An effective system to automate the conservation of water in irrigation using Internet of Things.

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Abstract*— Agriculture is an ancient culture which is in practice from many years and is known to be one of the most significant economic activities, so it is considered as the backbone of India. Agriculture involves hard work and conscious efforts of a human being to modify a part of the earth's surface by cultivating crops. Irrigation is the main feature of agriculture for over 5,000 years and it is the product of many cultures that's why it is the "Heart of Agriculture". Irrigation means providing controlled amount of water to the plants at needed intervals. Since a little less than 2% of water exists as groundwater, wetlands, lakes, rivers and water found in the soil which is the key source of the water that we use for consumption as well as for irrigation. Irrigation not only helps to grow but also maintains the agricultural crops and soils in dry areas during the period of drought. In order to conserve water, we are using IOT, Machine Learning and Cloud Computing. Our intension behind this project is to grow a greater number of crops using fewer amounts of water and a pledge to support our farmers. In order to fulfil these requirements, we are making use of two techniques namely, Drip and Sprinkler Irrigation. Our goal is to apply the water to the plants as uniformly as possible so that each plant has the amount of water it needs, neither too much nor too little. IOT has made everyone's life easy these days, so we want our farmers to utilize the emerging technologies of IOT for the betterment of their own as well as for our country. Trending technologies such as Cloud Computing, Android Application, and OpenCV are involved and the field activities will be handled by our robot, who is the "Heart of IrriServe".

Keywords-

1. INTRODUCTION

Agriculture is the backbone of India and for many other countries. Irrigation is the "Heart of Agriculture". Irrigation is the application of controlled amounts of water to plants at needed intervals. Irrigation helps to grow and maintain the agricultural crops and soils in dry areas during the periods of less than the average rainfall. For the conservation of water we are using the present technology which is purely based on IOT, Machine Learning and Cloud Computing. IOT is often referred as Internet of Everything or Internet of Intelligent objects or Internet of Things. This is used for the application of Irrigation by using some hardware and software's. For conserving water we are using following Agriculture based irrigation systems.

Water Conservation System is conserving the water on the basis of agriculture. Nowadays we are using drinking water for the agriculture purpose. By limited usage of water of obtaining the more crops is our aim, where the following systems are used for agricultural practices which can be implemented.

Drip irrigation is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface. The goal is to place water directly into the root zone and minimize evaporation. Drip irrigation systems distribute water through a network of valves, pipes, tubing and emitters. Depending on how well designed, installed, maintained, and operated.

An **Irrigation sprinkler** is a device used to irrigate agricultural crops, lawns, landscapes, golf courses, and other areas. They are also used for cooling and for the control of airborne dust. Sprinkler irrigation is the method of applying water to a controlled manner in that is similar to rainfall. The water is distributed through a network that may consist of pumps, valves, pipes, and sprinklers. Irrigation sprinklers can be used for residential, industrial, and agricultural usage. Higher pressure sprinklers that themselves move in a circle are driven by a ball drive, gear drive, or impact mechanism (impact sprinklers). These can be designed to rotate in a full or partial circle.

Technologies are growing rapidly with a boom in all sectors. One such sector is agriculture, where the combination of Internet Of Things (IOT) devices, Image processing, Machine Learning and Cloud Computing makes a better progress in an efficient and effective way. Agriculture is considered as the basis of life for us

as it is the main source of food and other raw materials. It plays a vital role in the growth of country's economy. Nowadays the availability of power and water is insufficient to fulfill the farmer's needs.

There are two ways of conserving water in agriculture field and mainly for Irrigation purpose, they are classified as follows:

1. Drip Irrigation System.
2. Sprinkler System.

2. **DRIP IRRIGATION SYSTEM:**

Drip Irrigation is a form of Irrigation System which in particular has the potential to change the way the farms are irrigated if employed with Information Communication and Dissemination Technologies (ICDTs). The Smart Automatic Drip Irrigation System based on IOT is a new mode to ensure smart farming practices for irrigation purposes. Drip Irrigation is one of the efficient irrigation methods to save water by allowing the water drip slowly to the root of the plants, either into the soil surface or directly on to the root zone. In the modern Drip Irrigation System, the most significant advantage is supplying water near the root zone which in turn saves large amount of water. Smart Irrigation System is one such good example for IOT. It allows remote monitoring and controlling the fields through various android devices. With the advent of open source Embedded systems along with cheap sensors, it is feasible to create devices that can monitor the soil moisture content and irrigating fields. Our project involves a robot which will sense the moisture content available in the soil and monitor the results with the actual sensation of the plants.

Fig. 1 Drip Irrigation Model Description.

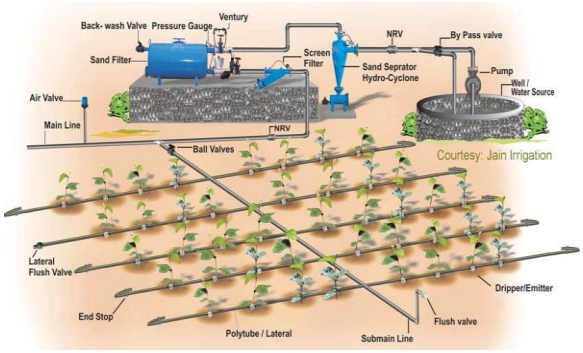

Fig. 2 Drip Irrigation Model Description.

3. **SPRINKLER SYSTEM:**

A sprinkler system can be operated as an intelligent device on the basis of real time moisture content in the soil that is to be watered. A sprinkler is a watering device that is used to deliver necessary content of water to the soil evenly. Sprinklers need a lot of water to function properly and these days shortage of raining and land reservoir water has turned out to be a major issue. To solve this issue **Internet of Things** (IOT) is an introduced concept of having everyday objects connected through internet including smart phones, sensors etc. Once connected, they enable smart processes and services between them for convenience. Sprinkler is connected through it and can be controlled remotely by users. Our project involves a robot that will give required water for the plants whenever necessary and if in case the water content is more than required then the robot will not allow the flow of water for the plants.

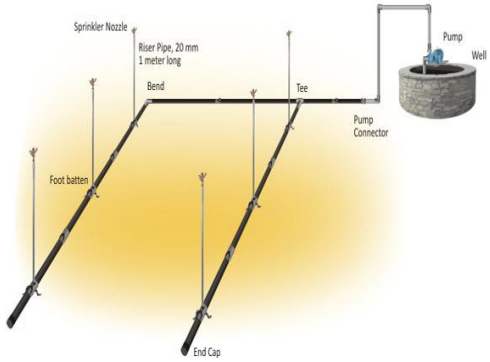

Fig. 3 Sprinkler Irrigation Model Description.

Fig. 4 Sprinkler Irrigation Model Description.

In this project an automation of farm irrigation and soil moisture control by a Micro-Controller using soil moisture sensor and L293D module. This automatic irrigation system senses the moisture content of the soil and automatically switches the pump when the power is on. A proper usage of irrigation system is very necessary because the main reason is the shortage of land reserved water due to lack of rain, spontaneous use of water as a result large amounts of water goes waste. For this reason, we use this automatic plant watering and soil moisture monitoring system and this system is very useful in all climatic conditions. India is the agriculture based country. Our most of peoples are completely depended on the agricultural harvesting. Agriculture is a source of employment for the majority of Indians and has great impact on the economy of the country. In dry areas or in case of lacking rainfall, irrigation becomes difficult. So, it needs to be automated for proper watering a plant and handled remotely by farmer. When soil goes dry pump will start watering. The aim of the implementation is to reduce water use and automatic irrigation can be used for save time and low power monitor device. The aim of the implementation of this project is to demonstrate the automatic plant irrigation to reduce the usage of water as well as time.

- **Irrigation Trends Since 1947**

India's irrigation covered crop area was about 22.6 million hectares in 1951, and it increased to a potential of 90 mha at the end of 1995, inclusive of canals and groundwater wells. However, the potential irrigation relies of reliable supply of electricity for water pumps and maintenance, and the net irrigated land has been considerably short. According to 2001/2002 Agriculture census, only 58.1 million hectares of land was actually irrigated in India. The total arable land in India is 160 million hectares (395 million acres). According to the World Bank, only about 35% of total agricultural land in India was reliably irrigated in 2010.

The ultimate sustainable irrigation potential of India has been estimated in a 1991 United Nations' FAO report to be 139.5 million hectares, comprising 58.5 mha from major and medium river-fed irrigation canal schemes, 15 mha from minor irrigation canal schemes, and 66 mha from groundwater well fed irrigation.

India's irrigation is mostly groundwater well based. At 39 million hectares (67% of its total irrigation), India has the world's largest groundwater well equipped irrigation system (China with 19 mha is second, USA with 17 mha is third).

India has spent ₹ 16,590 crore on irrigation development between 1950 and 1985. Between 2000-2005 and 2005-2010, India proposed to invest a sum of ₹ 1,03,315 crore and 2,10,326 crore on irrigation and flood control in India.

State wise irrigation types, capacity actual area :

State	Total crop area (million hectares)	Groundwater irrigation crop area (million hectares)	Canal irrigation crop area (million hectares)	Total crop area actually irrigated (million hectares)
All India	159.6	39.43	22.48	58.13
Andhra Pradesh	14.3	2.5	2.7	4.9
Arunachal Pradesh	0.4		0.07	0.05
Assam	3.0	0.13	0.1	0.22
Bihar	6.4	2.2	1.3	3.5
Chhattisgarh	5.1	0.17	0.74	0.85
Goa	0.1		0.1	0.1
Gujarat	9.9	3.1	0.5	3.2
Haryana	3.6	1.99	1.32	3.26
Himachal Pradesh	1.0	0.02	0.09	0.11
Jammu & Kashmir	0.9	0.02	0.38	0.37
Jharkhand	3.2	0.11	0.13	0.24
Karnataka	12.2	1.43	1.33	2.38
Kerala	1.5	0.18	0.21	0.39
Madhya Pradesh	15.8	2.74	1.70	4.19
Maharashtra	19.8	3.12	1.03	3.36
Manipur	0.2		0.05	0.05
Meghalaya	0.3		0.06	0.06
Mizoram	0.1		0.01	0.01
Nagaland	1.1		0.1	0.07
Odisha	4.9	0.17	1.07	1.24
Punjab	4.0	3.06	0.94	3.96
Rajasthan	21.1	3.98	1.52	5.12
Sikkim	0.1		0.01	0.01
Tamil Nadu	6.5	1.61	1.43	2.66
Tripura	0.3	0.02	0.05	0.07
Uttar Pradesh	17.6	10.64	4.21	14.49
Uttarakhand	0.8	0.22	0.14	0.35
West Bengal	5.5	2.09	1.22	2.98

Sprinkler Irrigation:
In this method, water is sprayed into the atmospheric air over the soil surface to be irrigated and allowed to fall on the soil surface at a rate less than the infiltration rate of the soil. Sprinkler irrigation provides controlled uniform application of water for frequent and light irrigation on shallow soils, sloping and undulating lands without having to develop them by land grading or levelling operation.
Rotating sprinkler-head systems are commonly used for sprinkler irrigation. Each rotating sprinkler-head applies water to a specified area size of which is governed by the nozzle size and the water pressure. Alternatively, perforated pipe can be used to deliver water through very small holes which are drilled at close intervals along a segment of the circumference of a pipe.
The trajectories of these jets provide fairly uniform application of water over a strip of farm land along both sides of the pipe. Because of the availability of flexible PVC pipes, the sprinkler systems can be made portable too.
Sprinklers have been used on all types of soils on lands of different topography and slopes, and for many crops. Sprinkler irrigation is normally recommended in the command areas where the land is highly undulating, water availability is poor, soils are sandy or shallow and where uniform application of irrigation water is required.

The following conditions are favourable for sprinkler irrigation system:
(i) Soils with very high infiltration rate.
(ii) Shallow soils, the topography of which prevents desired levelling at reasonable costs.
(iii) Undulating land and land with steep slopes where surface irrigation may result in excessive erosion.
(iv) Water is very scarce.
(v) Ground water is the source of irrigation water.

Following are the advantages of sprinkler irrigation:
(i) Saving of water and soil (due to no or negligible erosion of soil).
(ii) Saving in cost of land preparation.
(iii) Better control of soil moisture.
(iv) Frequent and light irrigation results in better crop yields.
(v) Easy and uniform application of water, fertilizers and pesticides.

Following are the disadvantages of sprinkler irrigation:
(i) Higher initial investment.
(ii) Higher power requirement.

(iii) Unsuitable for soils having low infiltration rate.
(iv) Poor application efficiency under high windy conditions and high temperature.
(v) Unsuitable for canal irrigation in which water is distributed by rotational supply system.
Because of its advantages, sprinkler irrigation is replacing the surface irrigation methods. In India, the gross area under spunkier irrigation has increased from 3 lakh hectares in 1985 to 5.80 lakh hectares in 1989 and is expected to further increase to about 20 lakh hectares by the turn of the 20th century.

Trickle (or Drip) Irrigation:
In the drip irrigation system, water is applied slowly and frequently to keep the soil moisture in the root-zone soil of the plant within the desired range. The water for irrigation is conveyed from the source to the plant root zone through a system comprising main line (37.5 to 70 mm diameter pipe), sub-mains (25 to 37.5 mm diameter pipe), laterals (6 to 8 mm diameter pipe), valves (to control the flow), drippers or emitters (to supply water at a desired rate of about 1 to 10 litres per hour to the plants), pressure gauges, water meters, filters (to remove all debris, sand and clay to reduce clogging of the emitters), pumps, fertiliser tanks, vacuum breakers and pressure regulators.

Flow is controlled manually or set to automatically deliver either:
(i) Desired amount of water for a predetermined time, or
(ii) Water whenever soil moisture decreases to a predetermined amount.
A line sketch of a typical drip irrigation system is shown in Fig 1.2.

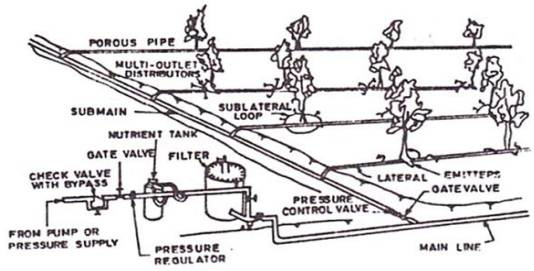

Fig. 1.2 Drip Irrigation System

Following are the advantages of this method:

(i) It saves water and improves water penetration.
(ii) It reduces weed growth.
(iii) Limited soil wetting permits uninterrupted agricultural operations.
(iv) Lower operating pressures and lower flow rates require lesser energy for pumping.
(v) It enhances plant growth and improves crop yield.
(vi) It does not require land preparation.
(vii) It does not cause soil erosion.
(viii) It improves fertiliser application efficiency.

Following are the main disadvantages of drip irrigation:
(i) It requires high skill in its design, installation and maintenance.
(ii) Initial investment cost is rather high.
(iii) The system is sensitive to clogging because of small openings used in the system.
Because of the obvious advantages of water saving and increased crop yield associated with drip irrigation, India has embarked on a massive programme for popularizing this method

A sprinkler irrigation system typically consists of:
i) A pump unit which takes water from the source and provides pressure for delivery into the pipe system. The pump must be set to supply water at an adequate pressure so that the water is applied at rate and volume adequate to the crop and soil types
ii) Main pipes and secondary pipes which deliver water from the pump to the laterals. In some cases these pipelines are permanently installed on the soil surface or buried below ground. In other cases they are temporary, and can be moved from field to field. The main pipe materials used include asbestos cement, plastic or aluminium alloy
iii) The laterals deliver water from the pipes to the sprinklers. They can be permanent but more often they are portable and made of aluminium alloy or plastic so that they can be moved easily
iv) Sprinklers, water-emitting devices which convert the water jet into droplets. The distribution of sprinklers should be arranged so as to wet the soil surface in the plot as evenly as possible.

A wide range of sprinkler systems is available for small and large-scale application. Set systems operate with sprinklers in a fixed position. These sprinklers can be moved to water different areas of the field, either by hand or with machinery. Hand-move systems are more labour intensive and may be more suited where labour is available and cheap. On the other hand, mechanically operated systems require a greater capital investment in equipment. Mobile systems minimise labour inputs by operating with motorised laterals or sprinklers, which irrigate and move continuously at the same time (Savva and Franken, 2002).

Sprinkler irrigation efficiency is highly dependent on climatic conditions. FAO (1982) proposed the figures of farm irrigation efficiencies provided in Table 1 on the basis of climate.

Table 1: Farm irrigation efficiencies for Sprinkler Irrigation in different climates (the overall efficiency comprises conveyance efficiency, field canal efficiency, and field application efficiency)

Climate/Temperature	Farm irrigation efficiency
Cool	**0.80**
Moderate	**0.75**
Hot	**0.70**
Desert	**0.65**

Source: adapted from FAO (1982)

Sprinkler irrigation technology can support farmers to adapt to climate change by making more efficient use of their water supply. This is particularly appropriate where there is (or is expected to be) limited or irregular water supply for agricultural use. The sprinkler technology uses less water than irrigation by gravity, and provides a more even application of water to the cultivated plot. Additionally, sprinkler irrigation can reduce the risk of crops freezing due to colder than usual temperatures. More frequent and intense frosts are already impacting on crops as a result of climate change. During the night, the motion of the sprinklers and the application of rain-like water droplets can reduce the stress on crops caused by a sharp decrease in temperature (Snyder and Melo-Abreu, 2005).

Advantages of the technology:
One of the main advantages of the sprinkler irrigation technology is more efficient use of water for irrigation in agriculture. Sprinkler systems eliminate water conveyance channels, thereby reducing water loss. Water is also distributed more evenly across crops helping to avoid wastage. The sprinkler irrigation system has also been shown to increased crop yields (Table 2) and is suited for

most row, field and tree crops that are grown closely together, such as cereals, pulses, wheat, sugarcane, groundnut, cotton, vegetables, fruits, flowers, spices and condiments cultivating paddy crop (Kundu et al, 1998).

Table 2: Response of different crops to Sprinkler Irrigation Systems

	Water saving %	Yield increase %
Barley	**56**	**16**
Cabbage	**40**	**3**
Cauliflower	**35**	**12**
Chillies	**33**	**24**
Cotton	**36**	**50**
Groundnut	**20**	**40**
Maize	**41**	**36**
Onion	**33**	**23**
Potato	**46**	**4**
Wheat	**35**	**24**

Source: adapted from INCID (1998)

Sprinkler irrigation technology is well adapted to a range of topographies and is suitable in all types of soil, except heavy clay. Sprinkler systems can be installed as either permanent or mobile fixtures. Sprinklers provide a more even application of water to agricultural land, promoting steady crop growth. Likewise, soluble fertilisers can be channelled through the system for easy and even application. The risk of soil erosion can be reduced because the sprinkler system limits soil disturbance, which can occur when using irrigation by gravity. In addition, sprinkler irrigation can provide additional protection for plants against freezing at low temperatures. Secondary benefits from improved crop productivity include income generation, employment opportunities and food security

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Disadvantages of the technology:

The main disadvantages associated with sprinkler systems are related to climatic conditions, water resources and cost. Even moderate winds can seriously reduce the effectiveness of sprinkler systems by altering the distribution pattern of the water droplets. Likewise, when operating under high temperatures, water can evaporate at a fast rate reducing the effectiveness of the irrigation. Although sprinkler irrigation can help farmers to use water resources more efficiently, this technology relies on a clean source of water and therefore may not be suited to areas where rainfall is becoming less predictable. Implementation costs are higher than that of gravity-fed irrigation systems and large labour force is needed to move pipes and sprinklers in a non-permanent system. In some places such labour may not be available and may also be costly. Mechanised sprinkler irrigation systems have a relatively high energy demand (Savva and Frenken, 2002).

Financial requirements and costs:

The cost of installing a sprinkler system suitable for a family production unit ranges from US$ 600 to US$ 2500 per hectare, depending on the type of materials used and the amount of labour contributed by rural producers. Affordable Micro Irrigation Technologies (AMITs) are low cost and low pressure systems with the same technical advantages as conventional micro-irrigation system, however the technology is packaged and marketed as kits suitable for small fields (25 m^2 to 4000 m^2). The AMIT has the specific advantage of being affordable, and easy to understand; they also have rapid pay back, divisibility and expandability.

Barriers to implementation

Possible barriers to implementation include lack of access to finance for the purchase of equipment, lack of local skills for design, installation and maintenance of the system and lack of nationally/locally available component parts. A low level of public awareness of or concern for the importance of sustainable water management and use could also be a barrier to the exploration of sprinkler irrigation technology as a climate change adaptation option. Sprinkler irrigation requires a suitable source of fresh water to be identified in close enough proximity to the farmland. This ensures that costs are kept at a reasonable level. Water availability will be highly dependent not only on current resources but also on future climate conditions. Where knowledge of potential climate change impacts on water resources does not exist, installing a sprinkler irrigation system could lead to conflicts over local water use.

Opportunities for implementation

Sprinkler irrigation is a versatile technology suitable for application in a wide range of contexts, can be implemented at small or large scale and with either low-cost or more sophisticated components. This technology can be employed in conjunction with other adaptation measures such as the establishment of water user boards, multi-cropping and fertiliser management.

Sprinkler irrigation system allows application of water under high pressure with the help of a pump. It releases water similar to rainfall through a small diameter nozzle placed in the pipes. Water is distributed through a system of pipes, sprayed into air and irrigates in most of the soil type due to wide range of discharge capacity.

Advantages

- Eliminates water conveyance channels, thereby reducing conveyance loss.
- Suitable in all types of soil except heavy clay.
- Water saving up to 30% - 50 %.
- Suitable for irrigation where the plant population per unit area is very high.
- Helps to increase yield.
- Reduces soil compaction.
- Mobility of system helps system operation easy.
- Suitable for undulating land.
- Saves land as no bunds required.
- Soluble fertilizers and chemicals use are possible.
- Provides frost protection & helps in alteration of micro climate.
- Reduces labour cost

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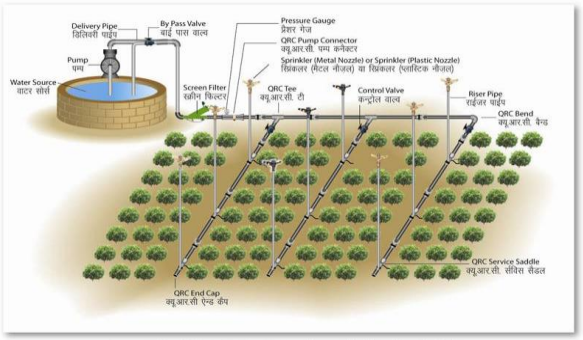
Type of Sprinkler	Precipitation (mm per hour)
Low Volume Sprinkler	Less than 13
Medium Volume Sprinkler	13 - 25
Large Volume Sprinkler(Raingun)	Above 25

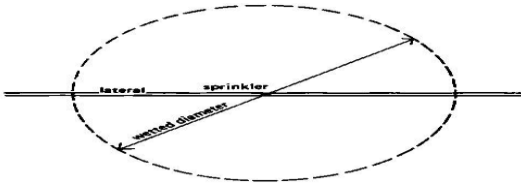


Layout of Sprinkler Irrigation System (छिड़काव सिंचाई प्रणाली का रेखाचित्र)

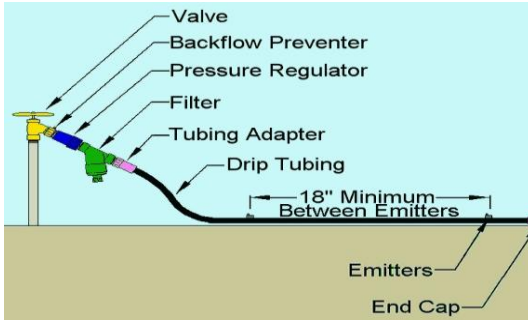
A typical sprinkler irrigation system consists of the following components:

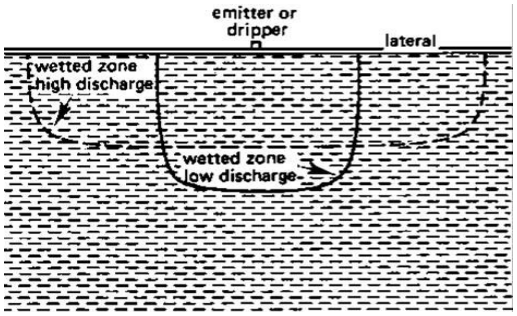
1. Pump unit
2. Mainline and sometimes sub-mainlines
3. Laterals
4. Sprinklers

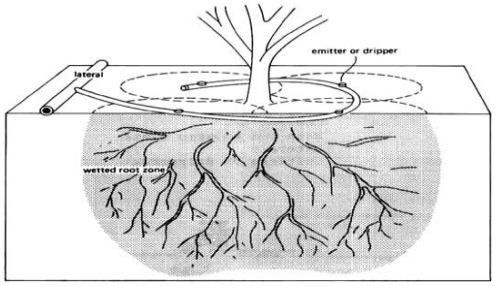
Top View of Sprinkler



Wetting pattern for a single sprinkler







Major Components of Drip Irrigation System			
1	Pump station.	2	By-pass assembly
3	Control valves	4	Filtration system
5	Fertilizer tank /Venturi	6	Pressure gauge
7	Mains / Sub-mains	8	Laterals
9	Emitting devices	10	Micro tubes

Pump station takes water from the source and provides the right pressure for delivery into the pipe system.
Control valves control the discharge and pressure in the entire system.
Filtration system cleans the water. Common types of filter include screen filters and graded sand filters which remove fine material suspended in the water.
Fertilizer tank/venturi slowly add a measured dose of fertilizer into the water during irrigation. This is one of the major advantages of drip irrigation over other methods.
Mainlines, submains and laterals supply water from the control head into the fields. They are usually made from PVC or polyethylene hose and should be buried below ground because they easily degrade when exposed to direct solar radiation. Lateral pipes are usually 13-32 mm diameter.
Emitters or drippers are devices used to control the discharge of water from the lateral to the plants. They are usually spaced more than 1 metre apart with one or more emitters used for a single plant such as a tree. For row crops more closely spaced emitters may be used to wet a strip of soil. Many different emitter designs have been produced in recent years. The basis of design is to produce an emitter which will provide a specified constant discharge which does not vary much with pressure changes, and does not block easily. Unlike surface and sprinkler irrigation, drip irrigation only wets part of the soil root zone. This may be as, low as 30% of the volume of soil wetted by the other methods. The wetting patterns which develop from dripping water onto the soil depend on discharge and soil type. Figure 64 shows the effect of changes in discharge on two different soil types, namely sand and clay

Although only part of the root zone is wetted it is still important to meet the full water needs of the crop. It is sometimes thought that drip irrigation saves water by reducing the amount used by the crop. This is not true. Crop water use is not changed by the method of applying water. Crops just require the right amount for good growth.
The water savings that can be made using drip irrigation are the reductions in deep percolation, in surface runoff and in evaporation from the soil. These savings, it must be remembered, depend as much on the user of the equipment as on the equipment itself.
Drip irrigation is not a substitute for other proven methods of irrigation. It is just another way of applying water. It is best suited to areas where water quality is marginal, land is steeply sloping or undulating and of poor quality, where water or labour are expensive, or where high value crops require frequent water applications.

Response of different crops to Drip Irrigation System

Crops	Water saving (%)	Increase in yield (%)
Banana	45	52
Cauliflower	68	70
Chilly	68	28
Cucumber	56	48
Grapes	48	23
Ground nut	40	152
Pomegranate	45	45
Sugarcane	50	99
Sweet lime	61	50
Tomato	42	60
Watermelon	66	19

Benefits of drip Irrigation

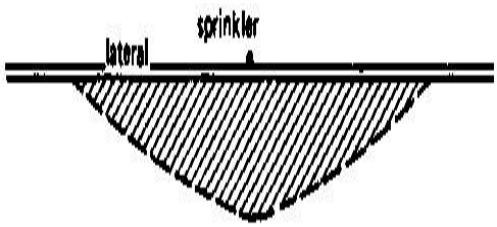
- Increase in yield up to 230 %.
- Saves water up to 70% compare to flood irrigation. More land can be irrigated with the water thus saved.
- Crop grows consistently, healthier and matures fast.
- Early maturity results in higher and faster returns on investment.
- Fertilizer use efficiency increases by 30%.
- Cost of fertilizers, inter-culturing and labour use gets reduced.
- Fertilizer and Chemical Treatment can be given through Micro Irrigation System itself.
- Undulating terrains, Saline, Water logged, Sandy & Hilly lands can also be brought under productive cultivation.

Water conservation through drip

Water is conserved in the following ways:

- Drip irrigation application uniformity is very high, usually over 90%.
- Unlike sprinklers, drip irrigation applies water directly to the soil, eliminating water loss from wind.
- Application rates are low so water may be spoon fed to the crop or plant root zone in the exact amounts required (even on a daily or hourly basis). In contrast, other methods entail higher water application quantities and less frequency. If young plants need water frequently, much of the water applied is often wasted to deep percolation or runoff.
- Low application rates are less likely to run off from heavier soils or sloping terrain.
- Drip irrigation does not water non-targeted areas such as furrows and roads in agriculture, between beds, blocks or benches in greenhouses, or hardscape, buildings or roads in landscape.
- Drip irrigation easily adapts to odd-shaped planting areas which are difficult to address with sprinklers or gravity irrigation.
- Drip irrigation is capable of germinating seeds and setting transplants which eliminates the need for "sprinklering up" and eliminates the resulting waste in the early stages of crop growth.

Drip irrigation is today's need because Water - nature's gift to mankind is not unlimited and free forever. World water resources are fast diminishing.



The uniformity of sprinkler applications can be affected by wind and water pressure. Spray from sprinklers is easily blown about by even a gentle breeze and this can seriously reduce uniformity. To reduce the effects of wind the sprinklers can be positioned more closely together.

Sprinklers will only work well at the right operating pressure recommended by the manufacturer. If the pressure is above or below this then the distribution will be affected. The most common problem is when the pressure is too low. This happens when pumps and pipes wear. Friction increases and so pressure at the sprinkler reduces. The result is that the water jet does not break up and all the water tends to fall in one area towards the outside of the wetted circle. If the pressure is too high then the distribution will also be poor. A fine spray develops which falls close to the sprinkler.

Application rate: This is the average rate at which water is sprayed onto the crops and is measured in mm/hour. The application rate depends on the size of sprinkler nozzles, the operating pressure and the distance between sprinklers. When selecting a sprinkler system it is important to make sure that the average application rate is less than the basic infiltration rate of the soil (see Annex 2). In this way all the water applied will be readily absorbed by the soil and there should be no runoff.

Sprinkler drop sizes: As water sprays from a sprinkler it breaks up into small drops between 0.5 and 4.0 mm in size. The small drops fall close to the sprinkler whereas the larger ones fall close to the edge of the wetted circle. Large drops can damage delicate crops and soils and so in such conditions it is best to use the smaller sprinklers.

Drop size is also controlled by pressure and nozzle size. When the pressure is low, drops tend to be much larger as the water jet does not break up easily. So to avoid crop and soil damage use small diameter nozzles operating at or above the normal recommended operating pressure.

References