth of a given area in transpiration and buildings of plant tissue and that evaporated from the adjacent soil in the area in any specified time.

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DEFINITIONS:

Effective Rainfall: it is that part of the precipitation falling during the growing period of a crop that is available to meet the evapo transpiration needs of the crop.

Water Conveyance Efficiency [η_a]: it is defined as the ratio of the quantity of water delivered to the filed to the quantity of water diverted into the canal system from the storage.

Water Application Efficiency [η_u]: it is defined as the ratio of the quantity of water stored in the root zone of the plant to the quantity of water delivered to the field.

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DEFINITIONS:

Water Use Efficiency [η_s]: it is defined as the quantity of water beneficially used including the water required for leaching to the quantity of water delivered.

Water Storage Efficiency [η_c]: it is defined as the ratio of the quantity of water stored in the irrigation to the quantity of water needed to bring the moisture content of the soil to the field capacity.

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DEFINITIONS:

Consumptive Use Efficiency [η_{cu}]: it is defined as the ratio of the normal consumptive use of water to the net amount of water depleted from the root zone.

Consumptive Irrigation Requirement [CIR]: it is defined as the amount of irrigation water that is required to meet the evapo transpiration needs of a crop during its full growth.

Consumptive Irrigation Requirement = Consumptive Use – Effective Rainfall

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DEFINITIONS:

Net Irrigation Requirement [NIR]: it is defined as the amount of irrigation water required to be delivered at the field to meet the evapo transpiration needs of a crop as well as other needs such a leaching etc.

Net Irrigation Requirement = Consumptive Use – Effective Rainfall + Amount of Water required for Leaching

Field Irrigation Requirement [FIR]: it is defined as the amount of water required to meet the net irrigation plus the amount of water lost as surface runoff and through deep percolation.

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DEFINITIONS:

Gross Irrigation Requirement [GIR]: it is defined as the amount of water required to meet the field irrigation requirements plus the amount of irrigation water lost in conveyance through the canal system.

Paleo: it is first watering before sowing the crop. Paleo watering is done to provide sufficient quantities of water to the unsaturated zone of the soil.

Full Supply Coefficient: it is defined as the area estimated to be irrigated during the base period divided by the design full supply discharge of the channel at its head during maximum demand.

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RELATION BETWEEN DUTY, DELTA AND BASE PERIOD:

Let

D = Duty of water in hectares/cumec

B = Base period of the crop in days

Δ = Delta of water in meters

Volume of water applied to D Hectares of the field corresponding to a depth of Δ meters in B days

= D x Δ Hectares – meter

$= D \times \Delta \times 10^4 \text{ meter}^3$ – [1]

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RELATION BETWEEN DUTY, DELTA AND BASE PERIOD:

Volume of one cubic meter of water flowing for B days = 1 x 24 x 60 x 60 x B

$$= 8.64 \times 10^4 \times B \text{ meter}^3 \quad – [2]$$

Equating 1 and 2 equations

$$D \times \Delta \times 10^4 = 8.64 \times 10^4 \times B$$

$$D = 8.64 \{B / \Delta\} \quad – [3]$$

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RELATION BETWEEN DUTY, DELTA AND BASE PERIOD:

In equation 3

D = hectares / cumec

B = days

Δ = meters

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FACTORS AFFECTING CROP WATER REQUIREMENTS:

- Depth of the ground water table.
- Slope of the ground surface.
- Climatic conditions of the region.
- Intensity of irrigation.
- Texture and structure of soil.
- Moisture storage capacity of the soil.
- Type and quantity of manure applied to the fields.

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FACTORS AFFECTING DUTY OF IRRIGATION WATER:

Soil Characteristics: the duty of water directly depends on the soil characteristics, if the soil is pervious and coarse grained, losses are more, thereby there will be reduction in duty.

Sub – Soil Conditions: seepage losses depends on the sub – soil condition. If the water table is close to the normal supply level, seepage losses will be minimum and the duty of water will be high.

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FACTORS AFFECTING DUTY OF IRRIGATION WATER:

Climate Conditions: evaporation of water will be high when the temperature is high and the humidity is less this results in severe reduction of the duty of water.

Rainfall: if the irrigated area receives sufficient rainfall at the right time, then the quantity of irrigation supplied reduces, thereby the duty will be more.

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FACTORS AFFECTING DUTY OF IRRIGATION WATER:

Type of Crop: it is a fact that different crops require different amounts of water and hence the duties would be different for different crops. This means that a crop requiring more water would have less duty and vice versa.

Crop Period: the crop period/base period varies from crop to crop. This means that a crop with longer base period has lesser duty and vice versa.

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FACTORS AFFECTING DUTY OF IRRIGATION WATER:

Unevenness of the Irrigation Fields: even fields have better duty compared to uneven fields as more water is lost in the latter case.

Preparation of Fields: properly deep ploughed fields require overall less quantity of water, hence the duty will be more.

Longitudinal Slope of Fields: fields having little longitudinal downward slope towards the further end, requires less water and hence duty of water will be high.

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FACTORS AFFECTING DUTY OF IRRIGATION WATER:

Field Position in Relation to Canal: duty of water depends on the distance of the field from the canal outlet, which means if the distance of the field is more than the water losses will be more, or the duty will be less.

Use of Irrigation Water: when the irrigation water is assessed volumetrically, water will be more economically used, meaning that the duty will be more.

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FACTORS AFFECTING DUTY OF IRRIGATION WATER:

Skill of the Farmer: skilled farmer will make proper use of water, thereby the duty of water ill be high at such places.

Chemical Composition of Water: when the water quality is good, lesser quantities are required for irrigation, compared with water having chemicals. Hence duty for good quality water will be high.

Method of Irrigation: duty of water is more in case of perennial irrigation.

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FACTORS AFFECTING DUTY OF IRRIGATION WATER:

Mode of Applying Water: the flood irrigation system has lesser duty than the furrow system.

Time and Frequency of Cultivation: frequent cultivation reduces the loss of moisture through weeds. Also when the soil is in good tilth, evaporation losses are less, hence better duty.

Canal Conditions: lined canals have higher duties compared to unlined canals as losses are minimum in the former case.

METHODS OF IMPROVING DUTY:

- By adopting suitable methods of applying water, conveyance losses can be minimized thereby duty of water can be increased.
- By properly ploughing and levelling off the field before sowing the crop and also giving good tilth, duty can be improved.
- By frequent cultivation of the land moisture loss is reduced, thereby duty can be increased.
- By lining the network of canals, percolation and evaporation losses are reduced and hence duty can be increased.

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METHODS OF IMPROVING DUTY:

- By reducing the idle length of the canal, duty can be increased.
- By practicing the rotation of crops, duty can be increased.
- By adopting the volumetric method of assessing the irrigation water, duty can be increased.
- By selecting the source, yielding good quality water, duty can be increased.
- By avoiding the canal route through sandy or porous reaches, losses can be minimized, thereby duty can be increased.

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METHODS OF IMPROVING DUTY:

- By properly training farmers, to use water economically, duty can be increased.
- By establishing research stations the study of soil and conservation of moisture, duty can be increased.

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CROP ROTATION:

- Crop rotation means that nature of the crop sown in a particular field is changed year after year.
- It is a fact that all crops require similar type of nutrient salts, but quantities may vary.
- Hence if different crops are grown there would be more balanced fooding and the soil deficient in one particular type of nutrient is allowed to build up.

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CROP ROTATION:

- Rotation will check the disease.
- There could be deep rooted and shallow rooted crops in rotation and if they are allowed to draw their food from different depths, the soil will be better utilized.

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FREQUENCY OF IRRIGATION:

- Irrigation frequency refers to the number of days between irrigation during periods without rainfall.
- It depends on consumptive use of rate of a crop and on the amount of available moisture in the crop root zone.
- It is function of crop, soil and climate.
- Sandy soils must be irrigated more often the fine texture deep soils.

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FREQUENCY OF IRRIGATION:

- A moisture use ratio varies with the kind of crop and climate conditions and increases as crop grows larger and days become longer and hotter.
- In general, irrigation should start when about 50 percent and not over 60 percent of the available moisture has been used from the root zone in which most of the roots are concentrated.
- The stage of crop growth with reference to critical periods of growth is also kept in view while designing irrigation frequency.

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FREQUENCY OF IRRIGATION:

- The interval that can be safely allowed between two successive irrigation is known as frequency of irrigation.

Irrigation Interval = {Allowable soil moisture depletion / Daily water use}