EduTap

NABARD GRADE A

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Method of irrigation

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Contents

1 What is Irrigation?

- ✓ Irrigation is defined as **the artificial application of water to the soil for the purpose of crop growth or crop production** in supplement to rainfall and ground water contribution.
- ✓ The application of water to plants is made naturally through rainfall and artificially through irrigation.

2 Types of Irrigation

2.1 Surface Irrigation

- ✓ Surface irrigation is where **water is applied and distributed over the soil surface by gravity**. It is by far the most common form of irrigation throughout the world

The following methods are used under Surface Irrigation:

2.1.1 Flood Irrigation

- ✓ Used for **lowland rice and other crops**.
- ✓ Water is allowed **from the channel into the field without much control** on either side of the flow.
- ✓ It **covers the entire field** and move almost unguided.
- ✓ The **height of bunds around the field should be 15 cm** for effective use of rainfall.
- ✓ It is a **minimum labour-intensive method**.
- ✓ **Useful in uniform surface soils** with good water holding capacity.

Advantages of Flood Irrigation

- **Less labour** required
- **No extra care**
- Large stream can be **easily managed**

Disadvantages of Flood Irrigation

- **Uneven distribution** of water
- **Low water application efficiency**

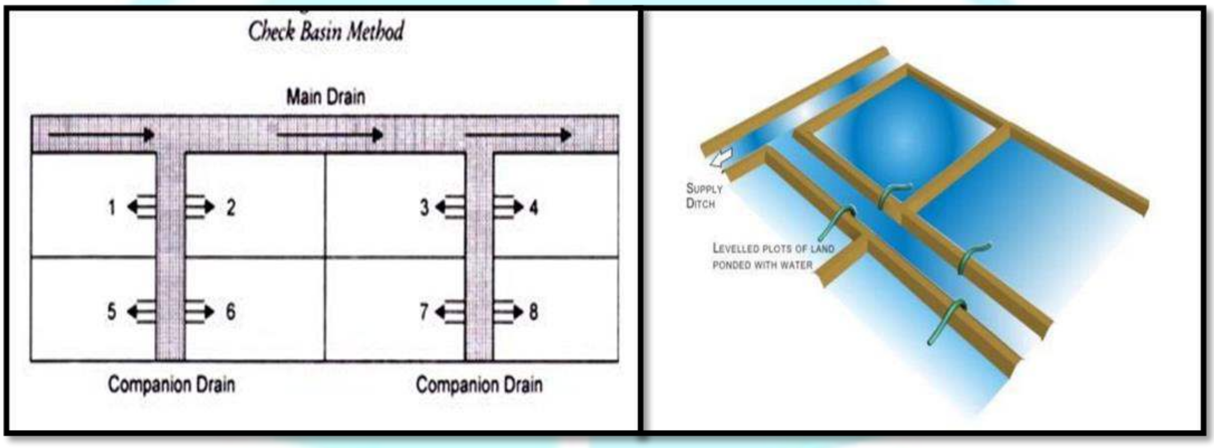
2.1.2 Basin Irrigation

- ✓ Basins are **flat areas of land surrounded by low bunds**.
- ✓ The **bunds prevent the water from flowing to the adjacent fields**.
- ✓ The **basins are filled to desired depth** and the **water is retained until it infiltrates into the soil**. Water may be maintained for considerable periods of time.

Basin method may be divided into two types:

- **Check Basin method**
- **Ring Basin method**

2.1.2.1 Check Basin method



- ✓ The check basin method is **the most common method of irrigation used in India**. In this method, **the land to be irrigated is divided into small plots or basins** surrounded by checks, levees (low bunds).
- ✓ Each plot or basin has a nearly level surface. The irrigation **water is applied by filling the plots with water up to the desired depth without overtopping the levees** and the water retained there is allowed to infiltrate into the soil. **The levees may be constructed for temporary use** or may be semi-permanent for repeated use as for paddy cultivation. **The size of the levees depends on the depths of water to be impounded** as on the stability of the soil when wet.
- ✓ **Water is conveyed** to the cluster of check basins **by a system of supply channels and lateral field channels or ditches**. The supply channel is aligned on the upper side (at a higher elevation) of the field for every two rows of plot.

- ✓ Basin irrigation **is suitable for many field crops**. **Paddy rice grows best when its roots are submerged in water** and so basin irrigation is the best method for use with the crop. Also, it is suitable for closely spaced crops like maize, pearl millet, groundnut etc.
- ✓ Check basins are **useful when leaching** is required to remove salts from the soil profile.
- ✓ **Not suitable for crops which are sensitive to wet soil conditions** around the stem.
- ✓ The size of the area may vary widely, based upon the crop, available water supply, soil infiltration characteristics and other local factors. **For soils with high infiltration capacity** (loam and sandy loam**) large sized basins may prove to be uneconomical and inefficient** (in terms of irrigation efficiencies). However, for clay soils with lower infiltration rates the size can of the check basin can be increased.
- ✓ **Check basin is the easiest and least costly method**, but is **usually highly inefficient only less than 20 percent of the water is taken up by the plant.**

Basin Width

- ✓ The main **limiting factor for basin width is the slope of the land**. For higher slopes the width should be small or else huge amount of earthwork would be necessary to level the land.
- ✓ The other factors which play an important role in the determination of basin width are **depth of fertile soil**, method of basin construction and agricultural practices.
- ✓ The basins **can be narrow if hand implements are used for intercultural operations** however if **machines are to be used for intercultural operations the width should be larger**.

SUGGESTED MAXIMUM BASIN AREAS (m^2) FOR VARIOUS SOIL TYPES AND AVAILABLE STREAM SIZES (l/sec)

Stream size (l/sec)	Sand	Sandy loam	Clay loam	Clay
5	35	100	200	350
10	65	200	400	650
15	100	300	600	1000
30	200	600	1200	2000
60	400	1200	2400	4000
90	600	1800	3600	6000

APPROXIMATE VALUES FOR THE MAXIMUM BASIN OR TERRACE WIDTH (m)

Slope %	Maximum width (m)	
	average	range
0.2	45	35-55
0.3	37	30-45
0.4	32	25-40
0.5	28	20-35
0.6	25	20-30
0.8	22	15-30
1.0	20	15-25
1.2	17	10-20
1.5	13	10-20
2.0	10	5-15
3.0	7	5-10
4.0	5	3-8

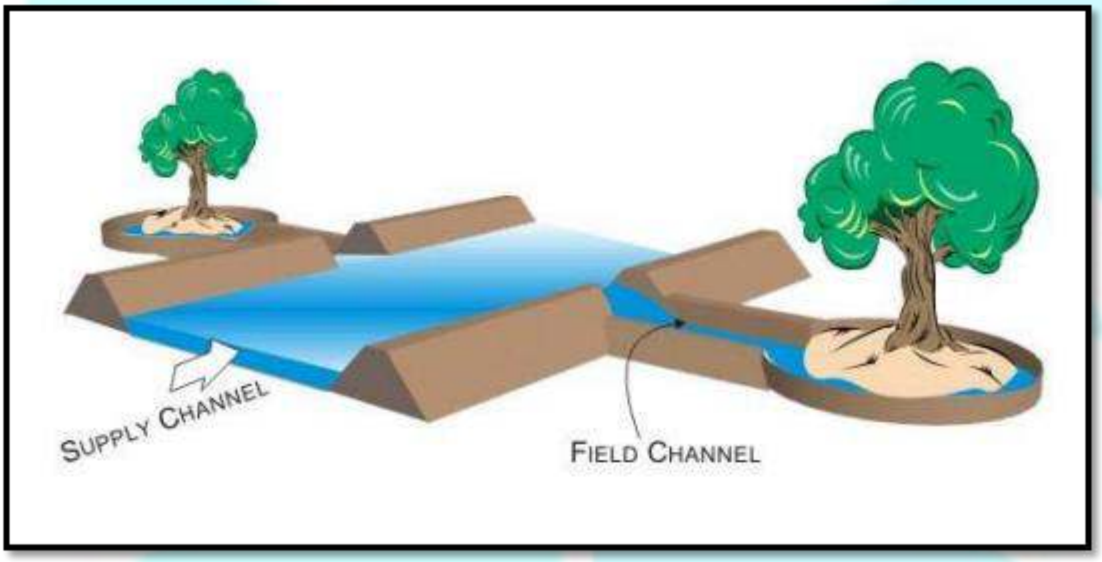
Water Requirement of Check Basin Irrigation

The requirement of irrigation water is estimated by the following equation :

Total volume of water required = Area of basin × Net depth of irrigation

$$A\ (m^2) \times d\ (m)$$

2.1.2.2 Ring Basin Method



- ✓ The other form of basin irrigation is the ring basin method **which is used for growing trees in orchards.**
- ✓ In this method, generally for each tree, **a separate basin is made which is usually circular in shape.**
- ✓ Sometimes, **basin sizes are made larger to include two more trees** in one basin.
- ✓ Water to the basins is supplied from a supply channel through small field channels.

Advantages of Basin Irrigation

- ✓ **Uniformly water** application
- ✓ Suitable for **those field which are quite large** and not easy to level the entire field.

Disadvantages of Basin Irrigation

- ✓ **More labour required** for field layout and irrigation
- ✓ **Wastage of field/ land is more under irrigations and bunds**.
- ✓ Mostly **5 percent of land is waste** for bunding.

2.1.3 Border Irrigation

- ✓ The **land is divided into number of long parallel strips called borders**.
- ✓ These **borders are separated by low ridges**.
- ✓ The border strip has a **uniform gentle slope** in the direction of irrigation.
- ✓ On clay soils (inflow stopped at 60% of the border); on loamy soils (it is at 70% - 80% of border); on sandy soils (entire border covered)

Suitability

- ✓ To **soils having moderately low to moderately high infiltration rates**. It is **not used in coarse sandy soils** that have very high infiltration rates and also in heavy soils having very low infiltration rate.
- ✓ **Suitable to irrigate all close growing crops** like wheat, barley, fodder crops and legumes and not suitable for rice.

Width of border strip: It varies from 3-15 m. Border length varies according to topography i.e slope

Slope	Soil	Length
0.25 - 0.60%	Sandy and sandy loam	60-120 m
0.20 - 0.40%	Medium loam soil	100-180 m
0.05 – 0.20%	Clay loam and clay soil	150-300 m

Soil type	Border Slope (%)	Unit flow per metre width (l/sec)	Border Width (m)	Border Length (m)
SAND	0.2-0.4	10-15	12-30	60-90
Infiltration rate greater than 25 mm/h	0.4-0.6	8-10	9-12	60-90
	0.6-1.0	5-8	6-9	75
LOAM	0.2-0.4	5-7	12-30	90-250
Infiltration rate of 10 to 25 mm/h	0.4-0.6	4-6	6-12	90-180
	0.6-1.0	2-4	6	90
CLAY	0.2-0.4	3-4	12-30	180-300
Infiltration rate less than 10 mm/h	0.4-0.6	2-3	6-12	90-180
	0.6-1.0	1-2	6	90

Note: The flow is given per metre width of the border. Thus the total flow into a border is equal to the unit flow multiplied by border width (in metres).

Advantages of Border Irrigation

- ✓ Large **irrigation streams can be efficiently used**;
- ✓ This method gives **highest water use efficiency** than other surface irrigation methods.

Disadvantages of Border Irrigation

- ✓ No uniform distribution of water;
- ✓ This method cannot be applied for sandy soils.

2.1.4 Furrow Irrigation

- ✓ Furrows are **small channels, which carry water down the land slope** between the **crop rows.**
- ✓ Water infiltrates into the soil as it moves along the slope.
- ✓ The **crop** is usually **grown on ridges between the furrows.**

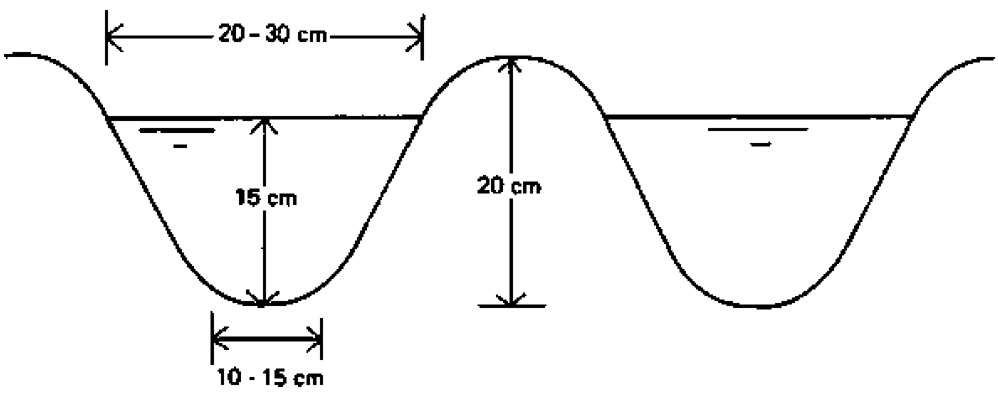
✓ This method is suitable for all row crops and for crops that cannot stand water for long periods, like 12 to 24 hours, as is generally encountered in the border or basin methods of irrigation.

✓ The furrow method of irrigation is **generally used to irrigate row crops and vegetables**, and is suited to soils in which the **infiltration rates are between 0.5 and 2.5 cm/hr**. It is **ideal for slopes varying from 0.2 to 0.5 percent and a stream size of 1–2 litre/ second**.

✓ **Furrow spacing-**As a rule, for sandy soils the spacing should be between 30 and 60 cm, i.e. 30 cm for coarse sand and 60 cm for fine sand.On clay soils, the spacing between two adjacent furrows should be 75-150 cm.

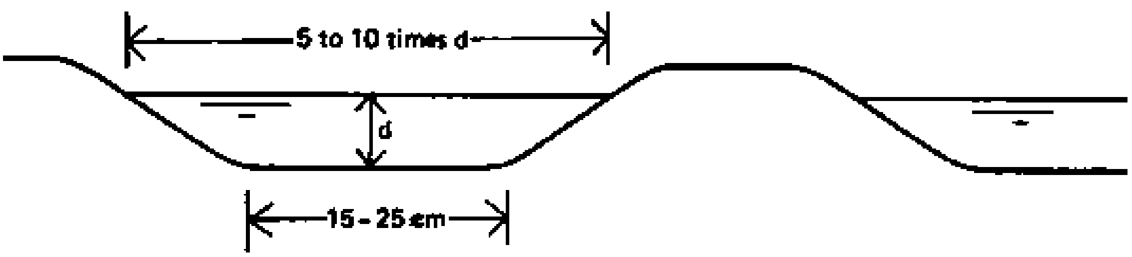
✓ **Furrow shape**- In sandy soils, water moves faster vertically than sideways (= lateral). Narrow, deep V-shaped furrows are desirable to reduce the soil area through which water percolates . However, sandy soils are less stable, and tend to collapse, which may reduce the irrigation efficiency.

Figure 28 A deep, narrow furrow on a sandy soil



✓ In clay soils, there is much more lateral movement of water and the infiltration rate is much less than for sandy soils. Thus a wide, shallow furrow is desirable to obtain a large wetted area to encourage infiltration.

Figure 29 A wide, shallow furrow on a clay soil



What is the mechanism of water supply?

✓ Water is **applied to the furrows** by letting in water from the **supply channel**, either by **pipe siphons** or by making temporary breaches in the supply channel embankment.

✓ The length of time the water is to flow in the furrows depends on the amount of water required to replenish the root zone and the infiltration rate of the soil and the rate of lateral spread of water in the soil.

✓ **Furrow irrigation** is suitable to most soils except **sandy soils** that have very **high infiltration water** and provide poor lateral distribution water between furrows.

What is the advantage of furrow irrigation when compared to the other methods of irrigation?

✓ Water in the furrows contacts only one half to one-fifth of the land surface, thus reducing puddling and clustering of soils and excessive evaporation of water.

NOTE: There is a modified furrow irrigation system, namely **furrow irrigated raised bed** (FIRB) **system.**

✓ In furrow irrigated raised bed (FIRB) system, water moves horizontally from the furrows into the beds and is pulled upwards in the bed towards the soil surface by capillarity, evaporation and transpiration, and downwards largely by gravity.

2.1.4.1 Types of furrow irrigation

A. Based on alignment of furrows

1. Straight furrows
2. Contour furrows

B. Based on size and spacing

1. Deep furrows
2. **Corrugations:** Small and shallow furrow are known as corrugation, suitable for close growing crops like wheat, ground nut etc.

2.1.5 Surge Irrigation

✓ Intermittent application of water to the field surface under gravity flow which results in a **series of ''ON and OFF'' modes of constant or variable time spans**.

✓ In simpler terms, the term "Surge irrigation" refers to the **delivering irrigation flows into individual long furrows (more than 25m upto 200m) in an intermittent fashion** of **predetermined ON-OFF time cycles (5 minutes to 10 minute)** with the design duration of irrigation.

✓ During the **ON time waterfront advances into the furrow over a certain length** and during the subsequent **OFF time the water applied partially saturates the soil and infiltration rate gets reduced** on the advanced length.

✓ When water is delivered in the **succeeding ON time**, **the water front advance gets accelerated due to the reduced intake rate and eventually it reaches the tail end of long furrow with in 30 -50% of the design duration of irrigation**.

✓ This process of ON OFF water supply and cutoff results in highly minimized deep percolation and runoff losses (hardly exceeding 20%).

✓ Hence, high uniformity of soil moisture distribution within the effective root zone is achieved over the entire furrow length resulting in enhanced irrigation efficiencies of more than 85% to 95%.

✓ In addition, due to the series of long furrows emanating from a single head channel, the criss -cross ridges and feeder channel of division are eliminated thereby limiting the land loss within 5% only.


Advantages

✓ Infiltration uniformity is increased

✓ Deep percolation is reduced compared to continuous water application due to intermittent wetting and drying process.

2.2 Sub-Surface Irrigation

✓ The application of water to fields in this type of irrigation system is **below the ground surface** so that it is **supplied directly to the root zone of the plants.**

✓ In sub-surface or sub-irrigation water is **applied beneath the ground by creating** and **maintaining an artificial water table at some depth**, usually 30 to 75 cm, below the ground surface.

✓ **Moisture moves upwards** towards the land surface through capillary action to meet requirements of the crops in plant roots.

✓ Water is applied through underground distribution system consisting of a properly designed main field ditches, laterals, laid 15 to 30 m apart.

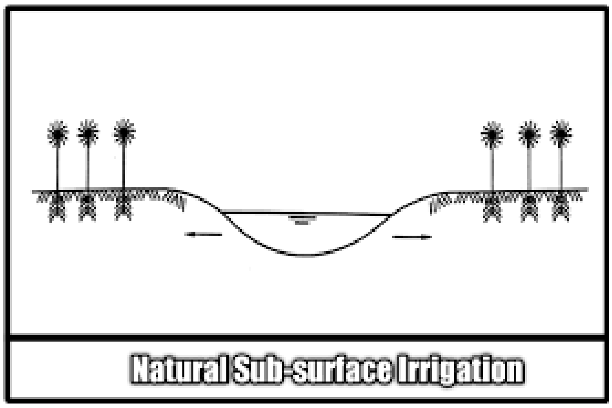
✓ **Water may be obtained from wells, streams, lakes etc.**

✓ The main advantages of these types of irrigation is reduction of evaporation losses and less hindrance to cultivation works which takes place on the surface.

There may be two ways by which irrigation water may be applied below ground and these are termed as:

1. Natural sub-surface irrigation method
2. Artificial sub-surface irrigation method

2.2.1 Natural Sub-Surface Irrigation method



Under favorable conditions of topography and soil conditions, the water table may be close enough to the root zone of the field of crops which gets its moisture due to the upward capillary movement of water from the water table.

This method is favourable when the following conditions exist:

- ✓ The **soil in the root zone** should be **quite permeable**
- ✓ There should be an impermeable substratum below the water table to prevent deep percolation of water
- ✓ There must be abundant supply of quality water that is one which is salt free, otherwise there are chances of upward movement of these salts along with the moisture likely to lead the conditions of salt incrustation on the surface.

2.2.2 Artificial sub-surface irrigation method

- ✓ The concept of maintaining a **suitable water table just below the root zone** is obtained by providing **perforated pipes** laid in a **network pattern below** the **soil surface at a desired depth.**
- ✓ This method of irrigation will function only if the soil in the root zone has high horizontal permeability to permit free lateral movement of water and low vertical permeability to prevent deep percolation of water.
- ✓ This method of irrigation is not very popular because of the high expenses involved, unsuitable distribution of subsurface moisture in many cases, and possibility of clogging of the perforation of the pipes.

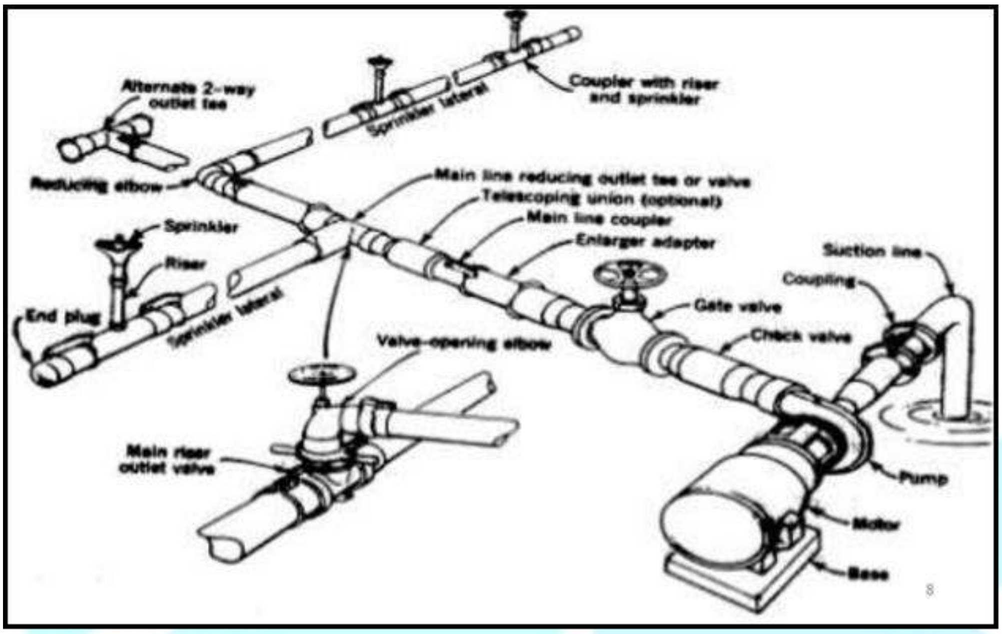
- ✓ The depth of installation depends upon soil characteristics and **crop species ranging from 15–20 cms for vegetables and field crops and 30–50 cms for tree crops.**
- ✓ The main disadvantages are the high cost of initial installation and the increased possibility for clogging, especially when poor quality water is used.

2.3 Pressurized Irrigation System/Micro-Irrigation

In pressurized irrigation systems water is pressurized and precisely applied to the plants under pressure through a system of pipes. Pressurized irrigation systems, as opposed to the surface irrigation systems, are more effective in application of irrigation water to the crops.

2.3.1 Sprinkler Irrigation

- ✓ Water is **applied with pressure to the surface of any crop or soil** in the form of a **thin spray**, somewhat **resembling rainfall**.
- ✓ This system consists of **sprinkler heads or nozzles**, which are mounted on risers in lateral lines taken from main line, which is further connected to a pumping unit.
- ✓ The **rate of spray of water** can be **regulated** and **natural rainfall can be simulated**.
- ✓ Sprinkler irrigation can be used for all crops, (except rice and jute) and on most soils (except heavy clay soils).
- ✓ It is **especially suited for field with steep slopes or irregular topography**.
- ✓ If soil erosion is a hazard, it can be used in conjunction with contour bunding, terracing, mulching and strip cropping.
- ✓ The rotary sprinklers are usually spaced 9-24 m apart along the lateral which is normally 5-12.5 cm in diameter.
- ✓ The wetting pattern from a single rotary sprinkler is not very uniform. Normally the area wetted is circular. The heaviest wetting is close to the sprinkler. For good uniformity several sprinklers must be operated close together so that their patterns overlap. For good uniformity the overlap should be at least 65% of the wetted diameter. This determines the maximum spacing between sprinklers.



The following tabular column shows various parts of a sprinkler system

Pumping Unit	**A high speed centrifugal or turbine pump can be installed for operating the system for individual farm holdings.**
Pipeline	Pipelines are generally of two types. They are main and lateral. Main pipelines carry water from the pumping plant to many parts of the field. The lateral pipelines carry the water from the main or sub main pipe to the sprinklers.
Couplers	A coupler provides connection between two tubing and between tubing and fittings.
Sprinklers	Sprinklers may rotate or remain fixed. The rotating sprinklers can be adapted for a wide range of application rates and spacing. They are effective with pressure of about 10 to 70 m head at the sprinkler. Pressures ranging from 16-40 m head are considered the most practical for most farms. Perforated Pipe system is usually designed for relatively low pressure (1 kg/cm2). The application rate ranges from 1.25 to 5 cm per hour for various pressure and spacing.

2.3.1.1 General classification of different types of sprinkler systems

Sprinkler systems are classified into the following two major types on the basis of the arrangement for spraying irrigation water.

1. Rotating head or revolving sprinkler system.

2. Perforated pipe system.

1. Rotating head:

- ✓ Small size nozzles are placed on riser pipes fixed at uniform intervals along the length of the lateral pipe and the lateral pipes are usually laid on the ground surface.
- ✓ They may also be mounted on posts above the crop height and rotated through 90 degrees, to irrigate a rectangular strip.
- ✓ In rotating type sprinklers, the most common device to rotate the sprinkler heads is with a small hammer activated by the thrust of water striking against a vane connected to it.

2. Perforated pipe system

This method consists of drilled holes or nozzles along their length through which water is sprayed under pressure. This system is usually designed for relatively low pressure (1 kg/cm2).

The application rate ranges from 1.25 to 5 cm per hour for various pressure and spacing.

2.3.1.2 Based on the portability, sprinkler systems are classified into the following types

1. Portable system

A portable system has portable main lines, laterals and pumping plant.

2. Semi portable system

A semi portable system is similar to a portable system except that the location of water source and pumping plant is fixed.

3. Semi permanent system

A semi permanent system has portable lateral lines, permanent main lines and sub mains and a stationery water source and pumping plant.

4. Solid set system

A solid set system has enough laterals to eliminate their movement. The laterals are positions in the field early in the crop season and remain for the season.

5. Permanent system

A fully permanent system consists of permanently laid mains, sub mains and laterals and a stationery water source and pumping plant.

Advantages of sprinkler irrigation

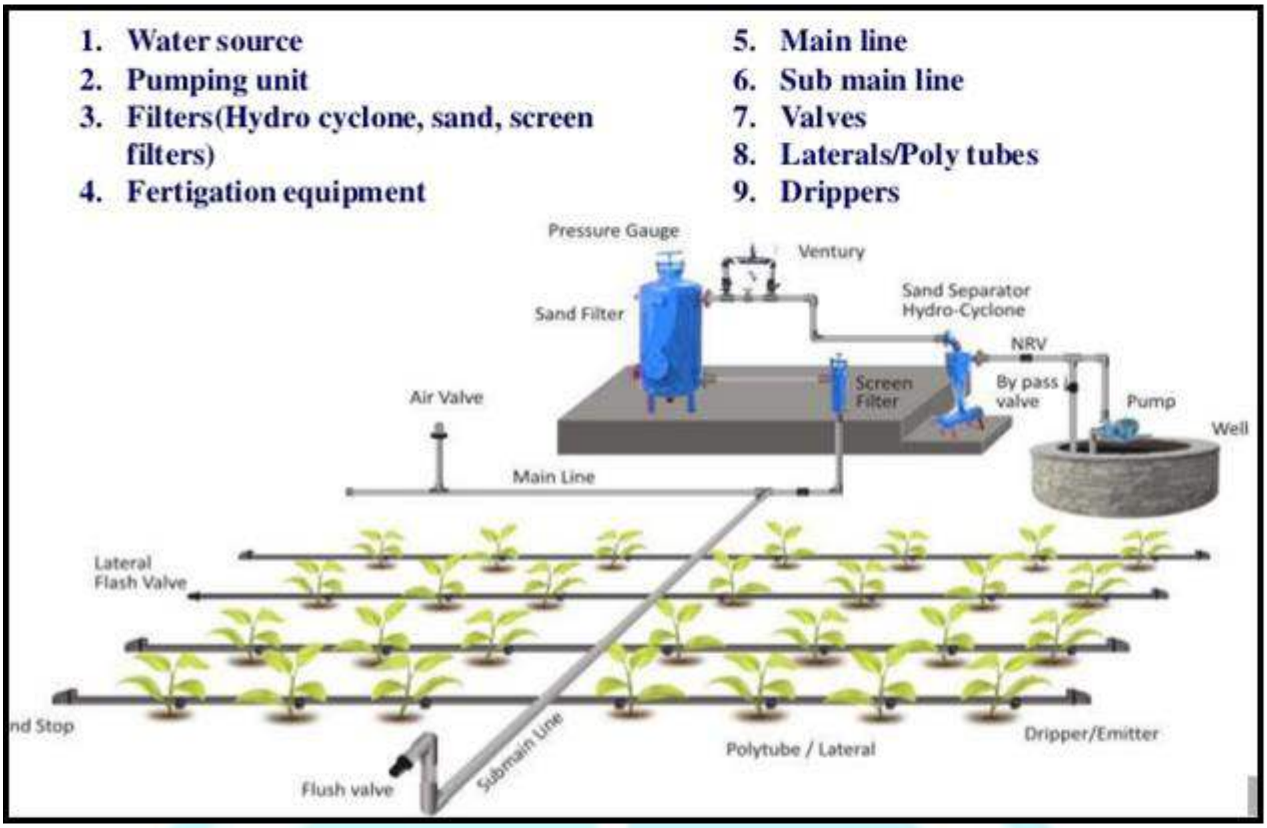
- ✓ Suitable for undulating topography and sandy soils.
- ✓ Saving of water from 25-50% for different crops.
- ✓ Discharge rate is more than 1000 lit/hr.
- ✓ Sprinkler pressure 2.5-4.5 kg/cm^2
- ✓ Water use efficiency can be as high as 60% much higher to surface method of irrigation.
- ✓ Increase 40% in irrigated area with same amount of water as compared with surface method of irrigation
- ✓ About 40-60% saving in labour compared with surface.
- ✓ It can be used to protect crops against frost and high temperatures.

Low Energy Precision Application (LEPA) and Low Elevation Spray Application (LESA) offers a more efficient alternative, which is a modified sprinkler irrigation system. In this system the water is delivered to the crops from drop tubes that extend from the sprinkler's arm. (alterations done on a center pivot where the sprinklers are moved much closer to the ground, the spacing between sprinklers is reduced (more sprinklers), and water is emitted at very low pressures.)

When applied together with appropriate water-saving farming techniques, LEPA can achieve efficiencies as high as 95 percent. Since this method operates at low pressure, it also saves as much as 20 to 50 percent in energy costs compared with conventional systems.

2.3.2 Drip Irrigation

- ✓ Introduced from **Israel**. Usage of a plastic emitter in drip irrigation was developed in Israel by Simcha Blass and his son Yeshayahu.
- ✓ Drip or trickle irrigation is one of the **latest methods of irrigation** which is becoming **increasingly popular in areas** with **water scarcity and salt problems**.
- ✓ **As per Pradhan Mantri Krishi Sinchayee Yojana data released in April 2020, the first place goes to Karnataka (8.16 lakh ha) followed by Andhra Pradesh (7.17 lakh ha) and Gujarat (7 lakh ha). At the all-India level, 43.71 lakh ha of lands were brought under micro irrigation in the last five years.**
- ✓ 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 reduced 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.



Per Drop More Crop component of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY-PDMC) *is operational in the country from 2015-16. The PMKSY- PDMC focuses on enhancing water use efficiency at farm level through Micro Irrigation viz. Drip and Sprinkler irrigation.*

The Government provides financial assistance @ 55% for small and marginal farmers and @ 45% for other farmers for installation of Drip and Sprinkler Irrigation systems. *In addition, some States provide additional incentives/top up subsidy for encouraging farmers to adopt Micro Irrigation.*

The following tabular column shows various parts of a drip system

Pump	**The pump creates the pressure necessary to force water through the components of the system including the fertilizer tank, filter unit, mainline, lateral and the emitters and drippers. The laterals may be designed to operate under pressures as low as 0.15 to 0.2 kg/ cm2 and as large as 1 to 1.75 kg/cm2**
Chemical Tank	A tank may be provided at the head of the drip irrigation systems for applying fertilizers, herbicides and other chemicals in solution directly to the field along with irrigation water.
Emitters	The discharge rate of emitters usually ranges from 2 to 10 litres per hour.
Filters	It is an essential part of drip irrigation system. It prevents the blockage of pipes and drippers/emitters.

Advantages of drip irrigation

- ✓ **Suitable for water scarcity area.**
- ✓ **Water saving is 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 1.5-2.5 kg/cm^2 pressure.**
- ✓ Most suitable for widely spaced crops, orchard trees and in green houses (protected cultivation of vegetables & flowers).

2.3.2.1 Maintenance of drip irrigation

- ✓ **Regular maintenance** is required for drip irrigation to **avoid clogging of the drippers** and pipes as such.
- ✓ **Flushing needs to be done** regularly but in case problem is severe can go for the following methods of cleaning

The commercial Grade of Acid recommended for Acid Treatment are:

Hydrochloric Acid	HCl - 35%
Nitric Acid	HNO_3 - 33%
Sulfuric Acid	H_2SO_4 - 65 %
Ortho Phosphoric Acid	H_3PO_4 - 85%

- ✓ In most of the cases the **0.6% application with irrigation of these commercial grades of acids brings down the pH** between 2-4 capable of dissolving most of the precipitations.
- ✓ Most of the cases **HCl can be used which is highly effective & the cheapest of all**, except the crops which cannot tolerate Chloride. In that case HNO_3 or H_2SO_4 could be used.
- ✓ **H_2SO_4 is not recommended where Ca, Mg salts are above 500ppm**. Acid treatment is always done before chlorination as chlorination is effective under pH range of 6.5-to-8.5.
- ✓ **If iron is present, do not use ortho phosphoric acid (H_3PO_4)** as iron would precipitate with phosphoric acid.
- ✓ H2O2 **Hydrogen Peroxide can also be used to bring down pH** where use of other acids is not feasible.

Select the most suitable acid and proceed as under:

- ✓ Flush & clean filters, Flush main, Submain & lateral ends.
- ✓ **Calculate quantity of Acid required for the valve (section/shift) based on 0.6% injection of Acid for 15 minutes.** As a thumb rule 15 ltr Acid @ 1 ltr/min Acid is required for each of 10m3/hr flow. (10,000 lph x 0.006(6%) x 0.25hrs). If injection rate is say 1.5 ltr/min add 7.5 ltr of water in Acid to ensure 0.6% rate of injection.
- ✓ **Open inlet & outlet of Venturi without disturbing its calibration settings**. In case of fertilizer tank create appropriate pressure differential between inlet & outlet by throttle valve. Do not spill the acid/chlorine on the fertilizer tank.
- ✓ **After the injection of Acid, allow acidified water to react with precipitated salts** for about minimum 4 - 6 hours (It is desirable to prolong the period for 24 hours). Then open the ends of laterals and submain flush valve. Start on the pump and allow all the water to flow out. Measure

the discharges of marked drippers. Flush Main, sub-main & laterals. If there is no significant improvement repeat the treatment, repeat the treatment as above for all the sections.

✓ **At the end of acid treatment wash the equipment & vessels with clean water**, whip & dry removing residue of Acid. If clogging is observed due to algae or other causes; carry out chlorination treatment.

✓ **Run the system for half an hour more than normal irrigation schedule** so that extra quantity of acid will be taken out of root zone.

Fertigation

Fertigation is a method of fertilizer application in which fertilizer is incorporated within the irrigation water by the drip system. In this system fertilizer solution is distributed evenly in irrigation. The availability of nutrients is very high therefore the efficiency is more. In this method liquid fertilizer as well as water soluble fertilizers are used. By this method, fertilizer use efficiency is increased from 80 to 90 per cent.

Name	N – P2O5 – K2O content	Solubility (g/l) at 20 C
Ammonium nitrate	34-0-0	1830
Ammonium sulphate	21-0-0	760
Urea	46-0-0	1100
Monoammonium phosphate	12-61-0	282
Diammonium phosphate	18-46-0	575
Potassium chloride	0-0-60	347
Potassium nitrate	13-0-44	316
Potassium sulphate	0-0-50	110
Monopotassium phosphate	0-52-34	230
Phosphoric acid	0-52-0	457