MANUAL
ON
PRESSURISED IRRIGATION

Er. Jippu Jacob
Dr. Mary Regina F
Er. Anu Varughese
Er. Priya G.Nair

Kerala Agricultural University
Precision Farming Development Centre
Kelappaji College of Agricultural Engineering
and Technology, Tavanur - 679 573, Kerala

Sponsored by
National Committee on Plasticulture Applications in Horticulture
Ministry of Agriculture and Co-operation
Govt. of India, New Delhi

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January 2008

Copies : 1000

Cover design:

Sri. V. Rajendran

Published by :

Dr. M. K. Sheela
Director of Extension
Kerala Agricultural University
Mannuthy-680 651, Thrissur

Printed at :

Kerala Agricultural University Press,
Mannuthy-680 651, Thrissur

CONTENTS

CHAPTER 1

INTRODUCTION

With four per cent of the world's freshwater resources, India is among the top ten water rich countries in the world. Barring the continent of South America, India receives the highest annual rainfall in the world. The country has perennial river systems, innumerable lakes and wetlands and substantial ground water resources and these sources are regularly replenished by two monsoonal patterns, the south-west and the north-east monsoons. In spite of this, India is water stressed and in the near future is likely to become a water scarce country. The reasons for this are varied. The annual average rainfall ranges between 100mm in the western deserts and 11,000mm in the north-eastern states. The rainfall is highly variable even over distances less than 5 kilometers.

Rivers and lakes are getting degraded due to multi source pollution and destruction of catchment areas. Lakes are being drained for real estate development in urban areas and for cultivation and industrial use in rural areas. Groundwater is depleting at an alarming rate due to over withdrawal. Absolute scarcity is already being experienced in different parts of the country, in high rainfall areas, low rainfall areas, in hilly terrain and in the plains.

In our country around 88% of water is being used in agriculture sector, 23% for industry and 8% for domestic purpose. The water demand is shooting up with the growth of agriculture, industries and population and within a decade or so water crisis may become as severe as oil crisis. Today the country is facing acute water scarcity in many states and the availability of water per person per annum has come down from 6000 cubic meter per person to 2500 cubic meter per person, in the post independence era.

The demand for water in our country is projected as 1050 km^3 in 2025. However, though India's water potential is assessed as 1869 km^3, the available surface water is only 680 km^3 and thereby India is in a deficit condition in the case of surface water available.

The seasonal nature of precipitation and variability of rainfall makes artificial irrigation necessary for agricultural development in the country. Traditional indigenous methods used available water from mountain streams, springs, shallow aquifers and harvested rainwater in tanks and ponds to irrigate land. Most of these systems are still functional and in use in some part of the country or the other.

Need for efficient irrigation

The development of irrigation is given top priority in Indian economy as agriculture contributes to about 50% of the Gross National Product. Efficient use of irrigation water is an important means for increasing the productivity. The surface irrigation methods, which is widely practiced in India leads to enormous loss of water due to seepage and evaporation. This is due to poor distribution of water in farm due to inadequate land preparation and lack of farmer's knowledge in the application of water, which leads to excess application and deep percolation. Generally, under surface irrigation methods, only less than one half of the water released reaches the plants. The unscientific use of water has resulted not only in wastage of water but also has caused soil erosion, salination and water logging, which ultimately degraded the quality of the two basic natural resources- soil and water.

Types of Irrigation

There are four general types of irrigation systems; namely, surface irrigation and subsurface irrigation, drip or micro irrigation, sprinkler irrigation The selection of an irrigation system depends upon water availability, topography, soil characteristics, crop requirements, cost and cultural practices. As an example, surface irrigation would not be appropriate for fruit crops but would be for rice, whereas drip or micro spray irrigation would not be appropriate for rice but would be for fruit crops. Likewise, if the crop to be irrigated is located adjacent to a stream or similar water source, and water abstractions would not adversely affect downstream users, surface irrigation might be used in preference to other, perhaps more water-efficient and more costly, methods of irrigation.

A. Surface Irrigation

In surface methods of irrigation, water is directly applied to the soil surface from a channel located at the upper reach of the field. Water is either diverted or pumped from a river or stream onto the area to be irrigated. The common surface irrigation methods are flood irrigation, border irrigation, check basin irrigation and furrow irrigation.

1. Flood irrigation - Water enters the area uncontrolled and minimal land preparation is required for flooding. To obtain high efficiency, the water distribution system must be properly constructed and the losses in the distribution system minimized.shown in

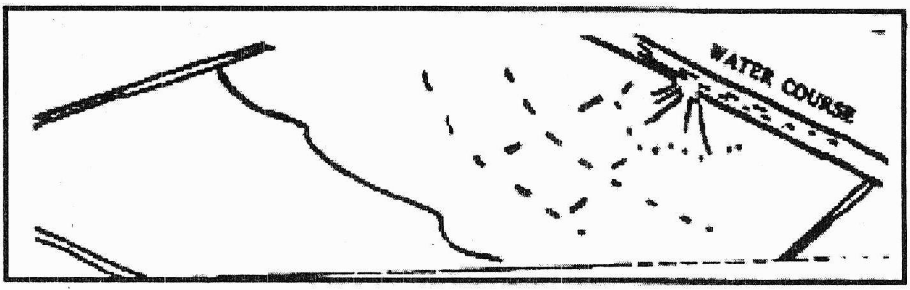

fig.1 Flood irrigation

2. Border irrigation - Water enters the area as a controlled sheet of water, resulting in less water loss than flood irrigation. The land is divided into a number of long parallel strips called borders that are separated by low ridges shown in fig.2. The border strip has little or no cross slope but has a uniform gentle slope in the direction of irrigation.

The border method of irrigation is adapted to most soils where depth and topography permit the required land leveling at a reasonable cost and without permanent reduction in soil productivity. It is however, more suitable to soils having moderately low to moderately high infiltration rates. The border method is suitable to irrigate all close growing crops like wheat, barley, fodder crops and legumes. It is however, not suitable for crops like rice which requires standing water during most parts of its growing season.

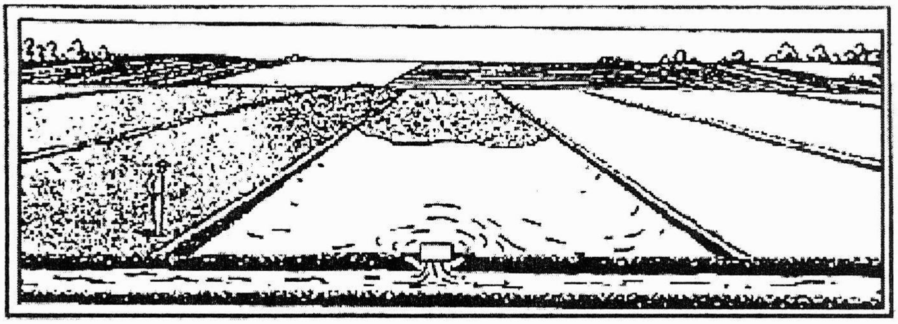

fig.2.Border Irrigation

3. Furrow irrigation – The furrow method of irrigation is used in the irrigation of row crops with furrows developed between the crop rows in the planting and cultivating processes. Water is directed into shallow channels that can be constructed using ordinary farm machinery. The size and shape of the furrow depends on the crop grown, equipment used and spacing between crop rows.

Disadvantages of Surface irrigation methods

1. Surface irrigation results in inefficient use of water resources, due to the losses by evaporation, infiltration below the root zone, and runoff.
2. Water stress for plants due to water logging at the time of irrigation and scarcity during the off time of irrigation.
3. Nutrients uptake by plants slows down
4. Loss of nutrients through leaching
5. Surface systems tend to be labour-intensive.
6. Difficulty in applying light, frequent irrigations early and late in the growing season of several crops.
7. Plant is more susceptible to soil borne diseases.
8. Salinization/alkalinization of soil
9. Proper soil aeration is not possible.

B. Micro irrigation

To bring more area under irrigation, it has become necessary to introduce new irrigation techniques viz. Micro and Sprinkler irrigation for economizing the use of water and to increase productivity per unit of water.

Micro irrigation is a method of delivering slow, frequent applications of water to the soil near the plants through a low pressure distribution system and special flow control outlets. It can be considered as an efficient irrigation method, which is economically viable, technically feasible and socially acceptable. It is the slow and regular application of water directly to the root zone of the plants through a network of economically designed plastic pipes and low discharge emitter. It enables watering the plants at the rate of its consumptive use thereby minimizing the losses such as deep percolation, runoff and soil evaporation. Micro irrigation is also referred to as drip, subsurface, bubbler or trickle irrigation, all of which have similar design and management criteria.

These systems deliver water to individual plants or rows of plants. The outlets are generally placed at short intervals along small tubing, and unlike surface or sprinkler irrigation, only the soil near the plant is watered. The outlets include emitters, orifices, bubblers and sprays or micro sprinklers.

Advantages of Microirrigation

i) Water saving
ii) Enhanced plant growth and yield
iii) Uniform and better quality of produce
iv) Efficient and economic use of fertilizers
v) Less weed growth
vi) Also suitable to waste lands
vii) Possibility of using saline water
viii) No soil erosion
ix) Flexibility in operation
x) Easy installation
xi) Labour saving
xii) Suitable to all types of land terrain
xiii) Saves land as no bunds etc. are required
xiv) Minimum diseases and pest infestation

Microirrigation systems

The basic types of microirrigation systems are as follows:

Surface system (Drip system)

It is the system in which emitters and laterals are laid on the ground surface along the rows of crops. The emitting devices are located in the root zone area of trees. The cost of drip irrigation systems is reasonable on wide-spaced crops such as trees. The closer the crop spacing, the higher the system cost per acre.

Sub-surface system

Water is applied slowly below the land surface through emitters. It involves the use of point and line source emitters to apply water just below the soil surface. Such systems are generally preferred in semi permanent/permanent installations.

Bubbler system

In bubbler irrigation, water is applied to the soil surface as a small stream or fountain. Bubbler systems do not require elaborate filtration systems.One of the bubbler which is now available in market is shown in fig.3

These are suitable in situations where large amount of water need to be applied in a short period of time and suitable for irrigating trees with wide root zones and high water requirements. Discharge rates are generally less than 225 lph.

Micro and mini sprinklers

These are small plastic sprinklers with rotating spinners. The spinners rotate with water pressure and sprinkle the water. These are available in different discharges (15-110 lph) and diameters of coverage and can operate at low pressure in the range of 1.0 to $2kg/cm^2$. Water is given only to the root zone area as in the case of drip irrigation but not to the entire ground surface as done in the case of sprinkler irrigation method.A typical micro sprinkler is shown in fig.4.

Jets

The spray pattern of jets is fan type, giving fine droplets and uniform distribution. Jets are mainly used to maintain adequate micro environment in the canopy area. They can be used to irrigate orchards, nurseries, vine yards, green houses and delicate plants such as flowers, vanilla etc. Mature large trunk-trees or trees having wide spread root zone can also be irrigated using jets.The spray pattern is either full circle or half circle. The discharge of half circle jet ranges between 24-52 lph and in case of full circle jet it is 30-66 lph.The full circle and half circle jets are shown in fig.5.

Fogger

Foggers are recommended for orchards and green/glass houses requiring a fine mist spray for humidity control shown in fig 6.They are suitable for crops which need to maintain micro climate in the canopy area.They are simple in construction and has no moving parts. The spray pattern is misty and the droplets are very fine.

Sprinkler Irrigation

In the sprinkler method of irrigation, water is sprayed into the air and allowed to fall on the ground surface some what resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles. The pressure is usually obtained by pumping. The water is conveyed from a pump or other source of water under pressure through a network of pipes called main lines and submains, to one or more pipes with sprinklers called laterals. The sprinklers distribute the water over the land surface. With careful selection of nozzle sizes, operating pressure and sprinkler spacing the amount of irrigation water required to refill the crop root zone can be applied uniformly to suit the infiltration rate of soil. Sprinkler irrigation systems can be fixed in place, portable, semi-portable, or mobile. Sprinkler nozzle types and numbers are selected depending on design application rates and wetting patterns.

Sub-surface irrigation

Water is directed to the subsoil (crop root zone) in the area to be irrigated. The water is used to artificially control the groundwater table, and is normally delivered through perforated pipes buried in the ground. In some Latin American countries, porous clay pots are buried in the ground and filled with water that slowly seeps into the subsoil to moisten the roots of crops. Of the irrigation methods, subsurface irrigation is used the least. The modern methods of irrigation (Micro irrigation) have number of advantages over the conventional irrigation methods like border, check basin, furrow etc.

Table 1.1 Comparative performance of Conventional irrigation with Micro irrigation

Performance indicator	Conventional Irrigation methods	Micro irrigation
1	2	3
Water saving	Waste lot of water, losses occur due to percolation, runoff and evaporation	40 – 70% of water can be saved over conventional irrigation methods. Runoff and deep percolation losses are negligible.
Water use efficiency	30-50%	80-95%
Saving in labour	Labour engaged per irrigation is higher than drip	Labour required only for operation and periodic maintenance of the system.
Weed infestation	High	Less wetting of soil, weed infestation is very less.
Use of saline water	Concentration of salts increases and adversely affects the plant growth. Saline water cannot be used for irrigation	Frequent irrigation keeps the salt concentration within root zone below harmful level
Disease and pest problems	High	Relatively less because of less atmospheric humidity

1	2	3
Suitability in different soil type	Deep percolation is more in light soil and with limited soil depths. Runoff loss is more in heavy soils	Suitable for all soil types as flow rate can be controlled
Water control	Inadequate	Very precise and easy
Efficiency of fertilizer use	Efficiency is low because of heavy losses due to leaching and runoff	Very high due to reduced loss of nutrients through leaching and runoff water
Soil erosion	Soil erosion is high because of large stream sizes used for irrigation soil erosion	Partial wetting of soil surface and slow application rates eliminate any possibility of
Increase in crop yield	Non-uniformity in available moisture reducing the crop yield	Frequent watering eliminates moisture stress and yield can be increased up to 15-50% as compared to conventional methods of irrigation

Source :Sivanappan,R.K.1994.Prospects of micro irrigation in India .Irrigation and Drainage Systems, Vol.8, pp.49-58.

Narayanamoorthy,A.(1997).Drip Irrigation-A viable option for future irrigation development, Productivity, Vol.38, No.3,October-December 1997.

The comparative irrigation efficiencies under different methods of irrigation is given in Table 1 2.

Table 1.2 Irrigation efficiencies under different methods of irrigation (Percent)

Irrigation efficiencies	Methods of irrigation		
	Surface	Sprinkler	Drip
Conveyance efficiency	40-50 (canal) 60-70(well)	100	100
Application efficiency	60-70	70-80	90
Surface water moisture evaporation	30-40	30-40	20-25
Overall efficiency	30-35	50-60	80-90

Source: *Sivanappan.R.K.(1998) Status, scope and future prospects of micro irrigation in India. Proc. Workshop on micro irrigation and sprinkler irrigation system. CBIP New Delhi, April 28-30,1998 : 1-7*

Scientific method of cultivation and judicious use of all the inputs, especially of water, is called upon to become cost competitive. Keeping in view acute water scarcity in many basins, efforts were made to introduce most efficient micro irrigation system at farms around 1970. Micro irrigation saved irrigation water by 40%, fertilizer by 25%, enhanced yield up to 50%, improved water – use efficiency by 2.5 times

Through the good management of micro irrigation systems, the root zone water content can be maintained near field capacity throughout the season providing a level of water and air balance close to optimum for plant growth. In addition, nutrient levels, which are applied with water through the system (fertigation), can be controlled precisely. Fertigation gives successful results in terms of yield, saving in fertilizer and improvement in quality of the produce. During the dry season in humid areas, micro irrigation can have a significant effect on quantity and quality of yield, pest control and harvest timing.

Fertigation is in its introductory stage in India and its success depends upon how efficiently plants uptake the nutrients. Proper scheduling must be planned as to provide nutrients at a time when plants require them. In India, fully soluble fertilizers have limited availability and firms manufacturing water-soluble fertilizers are not price competitive. The Government should adopt a fertilizer policy in such a way that the manufacturers of fully soluble fertilizer are on the same platform of the conventional fertilizer manufacturers. The field experiments also show quite successful results in terms of yield advantage, saving of fertilizer and improving quality of the produce.

Present scenario of micro irrigation in India

Micro irrigation is used extensively in many water scare countries like Israel, Arabian states, Mexico, etc. In India, its development is slow as compared to other developing countries. Experiments and farm trials have been going in India from 1970 onwards. Progressive farmers in Andhra Pradesh, Karnataka, Kerala, Maharashtra and Tamil Nadu adopted this method in the late 70's. The growth of micro irrigation has really gained momentum in recent years. From a mere 1500 ha in 1985, the area under micro irrigation has grown to 0.4 million ha at present (Table 1.3). These developments have taken place mainly in acute water scarcity states of Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu and Gujarat. The important high value crops under micro irrigation systems are Coconut, Grape, Banana, Mango, Sapota, Pomegranate, other fruit trees, plantation crops like Sugarcane, Cotton, Vegetables and Flowers,

Table 1.3 Present status of micro irrigation in India

State	Area (ha)
1	2
Andhra Pradesh	39500
Assam	200
Gujarat	10000
Haryana	3000

1	2
Karnataka	50000
Kerala	7500
Madhya paradesh	3800
Maharashtra	200000
Orissa	3000
Punjab	2000
Rajasthan	35000
Tamil Nadu	42500
Uttar Pradesh	2500
West Bengal	200
Others	2000
Total	**402000**

In 1981, the Government of India constituted National Committee on the use of Plastics in Agriculture (NCPA) under the Ministry of Chemicals and Petrochemicals. Later (in 2001) NCPA was re-christened as National Committee on Plasticulture Applications in Horticulture (NCPAH) with the Minister of Agriculture as its Chairman. The NCPAH has dedicated more than two decades in the development and promotion of plasticulture applications in the country, which included drip and sprinkler irrigation.

Seventeen Precision Farming Development Centres were established under the NCPAH in various agro climatic zones of the country to undertake development trials, demonstration of technologies and training of farmers and departmental officers and to recommend package of practices of plasticulture applications.

Considering the high cost of plasticulture applications, on the recommendation of NCPAH, the Government of India started providing subsidy to farmers and other eligible beneficiaries for adoption of these applications.Subsidy is provided for the plasticulture applications in water management (drip and sprinkler), greenhouse technology and plastic mulching. The subsidy is channelised through State Department of Horticulture/Agriculture. The NCPAH is assisting the GOI in formulating the plan for horticultural development and implementing the subsidy schemes.

Kerala, the land of coconut is also considered as the land of water with about 3m of rainfall, chains of backwater bodies, reservoirs, tanks, ponds, springs and wells. In spite of this, Kerala is frequently facing severe droughts followed by acute water scarcity for the last two decades. The major consumer of water resources is irrigation with about 70% of the total resources being used by this sector. Compared to the national average, unit land of Kerala receives 2.5 times more rainfall but the same unit of land has to support 3.6 times more population. Hence, for self-sufficiency, unit land of Kerala has to produce 3.6 times more food and biomass and also has to provide 3.6 times more water. This scenario forces us to think about efficient irrigation systems to have more crop per drop.

CHAPTER 2

DRIP IRRIGATION

Drip irrigation is the slow, nearly continous application of water as discrete drops. Water is applied at a single point (small wetted area) on the land surface through devices called drippers or emitters, or as a line source from a number of closely spaced drippers or tubes. Water is applied to each plant through one or more emitters located at, or just above ground level (up to 300 mm above). The system suits areas of high temperatures and limited water resources. This system allows for the accurate application of water with minimal loss due to evaporation, poor distribution and seepage, or over-watering. Due to the small diameter of the emitter openings, filtration of the water is normally required to reduce potential blockages in these systems.

Table 2.1 Comparison of drip and surface irrigation systems

Surface irrigation	Drip irrigation
Economical	Expensive
Saline water not suitable	Saline water can be used
Fertilizer and nutrients lost	No fertilizer and nutrient lost due to localized application
Low water distribution efficiency	High water distribution efficiency
Requires leveling of the field	Leveling of the field is not necessary
All surface soil is saturated	Only root zone is saturated
Soil moisture depleted at least by 50% before next irrigation	Moisture always at field capacity in the root zone
Soil factor plays important role in frequency of irrigation	Soil factor plays less important role in frequency of irrigation
Soil erosion may take place	No soil erosion
Water distribution not uniform	Highly uniform distribution controlled by each nozzle
High labour cost	Low labour cost
Variation in supply difficult to regulate	Variation in supply can be regulated by regulating the valves and drippers
Moisture movement normal in furrow slope and unidirectional in border	Moisture movement two dimensional

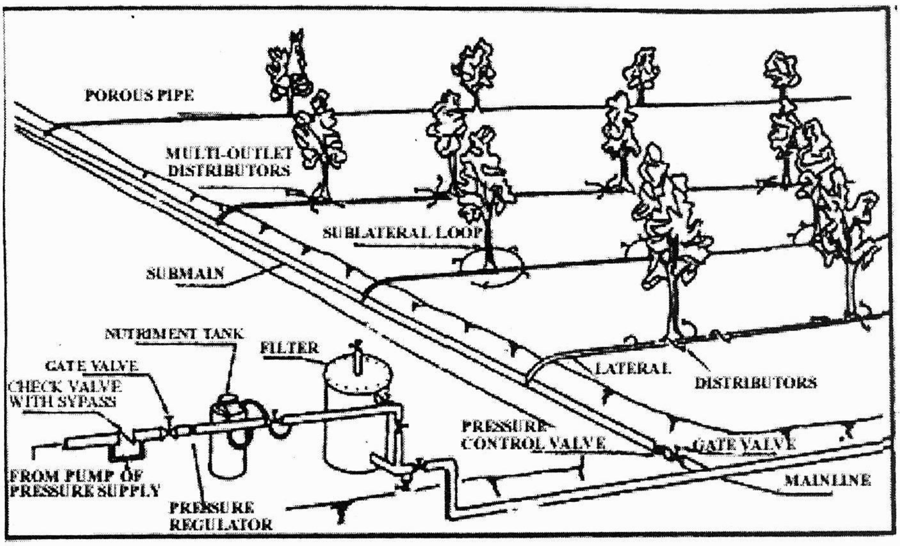

Fig. 7 *Drip or micro spray irrigation system*

Types of systems

Online drip irrigation system

In this type emitters dissipate water pressure through a long narrow path or a small orifice before discharging into the air.A schematic view of the drip irrigation system is shown in fig 7

In line drip irrigation system

These are suitable for closely spaced row crops in fields and gardens.

Subsurface drip irrigation system

It is the application of water below the soil surface at the root zone of the plants through tiny openings provided on the wall of the pipe at a rate that allows the soil to absorb the water at its natural sate.

Components of Drip irrigation

I. Emission Devices

The application of water in a micro irrigation system is through an emitter. The emitter is a metering device that delivers small but precise discharges. Number and discharge of emitter is decided by the water requirement of crop and water availability in the area. Normally drippers are available within the range of 2 to 24 litre per hour discharge rates. They function as energy dissipaters, reducing the inlet pressure head (0.5 to 1.5 atmospheres) to zero atmospheres at the outlet and discharge a small uniform flow or trickle of water at a constant rate that does not vary significantly because of minor difference in pressure. The commonly used drippers are online pressure compensating or online non-pressure compensating, in-line dripper, adjustable discharge type drippers, vortex type drippers and micro tubing of 1 to 4 mm diameter. These are manufactured from Poly- propylene or LLDPE (low density Poly ethylene).

Types of emitters

Depending on how the emitters are placed in the polyethylene distribution line, the drip mode is classified as a point source or a line source.

1. Point source emitters

These are installed on the outside of the distribution line. Point source emitters dissipate water pressure through a long narrow path or small orifice before discharging into the air. Most point source emitters are either on-line or in-line emitters. The primary difference between on-line and in-line emitters is that the entire flow required downstream of the emitter passes through an in-line emitter. There is usually more head loss along a lateral with on-line emitters than one with in-line emitters. On the other hand, on-line emitters can normally be replaced more easily when they fail or become permanently clogged. It is usually necessary to shut off flow to the lateral and cut the pipe to replace a malfunctioning in-line emitter. Point source emitters can also be classified as pressure compensating and non-pressure compensating emitters. In pressure compensating emitters, the influence of pressure on discharge is very less. These emitters are especially useful in minimizing emitter discharge variation when large pressure variations due to undulating terrain or system operation are expected.The different types of on-line emitter are shown in fig 8.

2. Line source emitters

Porous pipes or tape, perforated pipes that discharge water along their entire length, laterals with closely spaced point source emitters and bubblers discharging into furrows provide a "line source" of water. Although these emitters are used primarily for irrigating closely spaced row crops, they have also been used with other crops. Porous tubes are generally made of polymer compounds with small pores through which water seeps out of the pipe one drop at a time. Complete filtration of water is required for proper operation of porous tubes since they are very sensitive to clogging.The emitting device and the in-built emitter with the lateral tube is shown in fig.9.

II. Distribution line

The distribution line mainly constitutes main, submain and lateral lines.

Mainline

The main line transports water within the field and distribute to submains. Generally Rigid Poly Vinyl Chloride (PVC) or High-density polyethylene (HDPE) pipes are used as main line. Pipelines of 65 mm diameter and above with a pressure rating 4 to 6 kg/cm^2 are used for main pipes. To ensure longer life period, these pipes should be laid underground.

Submains

Submains distribute water evenly to a number of lateral lines. For sub main pipes, rigid PVC, HDPE or LDPE (Low Density Polyethylene) of diameter ranging from 32 mm to 75 mm having pressure rating of 2.5 kg/cm^2 are used. Size of pipe depends on the water requirement of the crop and the size of the field.

Lateral Pipe

Laterals distribute the water uniformly along their length by means of drippers or emitters. These are normally manufactured from LDPE and LLDPE. Generally pipes having 10, 12 and 16 mm internal diameter with wall thickness varying from 1 to 3 mm are used as laterals. These pipes are generally laid above ground.The polythylene tubes used for lateral pipe is shown in fig 10.

III. Filters

The hazard of blocking or clogging necessitates the use of filters for efficient and trouble free operations of the micro irrigation system. Particles of various sorts can be removed from the irrigation water by means of screen filters, media filters (containing gravel, sand or diatomaceous earth) and centrifugal separators. Filters of one kind or another are, in fact, integral components of dip irrigation system. Screen filters are rather delicate and require frequent inspection and servicing. Gravel and sand filters are less expensive, but tend to be bulky and result in considerable loss of pressure. As the pores of gravel or sand medium become clogged with retained solids or slime, pressure loss increases and flow rate diminishes, so these media require frequent back flushing and periodic replacement. Reversing the direction of flow and opening the water drainage valve cleans the filter. Pressure gauges are placed at the inlet and at the outlet ends of the filter to measure the head loss across the filter. If the head loss exceeds 2 m filter needs back washing.The different type of filters are shown in fig 11.

Sand filter (Gravel or Media)

Media filters consists of fine gravel or coarse quartz sand, of selected sizes (usually 1.5- 4 mm in diameter) free of calcium carbonate placed in a pressurized cylindrical tank. These filters are effective in removing light suspended materials such as algae and other vegetative materials present in water. These filters are made up of a circular tank filled with layers of coarse sand and different sizes of gravel with a provision of valves for flushing the filter assembly in case of clogging. The media filters are available in different sizes ranging from 500 to 900 mm diameter with an output of 15 to 50 cumec per sec.

Screen filter

Screen filters are the simplest and least expensive filters shown in fig 12. If water is having fewer impurities screen filters alone will be sufficient to remove the impurities. Otherwise screen filter is fitted in series with a sand filter to remove the solid impurities ie, they are used as a secondary filter. It consists of a single or double perforated cylinders placed in plastic or metal container for removing the impurities. Screen filters are always installed for final filtration as an additional safeguard against clogging. These are available in a wide variety of types and flow rate capacities with screen sizes ranging from 20 mesh to 200 mesh. The aperture size of the screen opening should be between one seventh and one tenth of the orifice size of emission devices used. It must be cleaned periodically for satisfactory operations. If head loss is higher than the permissible value provided by the manufacturers, it needs cleaning. If no pressure change occurs for a long period, it indicates that the screen or seals are broken or mesh size is too large and it needs replacement.

Disc filter

. Disc filters are very effective in the filtration of organic material and algae shown in fig 13. It contains stacks of grooved, ring shaped discs, which are held together by longitudinal rods. During the filtration mode, the discs are pressed together. There is an angle in the alignment of two adjacent discs, resulting in cavities of varying size and partly turbulent flow. The sizes of the groove determine the filtration grade. Disc filters are available in a wide size range (25-400 microns). The inlet provides tangential entry for water to the casing so that heavier particles are thrown outwards and only small particles move towards the disc at the centre. The tangential entry will also help to reduce the frictional losses. They are available for the flow rates from 4 to 30 m^3/hr. Back flushing can clean disc filters. However they require back flushing pressure as high as 2 to 3 kg/cm^2.

Hydrocyclone filter (Centrifugal sand separator)

If irrigation water is containing large amount of sand, hydro-cyclone type filters are required. They depend on centrifugal force to remove and eject high-density particles from water. They are inline systems which are used to remove suspended materials with specific gravities greater than water. It is also known as vortex sand separator. Hydrocyclone filters must be followed by a screen filter as a safeguard. Centrifugal filters are effective in filtering sand, fine gravel and other high density materials from well or river water. Water is introduced tangentially at the top of a cone and creates a circular motion resulting in a centrifugal force, which throws the heavy suspended particles against the walls. The separated particles are collected in the narrow collecting vessel at the bottom. The collected sand and other materials may be emptied annually or by using a special flushing valve.The filtering elements used in different types of filters are shown in fig.14.

IV. Fittings and accessories

Appropriate fittings are available for connecting PVC, HDPE and polyethylene distribution lines. PVC pipes can be joined by using PVC resin and HDPE pipes by using heat butt welding. Elbows, end cap, gate valve, reducer etc are the commonly used PVC fittings. Control valves, Tee connectors, straight connectors or joiners, grommet take off, lateral end caps and flush out valves are used in the lateral lines.

Planning and design of drip irrigation system

The planning and design of drip irrigation system is essential to supply the required amount of irrigation water. The water requirement of the plant per day depends on the water that is taken by the plant from the soil and the amount of water evaporating from the soil in the immediate vicinity of the root zone in a day. The plant intake is affected by the leaf area, stage of growth, climate, soil conditions etc. The water requirement and irrigation schedule can be determined from the soil or plant indicators based methods or soil water budget method, but the simplest and most commonly method is to use pan evaporimeter data. To apply the required amount of water uniformly to all the plants in the field, it is essential to design the system to maintain desired hydraulic pressure in the pipe network. The design of microirrigation system is essentially a decision regarding selection of emitters, laterals and manifolds, sub main, main pipeline and required pumping unit. The steps needed to be followed for designing the microirrigation system are given below:

i) Collection of general information

General information of water source, crops to be grown, topographic conditions, type and texture of soil and climatic data are essential for designing the drip irrigation system. A complete plan of the proposed area to be irrigated, including position of water source and pumping unit, spacing of crops etc. is to be prepared.

ii) Layout of the field

The layout of the field giving the details of the main line, sub main and laterals, is worked out to connect the water source with the existing/planned crop in the area.

iii) Crop water requirement

Water requirement of crops is a function of surface area covered by the plant and evapotranspiration rate. Irrigation water requirement has to be calculated for each plant and thereafter for the whole plot for different seasons, based on the plant population. The maximum discharge required during any one of the three seasons, is to be adopted for the design. The daily crop water requirement is estimated by using the equation

$$V = E_p \, x \, K_p \, x \, K_c \, x \, A \, x \, W_p \quad (1)$$

Net daily volume of water required

$$V_n = V - R_e \, x \, A \, x \, W_p \quad (2)$$

Daily operating hours of the system (T) = $\frac{V_n}{N_e \, x \, N_p \, x \, q}$ (3)

Where

V	=	Volume of water required in liter (L day^{-1})
E_p	=	Mean pan evaporation for the month in mm day^{-1}
K_c	=	Crop coefficient
K_p	=	Pan to coefficient
A	=	Plant to plant x Row to row spacing (m^2)
R_e	=	Effective rainfall (mm)
W_p	=	Wetting fraction (varies from 0.3 to 1.0)
N_e	=	Number of emitters per plant
N_p	=	Number of plants
q	=	Emitter discharge (Lh^{-1})

The crop coefficient (K_c) varies with crop growth stage and season. The crop coefficient (K_c) is considered for development of crop for design of microirrigation system.

Table 2.2 Crop coefficients (Kc) of various crops (Varadan, 1996)

Crop	Kc
Vegetables	1.0
Pulses	1.0
Tapioca	0.4
Banana	0.4-0.85
Sugarcane	1.2
Pineapple	1.0
Arecanut	0.94
Pepper	1.0
Coconut	0.75
Coffee	0.9
Tea	1.0
Cocoa	1.0
Cardamom	1.0
Groundnut	1.05

The values of pan evaporation for a particular area are normally available at the nearest meteorological observatory.

iv) Hydraulic design of the system

The ideal micro-irrigation system is one in which all emitters (orifices) deliver the same volume of water in a given time. From the practical point of view, it is almost impossible to achieve this ideal performance. However, the flow variation of water pressure can be controlled by the hydraulic design.

Flow carried by each lateral line

Q_l = Discharge of one dripper x No. of drippers per lateral (4)

Flow carried by each sun main line

$Q_s = Q_l$ x No. of lateral lines per sub main (5)

Flow carried by main line (Q) = Qs x No. of sub main line (6)

The size of mains, sub mains, laterals and pump are decided based on the desired flow rate and pressure head in the system. The pressure drop due to friction can be generally evaluated with the help of William Hazen or Darcy-Weisbach equation. The procedure for computation of head loss in lateral, sub main, main pipes and horse power requirement of pump are given in this section.

Head loss in laterals

The pipes used in micro-irrigation system are made of plastics and considered as smooth pipe. The pressure drop due to friction can be evaluated with the help of Hazen -William empirical equation as given below.

The friction head loss in mains can be estimated by Hazen-Williams formula given below:

$$h_f = K \times (Q/C)^{1.852} \times D^{-4.871} \times (L + L_e)$$

where

h_f = Friction head loss in pipe (m per 100 m)

Q = Discharge ($Lsec^{-1}$)

C = Hazen - William constant (140 for PVC pipe)

D = Inner dia of pipe (mm)

K = Constant = 1.22×10^{12} for metric units = 473 for Q= ft^3/sec and D = ft

L = Length of pipe (m)

L_e = Equivalent length of pipe and accessories (See Table C)

L_e for barbs = $0.25\, B_w\, (19 \times D^{-1.9})$

D = Dia of lateral, mm

B_w = Emitter barb diameter, mm

The design criteria for lateral pipe are to keep pressure variation and discharge variation within the prescribed limit. For lateral design, the discharge and operating pressure at the emitter are required to be known. Based on this, the allowable head loss can be calculated using above formula. The diameter of lateral pipe is usually selected such that the difference in discharge between emitter operating simultaneously will not exceed 10%. Pressure head difference should not exceed 10 to 15% of the operating pressure. For the discharge variation of 10%, the emission uniformity has to be more than 90%.

Head loss in submains

The submain line hydraulics is similar to that of the lateral hydraulics. The sub main hydraulic characteristics can be computed by assuming the laterals as analogous to emitters on lateral line. Hydraülic characteristics of sub main and main line pipe are usually taken hydraulically smooth since PVC and HDPE pipe are normally used. The Hazen Williams roughness coefficient is usually taken between 140 and 150. The energy loss in the sub main can be computed with the methods similar to those used for lateral computations.

Head loss in main line

Usually the pressure controls or adjustments are provided at the sub main inlet. Therefore energy losses in the main line should not affect system uniformity. There is no outlet in case of main line therefore reduction factor is not multiplied. The frictional head loss in main pipeline is calculated by the same Darcy-Weisbach formula or Hazen-Williams formula.

v) Horse power requirement of pumping unit

$$\text{Horse power required (hp)} = \frac{\text{Flow (lps) x Total head (m)}}{\text{Motor efficiency x Pump efficiency x 75}}$$

Efficiency of the motor and pump differ for different models and makes. Approximately, motor efficiency can be taken as 80% and pump efficiency as 75% for mono-block pump.

Fertigation

Efficient crop production requires efficient utilization of soil water and soil fertility. Placement of fertilizers in the correct zone of moisture availability is important to maximize fertilizer efficiency. Fertigation is the method of application of soluble fertilizer with irrigation water. Fertigation is a prerequisite for drip irrigation. Since the wetted soil volume is limited, the root system is confined and concentrated. The nutrients from the root zone are depleted quickly and a continuous application of nutrients along with the irrigation water is necessary for adequate plant growth. Fertigation offers precise control on fertilizer application and can be adjusted to the rate of plant nutrient uptake.

Advantages of fertigation

(1) Saving of energy and labour

(2) Flexibility of the moment of the application (nutrients can be applied to the soil when crop or soil conditions would otherwise prohibit entry into the field with conventional equipment)

(3) Convenient use of compound and ready-mix nutrient solutions containing small concentrations of micronutrients which are otherwise very difficult to apply accurately to the soil

(4) The supply of nutrients can be more carefully regulated and monitored.

(5) The nutrients can be distributed more evenly throughout the entire root zone or soil profile.

(6) The nutrients can be supplied incrementally throughout the season to meet the actual nutrition requirements of the crop.

(7) Soil compaction is avoided, as heavy equipment never enters the field.

(8) Crop damage by root pruning, breakage of leaves, or bending over is avoided, as it occurs with conventional chemical field application techniques.

(9) Less equipment may be required to apply the chemicals and fertilizers.

Fertilizer injection methods

Modern fertigation equipment should be able to regulate:

- quantity applied
- duration of applications
- proportion of fertilizers
- starting and finishing time

It is important to select an injection method that best suits the irrigation system and the crop to be grown. Incorrect selection of the equipment can damage parts of the irrigation equipment, affect the efficient operation of the irrigation system and reduce the efficiency of the nutrients. Each fertilizer injector is designed for a specified pressure and flow range.

The majority of injectors available today can generally incorporate automatic operation by fitting pulse transmitters that convert injector pulses into electric signals. These signals then control injection of preset quantities or proportions relative to flow rate of the irrigation system. Injection rates can also be controlled by flow regulators, chemically resistant ball valves or by electronic or hydraulic control units and computers.

Suitable anti-siphoning valves or non-return valves should be installed to prevent backflow or siphoning of water and fertilizer solution into fertilizer tanks, irrigation supply and household supply.

The three methods of injection are:

Fertilizer Tank

A fertilizer tank system is based on the principle of a pressure differential created by a valve, pressure regulation, elbows or pipe friction in the mainline. The pressure difference forces the water to enter through a by-pass pipe into a pressure tank which contains the fertilizer, and to go out again, carrying a varying amount of dissolved fertilizer.The fertilizer tank and its schematic view is shown in fig 15.

The application of nutrients is quantitative and inaccurate, therefore is adapted for perennial crops like citrus, fruit trees and/or crops grown on heavy soil.

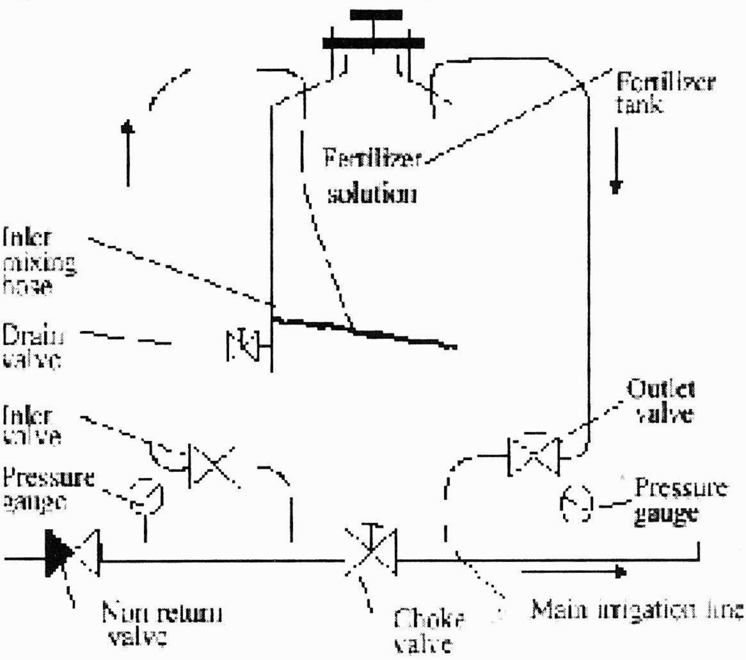

Fig 15. Fertilizer Tank

Advantages:

- Very simple to operate, the stock solution does have not to be pre-mixed
- Easy to install and requires very little maintenance
- Easy to change fertilizers
- Ideal for dry formulations
- No electricity or fuel is needed

Disadvantages:

- Accuracy of application is limited
- Requires pressure loss in main irrigation line or a booster pump
- Proportional fertigation is not possible
- Limited capacity
- Not adapted for automation

Vacuum injection (Venturi)

This method uses a venturi device to cause a reduced pressure (vacuum) that sucks the fertilizer solution into the line.A typical view of the venturi injector is shown in fig 16.

Advantages:

- Very simple to operate, no moving parts
- Easy to install and to maintain
- Suitable for very low injection rates
- Injection can be controlled with a metering valve
- Suitable for both proportional and quantitative fertilization

Disadvantages:

- Requires pressure loss in main irrigation line or a booster pump
- Quantitative fertigation is difficult
- Automation is difficult.

Pump injection

Pumps are used to inject the fertilizer solution from a supply tank into the line shown in fig 17. Injection energy is provided by electric motors, hydraulic motors (diaphragm and piston).

Advantages:

- Very accurate, for proportional fertigation
- No pressure loss in the line
- Easily adapted for automation

Disadvantages:

- Expensive
- Complicated design, including a number of moving parts, so wear and breakdown are more likely

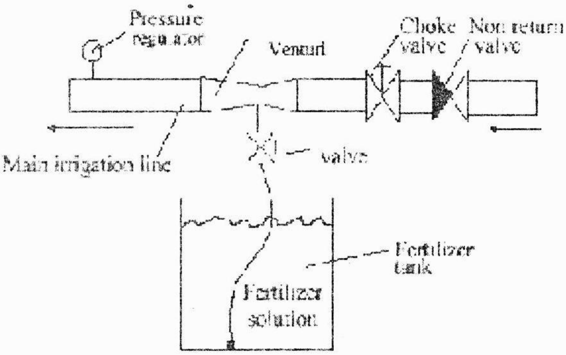

Fig.16 Venturi Injector

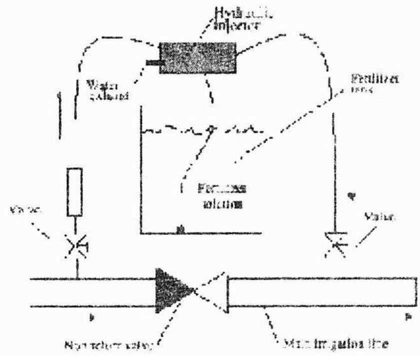

Fig .17 Injector Pump

Maintenance of drip system

There are basically two reasons why maintenance of drip irrigation system is also important.

1) Water is not found in its purest form in nature. Always it contains some physical, chemical & biological contamination those may block pipelines, laterals & drippers in the system.

2) The function of the dripper/emitter is such that it has to convert flow of water from high pressure (nearly 1.0 kg/cm2) to atmospheric pressure when it comes out through emitter so as to get discharge in the form of droplets. In doing so flow of water has to pass through a labyrinth of turbulent and minute flow path. There is always a chance of this flow path due to dirt particles or chemical substance in the water.

Emitter Clogging

In drip irrigation system water source can be open well, bore well, pond, canal or river.

Quality of water varies with its source. Emitter/Pipe line may clog due to following reasons.

1) Particle contamination

2) Expansion and contraction (forcing dirt in emitter outlet)

3) Algae and bacterial growth and precipitation

4) Chemical precipitation

1. Particle contamination

Particle contamination occurs from the following:

A. Insufficient filtration of small particles of soil are either bypassing the filter or going through the filter.

B. Particles introduced during installation and insufficient high flow flushing of drip lateral.

C. Particles introduced during mainline repair or with leaks in mainline, soil will wash back into the system when shut down.

D. Particles introduced during lateral disassembly and assembly.

Steps to remove particles

Regular backwash of the screen and media filters is highly essential for optimum filtration efficiency.

The thumb rule is, if the differential pressure between inlet and outlet of the filter is less than 0.5 kg/cm^2 then is time for backwash.

In case of sand filter, level of the sand media should be maintained as recommended by the manufacturer. Check the media frequently, if the media is getting rounded off and discoloured due to continuous use, change the media

Flushing of Main, Sub main, and Laterals

The system should always be flushed before daily operation or after any repairs.

Prevention

Bacterial growth can be controlled by using chlorination of water. Cholorine when dissolved in water acts as a powerful oxidizing agent and vigorously attack microorganisms such as algae, fungi and bacteria

Use bleaching powder, Calcium Hypocholrite- approximately contains 65 % freely available chlorine.

Recommended chlorination

Continuous : 2-3 mg/litre bleaching powder is to be applied to the water flow through the Ventry or

Intermittent: inject 20 mg/litre of bleaching powder at 30-45 minutes frequency depending on the level of contamination once at a fortnight.

CHAPTER 3

SPRINKLER IRRIGATION

In the sprinkler method of irrigation, water is sprayed into the air and allowed to fall on the ground surface somewhat resembling rainfall. In this system, water is conveyed from a pump or other source of water under pressure through a network of pipes. The spray is developed by the flow of water under pressure through small orifices or nozzles. The pressure is usually obtained by pumping. With careful selection of nozzle sizes, operating pressure and sprinkler spacing the amount of irrigation water required to refill the crop root zone can be applied nearly uniform at the rate to suit the infiltration rate of soil.

Adaptability of sprinkler irrigation

Sprinkler irrigation can be used for almost all crops and on most soils. It is however, not suitable in very fine textured soils (heavy clay soils), where the infiltration rates are less than 4mm per hour. The method is particularly suited to sandy soils that have high infiltration rate. Soils too shallow to be leveled properly for surface irrigation methods can be irrigated safely by sprinklers. The flexibility of the sprinkler equipment and its efficient control of water application make this method adaptable to most topographic conditions without extensive land preparation.

Historical development of sprinkler irrigation in India

Farmers started adopting it in large scale only since 1980s' in the hilly areas of Western ghats in states of Kerala, Tamil Nadu, Karnataka and in the North eastern states mainly for plantation crops like coffee, tea, cardamom etc. Slowly it spread to the water scarcity and light soil states of Rajasthan and Haryana in addition to the black soil area of Madhya Pradesh. Madhya Pradesh contributes 1.5 lakhs hectare which is almost 25 per cent of the total area under sprinkler in the country (6.7 lakh hectares). This is followed by West Bengal, Assam, Haryana and Rajasthan. The potential for coverage under sprinkler irrigation is estimated to be about 42.5 million ha. Government of India has taken an initiative to give subsidy to the farmers to an extent even upto 50% in order to popularize this method of water application. Earlier Aluminum was used as piping material. Now a days HDPE and PVC pipes are extensively used due to its higher strength, low energy loss due to friction and lower cost.

Advantages of sprinkler irrigation

1. Suitable to all types of soil except heavy clay.
2. Elimination of the channels for conveyance and therefore no conveyance loss.

3. Suitable for irrigating crops where the plant population per unit area is very high. It is most suited for oil seeds and other cereal and vegetable crops
4. Closer control of water application is possible and convenient for giving light and frequent irrigation and higher water application efficiency
5. Increase in yield
6. Mobility of system
7. May also be used for undulating area
8. Saves land as no bunds etc. are required
9. Greater conducive micro-climate
10. Possibility of using soluble fertilizers and chemicals
11. Less problems of clogging of sprinkler nozzles compared to drip

Table 3.1 Comparison of drip and sprinkler system

Sl.No.	Drip	Sprinkler
1.	Localized application of fertilizer possible	Localized application of fertilizer not possible
2.	Not affected by wind	Affected by wind
3.	No risers causing obstruction	Risers of requisite height and spacing necessary
4.	High yield irrespective of water quality	Less yield. Yield depends on quality of water
5.	Minimum evaporation loss	High evaporation loss especially under windy conditions
6.	Higher rate of crop growth, early yield, lower production cost	Comparatively slower rate of growth
7.	Pesticide application with irrigation water possible	Pesticide application with irrigation water not possible
8.	Pipes used are of low pressure rating and cheaper	Aluminum pipes are of high pressure rating and expensive
9.	Free from any movable components	Has movable components, laterals and risers
10.	Operators on much lower line pressure	Operators on high line pressure with high energy requirement
11.	High water application efficiency of 90% as water is applied at the base of the plant	Lower water application efficiency as water is sprinkled over the entire area
12.	Lowest water requirement	Comparatively higher water requirement
13.	Suitable even for tall crops	Not suitable for tall crops
14.	Labour cost low	Labour cost higher
15.	Uniform distribution of water	Lesser uniformity in distribution of water

Crop response to sprinkler

The trials conducted in different parts of the country revealed that water saving due to sprinkler system varies from 16 to 70 % over the traditional method with yield increase from 3 to 57 % in different crops and agro climatic conditions.

Types of sprinkler systems

1. Based on portability

Sprinkler irrigation systems may be classified as portable, semi portable, semi permanent or permanent. They are also classified as set- move, solid set or continuous move.

(i) Portable system

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

(ii) 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.

(iii) Semi permanent system

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

(iv) Permanent system

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

(v) Set-move system

These are moved from one set position to another by hand or mechanically. Set move system remains stationary as water is applied. When the desired amount of water has been applied, the water is shut off and the sprinkler laterals are drained and moved to the next set position.

(vi) Solid set system

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

(vii) Continuous move system

These systems have laterals and sprinklers that remain connected to the main line and move continuously as water is applied

2. Based on the arrangement for spraying irrigation water

a. *Rotating head or revolving sprinkler system.*

b. *Perforated pipe system.*

(i) 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 ⁰ 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. A view of the rotating head type sprinkler is shown in fig 18.

(ii) Perforated pipe system:

This method consists of drilled holes or nozzles along the length of the pipe through which water is sprayed under pressure. This system is usually designed for relatively low pressure (1 kg/cm^2). The application rate ranges from 1.25 to 5 cm per hour for various pressure and spacing.

Components of sprinkler irrigation system

The components of portable sprinkler system are shown in fig. 19

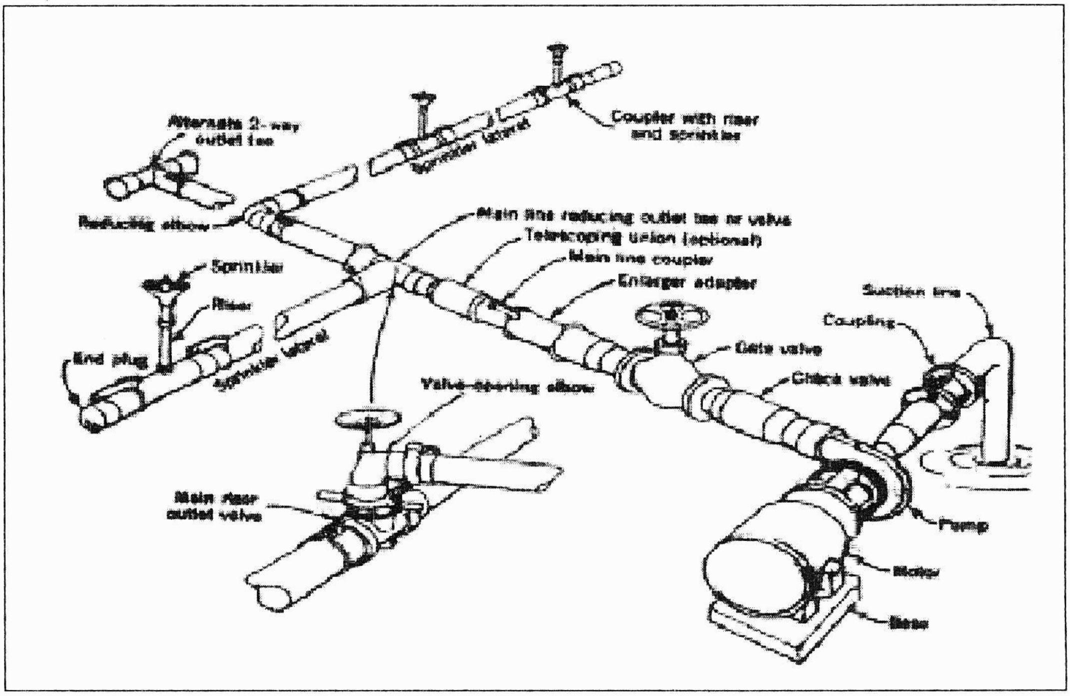

Fig. 19. Components of a portable sprinkler irrigation system

A sprinkler system usually consists of the following components

(i) A pump unit
(ii) Main/ submains and laterals
(iii) Couplers
(iv) Sprinker head
(v) Other accessories such as valves, bends, plugs and risers.

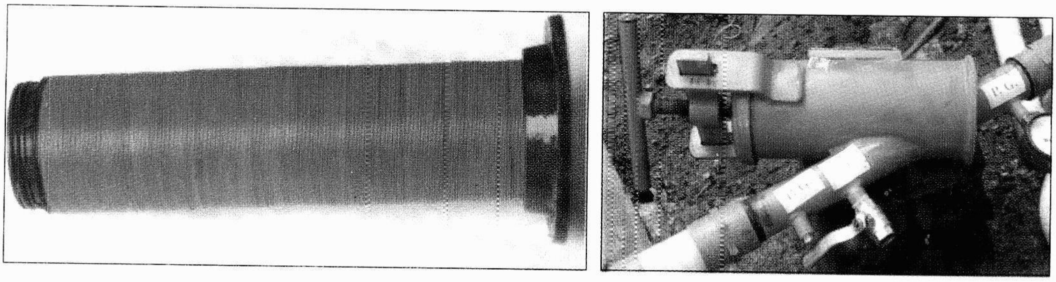

Fig. 13. Disc filter

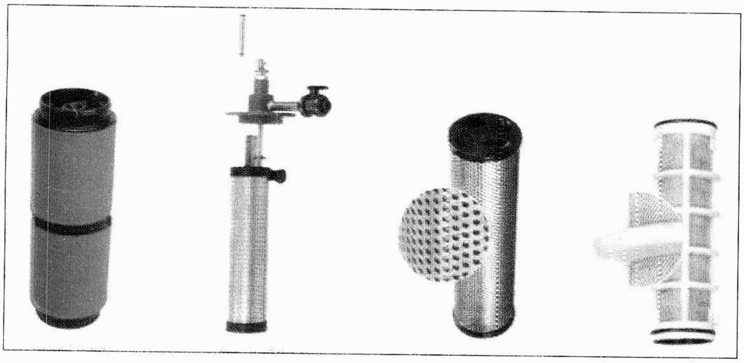

Fig. 14. Filtering elements

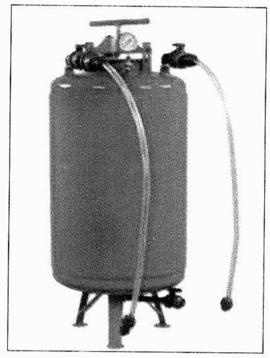

Fig.15.Fertilizer tank

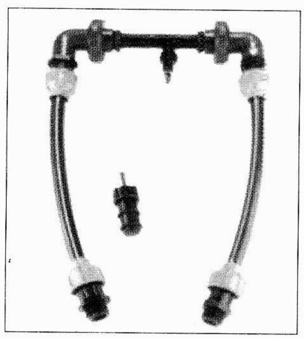

Fig. 16. Venturi Injector

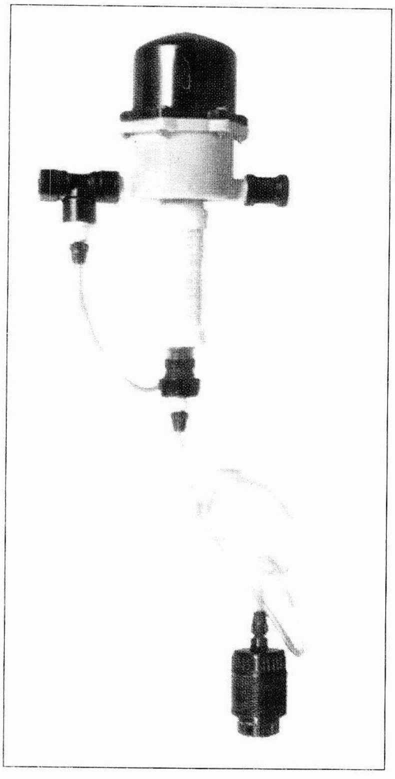

Fig. 17. Injector pump

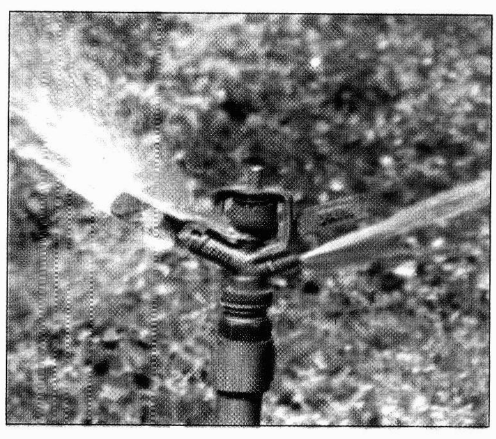

Fig. 18. Sprinkler head

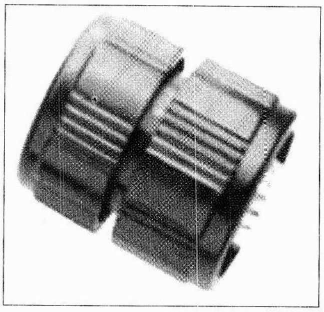

Fig. 3. Bubbler

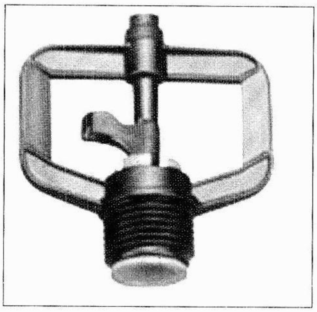

Fig. 4. Micro sprinkler

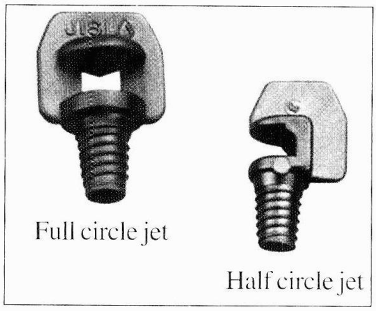

Fig. 5. Jet emitters

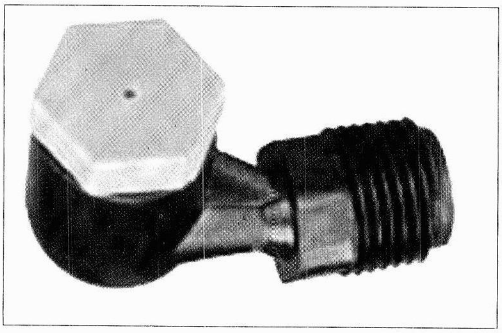

Fig. 6. Foggers

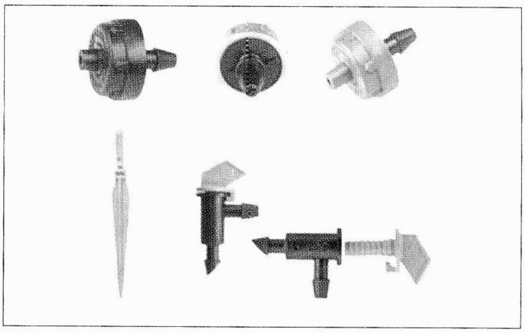

Fig. 8. Different types of on line emitters

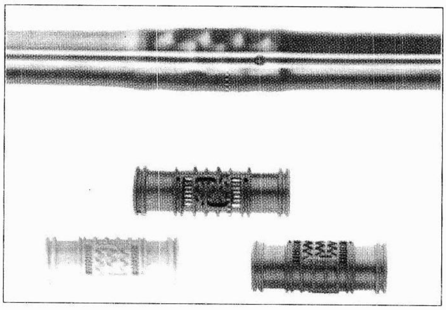

Fig. 9. In-line emitters

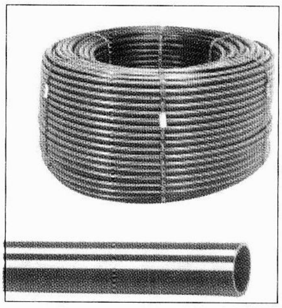

Fig. 10. Polyethylene tube

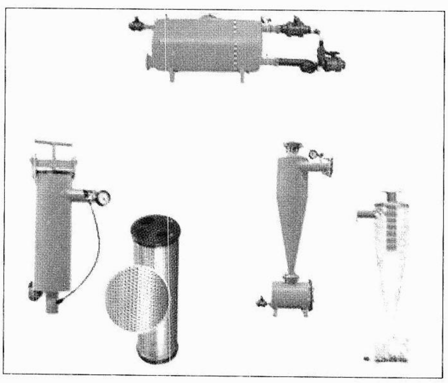

Fig. 11. Different types of filters

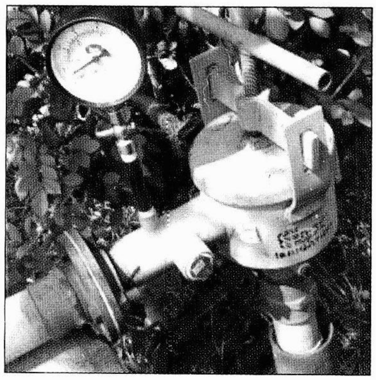

Fig. 12. Screen filter

i. **Pumping Unit**

The pump usually lifts water from the source and pushes it through the distribution system and the sprinklers. Sprinkler irrigation systems distribute water by spraying it over the fields. The water is pumped under pressure to the fields. The pressure forces the water through sprinklers or through perforations or nozzles in pipelines and then forms a spray. A high speed centrifugal or turbine pump can be used for operating sprinkler irrigation for individual fields. Centrifugal pump is used when the distance from the pump inlet to the water surface is less than eight meters. For pumping water from deep wells or more than eight meters, a turbine pump is suggested. The driving unit may be either an electric motor or an internal combustion engine.

ii. **Mains/submains and laterals**

The tubings consist of mainline, submains and laterals. Main line conveys water from the source and distributes it to the submains. The submains convey water to the laterals which in turn supply water to the sprinklers. Aluminium, PVC or HDPE pipes are generally used for portable systems, while steel pipes are usually used for center-pivot laterals.

iii. **Couplers**

Couplers are used for connecting two pipes and uncoupling quickly and easily. Essentially a coupler should provide

(a) a reuse and flexible connection

(b) not leak at the joint

(c) be simple and easy to couple and uncouple

(d) be light, non-corrosive, durable.

iv. **Sprinkler Head**

Sprinkler head distribute water uniformly over the field without runoff or excessive loss due to deep percolation. Different types of sprinklers are available. They are either rotating or fixed type. The rotating type can be adapted for a wide range of application rates and spacing. They are effective with pressure of about 1 to 7 kg/cm^2 head at the sprinkler. Pressures ranging from 1.6 to 4.0 kg/cm^2 head are considered the most practical for most farmers.

Fixed head sprinklers are commonly used to irrigate small lawns and gardens. Perforated lateral lines are sometimes used as sprinklers. They require less pressure than rotating sprinklers. They release more water per unit area than rotating sprinklers. Hence fixed head sprinklers are adaptable for soils with high intake rate.

v. **Fittings and accessories**

The following are some of the important fittings and accessories used in sprinkler system.

a. Water meters: It is used to measure the volume of water delivered. This is necessary to operate the system to give the required quantity of water.

(b) Flange, couplings and nipple used for proper connection to the pump, suction and delivery.

(c) Pressure gauge: It is necessary to know whether the sprinkler system is working with desired pressure to ensure application uniformity.

(d) Bend, tees, reducers, elbows, hydrants, butterfly valve and plugs.

(e) Fertilizer applicator: Soluble chemical fertilizers can be injected into the sprinkler system and applied to the crop. The equipment for fertiliser application is relatively cheap and simple and can be fabricated locally. The fertilizer applicator can be a sealed fertilizer tank with necessary tubings and connections. A venturi injector can be arranged in the main line, which creates the differential pressure suction and allows the fertilizer solution to flow in the main water line.

General rules for sprinkler system design

- Mains can be laid along the slope
- Lateral should be laid across the slope or nearly on the contour
- Water supply source should be nearest to the center of the area
- Layout should facilitate and minimize lateral movement during the season
- Booster pump should be considered where small portion of field would require high pressure
- Layout should be modified to apply different rates and amounts of water where soils are greatly different in the design area.

The layout of the sprinkler irrigation system is shown in fig 20.

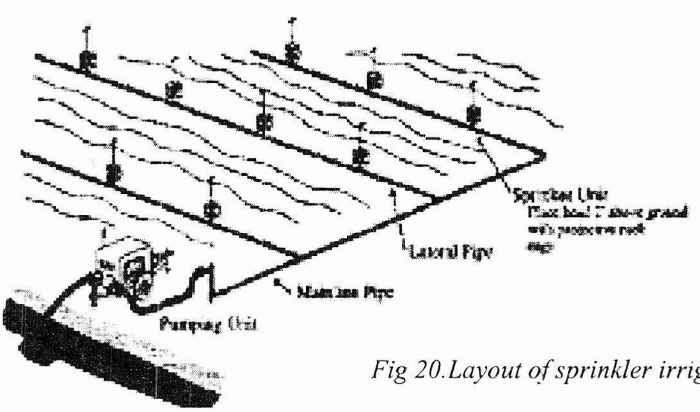

Fig 20.Layout of sprinkler irrigation system

Selecting the most appropriate sprinkler systems

While selecting a sprinkler system, the most important physical parameters to be considered are:

1. The crop or crops to be cultivated.
2. The shape and size of the field.
3. The topography of the field.
4. The amount of time and labour required to operate the system.

Selecting sprinkler system capacity

A sprinkler system must be designed to apply water uniformly without runoff or erosion. The application rate of the sprinkler system must be matched to the infiltration rate of the most resepective soil in the field. If the application rate exceeds the soil intake rate, the water will runoff the field or relocate within the field resulting in over and under watered areas.

The sprinkler system capacity is the flow rate needed to adequately irrigate an area and is expressed in litres per minute per hectare. The system capacity depends upon the peak crop water requirements during the growing season, effective crop rooting depth, texture and infiltration rate of the soil, the available water holding capacity of the soil, pumping capacity of the well or wells (if wells are the water source).

3.10 Constraints in application of sprinkler irrigation

i. Uneven water distribution due to high winds
ii. Evaporation loss when operating under high temperatures
iii. Highly impermeable soils are not suitable
iv. Initial cost is high
v. Proper design is essential
vi. Lack of awareness
vii. Lack of social concern to save natural resources
viii. High water pressure required in sprinkler (>2.5kg/cm^2)

3.11 Evaluation of sprinkler irrigation systems

Sprinkler systems are evaluated to know its performance. The performance indicators are:

i. Sprinkler discharge
ii. Distance of throw
iii. Distribution pattern
iv. Droplet size, and
v. Application rate

i) Sprinkler discharge

The equation relating sprinkler discharge with operating pressure and nozzle geometry:

$$Q = \sum_{i=1}^{n} C_i A_i P_i^{xi}$$

Where, Q = sprinkler discharge;

n = number of nozzles

C = coefficient (function of shape and roughness of opening in nozzle,

A = cross-sectional area of the opening in nozzle, i

P = operating pressure in nozzle, i

x = exponent for nozzle i

- Values of C and x for each nozzle are normally determined empirically
- For most sprinklers x is about 0.5
- Higher pressure andor larger openings will increase sprinkler discharge
- Manufacturers commonly publish tables of pressure and discharge data for various nozzle diameters.

ii) Distance of throw

It governs the spacing between adjacent sprinklers

- Spacing usually increases as the distance of throw increases.
- Depends on operating pressure and the shape, size and angle of nozzle opening.
- Distance of throw increases as pressure increases
- Distance of throw usually increases and then declines as nozzle angle rises above horizontal.
- Manufacturers commonly publish wetted diameter or other measures of distance of throw for different operating pressures and nozzle size, shape and angles.

iii) Distribution pattern

The volume and rate of water application beneath a sprinkler normally varies with distance from the sprinkler. The pattern of this variation, called the distribution pattern, which depends on the following factors.

- o Operating pressure
- o Nozzle geometry
- o Wind

A typical distribution pattern with operating pressure is shown in fig 21.

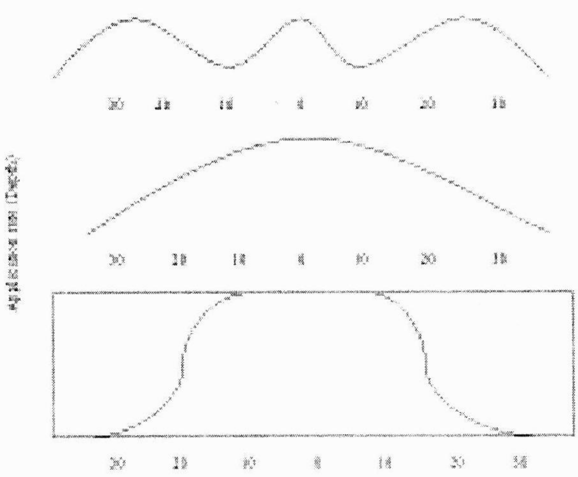

Fig.21 Typical distribution pattern with operating pressure

iv) Droplet size

Droplet size affects formation of seals on bare soil surface. Sealing is more for larger diameter (run off and erosion will be higher). It is especially important when sprinklers have to operate in wind condition. Smaller droplets are more subjected to wind distortion and lower application uniformity.

Nozzle opening shape has an important effect on droplet size.

v) Application rate

- Rate of water application by sprinkler is limited by infiltration capacity of the soil
- High application rate => more run off => poor distribution of water => loss of water

To measure the uniformity in water application the uniformity coefficient (C_u) index is used. It is affected by:

- Pressure nozzle size relation
- Sprinkler spacing
- Wind condition

The expression for uniformity coefficient, developed by Christiansen (1942)

$$C_n = 100\left[1.0 - \frac{\sum X}{mn}\right]$$

Where,

m = average value of all observations

n = total number of observation points

X = numerical deviation of individual observations from the average application rate.

Cu 85 percent is considered satisfactory.

Example: Determine the uniformity coefficient from the following data obtained from a field test on a square plot bounded by four sprinklers:

Sprinkler : 4.365 x 2.381 mm nozzles at 2.8 kg/cm^2

Spacing : 24 m x 24 m

Wind : 3.5 km/ hr from south – west

Humidity : 42 %

Time of test : 1.0 hour

S	8.9	7.6	6.6	S
8.1	7.6	9.9	10.2	8.3
8.9	9.1	9.1	9.4	8.9
9.4	7.9	9.1	8.6	9.1
S	7.9	6.6	6.8	S

S indicates the location of sprinklers.

Solution: The computations are shown in the following table

Observation	Frequency	Application x frequency	Numerical deviations	Frequency x deviations
10.2	1	10.2	1.6	1.6
9.9	1	9.9	1.3	1.3
9.4	2	18.8	0.8	1.6
9.1	4	36.4	0.5	2.0
8.9	3	25.7	0.3	0.9
8.6	1	8.6	0.0	0.0
8.3	1	8.3	0.3	0.3
8.1	1	8.1	0.5	0.5
7.9	2	15.8	0.7	1.4
7.6	2	15.2	1.0	2.0
6.8	1	6.8	1.8	1.8
6.6	2	13.2	2.0	4.0

$$\text{Mean} = \frac{178.0}{21} = 8.48$$

$$C_u = \left\{1 - \frac{\sum \|x\|}{m.n}\right\} \times 100$$

$$= \left[1 = \frac{17.4}{178.0}\right] \times 100$$

$$= (1-0.\ 0977)$$

$$= 90.23\ \%$$

The data on uniformity coefficient are useful as a basis for selecting the combination of spacing, discharge, nozzle size and operation pressure to obtain high values of irrigation efficiency at specific operating conditions.

3.12 Operation and maintenance of sprinkler systems

Proper design of a sprinkler system does not in itself ensure success. It should be ensured that the prime mover and the pump are in alignment, particularly in the case of tractor-driven pumps.

While laying the main and lateral pipes, always begin laying the pump. This necessarily gives the correct connection of all quick coupling pipes. While joining couplings, it should be ensured that both the couplings and the rubber seal rings are clean.

In starting the sprinkler system, the motor or engine is to be started with the valves closed. The pump must attain the pressure stated on type-plate or otherwise there will be fault in the suction line. After the pump reaches the regulation pressure, the delivery valve is opened slowly. Similarly, the delivery valve should be closed after stopping the power unit.

The pipes and sprinkler-lines are shifted as required after stopping. Dismantling of the installation should be done in the reverse order to the assembly described above.

Maintenance

General principles regarding the maintenance of the pipes and fittings and sprinkler heads are given below:

1. Pipes and fittings

The pipes and fittings require virtually no maintenance but attention must be given to the following procedures:

(a) Occasionally clean any dirt or sand out of the groove in the coupler in which the rubber sealing ring fits. Any accumulation of dirt or sand will affect the performance of the rubber sealing ring.

(b) Keep all nuts and bolts tight.

(c) Do not lay pipes on new damp concrete.

2. Sprinkler heads

The sprinkler heads should be given the following attention:

(a) While moving the sprinkler lines, make sure that the sprinklers are not damaged or pushed into the soil.

(b) Do not apply oil, grease or any lubricant to the sprinklers. They are water lubricated and using oil, grease or any other lubricant may stop them from working.

(c) Sprinklers usually have a sealed bearing and at the bottom of the bearing there are washers. Usually it is the washers that wear and not the more expensive metal parts. Check the washers for wear once a season or every six months which is especially important where water is sandy. Replace the washers if worn.

(d) After several season's operation the swing arm spring may need tightening. This is done by pulling out the spring end at the top and rebending it. This will increase the spring tension.

In general, check all equipment at the end of the season and make any repairs and adjustments and order the spare parts immediately so that the equipment is in perfect condition to start in the next season.

Storage

The following points are to be observed while storing the sprinkler equipment during the off season:

(a) Remove the sprinklers and store in a cool, dry place.

(b) Remove the rubber sealing rings from the couplers and fittings and store them in a cool, dark place.

(c) The pipes can be stored outdoors in which case they should be placed in racks with one end higher than the other. Do not store pipes along with fertilizer.

(d) Disconnect the suction and delivery pipe-work from the pump and pour in a small quantity of medium grade oil. Rotate the pump for a few minutes. Blank the suction and delivery branches. This will prevent the pump from rusting. Grease the shaft.

(e) Protect the electric motor from the ingress of dust, dampness and rodents.

3.13 Trouble shooting

The following are the general guidelines to identify and remove the common troubles in the sprinkler systems:

1. Pump does not prime or develop pressure

(a) Check that the suction lift is within the limits. If not, get the pump closer to the water.

(b) Check the suction pipeline and all connections for air leaks. All connections and flanges should be air tight.

(c) Check that the strainer on the foot valve is not blocked.

(d) Check that the flap in the foot valve is free to open fully.

(e) Check the pump gland (s) for air leaks. If air leaks are suspected tighten the gland (s) gently. If necessary repack the gland (s) using a thick grease to seal the gland satisfactorily.

(f) Check that the gate valve on the delivery pipe is fully closed during priming and opens fully when the pump is running.

2. Sprinklers do not turn

(a) Check pressure.

(b) Check that the nozzle is not blocked. Preferably unscrew the nozzle or use a small soft piece of wood to clear the blockage. Do not use a piece of wire or metal as this may damage the nozzle.

(c) Check the condition of washers at the bottom of the bearing and replace them if worn or damaged.

(d) Check that the swing arm moves freely and that the arm which moves into the water stream is not bent by comparing it with a sprinkler which is operating correctly.

(e) Adjust the swing arm spring tension~ Usually it should not be necessary to pull up the spring by more than about 6 mm.

3. Leakage from coupler or fittings

The sealing rings in the couplers and fittings are usually designed to drain the water from the pipes when the pressure is turned off. This ensures that the pipes are automatically emptied and ready to be moved. With full pressure in the system the couplers and fittings will be effectively leak-free. If, however, there is a leakage, check the following:

(a) There is no accumulation of dirt or sand in the groove in the coupler in which the sealing ring fits. Clean out any dirt or sand and refit the sealing ring.

(b) The end of the pipe going inside the coupler is smooth, clean and not distorted.

(c) In the case of fittings such as bends, tees and reducers ensure that the fitting has been properly connected into the coupler.

Unit cost of sprinkler systems

Different components required for a sprinkler irrigation system to irrigate 1 ha to 4 ha area and their cost has been estimated and given in Table 3.2

Table 3.2 Unit cost of sprinkler systems

Sprinkler system components	1.0 ha (50mm dia)		2.0 ha (63mmdia)		3.0 ha (75mm dia)		4.0 ha (75 mm dia)	
	Quantity (No.)	Amount (Rs)	Quantity (No)	Amount (Rs)	Quantity (No)	Amount (Rs)	Quantity (No.)	Amount (Rs.)
HDPE Pipes with quick action coupler (2.5 kg/cm^2) of 6m long	25	7770.00	30	10448.70	37	13378.09	45	16270.65
Sprinkler coupler with foot baton assembly	5	921.60	7	1411.20	11	2382.30	14	3032.00
Sprinkler nozzles (1.7 to 2.8 kg/cm^2)	5	1188.00	7	1662.20	11	2613.60	14	3326.40
Riser pipe 20mm diameter x 75cm long	5	264.00	7	369.60	11	580.80	14	739.20
Connecting nipple	1	115.20	1	129.00	1	167.00	1	167.00
Bend with coupler 90^0	1	108.00	1	126.00	1	168.00	1	168.00
Tee with coupler	1	138.00	1	152.40	1	180.00	1	180.00
End plug	2	96.00	2	108.00	2	132.00	2	132.00
Basic system cost per hectare (Rs.)		10600.80		14407.10		19601.79		24015.25

CHAPTER 4

SELECTION OF PUMPS

From ancient times, man has been trying to find suitable convenient methods of lifting water to higher levels for water supply or irrigation purposes. It is believed that the concept of lifting water by centrifugal force was introduced by L.D. Vinci an Italian Engineer in the last part of sixteenth century. Later French Scientists designed centrifugal pumps having impeller and vanes.

Centrifugal Pump

A pump may be defined as a machine which when driven from some external source, lifts water or some other liquid from a lower level to a higher level. It is a machine which converts mechanical energy into pressure energy.

The pump which raises water or a liquid from a lower level to a higher level by the action of centrifugal force is known as a centrifugal pump. In a pump, the mechanical energy is fed into the shaft and water enters the impeller which increases the pressure energy of the outgoing fluid.

Types of Pumps

There are pumps of different types and designs to meet specific installation and operation requirements.

Table 4.1 Types of pumps and their features

Sl.No.	Pump type	Features of the pump
1	2	3
1.	Centrifugal pumps	Most suitable and widely used Cheaper and simpler to operate and maintain Widest range of head and discharge Other types are selected only if the operating conditions are unsuitable for centrifugal pump
2.	Propeller pumps	High discharge and very low head applications. Usually used for drainage. Higher power ratings. Comparatively less efficient Can handle muddy water also.
3.	Mixed flow pumps	High discharge – low head applications; falls between propeller and CF types. Costlier than CF pumps.

1	2	3
4.	Jet pumps	For deep well applications Needs two suction pipes and a bottom jet assembly Costly and less efficient
5.	Turbine pumps	For deep well use. Need vertical shaft and bearings with suitable lubrication. Costly, less efficient and difficult to maintain
6.	Submersible pumps	For deep well use; good for tube wells. The motor and pump are integral and submerged in the water Costly and less efficient. Need electrical cable upto the bottom Require more attention and special protectors in operation
7.	Monoblock pumps	Single shaft for pump and motor; usually centrifugal type Cheaper and easy to maintain Lighter than other designs. No loss of power in transmission Most popular design

Field data for pump selection

The three important parameters needed to select a pump are (i) total head, (ii) discharge rate and (iii) suction lift. Other details like the quality of water, details of channels, cropping pattern, type of drive, power source, etc. are considered in the final selection or in arriving at the above three parameters.

Calculation of total head

It is the gross head in metres of water against which the required quantity (rate of discharge) is to be pumped. It comprises of

(i) depth of water table and drawdown

(ii) height of delivery pipe.

(iii) friction head due to the length of suction and delivery pipes and fittings like bends,valves, etc.

(iv) velocity head ($v^2/2g$)

Determination of discharge rate

The discharge rate in litres per second (lps) is arrived at after considering the yield of the well and requirement of crop. The discharge rate of the pumpset should be less than the well yield and more than the crop requirement.

Suction lift

As the centrifugal pumps receive water from the well at the eye of impeller by the atmospheric pressure, the maximum suction lift decides the type of pump to be selected. Though the barometric pressure is 10.3 m of water at sea level, this is reduced at higher altitudes. Also certain pumps need a higher head (NPSH) to push water into the impeller. Studies have shown that, a suction lift of 4-5 m is ideal for ordinary CF pumps. However, this can be more if the operation is for shorter time and for less quantity.

Use of performance characteristics of pump

After finalizing the best suitable discharge rate to suit the well and crop, the next step is to finalize the maximum limits of total head and suction lift. Both these vary seasonally a pump having suction lift of 15 m or more in summer may be submerged in rainy season.

Since single stage, monoblock CF pumps are the best and cheap choice of the day, every effort should be put to use such pumps in the system. If there are problems like larger suction lift, difficulty to install the pump nearer to the water table and so on the next suitable type is selected.

Lower limit for head of CF pumps

It is evident from the characteristic curves that as the head decreases, the discharge increases; so is the BHP. Therefore, a pump designed to operate between a range of head, should never be operated below this head range; otherwise the motor will overheat and eventually fail. The ranges of heads for various pumps will be available from the makers of the pump.

High speed and high head pumps

The impeller geometry of a Centrifugal pump of radial flow type is fixed by the specific speed Ns, which is given by

$$Ns = \frac{N\sqrt{Q}}{H^{3/4}}$$

where,

N = actual pump rpm

Q = flow rate in m^3/sec

H = total head in m

Ns varies from10 to 30 for slow speed , 30 to 50 for medium speed and 50 to 80 for high speed impeller. Moreover, the centrifugal head created varies as the square of rotating speed. Therefore, for high head applications, high speed pumps are available; however, with a 3 phase, 50 c/s AC input, the maximum speed possible is about 2850 rpm. High speed motors are lighter and cheaper, but the rate of wear is higher.

Deep well pumps

When the maximum suction lift exceeds the limit of 7-8 m, the output of an ordinary CF pump reduces substantially and this calls for deep well pumps. Jet pumps are a good choice in such situation. Submersible pumps and turbine pumps are other alternatives.

Relation between speed, head and power

Discharge rate (Q), the head (H) developed and the power (HP.) absorbed by a pump varies with the rotating speed (N) of the impeller, as shown below:

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2} \quad ; \quad \frac{H_1}{H_2} = \left[\frac{N_1}{N_2}\right]^2$$

and

$$\frac{HP_1}{HP_2} = \left[\frac{N_1}{N_2}\right]$$

Thus the head of a pump decreases very much, if the supply voltage is less; so is the case with discharge rate.

While selecting the motor, totally enclosed fan cooled (TEFC) motors of continuous rating is preferred. A back pull out design permits repair of motor without dismantling the piping.

Installation

One of the important factors in successful operation and maintenance of all classes and types of pumps is correct installation. Pumps which are properly installed remain in suitable alignment for longer time, develop lower casing and flange leak, vibrate least and results in fewer overhauls. However, most of the pumps used for farm irrigation are monoblock types and are of low HP. Many a time these will be shifted from place to place and are not installed permanently which is not a desirable practice. If a pump needs to be operated at more than one place, it should have concrete base with foundation bolts at all the locations.

Pump location

Correct location of the pump with respect to the water source and the field is important both from the operating and maintenance stand points. In order to ensure good flow conditions, locate the pump as close to the water source as possible, have the pump inlet below the level of the source. The pipe lines should be of correct size, shortest length and minimum fittings. There must be enough open space around the pumpset for inspection, maintenance and cooling ventilation. Clean, dry areas farther from traffic, higher than flood levels and away from leaks or drips are ideal.

Pump foundation and alignment

Concrete is best as pump foundation. Anchor bolts (inverted 'T' bolt) embedded in the concrete foundation shall be used to fix the base of the pump. As the ordinary pumps are available on common base plates, these can be installed directly on the concrete base. But these should be leveled perfectly both longitudinally and transversely. The installation of multistage large Centrifugal pumps, vertical turbine jet or submersible pumps need more technical supervision.

Piping

The most important points to be borne in mind in fixing the piping is that, the size of the piping should be correct and their frictional coefficient should be minimum. Many a time farmers buy smaller size of pipe, to save cost, but this increases the head on the pump and consumes more energy. Wherever possible, larger size pipes may be recommended. The fittings should offer minimum frictional resistance and so bends of larger radii and valves of least friction should be used. More attention should be paid to make the suction line absolutely leak proof, as otherwise the pump will fail to deliver water. In the case of larger installations with longer pipe lines, a drawing may be prepared before hand so as to aid the job best.

Maintenance and repair of Centrifugal pumps

The breakdown of an irrigation pump during the season may result in a great loss to the farmer.The following points should be observed for the maintenance and successful operation of a Centrifugal pump.

1. In coupled pump sets, the misalignment of flanges should be inspected regularly and rectified as needed.
2. The suction and discharge pipes and fittings should not add any fraction of their weights on the pump; otherwise the pump casing may fail.
3. While pumping from an open pit a suitable strainer should be used with the foot valve.
4. The gland packing or mechanical seal should be periodically inspected and adjusted or replaced as required.
5. Never run a pump dry.
6. Coat all the pipe joints with white lead.
7. The bearings should be lubricated with proper grade of oil/greases as recommended by the manufacturer.
8. The electric motor should be provided with starter and over load protector of correct rating.

CHAPTER 5

CENTRALLY SPONSORED SCHEME ON MICRO IRRIGATION

Agriculture is the largest user of water, which consumes more than 80% of the country's exploitable water resources. The use of modern irrigation methods like drip and sprinkler irrigation is the only alternative for efficient use of surface as well as ground water resources. The National micro irrigation scheme has been approved for increasing the area under drip and sprinkler irrigation during 10^{th} plan. The target of 6.2 lakh ha has been fixed which includes 3.8 lakh ha under drip irrigation and 2.4 lakh ha under sprinkler irrigation.

Nature of scheme

Under the Centrally Sponsored Scheme on Micro Irrigation (CSS on MI), out of the total cost of the MI System, 40% will be borne by the Central Government, 10% by the State Government and the remaining 50% will be borne by the beneficiary, either through his/her own resources or through soft loan from financial institutions. In other words, out of the Governmental assistance, 80% share (40% of unit cost) will be met by the Government of India (GOI) and the balance 20% (10% of unit cost) will be met by the participating State Government. The concerned States shall make available their share of 20% to the Implementing Agencies (IA) during the financial year.

Pattern of assistance

In the case of drip irrigation, the assistance will be limited to 50% of the cost of the system for the specified crop spacing and for the area covered under the crop by the farmer. The assistance for sprinkler irrigation will also be 50% of the cost. In both the cases, the assistance will be limited to 5 ha per beneficiary family. The assistance for MI demonstrations, to be taken in farms belonging to State/Central Governments, State Agricultural Universities (SAUs), ICAR Institutions, progressive farmers and Non-Governmental Organizations (NGO) / Trusts, on their own land will be @ 75% of the cost for a maximum area of 0.5 ha per beneficiary, which will be met entirely by the Central Government. The scheme will cover all categories of farmers irrespective of the size of land holding. However, while selecting the beneficiaries, care will be taken to ensure that the small and marginal farmers are given due priority for supplying the system. At least 25% of the beneficiaries should be small and marginal farmers. The Panchayati Raj Institutions (PRI) will be involved while selecting the beneficiaries.

Scheme components

Scheme has two major components

1. Area coverage under micro irrigation
2. Transfer of technology through human resources

Area coverage under micro irrigation

Scheme facilitates increase in coverage of area under drip as well as sprinkler irrigation system for enhancing crop productivity.

A) Drip irrigation

1. Drip Irrigation involves technology for irrigating plants at the root zone through emitters fitted on a network of pipes (mains, sub-mains and laterals). The emitting devices could be drippers, micro sprinklers, mini sprinklers, micro jets, misters, fan jets, micro sprayers, foggers and emitting pipes, which are designed to discharge water at prescribed rates. The use of different emitters will depend upon specific requirements, which may vary from crop to crop. Water requirement, age of plant spacing, soil type, water quality and availability are some of the factors which would decide the choice of the emitting system. Sometimes micro tubes are also used as an emitter, though it is inefficient. All types of surface and subsurface irrigation systems are covered under MI Technology. An indicative list of system components required for installing a drip irrigation system in areas ranging from 0.4 ha to 5 ha is given in Annexure-I. The estimated cost of drip irrigation system (assuming peak water requirement with source of water at the corner of the plot) for different crop spacing and plot sizes is given in Table 5.1.

Table 5.1 Estimated cost of installing drip irrigation system (cost in Rupees)

Spacing (Metre)	Area, 0.4	hectares 1	2	3	4	5
12 x 12	10600	16700	25200	32600	53700	71300
10 x 10	12100	18000	27700	36000	57900	76900
9 x 9	12400	22100	35500	55900	61400	81100
8 x 8	12900	19900	31300	41700	65500	86200
6 x 6	14400	30200	51200	70300	105800	137400
5 x 5	15100	32800	56600	83100	117100	150800
4 x 4	16900	39300	63100	100700	142200	179300
3 x 3	17900	35600	71400	96100	130800	158300
3 x 1.5	19700	40200	80500	109700	146100	180900
2.5 x 2.5	20000	39800	81400	111200	199500	239600
2 x 2	21300	49800	86400	122700	164900	223400
1.5 x 1.5	26100	55000	109500	165100	205900	281000
1 x 1	26500	57600	96500	146500	199900	249200

2. The unit cost of drip irrigation system varies with respect to plant spacing and location of the water source. Moreover, the cost of the drip system varies from state to state depending upon the existing demand and marketing network. Accordingly, the states

have been categorized into three categories, viz., Category A, B and C. States where more than 10,000 hectares have been brought under drip irrigation as on 1-4-2004 would come under 'A' Category. This would include the States of Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu. All the States except those covered under Category 'A' and those falling in the Himalayan belt would come under Category 'B'. All the North Eastern States, Sikkim, Himachal Pradesh, Jammu & Kashmir, Uttaranchal and Darjeeling district of West Bengal would come under Category 'C'. Keeping in view the level of awareness, proximity to the manufacturing units, distance involved in transportation, potential for drip irrigation, the cost of drip system in Category 'B' States is estimated to be 15% higher than Category 'A'. States while for Category 'C' States it is estimated to be 25% higher than Category 'A' States. Accordingly, the average unit cost of drip irrigation system for different State categories is given in Table 5.2.

Table 5.2 Average of unit cost for installing drip irrigation system

State Category	Average Cost, Rs./ha
A	40,000
B	46,000
C	50,000

3. The assistance under the scheme is available for all type of drip irrigation system such as online drip irrigation, inline systems, sub-surface drip irrigation system, micro jets, micro sprinkler, misters and similar other low discharge irrigation systems. Use of micro tubes as an emitting device under the MI scheme will be allowed only under exceptional circumstances where the water quality does not permit the use of any other types of emitters.
4. Assistance will be available to the farmer growing all horticultural crops like fruits, vegetables including potato, onion and other root and tuber crops, spices, medicinal and aromatic plants, all plantation crops including tea, coffee, rubber and oil palm. The scheme will be implemented on compact area basis.
5. Only new installation i.e. system invoiced and installed during 2005–06 and the current financial year which have not availed any subsidy under any government schemes shall be eligible for assistance under the scheme.
6. Cooperative society/ Self Help Group/ Incorporated Company will also be entitled to avail assistance on behalf of its members. In such cases, the individual beneficiary will receive assistance through the Cooperative Society/SHG/ Incorporated Company and not directly.
7. Assistance of drip irrigation will be 50 per cent of the system cost applicable to different crop spacing as given in Annexure-II.
8. In case of crop with plant spacing other than those mentioned in Table 5.1, the amount of assistance could be calculated on pro rata/ average basis of the nearest plant spacing. Alternatively, assistance amount may be calculated as per the unit cost of the nearest

spacing of plant. As small farm holding may not have individual source of water, it would be preferable to encourage a group of farmers to avail the benefits of drip irrigation through a common water source. However, the cost norms for smaller area (0.4 ha) also have been provided with the view to enable small and marginal farmers to avail the scheme. A beneficiary cannot split an area into smaller pockets of the same crop for claiming assistance under the scheme.

9. In case of inter-cropping, assistance will be available for the prescribed plant spacing indicated in Annexure-II subjected to condition that the assistance will be provided only for one crop as per farmer's choice. However, if the beneficiary has more than one crop with different crop spacing being grown separately in his/her land holding, assistance will be available for installing the drip irrigation system as per the individual crop spacing, the combined area of which will not exceed 5 ha per beneficiary family.

B) Sprinkler Irrigation

1. Under sprinkler irrigation water is sprinkled under pressure into the air and plant foliage through a set of nozzles attached to a network of Aluminum or High Density Poly Ethylene (HDPE) pipes in the form of rainfall. These systems are suitable for irrigation crops where the plant density is very high where adoption of drip irrigation system may not be economical. Sprinkler irrigation is suitable for horticultural crops like vegetables and spices. Conventionally, sprinkler irrigation has been widely in use for irrigating cereals, pulses, oil seeds, and other field crops.

2. The indicative list of components required for a sprinkler irrigation system is given in Annexure-III. The cost of sprinkler irrigation for one-hectare plot with different coupler diameter is given in Table 5.3.

Table 5.3 Cost of sprinkler irrigation system

Coupler diameter (mm)	Cost (Rs.)
63mm	13690
75mm	14270
90mm	17280

3. Financial assistance to the beneficiary for sprinkler irrigation will be limited to 50 per cent of the system cost subjected to a maximum of Rs. 7500/- per ha. Since sprinkler system is movable, the cost of the system will be governed by the actual quantity of materials used.

4. The sprinkler system sets, unlike drip irrigation system, are movable. Hence one sprinkler set could cover more than one ha by shifting from one place to another. Only those farmers who have not availed of assistance for sprinkler irrigation from any other scheme would be eligible for assistance under this scheme. Assistance for sprinkler irrigation will be limited to only those crops for which drip irrigation is uneconomical. Depending upon the type of crop a farmer can avail assistance for sprinkler irrigation as well as drip irrigation, the combined area of which should not exceeds five ha per

beneficiary. However, assistance for both sprinkler and drip irrigation will not be available for a crop on the same plot/ field being cultivated by the farmer. Moreover, assistance for sprinkler irrigation alone, which is less efficient than drip irrigation, should be discouraged.

5. The cost for installation of system will be borne by the beneficiary. The beneficiary will also be responsible for all electrical and mechanical works such as pumps, panels, electrification works, etc; at his own costs. The manufacturer will be responsible for repair or replacement of the system components against manufacturing defects. Since the system manufacturers are supplying a tailor made system to the farmers, the transportation and installation charges of the system will be borne by the farmers.

6. A farmer shall be eligible for assistance only if adequate water is available for the area proposed to be brought under Drip/Sprinkler irrigation. The installation of drip/sprinkler irrigation system and the assistance should be limited to the area for which adequate water is available. The scheme does not provide for creating new water sources. However, various schemes of the Government such as National Horticulture Mission (NHM) and Macro Management Schemes of Ministry of Agriculture, Integrated Watershed Development Scheme (IWDS), Swarnajayanti Gram Swarozgar Yojana (SGSY), Sampoorna Grameen Rozgar Yojana (SGRY) and Integrated Wastelands Development Project (IWDP) of Ministry of Rural Development, Rashtriya Sam Vikas Yojana (RSVY) of Planning Commission are being implemented under which there is a provision for creating water resources. These schemes should be availed and the water resources developed through such schemes should be used in conjunction with drip/sprinkler irrigation systems.

7. Assessment of water availability should be made by the implementing agencies. The officers of the concerned Irrigation Association may also be associated in the process. The Irrigation Association may also nominate accredited trained graduates for verifying the drip installation systems. Sample format for collecting application from a farmer/ beneficiary is given in Annexure IV. Details on the principles of estimating water and power requirement for installing drip irrigation system is given in Annexure V and the methodology for assessment of water and power is given in Annexure VI. The questionnaire at Annexure VII, which provides the format for assessing water and power availability for installing drip irrigation system, may be used for assessing water availability in the beneficiary's plot. The field functionaries should collect the data accurately and thereafter an assessment of adequacy should be made on the basis of norms given in these guidelines. In general the following thumb rule may be followed:

    a. Orchard crops: Orchard crops may be irrigated with drip irrigation system if assured water supply of one liter per second / hectare is available for four hours per day from the existing water sources.

    b. Vegetables and other closely spaced crops: Drip irrigation system may be used if assured water supply of three liters per second / hectare is available for four hours per day from the existing water sources.

8. Where a farmer proposes to use canal water for drip irrigation, overhead storage capacity (assessed in accordance with Annexure VII) should be created.

9. All efforts should be made to arrive at the realistic water requirement of the crop for the particular region. Moreover, the drip irrigation system should be designed in such a manner that required amount of water is made available to the crops depending upon stage of growth of the crop.

10. One or more farmers who agree to use the same water source for irrigating their land, could be permitted to avail assistance for installing the Micro irrigation system as an individual.

11. The availability of motive power and pumps of adequate capacity should be ensured before installation of the drip irrigation system and sanction of assistance. In general when water is to be lifted from a depth of 15 m to 25 m, the power requirement would be:

    a) 1 HP/ha for orchard crops

    b) 3 HP/ha for vegetables and other closely spaced crops

12. Assistance should not be sanctioned without ensuring adequate power availability. Assistance should be limited to the extent of land for which adequate power is available. The source of power could be electricity through state electricity boards, distribution companies, non- conventional energy or diesel engines.

Transfer of technology through human resources

A. Training programmes

Training programmes for officials, farmers, entrepreneurs and other active players involved in micro irrigation is an important element of the scheme

B. Seminars / exhibitions

Scheme facilitates organizing seminar, workshops, exhibitions and publicity campaigns.

Demonstrations of micro irrigation

The demonstration will be taken up only on recognized farms belonging to State/ Central Government / SAUs /NGOs of repute/Trusts, on their own land/ ICAR Institutes and progressive farmers growing horticultural crops. Each farm will get a demonstration unit of 0.5 hectares area only. The demonstration should be laid at strategic locations along roadside for the maximum benefit of the farmers.

The procedure to implement this component of the scheme is the same as suggested for drip irrigation installation component. The manufacturers/suppliers approved for drip irrigation installation may lay demonstrations.

For demonstrations, assistance would be provided @ 75% of unit cost for a maximum area of 0.5 ha per beneficiary.

Scheme Administration

The scheme will have a three-tier system for effective implementation and monitoring of the scheme.

I. National Level

a) National Committee on Plasticulture Applications in Horticulture (NCPAH)

At the national level, the National Committee on Plasticulture Applications in Horticulture (NCPAH) under the Chairmanship of Minister of Agriculture, GOI will be the apex body, which will provide overall guidance and review the progress on the coverage of area under MI in the country.

b) Executive Committee on Micro irrigation

The Executive Committee (EC) of NCPAH headed by the Secretary, Department of Agriculture & Cooperation will oversee the activities of the MI scheme and approve the action plans including plans of PFDCs, projects on technology transfer and sponsored project (Annexure VIII).

The allocation for various states/components would be within the discretions of EC. It will ensure smooth functional linkages among different agencies. The EC shall meet as frequently as necessary but at least once every quarter.

II. State Level

State Micro irrigation Committee

The concerned State Government under the Chairmanship of the Agriculture Production Commissioner/Principal Secretary/Secretary Horticulture/ Agriculture will form a State Micro irrigation Committee (SMIC). The SMIC will devise strategies to promote MI in their respective States. The Panchayati Raj Institutions existing in the State will be involved in the implementation structure, particularly the selection of beneficiaries. The structure of SMIC will be as follows:

Designation	Status
APC/Secretary (Hort. / Agri.)	Chairman
Secretaries:	Member
Water Resources	Member
Rural Development	Member
Panchayati Raj	Member
Representative of Ministry of Agriculture, New Delhi	Member
Director/Head of Rural Development	Member
Director (s) of Research of SAUs of the State	Member
Principal Investigator (PI) of PFDC	Member
Representative of Lead Banks	Member

Designation	Status
Two representatives of State level Growers Associations	Member
Representative of State Agro Industries	Member
Representative of Irrigation Association of India (IAI)	Member
Experts (one each from the fields of Horticulture, Agronomy, Soil Science, Agricultural Engineering, Water Management, Economist, Information Technology)	Member
Representative from state ground water board	Member
Director of Horticulture/Agriculture/Mission Director (NHM) of state	Secretary Member

The Chairman at his discretion can co-opt official/ expert as an invitee.

The SMIC will have the following functions

i) Organize base line survey and feasibility studies in different parts of the State covering various crops and technologies.

ii) Ensure smooth implementation of micro irrigation project in different districts of the State.

iii) Ensure allocation of State's share of resources required for implementing the Scheme and make it available to the Implementing Agencies at the district level.

iv) Finalize and forward the consolidated action plan of the Districts to DAC.

v) Circulate the list of system manufacturers registered with them along with the price list to the District Micro Irrigation Committee (DMIC) and Implementing Agency. They will also indicate the quantum of money to be paid by the beneficiary / Bank to the manufacturer before installing the system.

vi) Mobilize credit requirement of the farmers for installing micro irrigation system through the financial institutions.

vii) Facilitate PFDCs in organizing various training and extension programmes for farmers, officials, NGOs, entrepreneurs *etc.*

This committee shall host a website indicating the details and status on the progress of the Micro irrigation Scheme in different districts of the State.

III. District level

a) District Micro Irrigation Committee (DMIC)

At the district level, the State Government will constitute the District Micro Irrigation Committee (DMIC). The DMIC will be headed by the Chief Executive Officer (CEO) of Zila Parishad/District Rural Development Agency (DRDA)/Collector of the District having its members / representatives from concerned Departments viz. Agriculture, Horticulture, Rural Development, Irrigation and Water resources, Growers' Association, Krishi Vigyan Kendras (KVKs) and representative of the local lead Banks including the IA. The local Panchayath Raj Institutions (PRI s) will be involved in implementation of MI Scheme to the extent and manner considered appropriate by the IA keeping in view the capacity of the PRI. The District Horticulture Officer/ District Agriculture Officer will be the Member Secretary of DMIC.

The DMIC will have the following functions:

i. Review and forward the action plan and forward it to the Ministry of Agriculture through SMIC.
ii. Mobilize credit requirement of the farmers for installing Micro irrigation System through the financial institutions.
iii. Monitor and review the physical and financial progress of implementation of MI Scheme.
iv. Review the submission of utilization certificate by the IA.
v. Provide feed back to SMIC on monthly basis.

b) Implementing Agency (IA)

In the States, the Scheme will be implemented by an Implementing Agency (IA) specially designated for this purpose by the State Government, which will be the District Rural Development Agencies (DRDA) or any identified Agency in conjunction with Directorate of Horticulture/ Agriculture having the required infrastructure. The Directorate of Horticulture/Agriculture would provide the technical support for the scheme. The financial assistance to the farmers will be routed through the IA. Assistance to the tune of one percent of the annual outlay for the District will be provided for monitoring the scheme in the District by the IA.

The IA shall

i. Formulate action plan for their district as per the prescribed format (Annexure-IX).
ii. Forward action plan to Ministry of Agriculture through DMIC/SMIC
iii. Receive funds directly from the Ministry of Agriculture.
iv. Disburse the assistance to the beneficiaries.

The IA shall ensure that:

i. The MI technology is promoted in a holistic manner involving appropriate cultivars, good agronomic practices, post harvest handling, processing and marketing with an end-to-end approach.
ii. The assistance for micro irrigation system is commensurate with the size of the holding of the beneficiary family as per revenue records.
iii. No service charges are levied by any institution/ organization entrusted with the task of commissioning of the drip/sprinkler system. To avoid any discrepancies and for smooth implementation of the scheme, it will be necessary to have only one implementing agency in the districts.

iv. Assistance is disbursed to the beneficiary within one month of commissioning the system.

General guidelines for administering the micro irrigation scheme

(A) Transparency in Beneficiary Selection

The Implementing Agency (IA) at the district level should follow a uniform procedure duly ensuring full transparency in selecting the beneficiaries and releasing the assistance to them in an efficient manner. In order to bring about uniformity, the IA could adopt the procedure described below.

I. Pre-installation

a) The IA will

   i) Widely publish the scheme at the block and village levels through its existing network.

   ii) Appoint a nodal officer, who is preferably well versed in horticulture/ agriculture, and will be responsible for the micro irrigation scheme.

   iii) Disseminate the list of suppliers and rate list approved by SMIC to the farmers.

   iv) Organize at least one District Level Seminar/Workshop with the participation of industry representatives.

   v) Compile the application forms/proforma invoice submitted by the farmers, scrutinize it, codify it and forward the same to the company's/ manufacturer's local office indicated by the farmer.

b) The manufacturer/ company will

   i) Assess the crop water requirement as per the crop for which the system is to be provided.

   ii) Prepare an estimate of cost and submit to IA duly indicating the time frame by when the system will be supplied in the farmer's field.

c) The IA will examine the estimate and convey its approval indicating the approved amount and the farmer's share after deducting the eligible subsidy,duly endorsing a copy to the selected company/dealer and in case the farmer avails bank loan, a copy to the concerned bank.

d) Beneficiary will pay his/her share of contribution to the manufacturer/ supplier; who issues receipt to the farmer in duplicate for the amount received. The payment of beneficiary's share could be in installments as decided by the SMIC while registering the manufacturers.

e) In case the beneficiary intends to avail credit he/ she will submit proposal along with the quotation from the manufacturer/ supplier to the concerned Bank, who in turn will:

   i) Scrutinize the proposal and sanction the loan amount based on guidelines and norms.

   ii) Pay the beneficiary's sanctioned amount to the manufacturer/supplier under intimation to the beneficiary in suitable installments as decided by SMIC.

II. Installation

The Company will install the system and commission it to the satisfaction of the farmer duly ensuring the following:

i) Only good quality components having BIS marking will be installed in the farmer's field.

ii) The installed system should match the water requirement of the crop standing in field at the time of installation.

iii) Provide necessary orientation training to the farmer on the agronomic practices to be followed for irrigating the crop with drip/sprinkler irrigation.

iv) Provide proper warranty and also a user's manual for running & maintenance of the system, whether drip or sprinkler or both, as the case may be.

III. Disbursement of Assistance - Post Installation

If Beneficiary Pays His Own Share

Subject to satisfactory installation of the System, the Implementing Agency will release payment to the beneficiary through crossed Cheque/ Draft. In case the cheque is drawn in favour of the company, it will be delivered through the farmer. The farmer will pay the balance amount due to the manufacturer.

If Beneficiary Takes Loan

If the sanctioned loan amount is less than 50% of the system cost, the beneficiary shall bear the balance amount.

Subject to satisfactory installation of the system, the balance amount payable to the manufacturer/supplier will be released by the IA through the beneficiary by crossed cheque. The Bank will also release the balance amount, if any, due to the manufactures by crossed cheque through the beneficiary.

The IA will ensure that the payment of subsidy is made within a month from the date of installation of the system. The applicant should be informed about sanctioning of the system within one month from the date of receipt of his/her application. As far as feasible, the details of the beneficiary and the amount sanctioned, the company and area covered should be posted on the web site by the IA.

The farmers shall be free to select the manufacturers/ suppliers from an approved list of manufacturers/suppliers registered by the SMIC for installing the micro irrigation system in the area/ taluka/ of the location of farmer's field.

The IA should ensure that bills are accepted and passed only for the material conforming to BIS standards. (If at a later date, it is found that the subsidy is paid for the sub standard material, not beating BIS markings, the concerned official of IA will be held responsible). If Implementing Agency finds that system components supplied does not bear BIS markings, they should reject the bill and take steps to black list the company which has supplied the sub standard system and take necessary corrective steps to supply standard quality material to the concerned farmer. Supply of substandard materials should be severely dealt with.

(B) Registration of manufacturers

Registration of the system manufacturers will be done by the SMIC, for use of the Districts. Only those manufacturing companies which have all the facilities to ensure the quality of product and who can provide prompt after sales services will be registered. The companies who wish to participate in the micro irrigation scheme should either manufacture all the major drip components within their factory or in collaboration with specialized manufacturers. While registering, the manufacturers should declare the technical details of the components proposed to be manufactured and supplied.

While, registering the manufacturers, the following aspects shall be ensured:

i. In the case of drip irrigation, the company must manufacture at least laterals and emitting devices (other than micro-tubes) conforming to BIS standards. In the case of sprinkler irrigation the company should manufacture at least the HDPE pipes and nozzles as per BIS specifications. They must provide guarantee of quality assurance of other components, which is not manufactured by them.

ii. The company must provide free after sales service to the farmers at least three years. Moreover, they should set up service centers for providing technological and agronomic support at the grass root level.

iii. The companies will supply the BIS marked material only. The list of relevant BIS components is given in Annexure X

iv. In case, the company intends to supply imported components, they should have prior approval of the DAC.

v. The material should be supplied directly by the manufacturers only or their authorized distributor dealer. In all cases the manufacturers should authenticate the invoices. Such manufacturers/dealers shall furnish a Bank Guarantee, quantum of which will be prescribed by the SMIC, valid for a maximum period of three years.

vi. Each company will have its own pricing system. However, the company would be required to submit the same to the Registering Authority/SMIC in the beginning of the year and as and when the prices are revised by the manufacturers.

A registration fee not exceeding Rs.50, 000 per annum may be charged from system manufacturers at the time of registration. The revenue generated from the registration fee may be used for promoting micro irrigation in the State such as engagement of State TSG.

(C) Quality Control

The crucial aspect of supply of micro-irrigation system is quality of the hardware delivered to the farmer. Poor quality can directly affect performance of the system. The poor performance may affect yield of the crop, quantity of water applied, quantity of system will not only impact performance, but could also reduce the durability and the life of the components and/ or system. Therefore, quality assurance is a prerequisite, which cannot be compromised under any circumstance.

Frequent surveillance by inspection teams comprising of officials from NCPAH/ PFDC, CIPET, IAI, BIS or personnel from these agencies/ TSG will be a regular feature under the scheme. They will draw samples periodically from the field on random basis within a period of three years from the date of installation of the system. At the time of inspection the system should be fully functional.

In case of detection of failures or supply of poor sub standard quality material; the concerned manufacturer will be issued warning for first offence. In case of subsequent offences, the company will be deregistered and debarred from participating in the MI Scheme through out the country in addition to invoking of bank guarantee furnished by their dealers.

In order to ensure supply of BIS quality materials to the farmers the manufacturers who are registered to participate in micro irrigation scheme should manufacture only such system component which has BIS Certification. It will be the responsibility of the Irrigation Association of India (IAI) to promote the quality assurance mechanism by registering only such manufacturers who gives an undertaking to this effect, as a member of IAI.

Check list for sanctioning assistance under micro irrigation scheme

1. Material supplied by the manufacturer should be of good quality having BIS certification. Moreover, the components installed should conform to the specifications declared by the manufacturer during their registration.
2. Distribution of the drip laterals and emitters should be in accordance with the crop spacing duly ensuring effective root zone wetting.
3. The application of water between the first and the last emitters on a lateral should be fairly uniform (within 10% variation).
4. The drip system should be installed and commissioned to the satisfaction of the farmer.
5. The farmer should be in possession of a user's manual of the relevant manufacturer who has installed the system.

(D) After sales service

The manufacturers should have the network for providing after sales service in the area of operation. Operation and maintenance of the system though simple, requires training for maintenance, fertigation, chemigation etc. in the initial stage. Therefore the manufacturers should provide detailed operational and maintenance manuals in vernacular languages at the time of installation of the system. The beneficiaries should be made aware to follow the instructions provided by the manufacturers in operation and maintenance of the drip/sprinkler irrigation system.

SMIC should ensure that drip/sprinkler system manufacturers should open their regional offices/ service centers at the District/Block level when a reasonable area has been covered by the company in a Block/ District. These service centers and/or offices should have the facilities to provide technical guidance on agronomic practices, system maintenance, supply spare parts and ensure satisfactory performance of the system during the warranty period. List of such after sales center with full address/ telephone numbers/ e-mail should be widely published.

Free after sales service should be provided by the manufacturer/ authorized distributor at least for three years. In the event, if any system manufacturer fails to abide by his commitments, the same should be brought to the notice of DMIC and DAC/EC for taking appropriate action.

The SMIC/ IAs are free to evolve strong punitive measures against erring companies as well as against their own staff, in order to safeguard the interests of farmers and in order to ensure qualitative utilization of public funds.

Supply of imported components

In the case of suppliers importing systems/ components into India, only those may be considered who have a definite intension to manufacture the presently imported systems/ components within the country within a period of two years from the date of registration.

Suppliers importing systems/components into India whose intention to manufacture is established will be included in the list of approved suppliers under the scheme initially for a period of one year.

Suppliers importing systems/components into India who satisfy the condition specified will have to get their approval renewed at the end of one year, provided they produce proof for having taken steps to setup manufacturing facilities. The event of manufacturing facilities not having been established at the end of second year the approval will be liable to be withdrawn.

CHAPTER 6

MICRO IRRIGATION PROJECT IN KERALA

Kerala, the land of coconut is a narrow strip of land spread over an area of 3885497 ha with Western Ghats and the Arabian Sea bordering it. The land use pattern as on 2003-04 is as follows:

Forest – 1081509 ha, Land put to non-agricultural use – 395980 ha, Barren and uncultivable land – 28803 ha, permanent pastures and other grazing land – 316 ha, Land under miscellaneous trees crops not. included in net area sown – 10831 ha cultivable waste –67285 ha, Fallow other than current fallow – 41261 ha, current fallow – 68679 ha, Net sown area – 2189940 ha, Area sown more than once – 764516 ha, Total cropped area – 2954454 ha.

Out of the total area, net area irrigated in the state is only 384044 ha and the State share of fresh water withdrawal for agriculture is 71%. The fresh water availability of Kerala according to the available estimates is 77.35 billion cubic metres (BCM) including regenerated flow from ground water. Nearly 40% of available water resources is lost as run off. The utilizable resources as per the assessment is around 42 BCM whereas, the requirement for water for various purposes like irrigation, domestic and saline water intrusion etc., is reckoned at 49.70 BCM.

Water sector has undergone basic changes in recent years due to perceived scarcity. The pattern of demand for water in Kerala is undergoing gradual but continuous change towards increasing pressure for drinking and other household and commercial needs relative to the demand for irrigation which is also declining towards less water demanding perennial crops in lieu of seasonal food crops. The state is receiving 3000 mm of mean annual rainfall. Due to the undulating terrain a major quantity of water is lost as surface run off and due to this the state is facing acute shortage of water and unprecedented droughts. The only way to overcome this problem is economic usage of water resources by adopting scientific technologies thereby reducing the conventional loss.

It was proposed to implement the CSS on Micro irrigation in Kerala during the year 2006-07 in an area of 13828 ha, with a financial out lay of Rs. 4400 lakhs out of which the assistance from Government is Rs.2200 lakhs(50%) [Government of India share – Rs.1760.00 lakhs, (40%), State share - Rs.440.00 lakhs (10%)] and the rest is to be borne by the beneficiary/credit

The salient features of CSS on Micro irrigation in Kerala are given below:

Total area proposed

- The total area proposed was 13828 ha spreading across 14 districts.
- The area proposed under Drip: 10189 ha preferably for the major horticultural crops like Coconut, Cashew, Pepper, Arecanut, Cocoa, Cardamom, Banana, fruits and vegetables, etc.
- The area proposed under Sprinkler : 3639 ha for the crops like Coffee,Leafy vegetables, Medicinal and Aromatic plants etc.
- Kerala is categorized under category "A" as per the GOI classification and accordingly the plan has been worked out.

Process of Implementation :

- A State level committee was constituted with Agriculture Production Commissioner to Government of Kerala as Chairman.
- A district level committee with District Collector as Chairman was constitued.
- At district level the scheme is implemented through the Principal Agricultural Officers of the Department of Agriculture. At grass root level,Agricultural Officers will implement the scheme.
- The selection of the farmers is carried out in the potential Panchayats duly involving the Panchayat Raj Institution and Krishi Bhavan staff. It will be ensured that at least 30-40% of the beneficiaries are small and marginal farmers and the list of beneficiaries will be approved by both District level and State level committees.
- Preference will be given to SC /ST farmers and other farmers belonging to weaker sections of the society.

Selection of Micro Irrigation companies:

The approved system manufactures has been selected by the State Level Committee, confining to GOI guidelines.

The Monitoring and Evaluation

For effective implementation of the programme it is proposed to conduct an evaluation as follows:

Krishi Bhavan Staff – 100%, Assistant Director of Agriculture – 25%, Assistant Executive Engineer (Agriculture) – 25%, Deputy Director of Agriculture – 10 %. Principal Agricultural Officer – 1%, Executive Engineer (Agriculture) –10%, Additional Director of Agriculture (Zonal) – 5%, State Agricultural Engineer - at random. Monthly progress report should be sent to the Director of Agriculture, in the name of State Agricultural Engineer on or before 5th of every month and utilization certificate may also be furnished at the end of the financial year for keeping audit discipline. A register will be maintained at Krishi Bhavans and Office of the Additional Director of Agriculture showing the details of implementation.

Annexure-1

Indicative requirement of material for drip irrigation (One hectare)

Sl. No.	Description	Quantity of material required for different crop spacings (metre)													
		Unit	12x12	10x10	9x9	8x8	6x6	5x5	4x4	3x3	3x1.5	2.5x2.5	2x2	1.5x1.5	1x1
1	PVC PIPE 90 MM	Metre	0	0		0	0	0	0	0	0	0	0	0	102
2	PVC PIPE 75 MM	Metre	0	0		0	0	0	0	54	54	54	54	54	102
3	PVC PIPE 63 MM	Metre	0	0		0	54	156	156	102	102	102	102	102	0
4	PVC PIPE 50 MM	Metre	156	156	156	156	102	0	0	0	0	0	0	0	0
5	LATERAL 12 MM	Metre	850	1050		1310	0	0	0	3500	3500	4000	5100	6700	5050
6	LATERAL 16 MM	Metre	0	0	1150	0	1760	2020	2625	0	0	0	0	0	0
7	EMITTER 4 LPH / 8 LPH	No.	300	425	500	660	1150	1225	1875	2250	4500	3200	2510	4500	5050
8	MICRO TUBE 6MM	Metre	250	325	375	495	865	920	1410	0	0	0	0	0	0
9	CONTROL VALVE 75MM	Metre	0	0		0	0	0	0	1	1	1	1	1	2
10	CONTROL VALVE 63MM	Metre	0	0		0	1	1	1	0	0	0	0	0	0
11	CONTROL VALVE 50MM	Metre	1	1	1	1	0	0	0	0	0	0	0	0	0
12	FLUSH VALVE 63MM	Metre	0	0		0	0	1	1	1	1	1	0	0	2
13	FLUSH VALVE 50MM	Metre	1	1	1	1	1	0	0	0	0	0	1	1	0
14	SCREEN FILTER 25 M³/HR	No.	0	0		0	0	0	0	0	0	0	0	0	0
15	SCREEN FILTER 10 M³/HR	No.	1	1	1	1	1	1	1	1	1	1	1	1	1
16	BY PASS ASSEMBLY- 2"x1.5"	No.	0	0		0	0	0	0	0	0	0	1	1	0
17	BY PASS ASSEMBLY- 1.5"x1.5"	No.	0	0		0	0	0	0	1	1	1	0	0	1
18	BY PASS ASSEMBLY- 2"	No.	0	0		0	1	1	1	0	0	0	1	1	0
19	BY PASS ASSEMBLY - 1½"	No.	1	1	1	1	0	0	0	0	0	0	0	0	0
20	VENTURY & MANIFOLD (2½")	No.	0	0		0	0	0	0	1	1	1	0	0	1
21	VENTURY & MANIFOLD (2")	No.	0	0		0	1	1	1	0	0	0	1	1	0
22	VENTURY & MANIFOLD (1½")	No.	1	1	1	1	0	0	0	0	0	0	0	0	0
23	FITTING & ACCESSORIES	Set	1	1		1	1	1	1	1	1	1	1	1	1
	OPTIONAL ITEMS														
24	SAND FILTER 30 M³/HR	No.	0	0		0	0	0	0	0	0	0	0	0	1
25	SAND FILTER 10 M³/HR	No.	1	1	1	1	1	1	1	1	1	1	1	1	0

Annexure-II

Limit of Assistance for Installing Drip Systems (Considering 50% Subsidy)

A. Category A States

(Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu)

Spacing (Metre)	Limit of assistance for different areas (Rupees)					
	0.4	1	2	3	4	5
12 x 12	5300	8350	12600	16300	26850	35650
10 x 10	6050	9000	13850	18000	28950	38450
9 x 9	6200	11050	17750	27950	30700	40550
8 x 8	6450	9950	15650	20850	32750	43100
6 x 6	7200	15100	25600	35150	52900	68700
5 x 5	7550	16400	28300	41550	58550	75400
4 x 4	8450	19650	31550	50350	71100	89650
3 x 3	8950	17800	35700	48050	65400	79150
3 x 1.5	9850	20100	40250	54850	73050	90450
2.5 x 2.5	10000	19900	40700	55600	99750	119800
2 x 2	10650	24900	43200	61350	82450	111700
1.5 x 1.5	13050	27500	54750	82550	102950	140500
1 x 1	13250	28800	48250	73250	99950	124600

Annexure - III

Components for Sprinkler System Using Different Couplers

I. Using 63 mm Coupler

Sl. No.	*Components*	*Quantity (Nos.)*			
		1ha	2 ha	3 ha	4 ha
1.	HDPE Pipes, with quick action coupler (Class of pipe -1 i.e. 2.5 kg/cm^2 1S:14151) 63/50 mm diameter & 6m long	30	37	45	52
2.	63 mm Sprinkler coupler with foot batten assembly Quick Action	5	7	11	14
3.	Riser Pipe 20mm diameter x 75 cm long	5	7	11	14
4.	Sprinkler Nozzles (1.7 to 2.8 kg/cm^2)	5	7	11	14
5.	Bend with coupler 90° (63/50 mm)	2	1	1	1
6.	Pump Connecting coupler/Nipple Quick Action	1	1	1	1
7.	End plug (63/50 mm)	2	2	2	2
8.	Tee with coupler (63/50 mm)	0	1	1	1
II.	**Using 75 mm Coupler**				
1.	HDPE Pipes, with quick action coupler (Class of pipe -1 i.e. 2.5 kg/cm^2 1S:14151)75 mm diameter & 6m long	30	37	45	52
2.	75 mm Sprinkler coupler with foot batten assembly Quick Action	5	7	11	14
3.	Riser Pipe 20 mm diameter x 75 cm long	5	7	11	14
4.	Sprinkler Nozzles (1.7 to 2.8 kg/cm^2)	5	7	11	14
5.	Bend with coupler 90°	2	1	1	1
6.	Pump Connecting coupler/Nipple Quick Action	1	1	1	1
7.	End plug (75 mm)	2	2	2	2
8.	Tee with coupler	0	1	1	1
III.	**Using 90 mm Coupler**				
1.	HDPE Pipes, with quick action coupler (Class of pipe -1 i.e. 2.5 kg/cm^2 1S:14151) 90 mm diameter & 6m long	30	37	45	52
2.	90 mm Sprinkler coupler with foot batten assembly Quick Action	5	7	11	14
3.	Riser Pipe 20 mm diameter x 75 cm long	5	7	11	14
4.	Sprinkler Nozzles (1.7 to 2.8 kg/cm^2)	5	7	11	14
5.	Bend with coupler 90°	2	1	1	1
6.	Pump Connecting coupler/Nipple Quick Action	1	1	1	1
7.	End plug (90 mm)	2	2	2	2
8.	Tee with coupler	0	1	1	1

Annexure -IV

Format of Application Form to be submitted by the Head of Beneficiary Family for Availing Assistance under Micro Irrigation Scheme

Name of the farmer	:	
Father's name	:	
Husband's name (if female)	:	
Caste	:	
Village	:	
Block/Taluk	:	
District	:	
Total hectarage in his name	:	
Survey number (s) of the field (s) where he wants to install the system (Enclose certificate from Tahsildar)	:	
Has he or any of his family members availed subsidy for MI from any GOI scheme earlier?	:	Y/N
If yes, details thereof	:	
Area (ha)	:	
Crop covered (ha)	:	
Year of installation	:	
Crops cultivated	:	
Type of system required	:	
Crop for which the system is required	:	
If the system is for plantation crop any inter crop is taken?	:	
If so, the type of intercrop	:	
Total area under irrigation	:	
Source of irrigation water	:	
If wells, then open or tube well	:	
Depth of the water table in the well	:	
Depth of the tube well	:	

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Quality of the irrigation water :
(Attach analysis report)

Daily usage time of the well :

If canal then any provision made for storage :

If, yes, then the dimensions of the reservoir (l x b x d) :

Any farm pond available :

If yes, the dimensions of the pond (l x b x d) :

If there is no water source then what is the plan :

Hours of electricity available daily :

Time of electricity available :

Horse power of the pump :

Horse power of the diesel engine :

Dimensions of the land :

Soil is problematic or good :
(Enclose copy)

Soil depth :

Water table depth in the land :

Signature of farmer/Beneficiary

The following certificates are to be attached:

1. Field map along with the survey number and hecrarage of field in his name.
2. Certificate to the effect that he or his family members (if undivided) has not availed subsidy for sprinkler/ drip under GOI scheme.
3. Consent letter from the neighboring farmer from whom he wishes to take water, in case he does not have a water source
4. Soil and water test reports
5. Agreement stating that he will not either sell or donate or lend his system to any body for a period of three years.
6. He will allow any officers from Agriculture/Horticulture/DRDA or any other Government officials to inspect the system installed in his field any time during the three years period.

Annexure – V

Principles for estimation of water and power requirement for installation of drip irrigation system

A. Estimation of quantity of water

To irrigate an area by drip irrigation system sufficient quantity and rate of water should be made available at the place. To estimate the minimum quantity of water for meeting the irrigation water requirement of any area, the following steps are required:

Collection of general information

General information on water source, crops to be grown, topographic conditions, type and texture of soil and climatic data are essential for designing the drip irrigation system.

Layout of the field

The layout of the field by giving the path and lengths of main line, sub main line and lateral lines in meters to connect water source with the existing/planned crop in the area must be worked out.

Crop water requirement

Water requirement of crops (WR) is a function of plants, surface area covered by plants and evapotranspiration rate. Irrigation water requirement has to be calculated for each plant and thereafter for the whole plot based on plant population, for different seasons. The maximum discharge required during any one of the three seasons is adopted for design purposes. The daily water requirement for fully grown plants can be calculated as under:

$V = E_p \times K_c \times K_p \times W_p \times S_p$

Net volume of irrigation to be applied (V_n) $= (V - R_e)\, S_p$

The total water requirement of the farm plot $= V_n \times$ No. of plants per sqm x A

where,

V is the water requirement (litres per day plant)

E_p is the pan evaporation (mm/ day)

K_c is the crop factor

K_p is the pan factor

W_p is the wetted area (0.3 for widely spaced crops and 0.9 for closely spaced crops)

S_p is the spacing of crops / plant, (m^2)

R_e is the effective rainfall (mm) and A is the area of the plot (m^2)

B. Estimation of horse power of pumping unit

Power is required to pump the required irrigation water from the source and to develop sufficient pressure to operate the drippers effectively.

The ideal drip irrigation system is one in which all drippers (or orifices) deliver the same volume of water in a given irrigation time. The dripper flow variation caused by water pressure can be controlled by hydraulic design.

Flow carried by each lateral line (d_l) = discharge of one dripper x No. of drippers per plant x No. of plants along each lateral.

Flow carried by each sub-main line (d_s) = d_l X No. of lateral line per sub main line

Flow carried by each main line (d_m) = d_s x No. of sub-mains

The friction head loss in mains can be estimated by Hazen-Williams formula given below:

$$h_f = K \times (Q/C)^{1.852} \times D^{-4.871} \times (L + L_e)$$

where

h_f = Friction head loss in pipe (m per 100 m)

Q = Discharge ($Lsec^{-1}$)

C = Hazen - William constant (140 for PVC pipe)

D = Inner dia of pipe (mm)

K = Constant = 1.22×10^{12} for metric units = 473 for Q= ft^3/sec and D = ft

L = Length of pipe (m)

L_e = Equivalent length of pipe and accessories (See Table C)

L_e for barbs = $0.25\, B_w\, (19 \times D^{-1.9})$

D = Dia of lateral, mm

B_w = Emitter barb diameter, mm

The design of lateral pipe involves selection of pipe for a given length which can deliver required quantity of water to the plant.

In designing the lateral, the discharge and operating pressure at drippers are required to be known and accordingly, the allowable head can be determined by the same formula as the main line.

Design criteria

1. It should be ensured that the head loss in the lateral length between the first and last emitter is within 10 per cent of the head available at the first emitter.
2. The friction head loss in the mainline should not exceed 1m/ 100m length of the mainline.

Friction head loss for various discharges is given in Table B and equivalent lengths of straight pipe in meters giving equivalent resistance to flow in pipe fittings in Table C.

After finalization of dimensions of main, sub-mains and laterals the selection of pump consist of the following steps.

Total pressure head drop in meters due to friction (H_f) = Friction head loss of main + Friction head loss of sub-mains + friction head loss of laterals.

Operating pressure head required at the dripper = H_e in meters.

Total static head, m = H_s

Total Pumping Head (H), m = $H_f + H_e + H_s$

Discharge of main, $Lsec^{-1}$ = d_m

Efficiency (overall) = (60% in the case of electric pump, 40% in the case of diesel engine)

Horse Requirement of Pump $H.P. = \dfrac{H \times d_m}{75 \times e}$

Table A : Friction head loss in meters per 100 m pipe length

Flow, lh^{-1}	Inside diameter (mm)						
	9.2	11.7	12.7	13.9	15.8	18	19
	Head Loss in Meters per 100 Length of Pipe						
200	10.2	5.2	2.5	1.7	0.8	0.4	0.3
400	39.0	18.0	8.6	5.7	2.7	1.6	1.1
600		39.0	18.0	13.0	5.9	3.2	2.5
800			30.0	21.0	10.0	5.5	4.1
1000			45.0	30.0	16.0	8.3	6.2
1200			42.0	21.0	11.0	8.8	
1400				56.0	28.0	16.0	11.0
1600					36.0	20.0	15.0
1800					45.0	25.0	19.0
2000					54.0	30.0	23.0

Table B: Friction losses for flow of water (meters / 100 M) in smooth pipes (for C=140)

Discharge ($lsec^{-1}$)	Bore diameter (mm)									
	20	25	32	40	50	65	80	100	125	150
	Head loss in meters per 100 Length of pipe									
0.5	16.40	5.50	1.66	0.56						
1.0		10.00	6.00	2.00	0.68					
1.5			12.70	4.30	1.45	0.40				
2.0			16.00	7.30	2.50	0.68	0.25			
3.0				15.50	5.20	1.45	0.53			
4.0				26.40	8.90	2.50	0.90	0.30		
5.0					13.40	3.80	1.36	0.46		
6.0					18.80	5.20	1.90	0.64	0.22	
7.0						6.90	2.50	0.84	0.29	
8.0						8.90	3.20	1.10	0.37	0.10
9.0						11.10	4.00	1.36	0.46	0.19

Table C: Friction Losses for Flow of Water (M / L00m) in Smooth Pipes (for C=140)

Sl.No.	Pipe Size (mm)	Elbow Bend (K_s=0.7)	90 Bend (K_s=0.12)	Standard Tee (K_s=0.12)	Sluice Valve (K_s=0.4)
1.	25	0.536	0.396	0.704	0.007
2.	40	0.997	0.596	1.131	0.142
3.	50	1.296	0.741	1.704	0.185
4.	65	1.814	1.037	2.384	0.259
5.	80	2.241	1.281	2.946	0.32
6.	100	2.959	1.691	3.889	0.422
7.	125	4.037	2.307	5.306	0.576
8.	150	5.125	2.928	6.735	0.732

Worked example for Coconut plantation of 1 ha

Principles for estimation of water and power requirement for installation of Drip irrigation System

1. General Information
    - water source
    - crop
    - topographic conditions
    - type and texture of soil
    - climatic data
2. Layout of the field

   Length and path of the main line, sub main and laterals
3. Crop water requirements

   Irrigation water requirement has to be calculated for each plant and thereafter for the whole field based on plant population for different seasons.
4. Horse power of pumping units

   An ideal drip irrigation system is one in which all drippers deliver the same volume of water in a given irrigation time.

Design criteria

1. The head loss in the lateral length between the first and last emitter is within 10 percent of the head available at the first emitter.
2. The friction head loss in he main line should not exceed 1m/100m length of the main line.

1.No. of plants

Area = 1ha = 100x100 m

Spacing = 8mx8m

No.of plants = (100x100)/(8x8) = 156 plants

2. Water requirement of plant

WR = 40 lpd/plant
= 6240 lpd/ha
= 6.24 m3/day/ha

3. Pumping rate

Let the average working hrs of pump be 2 hr/day

Pumping rate = 6.24 m^3/day/ha
= 3.12m^3/hr/ha(20 lph/plant)
= 0.86 lps say 1.0 lps

4. Selection of drippers

For a pressure head of 10m and discharge (Q) 8 lph

No.of drippers per plant

= (rate of pumping /hr/plant)/(av.Q of one dripper)

= 20/8 = 2.5 nos. say 2 no.

Assume plot as square

Then main line would be 100 m long and laterals would also be 100 m in length

No.of laterals = 100/8 = 12.5 say 13 nos.

For 8 m x 8m spacing, each lateral serve approximately 13 plants

Total no. of drippers per lateral = 13x2 = 26 nos

5. Main line

Main line is designed to carry the maximum Q required for total no. of plants in the plot.

Max Q required = no. of plants x peak Q per plant
= 156 x 20 lph
= 3120 lph
= 0.86 lps say 1.0 lps

Frictional head loss (m)
Total length = 100 m
Equivalent length of
13 straight connection = 6.5 m
(0.5 m per connection)
Equivalent length of T, bends, etc. = 5m
Total = 111.5 m say 112 m

For a Q of 1 lps through a pipe of say 40 mm dia, friction loss would be 2.0 per 100 m length

i.e. 2.24 m for 112 m (2.0x 112/100)

(Correction factor = 0.88)

Friction head loss = 2.24 x 0.88 = 1.97

Since there are multiple openings, friction loss is taken as 1/3 of total friction loss

i.e. 1.97/3 = 0.65 m

Since the loss in mains is within 1m/100 m length, the pipe of 40 mm dia will be ideal in the layout.

6. Laterals

A lateral is so selected that the pressure difference from the proximate end to the last dripper does not exceed 10 % of the normal operating head.

i.e, 10x10/100 = 1m for a lateral of 100m length

Let the land slope be 0.5m per 100 m

Total friction loss allowable = 1+0.5 =1.5 m

Loss due to connectors

(0.5 m for each connector) = 13x 0.5 = 6.5 m

Total flow in laterals = 8 lph x 2 no x 13 plants

= 208 lph

For 200 lph flow, the friction loss in say 12.7 mm inner dia pipe would be 2.5 m per 100m length. Therefore, in 106.5 m length (100 m of lateral + 6.5 m due to connectors) it would be 2.66 m

Since there are multiple connections, friction loss is taken as 1/3 of total friction loss

i.e, 1 x 2.66/3 = 0.89 m

this is within he permissible limit of 0.9 m

Therefore pipe of 1.27 mm inner dia will be ideal in the layout.

7. H.P of pump set

Static head		
Depth of water	=	10 m
Draw down	=	3 m
Oulet level above ground level	=	1 m
Friction loss in pipes, bends, foot valves etc.(assume)	=	2 m
Total static head		
Friction loss in drip unit		
a. Friction loss in main pipe	=	0.56m
b. Friction loss in laterals	=	0.89m
c. Max head required over drippers	=	10m
Total friction loss	=	11.45 m
Total head = static head + friction head loss		
	=	16.0+ 11.45 = 27.45 m
		say 28m
HP of pump	=	(QxH)/ (75xe)
(efficiency = 60%)	=	(1.0x28)/(75x0.6)
	=	0.62 hp say 1.0 hp

Annexure – VI

Methodology for assessment of water and power availability

I. In cases where the water source is an open well or tube well/ bore well, then for assessment of water availability and pumping power requirement it is necessary to compute the following:

a. Depth of the water table

b. Discharge of the well

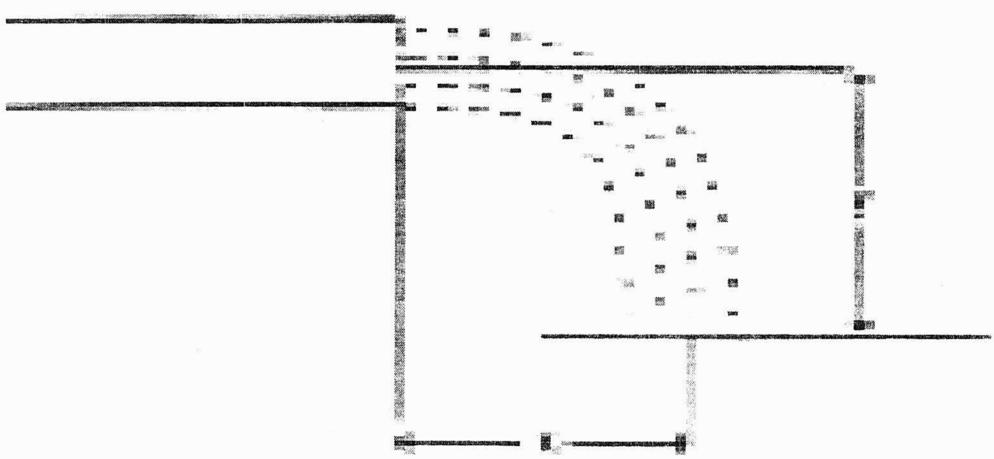
c. Total pumping level

1. The depth of water level below the ground level, before pumping begins, is the depth of the water table. It can be measured by a simple procedure using a rope with a stone tied at one end.

2. The discharge of the well/ tube well is measured after running the pump for a period of 30 minutes to one hour. It can be measured by adopting volumetric measure. Under this method, the discharge is emptied into a ditch or container of known dimensions for a certain length of time. The rate of discharge is calculated by dividing the total volume of water discharged by the time taken. This method works for low discharge, say upto 5 litres per second.

For higher discharges, volumetric measurement may be difficult and therefore standard devices like water metre /v-notch/ flume may be used. In the case of non-availability of these devices, the discharge may be assessed approximately using the co-ordinate method described below.

Co-ordinate Method: For measuring the discharge from wells/ tube wells, the outlet pipe should be horizontal. The X and Y co-ordinates are measured from the centre of the pipe to the centre of the water jet as indicated in the figure shown below.



Flow sketch

The discharge is computed using the equation $Q = \frac{C\,A \times \sqrt{g}}{\sqrt{2y}} \times 1000$

Q	=	Discharge in $Lsec^{-1}$
C	=	Co-efficient of contraction (Use 1.0)
A	=	Cross sectional area of the pipe in m^2
x	=	X co-ordinate in metres
y	=	Y co-ordinate in metres
g	=	Acceleration due to gravity ($m\ sec^{-2}$)

3. Total pumping level includes the depth of the water level, drawdown and height of the outlet above the ground level. To measure the drawdown, the pump installed over the well/ tubewell is run for a period of 30 minutes to 1 hour so that constant water level is attained in the well/tube well. The new depth of the water level is measured. The difference between the depth and the original depth of the water table is the draw down. The height of the outlet level above the ground level is also to be measured. Once the total pumping level is determined, the horsepower can be calculated.

4. Power rating of the pump required can be approximately determined with the reference to the table given below:

Power requirement to pump and operate drip irrigation system for orchard and vegetable crops

No. Depth (M)	Static water (hp/ha)	Orchard crop (hp/ha)	Vegetable crop
1	00-10	0.64	1.93
2	10-20	0.87	2.61
3	20-30	1.10	3.30
4	30-40	1.31	3.93
5	40-50	1.53	4.59
6	50-60	1.76	5.28
7	60-70	1.98	5.94
8	70-80	2.20	6.60
9	80-90	2.42	7.26
10	90-100	2.64	7.92

II. In cases where the water source is perennial stream of low discharge (generally available in hilly areas), drip irrigation systems can be operated by diverting these streams at a higher elevation to a small storage tank of approximately 2 cubic metre capacity and it can be directly connected to the drip irrigation system for irrigating lands at a lower elevation. If drip irrigation system is being used with drippers then the average elevation difference between tank and area of operation should be 12-15 metres. If micro tube system is used, elevation difference of 3 m to 4 m would be sufficient to operate the system. The area proposed to be irrigated should commensurate with the flow of water in the stream. If flow of one litre per second is available it is sufficient to irrigate one ha of orchard crops at a time. The rate of flow of water in the stream can be measured by volumetric measurement or by using other devices mentioned above.

Annexure - VII

Field level questionnaire for assessment of water and power availability for installation of drip irrigation system

1. Name of the applicant :
2. Residential Address :
3. Farm address/location (Survey No. to be indicated) :
4. Total farm area (ha) :
5. Area proposed to be irrigated under drip :

Crop	Plot 1	Plot 2	Plot 3	Plot 4
Area under crop (ha) Row to row distance (m) Total No. of plants Type of Soil				

6. What is the water source proposed to be used by farmer?
   a Open well :
   b. Tube well/ bore well :
   c. Surface flow :
   d. Others (specify) :
   e. Storage tank :
7. Open well
   a. Depth of water table (in meters) :
   b. Date and season during which assessment made :
   c. Draw down in meters (Please refer Annexure V) :
   d. Height of outlet above ground level :
   e. Assessment of water availability (in litres /second) :
   f. Method used for determining water availability :
   g. Total duration for which pumping was done :
   h. Duration of pumping after which constant water level was obtained :
   i. Pump used / Mention make (electric / diesel) :
   j. H.P of pump used :
   k. Diameter of outlet pipe :

8. Tube well / Bore well

a. Depth of water table (in meters) :

b. Date and season during which assessment made :

c. Draw down (in meters) (Please refer Annexure VI) :

d. Height of outlet above ground level :

e. Assessment of water availability (in litres / second) :

f. Method used for determining water availability :

g. Total duration for which pumping was done :

h. Duration of pumping after which constant water level was obtained :

i. Pump used (mentioned make) (electric / diesel) :

j. Horse power of pump :

k. Diameter of outlet pipe :

9. Surface Flow / Stream in hilly areas

a. Rate of flow of water (in litres / second) in the stream during the lean season :

b. Methodology used for assessing the rate of flow of water :

c. Whether storage tank is available :

d. If so, capacity of the storage tank? :

e. Structure used for diversion of water into storage tank :

10. Storage tank using canal water

a. Distance of farmer's field from canal delivery point :

b. Whether storage tank has been constructed or is proposed to be constructed by the farmer :

c. If so, capacity of the storage tank? :

d. Elevation of storage tank above ground level :

e. Availability of water in canal according to "turn" system (No.of days in a week / fortnight / month) :

f. Pump available with farmer (electric / diesel) to lift water from canal to water storage tank (mention make) :

g. Horsepower of the pump. :

11. Details of Pump

a. Does the farmer own a pump :

b. If so, what make? :

c. What is the horsepower of the pump :

d. In the case of electric pump no. of hours :

e. Per day for which electricity is generally available :

f. In case the diesel pump, name of the nearest diesel station :

g. Does the farmer propose to buy a new pump (if so, specify make and HP) :

h. Other farm machinery owned by farmer (i.e. tractor, tiller, thresher etc) :

12. Nearby Drip Installation

a. How many drip irrigation installation are there in the same village :

b. What is the approximate area under these installations? :

c. What are the problems faced by the existing drip installations :

Name, Signature and
Designation of the Field Officer

13. Analysis of water and power availability by an authorized officer of Implementing Agency

a. Total requirement of water for the area proposed to be covered by farmer under drip irrigation (litres per day / plant x total number of plants or total requirement in litre per ha. X total area) :

b. Total availability of water? :

c. Area recommended to be brought under drip irrigation :

d. Horsepower of pump available :

e. Horsepower of pump required :

f. Recommendation regarding area to be covered under drip irrigation (also give recommendation regarding up-gradation of pumping capacity, if required) :

g. Recommendation regarding elevation, capacity and construction of storage tank :

Signature of authorised officer of
the Implementing Agency

Annexure – VIII

Proforma for furnishing Annual Action Plan by Implementing Agency

PART A: Summary Statement

Year:

Name of State

Name of District

I. Area Coverage Physical and Financial Programme

A. Drip Irrigation

Sl. No.	Crop/ Spacing (m)	No. of Beneficiaries	Area (ha)	Total Cost Involved (Rs.)	Financial Outlay (Rs in Lakh)	
					Govt. of India Share	State Share

Sub Total Drip

B. Sprinkler irrigation

Sl. No.	Crop/ Spacing (m)	No. of Beneficiaries	Area (ha)	Total Cost Involved (Rs.)	Financial Outlay (Rs in Lakh)	
					Govt. of India Share	State Share

Sub Total Sprinkler

II. Demonstration for drip irrigation

Sl. No.	Crop/ Spacing (m)	No. of Beneficiaries	Area (ha)	Total Cost Involved (Rs.)	Financial Outlay (Rs in Lakh)	
					Govt. of India Share	State Share

Sub total Drip Demonstration

Grand Total

PART B. General details of District

1. Land use:

Sl.No	Category	Area (ha)	% of total
1.	Agriculture		
2.	Forest		
3.	Wasteland		
4.	Other		

2. Average monthly rainfall (mm)
3. Average monthly temperature (°C)
4. Broad soil type
5. Area under cultivation (Year)

A. Agricultural
Rice
Wheat
Pulses
Oilseeds
Others

B. Horticulture

Fruits	Coconut
Vegetables	Arecanut
Spices	Cashew
Flowers	Cocoa
Medicinal & Aromatic Plants	Others

Irrigated area

a) Major Irrigation b) Medium Irrigation c) Minor Irrigation

6. Source of irrigation

a) Ground water b) Surface water

7. Canals in the district (Name & command area)
8. Status of land holding (Number & total area) 1, 1-2, 2-3, 3-4, More than 4 hectare
9. Number of Agro / horticultural processing units
10. Name of the PFDCs nearest to the District
11. Crops selected under National Horticulture Mission (NHM)

12. Name of Industrial units in the District manufacturing drip/ sprinkler system components

a) List of manufacturers/ distributors/ dealers of Micro Irrigation System

b) List of liquid fertilizers

13. Professional Institutes / Organisations/ University preferably in Agricultural field available in the District along with the probable help which may be rendered by-them

14. Existing Farmers' Association and their main functions

15. KVKs in the district

16. District taxes and levies on Micro / Sprinkler Irrigation components / systems

Octroi

Sales Tax on components

Sales Tax on systems

PART C: Details of area coverage under MI Scheme.

1. Present area covered under drip/sprinkler (year wise/ crop wise in the district) (ha)
2. Area proposed to be covered under Drip/ Sprinkler Irrigation

	Sl. No.	Name of Block/ Taluke	Crop/ Spacing	No. of Bene-ficiaries	Area (ha)	Total Cost Involved	Financial Outlay (Rs. In Lakh)	
							GOI share	State share
A. Drip Irrigation								
B. Sprinkler Irrigation								
C. Demonstration								

Name and complete details of the Bank
Where GOI assistance is to be paid

Signature

(Name & Designation)

Authorized signatory of IA

Annexure - IX

Performa for Furnishing Progress Report under Micro Irrigation Scheme

Name of State :

Name of District :

Period of Report :

Details of Progress Achieved :

(Rupees in Lakhs)

	During the Month							Cumulative Progress				
	Sl. No	Crop/ Crop spacing	No. of Benefi- ciaries	Target (ha)	Ach (ha.)	Outlay	Exp	No. of Benefi- ciaries	Target (ha)	Ach (ha.)	Outlay	Exp
A. Drip irrigation												
Sub Total												
B. Drip demonstration												
Sub Total												
C. Sprinkler irrigation												
Name of crop												
Sub Total												
Grand Total												

Number and area covered by Small & Marginal Farmers:

Annexure – X

List of BIS Standards

1. Polyethylene pipes for Irrigation – Laterals (IS 12786 : 1989)
2. Emitters (IS 13487: 1992)
3. Emitting pipes system (IS 13488 : 1992)
4. Strainer type filters (IS 12785 : 1994)
5. Irrigation equipment rotating sprinkler Part II, Test method for uniformity of distribution (1st revision) (amendment 1) (IS 12232 (Part II) – 1995)
6. Irrigation equipment rotating sprinkler Part I, Design and Operational requirements (1st revision) IS 12232 (Part I) - 1996
7. Polyethylene microtubes for drip irrigation system (IS 14482: 1997)
8. Fertiliser and Chemicals Injection system Part I Ventury Injector(IS14483 (Part1) 1997)
9. Micro sprayers (IS 14605 : 1998)
10. Media Filters (IS 14606 : 1998)
11. Hydro cyclone separators (IS 14743 : 1999)
12. PVC pipes for water supply (IS 4985 – 1999)
13. Irrigation equipment sprinkler pipes specifications Part I Polyethylene pipes { IS 14151 (part 1) 1999 }
14. Irrigation equipment sprinkler pipes specifications Part II Quick Couples Polyethylene pipes {IS 14151 (part II) 1999}

Annexure - XI

SUMMARY SHEET ABSTRACT (DISTRICT WISE)

(Rs. in lakhs) 2006-07

Sl. No.	Name of District	Drip Irrigation					Sprinkler Irrigation				
		Area in ha	GOI Share	State Share	Total Subsidy Involved	No. of benefici-aries	Area	GOI Share	State Share	Total Subsidy Involved	No. of benefici-aries
1	Thiruvananthapuram	907	132	33	165	907	200	12	3	15	75
2	Kollam	1055	148	37	185	1055	100	6	1.5	7.5	75
3	Pathanamthitta	625	94.58	23.65	118.23	625	100	6	1.5	7.5	75
4	Alappuzha	175	28.05	7	35.05	175	39	2.34	0.59	2.93	10
5	Kottayam	745	111.92	27.98	139.9	745	300	18	4.5	22.5	75
6	Idukki	775	146.96	36.74	183.7	775	300	18	4.5	22.5	75
7	Ernakulam	739	108.03	27	135.03	739	100	6	1.5	7.5	75
8	Thrissur	739	108	27	135.01	739	300	18	4.5	22.5	75
9	Palakkad	645	104	26	130	645	500	30	7.5	37.5	75
10	Malappuram	1050	163.73	40.94	204.67	1050	500	30	7.5	37.5	75
11	Kozhikode	700	102.9	25.73	128.62	700	300	18	4.5	22.5	75
12	Wayanad	750	110.86	27.71	138.57	750	500	30	7.5	37.5	75
13	Kannur	700	102.88	25.72	128.6	700	300	18	4.5	22.5	75
14	Kasaragode	584	79.75	19.94	99.69	584	100	6	1.5	7.5	50
	Total	**10189**	**1541.66**	**385.41**	**1927.07**	**10189**	**3639**	**218.34**	**54.59**	**272.9**	**3960**

Annexure – XII

List of Micro irrigation Equipment Manufacturers

DRIP & SPRINKLER SYSTEM MANUFACTURERS

1. Premier Irrigation Equipment Limited
   271,Mysore Road, Bangalore-560056

2. Nagarjuna Fertilizers and Chemicals Limited
   Plot No.P.10/1, IDA, Nacharam, Hyderabad

3. Jain Irrigation system Limited
   147, First street,Thirunagar, Ukkadam
   Perur by pass road, Selvapuram, Coimbatore-600026

4. Sujay Irrigation Private Limited
   No.86, Main road, Petechannappa Industrial Estate
   Kamakshipalaya, Bangalore-560076

5. Rungta Irrigation Limited
   74/2A, Srigadhanagar, Heggenhalli, IInd stage
   Vishwaneedam post
   Bangalore-560091

6. Netafim Irrigation India Pvt. Limited
   No.B-80, Rajajinagar Industrial Estate
   Rajajinagar-6th block, Bangalore-56044

7. Flow tech power, Flow tech towers
   81 New scheme road, Peppenaichenpalayam,
   Coimbatore-641037, Tamil Nadu

8. Plastro Plassion Industries(India) Ltd
   Plot 399, URSE, Talukamaval(Dt.)
   Pune-410506

9. EPC Industries Ltd.
   Irrigation systems division
   Aathira, Chiyyaram, Thrissur-680026

10. Elgi Ultra Industries Limited
    India House, 1443/1, Trichy Road,
    Coimbatore- 641018

Annexure – XIII

ADDRESS OF PRECISION FARMING DEVELOPMENT CENTRE (PFDC), KERALA

PRECISION FARMING DEVELOPMENT CENTRE
KERALA AGRICULTURAL UNIVERSITY
KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING &TECHNOLOGY (KCAET)
TAVANUR, MALAPPURAM(DT.)-679 573
Tel. No. 0494 - 3297592, 2686214(O)
Fax: 91- 494- 2686009
Email:pfdc_tavanur@rediffmail.com, jippujacob@yahoo.co.in

Name of Principal Investigator	Er. Jippu Jacob
Research staff working in the project	
Assistant Professor (Sl.Grade)	Er. Levan.K.V
Research Associates	Er. Anu Varughese
	Er. Priya G. Nair