TECHNICAL MANUAL

FOR

AFFORDABLE

MICRO-IRRIGATION

TECHNOLOGY

(AMIT)

PREPARED BY

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INTRODUCTION

What is Micro Irrigation?

Slow & regular application of water directly to the root zone of plants through network of economically designed plastic pipes and low discharge emitters.

What is Affordable Micro Irrigation Technology (AMIT) / Low Cost Drip Irrigation (LCDI) Kit?

Network of plastic pipes with emitters assembled and packaged for small plots along with user-friendly instruction manual for small holders to enable them to cultivate commercial crops.

Micro Irrigation is an ideal way to produce high value crops as it reduces water use, increases crop yield and gives good quality produce within less time and money as compared to traditional ways of cultivating and irrigating commercial crops. However majority of the small holders in developing countries are deprived of this amazing technology due to its high initial cost and non-adaptability to small holdings. Until recently it has been too expensive to be affordable for poor families and too large for tiny plots of land. International Development Enterprises (IDE), a non-profit voluntary organization has now overcome this problem by developing range of small and easy to use affordable micro irrigation kits to produce high value crops.

IDE has been working on low cost micro irrigation technology in India and Nepal since 1995 and in has developed range of products and configurations for small holders. These products are in the form of ready-to-use kits, assembled and packaged so that they can be sold off-the-shelf, installed and used by the farmers on their own. Most of the components in a typical low cost micro irrigation system are manufactured from polyvinyl chloride, different types of polyethylene and polypropylene. IDE has found that manufacturing technology is based on simple extrusion or injection molding process and manufacturers of plastic pipes can adapt it easily. While working in India, Nepal, Vietnam and China, IDE observed that affordable micro irrigation technology enables small holders to cultivate cash crop with small amount of water and increase crop intensity. This enables them to increase their incomes two to three times more as compared to income from traditional crops. Farmers can also increase their area under irrigation by using AMIT system with available water.

This manual aims at providing skills and knowledge base to support an ever-growing network of institutional efforts for the dissemination of AMIT. It can also be used in-group training courses for professional / technical staff of implementing organizations, supply chain and training of farmers regarding AMIT.

ADVANTAGES OF AMIT

Some of the major advantages of AMIT are given below:

1. Affordability : AMIT Systems are available in affordable sizes from local suppliers at low price as compared to other costly irrigation systems.

2. Improved Yield : Slow and regular application of water and nutrients uniformly to all the plants gives improved quality and increase in total produce.

3. Water Saving : There is saving of water up to 50% as compared to traditional method. So AMIT can give more crop (area) per unit of water used.

4. Labor Saving : Less labor is required for irrigation, weeding, fertilizer application etc. incase of AMIT as compared to traditional method.

5. Fertilizer Saving : Fertilizer losses are minimized in AMIT. So there is saving in fertilizer application as compared to traditional method of irrigation.

6. Energy Saving : Most of the AMIT Kits are gravity operated systems or run with low horse power pump.

7. Difficult Terrain : AMIT can be used on undulated terrain (hilly area) where irrigation by traditional method is difficult.

8. Tolerance to Salinity : Due to slow and regular application of water by AMIT concentration of salts in the root zone is reduced and by micro leaching salts are kept away from the root zone.

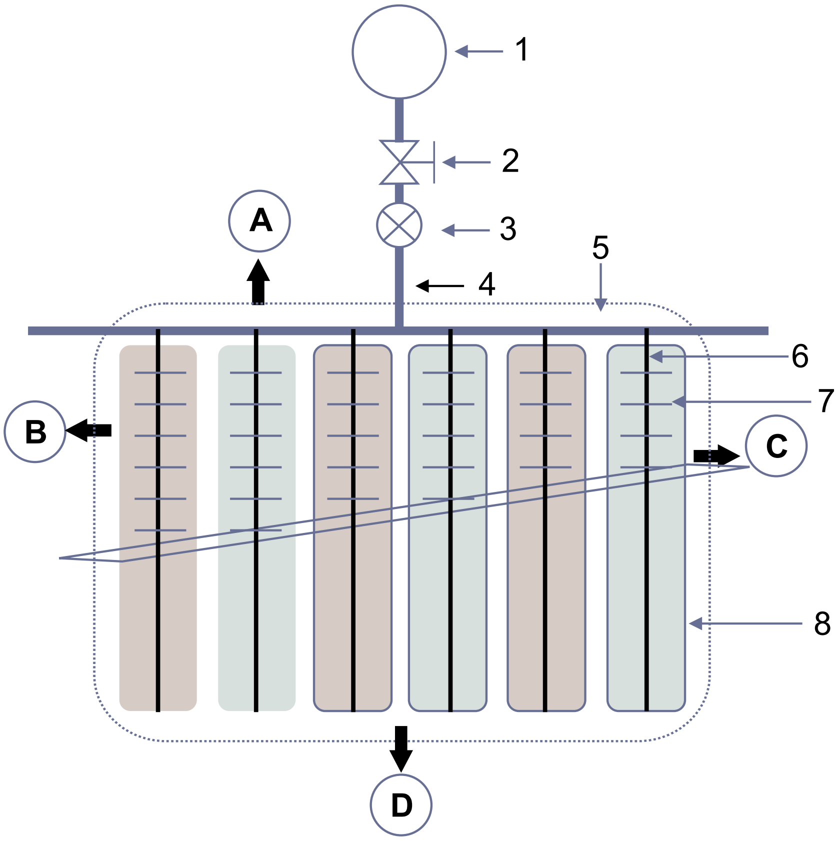
9. Improved Crop and Disease Control : Regular irrigation ensures timely inter-culturing operations and spraying etc. which gives better crop control and prevents spread of diseases caused due to flooding.

10. Uniform Application of Water : Since water is applied uniformly to all the plants, there is uniformity in growth and quality of yield.

11. Reduced Cultivation Cost : Slow and regular application of water keeps optimum soil-water-air ratio in the soil which is essential for healthy plant growth. It also reduces need for frequent inter-culturing, weeding etc. Combined with above saving it gives reduced cost of cultivation.

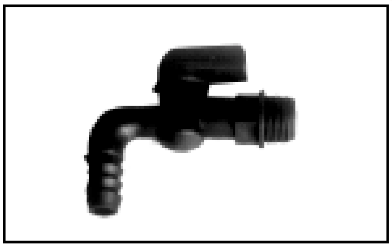
12. Application to Variety of Crops : Number of crops can be irrigated using AMIT viz. Vegetable crops, fruit crops, commercial cash crops, flowers etc.

BASIC COMPONENTS OF AMIT SYSTEM

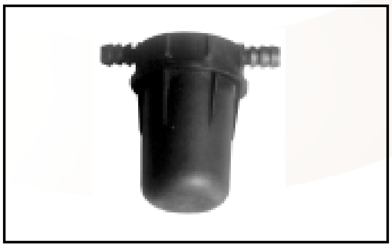


A typical AMIT System will contain each of the following components:

1. Water Source: The AMIT Kit is a low-pressure system that uses gravity to increase water pressure. The water source can be an overhead tank placed at a minimum of one meter above ground level for smaller systems up to 400 m^2 area. For larger systems, the height of the tank should be increased. If the height of the tank is not increased the system can be connected to a pump that lifts water from sources such as a well, farm pond, storage tank, or a stream / canal. A manually operated pressure pump also can be used to lift water from a shallow water table (up to 7 meters) and used for AMIT kits.

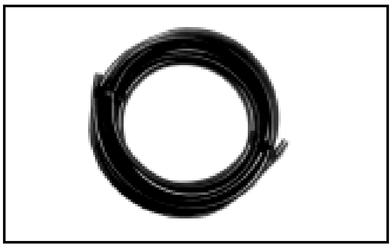


2. Control Valve: Valve made of plastic or metal to regulate required pressure and flow of water into the system. There are valves of various sizes depending on flow rate of water in the system.

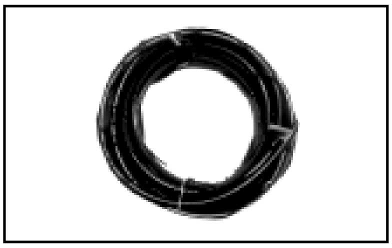


3. **Filter:** Strainer filter to ensure that clean water enters into the system. There are different types of filters viz. Screen, media and disc type filters. Different sizes of filters are available depending on flow rate of water in the system.

4. **Mainline:** Poly vinyl chloride (PVC) or Polyethylene (PE) pipe to convey water from source to the sub-main. Polyethylene pipe material is normally made from HDPE, LDPE and LLDPE. Size of pipe depends on flow rate of water in the system.

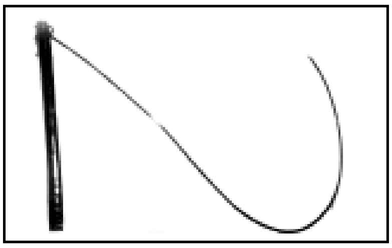


5. **Sub-main:** PVC / HDPE / LDPE / LLDPE pipe to supply water to the lateral pipes. Lateral pipes are connected to the sub-main pipe at regular intervals. Size of pipe depends on flow rate of water in the system.

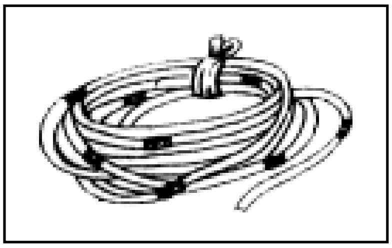


6. **Lateral:** LLDPE / LDPE Pipes placed along the rows of the crop on which emitters are connected directly or through spaghetti to provide water to the emitters. The lateral pipe size is from 12 mm to 16 mm in most of the drip systems.

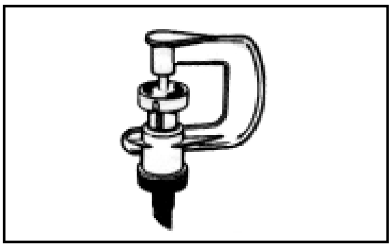
7. **Emitters:** Device through which water is emitted at the root zone of the plant with required discharge. Different types of emitters used in AMIT Kits are described below:



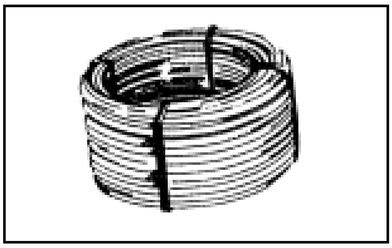
i) **Micro-tube:** Straight or curled LLDPE tube with an inner diameter ranging from 1 to 1.2 mm. The discharge from the micro-tube is directly proportional to the operating pressure and inversely proportional to its length. The operating pressure that is required can be as low as 1m to 5 m.



ii) Baffle : The hole on the lateral pipe is 0.75 mm in diameter. This hole is covered with a plastic device called baffle so that water is discharged using a desired flow at a given pressure. Operating pressure required is as low as 1m to 5 m.

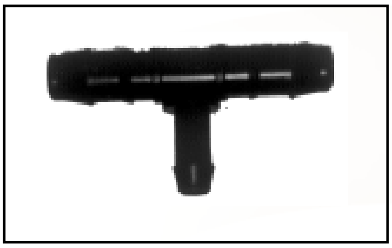


iii) Micro-Sprinkler : The sprinkler is able to spray water with coverage of 3 to 4 m in radius. It has a small rotating device to cover larger areas. Operating pressure required is from 5m to 15 m.

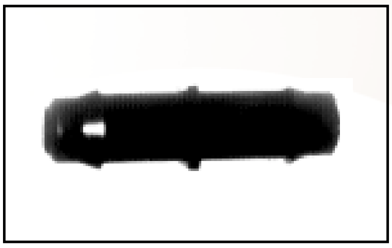


iv) Drip Tape / Easy Drip: It has inbuilt drippers / outlets on the lateral line which give a continuous wetting strip. It is mainly used for row crops. Operating pressure required is from 1m to 5m.

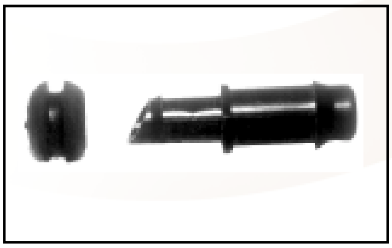
8. Fittings: Various fittings required in AMIT System are described below.



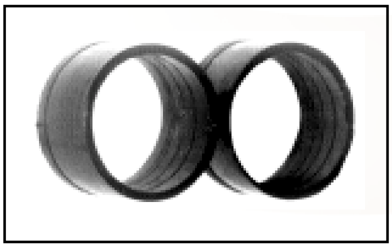
i) Tee Connector: Tee Connectors of various sizes are required in AMIT system to connect a branch to the Main pipe, Main pipe to Sub-main pipes, Lateral Pipes to Sub-main pipes etc. The Tee Connectors can be Equal Tee or Reducing type Tee viz. 12mm x 12mm, 16mm x 12mm, 16mm x 16mm, 25mm x 12mm, 32mm x 12 mm etc.



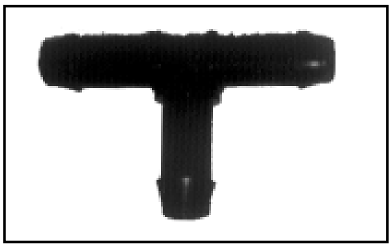
ii) Straight Connector: Also called as Joiner. It is required to connect pipes. It can be Equal Joiner or Reducing Joiner viz. 12mm x 12mm, 12mm x 16mm, 25mm x 32mm, 32mm x 40 mm, 40mm x 50mm etc.



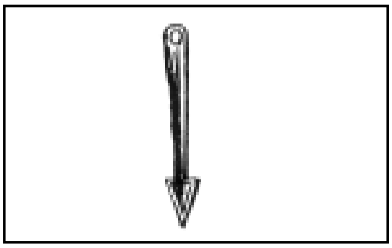
iii) Take-Off: It is used to connect lateral pipes to the sub-main pipe in larger systems. It is fixed in the wall of sub-main pipe with the help of a rubber washer called as Gromate. It is available for different sizes of lateral pipes viz., 12mm, 16mm.



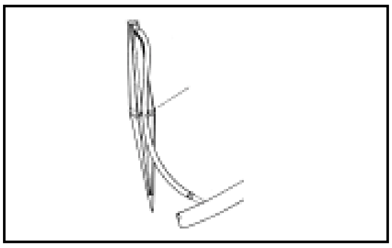
iv) Lateral End Stop: The lateral pipes are closed at the other end with the help of plastic ring in the shape of figure of '8', or barbed End Cap. It is available for different sizes of pipes viz. 12mm, 16mm etc.



v) Micro-Tee: It is used to connect Micro-tube to the lateral pipe. Simply inserting it into the lateral pipe and tying a knot around the lateral pipe can also connect the Micro-tube. Micro-tee makes it simple and easy for assembling purpose as well as to dissemble the system and pack it after harvest.



vi) Pegs: Small plastic pegs are used to place the micro-tube and lateral pipe in place. The pegs for micro-tube are mostly used in Micro-tube drip kit while pegs for laterals are used in baffle drip kits for shifting of laterals.



vii) Stakes: Micro-Sprinklers are mounted on 12" or 18" long plastic / metal stakes and micro-sprinkler are connected to lateral pipes through extension / spaghetti tube of 6 mm diameter.

TYPES OF AMIT SYSTEMS

IDE started working with low cost drip in India and Nepal simultaneously and developed different AMIT Kits depending on local industry, raw material for plastic products and farmers acceptance. The AMIT Systems can be classified in to three main categories, based on emitter type, as given below :

1. Micro-tube Drip System (Non shiftable)
2. Baffle Drip System (Shiftable)
3. Micro-Sprinkler System (Shiftable)

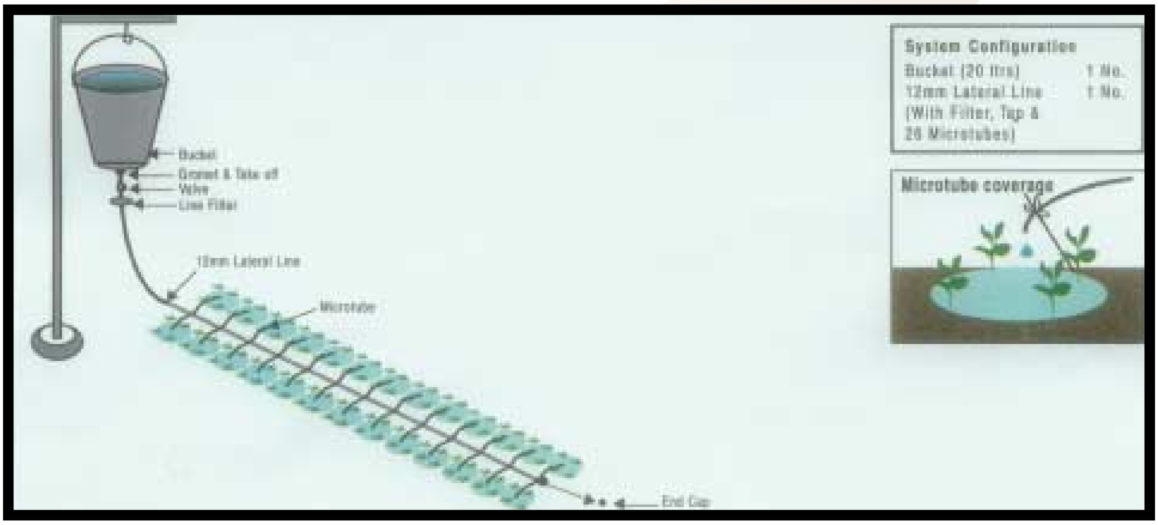
Depending on area covered / number of plants and type of crop, packaged kits were developed for above mentioned each main category. These kits can be upgraded or combined to form larger systems by using some additional fittings and accessories. Following table shows different types of AMIT Kits and area that can be covered with each type and approximate cost of the kit.

Micro tube Drip (MTD) System (Non Shiftable)			Baffle Drip Kit (BDK) – (Shiftable)			Micro Sprinkler System – (Shiftable)		
Type of Kit	Area Sq.m	Cost US$	Type of Kit	Area Sq.m	Cost US$	Type of Kit	Area Sq.m	Cost US$
Bucket Kit / Micro-tube Drip Kit (MTD 20)	20	6	Small Baffle Drip Kit (BDK125)	125, with one shift	15	Micro Sprinkler Kit - MS2	125 with five shift	6
Drum Kit / Micro-tube Drip Kit (MTD 100)	100	20	Medium Baffle Drip Kit (BDK250)	250 with one shift	20	Micro Sprinkler Kit - MS4	250 with five shift	10
Micro-tube Drip Kit (MTD 500)	500	80	Large Baffle Drip Kit (BDK500)	500 with one shift	30	Micro Sprinkler Kit - MS8	500 with five shift	15
Quarter Acre Drip Kit (MTD 1000)	1000	130	Upgrade kit for small & medium BHD Kits		7 & 12 resp.	Micro Sprinkler Kit - MS16	1000 with five shift	25

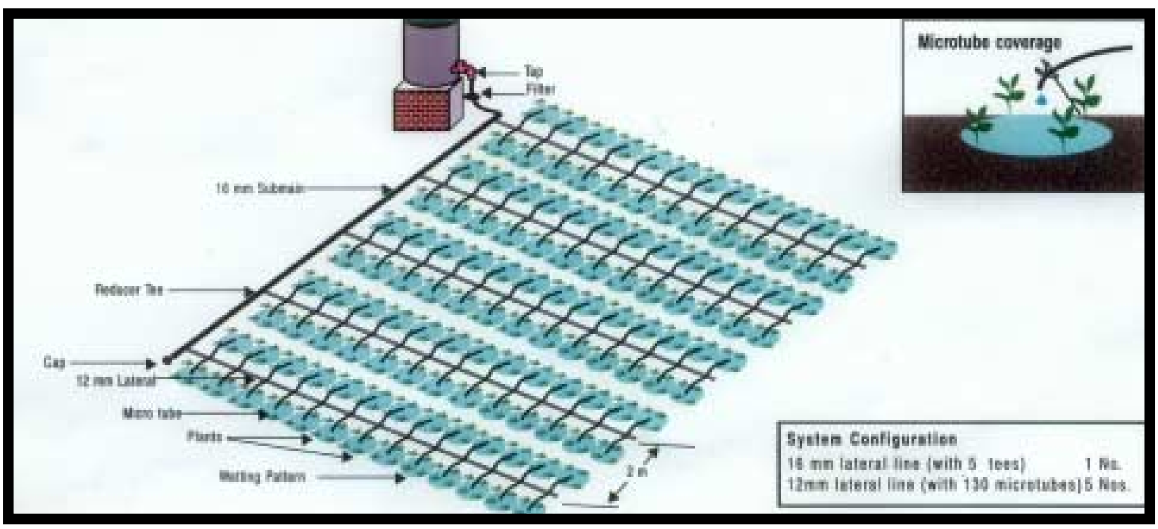
Each AMIT Kit is specific in application depending on area, type of crop, soil, water source etc. The salient features are given below along with diagrams.

4.1 Micro-tube Drip System (Non Shiftable):

4.1.1 Bucket Kit / Micro-tube Drip Kit (MTD20)



4.1.2 Drum Kit / Micro-tube Drip Kit (MTD 100)

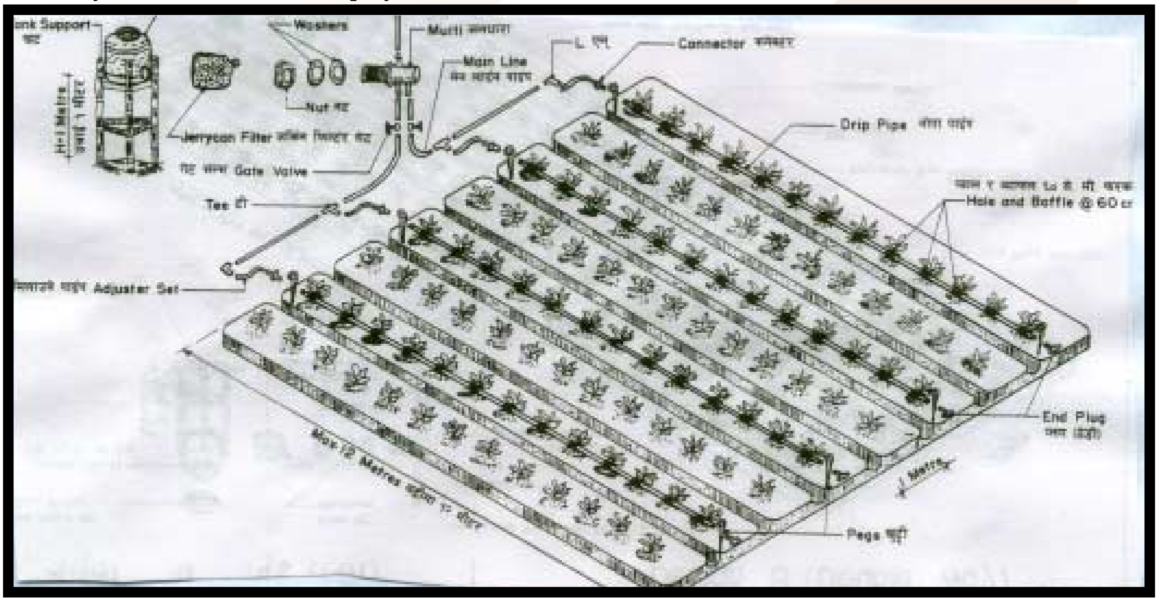


4.1.3 Salient Features of Micro-tube Drip Kits:

Specification	Bucket Kit / Micro-tube Drip Kit (MTD20)	Drum Kit Micro-tube Drip Kit (MTD 100)	Micro-tube Drip Kit (MTD 500)	Quarter Acre kit / Micro-tube Drip Kit (MTD 1000)
Area Coverage	20 sq. meter	100 sq. meter	500 sq. meter	1000 sq. meter
Type of Emitter	Micro-tube 1.2 mm I.D., 60 cm long	Micro-tube 1.2 mm I.D., 60 cm long	Micro-tube 1.2 mm I.D. 60 cm long	Micro-tube 1.2 mm I.D., 60 cm long
No. of Emitters/ Micro-tubes	60 / 30	300 / 150	1500 / 750	3000 / 1500
Emitter / Micro -tube Spacing	30 cm / 60 cm	30 cm / 60 cm	30 cm / 60 cm	30 cm / 60 cm
Type of Lateral	LLDPE 12 mm O.D.	LLDPE 12 mm O.D.	LLDPE 12 mm O.D.	LLDPE 12 mm O.D.
Lateral Length	5.0 m	9 m	16 m	16 m on each side of the sub-main
No. of Laterals	2	5	16	32
Lateral Spacing	2 m	2 m	2 m	2 m
Type of Sub-Main	LLDPE 12 mm O.D.	LLDPE 16 mm O.D.	LLDPE 32 mm O.D.	LLDPE 32 mm O.D.
Sub-main Length	1.8 m	10 m	32 m	32 m
Filter	Screen Filter (12 mm inlet & outlet size)	Screen Filter (16 mm inlet & outlet size)	Screen Filter (25 mm inlet & outlet size)	Screen Filter (25 mm inlet & outlet size)
Operating Head/ Height of Tank	1 meter	1 meter	2 meter	2 meter
Emitter Flow	2.5 lit / hour	2.2 lit / hour	2.4 lit / hour	2.2 lit / hour
Water Storage	20 liters	200 liters	1000 liters	2000 liters
Crops	Tomato, Egg Plant, Onion, Cabbage, Rape Seed, Paprika, Cauli-Flower, Garlic, WaterMelon, Cucumber, Lettuce etc. vegetable crops.		Tomato, Egg Plant, Onion, Cabbage, Rape Seed, Paprika, Cauli-Flower, Garlic, Water Melon, Cucumber, Lettuce etc. vegetable crops and also fruit crops viz. banana, papaya, pomegranate, citrus, mango etc with required modifications.	

4.2 Baffle Drip System (Shiftable):

4.2.1 Layout of Small Baffle Drip System:

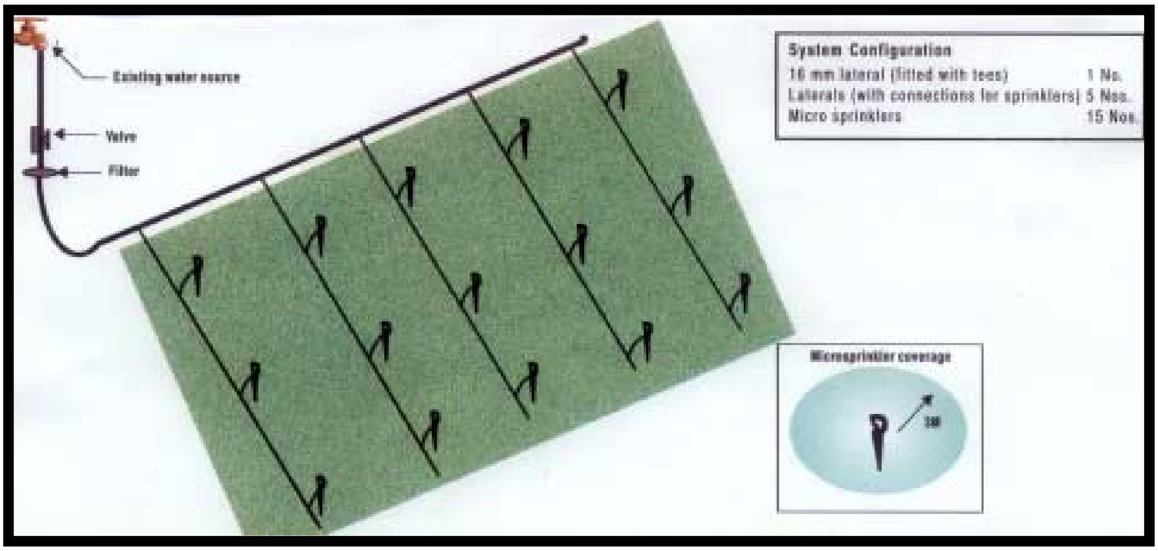


4.2.2 Salient Features of Baffle Drip System:

Specification	Small BDK	Medium BDK	Large BDK
Area Coverage	125 sq. meter with one shift	250 sq. meter with one shift	500 sq. meter with one shift
Type of Emitter	0.75 mm dia. Hole covered with Baffle	0.75 mm dia. Hole covered with Baffle	0.75 mm dia. Hole covered with Baffle
No. of Emitters	80	160	320
Emitter Spacing	60 cm	60 cm	60 cm
Type of Lateral	PVC 8 mm O.D.	PVC 8 mm O.D.	PVC 8 mm O.D.
Lateral Length	12 m	12 m	12 m
No. of Laterals	4	8	16
Lateral Spacing	2.7 m	2.7 m	2.7 m
Type of Sub-main	PVC 14 mm O.D.	PVC 14 mm O.D.	PVC 14 mm O.D.
Sub-main Length	10 m	20 m	40 m
Filter	Jerry-can Strainer with two layers of 100 mesh Nylon net	Jerry-can Strainer with two layers of 100 mesh Nylon net	Jerry-can Strainer with two layers of 100 mesh Nylon net
Operating Head/ Height of Tank	1 meter	1.5 meter	1.5 meter
Emitter Flow	2.5 lit / hour	2.5 lit / hour	2.5 lit / hour
Water Storage	50 to 100 liters	100 to 200 liters	200 to 400 liters
Type of crops	Vegetable crops	Vegetable crops	Vegetable crops

4.3 Micro-Sprinkler System (shiftable):

4.3.1 Layout of MSK-15 Kit:



4.3.1 Salient Features of Micro-Sprinkler System:

Specification	Micro Sprinkler Kit - MSK2	Micro Sprinkler Kit - MSK4	Micro Sprinkler Kit - MSK8	Micro Sprinkler Kit - MSK15
Area Coverage	100 sq. m with five shifts	200 sq. m with five shift	400 sq. m with five shift	800 sq. m with five shift
Type of Emitter	Micro Sprinkler	Micro Sprinkler	Micro Sprinkler	Micro Sprinkler
No. of Emitters	2	4	8	15
Emitter Spacing	3 m	3 m	3 m	3 m
Type of Lateral	LLDPE 12mm/ PVC 14 mm	LLDPE 12 mm/ PVC 14	LLDPE 12 mm/ PVC 14 mm	LLDPE 12 mm/ PVC 14 mm
Lateral Length	6 m	12 m	12 m	12 m
No. of Laterals	1	1	2	5
Lateral Spacing	-	-	3 m	3 m
Sub-Main Size	-	-	LLDPE 16 mm	LLDPE 16 mm
Sub-main Length	-	-	6 m	15 m
Filter	Screen Filter 0.5 – 1 m3/hr	Screen Filter 0.5 – 1 m3/hr	Screen Filter 0.5 – 1 m3/hr	Screen Filter 0.5 – 1 m3/hr
Operating Head	5 m – 10 m	5 m – 10 m	5 m – 10 m	5 m - 10 m
Emitter Flow	30 – 40 lph	30 - 40 lph	30 – 40 lph	30 – 40 lph
Type of crops	Vegetables, Flowers, Seedling Nursery			

CUSTOMIZATION OF AMIT KITS

AMIT Kits have standard sizes and are suited for small plots with fixed dimensions. But farmer may have plots of varied size and dimension. In that case AMIT Kit can be customized for particular farmer plot or changed to increase / reduce the area covered as per farmer's need. It can be done in following ways:

1. Adjusting length of the lateral pipes.
2. Using upgrade kit to increase area coverage.
3. Connecting additional kits to the same water source.
4. Making tailor made system using simple rules.

5.1 Adjusting length of the lateral pipe:

Using AMIT kit for smaller area than specified size, it can be done easily by closing the emitters or reducing lateral / sub-main length by using end cap. Incase of using the kit for larger area, it can be done by increasing lateral length or connecting additional laterals to the sub-main along with increase in pressure head (height of water tank). However it should be in accordance with the specified limits so that desired water distribution uniformity is not affected. Following table gives length that can be increased with corresponding increase in the height of the water source. Water storage also needs to be modified to suite the area covered or frequency of filling has to be increased.

Type of Kit	Length of 12mmLateral at Different Pressure Heads (Tank Height)				
	1 m Head	1.5 m Head	2.0 m Head	2.5 m Head	3.0 m Head
Bucket Kit (MTD20)	12	16	20	24	26
Drum Kit (MTD100)	10	14	18	22	25
Micro-tube Drip Kit (MTD500)	-	-	16	20	24
Quarter Acre Kit (MTD1000)	-	-	16	19	22

5.2 Using upgrade kit to increase area coverage:

Ready made upgrade kits are available incase of small and medium baffle hole drip systems. By using the upgrade kit, small BHD system can be converted into medium system and medium BHD system in to large system. Following table gives details of area covered by connecting upgrade kit.

Type of Kit	Area covered with original Kit (sq. m)	Area covered after connecting upgrade kit (sq. m)
Small BHD Kit	125	250
Medium BHD Kit	250	500

5.3 Connecting additional kits to the same water source:

For larger area AMIT drip kits can be clubbed together to irrigate required area. On a single source, up to four kits can be easily put together around the water tank, provided it has enough storage capacity (or refilling available) for all the kits. Following table gives area covered by addition of kits.

Type of Kit	Area under one kits (sq.m)	Area under two kit (sq.m)	Area under three kits (sq.m)	Area under four kits (sq.m)
Bucket Kit (MTD20)	20	40	60	80
Drum Kit (MTD100)	100	200	300	400
Micro-tube Drip Kit- MTD500	500	1000	1500	2000
Quarter Acre Kit-MTD1000	1000	2000	3000	4000
Small BDK	125	250	375	500
Medium BDK	250	500	750	1000
Large BDK	500	1000	1500	2000

DESIGN OF MICRO IRRIGATION SYSTEM

6.1 Design Inputs:

AMIT kits are designed to provide high irrigation efficiency and uniform distribution of water and nutrients for high value crops as compared to conventional flood irrigation system. Incase a larger system is required by the farmer tailor made to his field conditions it can be designed within allowable discharge variation limit by using following procedure. The inputs required to make a good design of micro irrigation system are as follows:

1. Layout of the area.
2. Details of the water source and soil type.
3. Agronomical details (plant spacing, crop period, season, canopy, etc)
4. Climatic data (rainfall, temperature, evapo-transpiration etc).

A survey questionnaire is provided in the annexure, which can be used to get specific information on above inputs. All the information is not required for designing basic layout of AMIT System and determining pipe sizes. However by using above information complete micro irrigation system can be designed which will give following outputs :

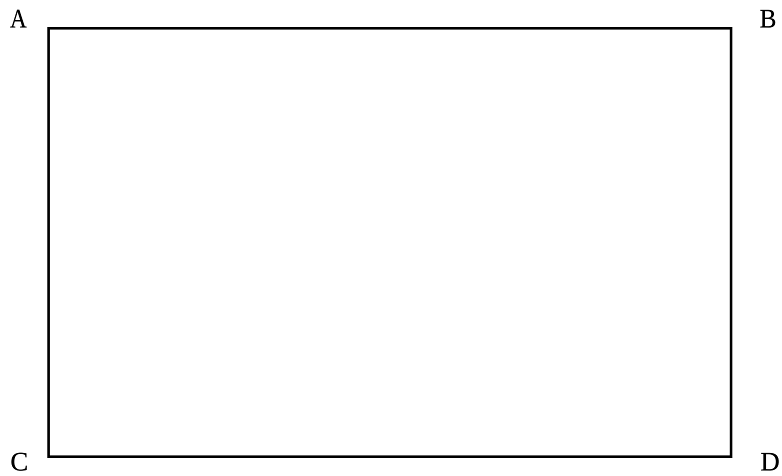
6.1 Design Outputs:

1. Detail layout of the system in the field.
2. Emitter selection and placement.
3. Size and length of mainline, sub main and lateral pipes.
4. Pumping and filtration requirement.
5. Operating Schedule (Irrigation Scheduling).
6. Bill of material and cost estimate.

System design starts with selection of suitable emitter depending on type of crop, water requirement, operating time, soil type, water quality etc. Length and size of lateral is determined from the table based on lateral flow rate, field size etc. Similarly size and length of sub main is determined. Each sub main is individual unit with a control valve. Whole area is then divided in to different sub main units and number of sub main units operating at a time are selected based on existing pumping / water source capacity. Each operating section is decided so that discharge is more or less similar for all the sections. The mainline is then planned connecting all the sub mains by taking shortest possible route and its size is determined from the table based on the flow rate so that frictional head loss is with in limit and total pressure head required for the system is within pump / water source capacity. If there is no pump then pump requirement is worked out from total discharge and pressure head required for the system. Depending on flow rate and water quality suitable filtration device is selected. Total quantity of all the components is calculated from the layout to prepare bill of quantity and cost estimate.

6.3 Survey:

To prepare accurate layout of any area (size, shape and slope), survey inputs that are required to make a layout (e.g. ABCD) for design of micro irrigation system are described as given below:



1. Straight distance: between points at the corners (e.g. AB, BC, CD & DA). It can be measured with a tape in a straight line with corner points duly identified by putting stones or sticks.

2. Angle at the corner: For three cornered area distances of three sides is enough to make the layout. For four-cornered area any one angle has to be measured along with distances of the sides. For five cornered figure two consecutive angles will be required and so on for multiple sides. Distance of 10 meters is marked from the corner on each line forming the angle and then a tie length is measured between these points. The angle then can be determined from the table for tie length and corresponding angle as given in the annex.

3. Elevation: Slope of the ground surface may be judged with naked eye for small plots wherever possible and taken in to consideration while designing the drip system. If the ground surface is too undulating and slope is difficult to be judged by naked eye, then levels should be taken with leveling instrument and contours drawn on the map to make proper design of the drip system.

4. Water Source: Position of water source (Tank, well, reservoir, pond, river, stream, existing pump, pipe line etc) should be marked on the map and following details should be noted.

   a) Size, Volume, flow rate etc. of water source and its height above ground level or depth from ground surface.

   b) Pump details for existing pump viz. suction, delivery, actual discharge & head, operating time, pump HP, expected discharge & head etc.

   c) Quality of water, impurities in water (algae, sand /silt etc.). If water analysis report is available it should be enclosed with the survey report or if possible farmer should try to get it analyzed from local laboratory.

5. **Agro-climatic details:** The details of existing crops or crops to be planted should be noted viz. specific area under particular area, crop spacing (plant to plant distance x row to row distance), no. of plants and no. of rows, crop duration, expected canopy, rainfall, evapo-transpiration etc.

6. **Soil details:** The details of soil quality visible to naked eye should be noted viz. heavy soil or light soil depending on soil texture(proportion of clay, silt & sand). If soil analysis report is available it should be enclosed with the survey report or farmer try to get it analyzed from local laboratory.

7. **Permanent details:** like farm house, large tree, huge rock etc. should be marked by taking angular measurements from minimum two points so that it can be plotted accurately on the survey plan.

8. **Survey Plan:** From above information (1 to 6) plan of the area surveyed can be prepared on 1: 1000 scale. For smaller area scale can be used depending on size of the area. Design of drip system (lay out) can be prepared on this plan and then it can be used for installation purpose.

6.4 Water Requirement:

Water Requirement of plants depends on many factors viz. temperature, humidity, soil type, wind velocity, growth stage, shade / sun etc. Plants absorb soil moisture and transpire it to the atmosphere during the process of photosynthesis. Some amount of water is retained in the plant tissue and rest of the soil moisture gets evaporated to the atmosphere. Drip Irrigation involves frequent application of water, even on a daily basis. Therefore water requirement of the plant per day is equivalent to the rate of potential evapo-transpiration (PET) per day. Evapo-transpiration is the quantity of water transpired by the plants plus quantity of water retained in the plant tissue and water evaporated from the soil surface. The values for reference evapo-transpiration are normally available for particular area at the nearest meteorological observatory.

Water requirement can be calculated as:

WR (Liters per day) = ET x Kc x Cp x Area, where

ET is evapo-transpiration (mm per day)

Kc is crop factor,

Cp is canopy factor,

Area in sq. meter.

If specific crop factor values are not available then it can be assumed as one.

Canopy factor is the percentage area covered by plant canopy (foliage). It varies as per the growth stage of the plant.

Area incase of orchard plant is the multiplication of the distance from plant to plant (m) and distance from row to row (m). Incase of row plantation unit area can be taken to calculate water requirement.

Example: Calculate Peak water requirement for grapes planted at the spacing of 2 m by 2m. Assume peak ET for the area as 6 mm per day, crop factor for grape 0.8 and canopy factor 0.8.

Peak water requirement per day = 6 x 0.8 x 0.8 x 2 x 2

= 15.36 liters per day per plant

It is called as peak water requirement because it is calculated on the basis of highest rate of evapo-transpiration which normally occurs in high temperature and windy conditions in summer. However daily water requirement will depend on daily rate of evapo-transpiration. It will be less during winters and more in summer. The drip system has constant discharge at the given pressure. Therefore operating time can be varied to provide required amount of water depending on the season.

6.5 Operating Time / Irrigation Scheduling :

Operating (Irrigation) time is the duration for which the irrigation system is run to provide required amount of water for the plants. It can be calculated as following:

$$\text{Irrigation time (hrs / day)} = \frac{\text{Water requirement (liters per day)}}{\text{Application rate (liters per hour)}}$$

Example: 1

Calculate Irrigation time for a papaya tree with daily water requirement of 10 liters per day per plant and provided with microtube system with discharge rate of 4 liters per hour.

$$\text{Irrigation time (hrs / day)} = \frac{10}{4} = 2.5 \text{ hrs / day}$$

Example: 2

Calculate Irrigation time for a vegetable plot of size 100 sq. meter with daily water requirement of 400 liters per day and provided with microtube system with discharge rate of 200 liters per hour.

$$\text{Irrigation time (hrs / day)} = \frac{400}{200} = 2 \text{ hrs / day}$$

6.6 Selection of emitter:

Emitter is the most important part of a drip system through which water is delivered at desired rate to the plant and uniformity of water application is maintained all over the irrigated area. Therefore an emitter should match particular conditions existing at the field viz. type of crop, spacing of the plants, terrain, water requirement, water quality, operating time, pressure head etc. Some of the criteria that can be applied to the selection of dripper are given below:

1. Reliability against clogging and malfunctioning.
2. Emission Uniformity

3. Simple to install and maintain.
4. Permissible variation of pressure head (Pressure compensating incase of undulated terrain).
5. Percentage area wetted.
6. Flow rate
7. Operating pressure.
8. Cost

Following table shows application of major type of emitters to different crops.

Type of Emitter	Discharge Range, (Liter/hour)	Operating Pressure head, (Meter)	Application to type of crops, terrain etc.
Micro-tube, Baffle, Online- Inline Drippers.	1 LPH to 10 LPH	1 m to 10 m	Vegetable, Fruit and Row crops on flat terrain.
Dripper - self / pressure compensating (online, inline etc.)	1 LPH to 10 LPH	10 m to 30 m	Vegetable, Fruit and Row crops on undulated terrain.
Line source tube / Thin	1 LPH per meter to walled Tape	1 m to 10 m 5 LPH per meter	Long Row crops (sugarcane, vegetables, pulses etc.)
Micro Sprinkler / Micro Jet	20 LPH to 100 LPH	5 m to 30 m	Vegetable, nursery.
Mini Sprinkler	500 LPH to 1000 LPH	10 m to 30 m	Closely spaced crops.

6.7 Design of Lateral:

In most of the drip systems LLDPE laterals of 12 mm and 16 mm size are used. For AMIT micro tube system 12 mm LLDPE lateral is used and for Baffle hole drip system 8 mm PVC lateral is used. There are some important points to be considered while designing the lateral pipe as given below:

1. If the average slope of the field is less than 3 % in the direction of the lateral, it can be used at equal length on both sides of sub main pipe.
2. If the slope of the field is more than 3 % laterals should be used along the contours as far as possible.
3. If it is not possible to use laterals along the contours on sloping surface due to plant spacing etc., the length of laterals on downside of the sub main should be more than laterals on the upside. For higher slopes laterals only on downside should be used.

It is important to find out how long a lateral can be used on each side of the sub main so that variation in discharge due to friction loss is within allowable limit. The desirable limit for emitter flow variation is less than 10 % but depending on the crop, variation of 10 to 20 % is acceptable. For 10 % variation in discharge, approx. 20 % variation in the available head is acceptable. Accordingly allowable length of lateral can be calculated from flow equations like Hazen-Williams (using C = 150) as given below:

$$H_l = \frac{5.35\ Q^{1.852}\ L}{D^{4.871}}$$

where H_l is pressure loss due to friction (m),
Q is total discharge of lateral (lps),
L is length of lateral (m) & D is inside diameter (cm).

To cover range of emitter discharge and spacing, a parameter Specific Discharge Rate (SDR) is used. It is actually flow per unit length of the lateral. It can be calculated as given below.

$$\text{Lateral SDR (lph/m)} = \frac{\text{Emitter flow rate (lph)}}{\text{Spacing between two emitters (m)}} = \frac{\text{Discharge from lateral (lph)}}{\text{Length of lateral (m)}}$$

Following tables gives allowable length for 8 mm, 12 mm, 14 mm & 16 mm pipe sizes at different pressure head and lateral flow rates.

Allowable Length of 8 mm and 12 mm Pipes (m):

Lateral SDR (lph/m)	Available Pressure Head											
	1 m		2 m		3 m		5 m		10 m		15 m	
	8 mm	12 mm	8 mm	12 mm	8 mm	12 mm	8 mm	12 mm	8 mm	12 mm	8 mm	12 mm
1.00	18	30	20	35	25	40	35	70	50	100	60	120
2.00	15	25	16	30	22	35	25	50	35	60	45	70
4.00 *	12	20	15	25	18	30	20	35	25	40	35	50
6.00 ^	06	12	10	15	14	20	15	25	20	30	25	35
10.00	04	08	08	12	10	15	10	18	15	20	20	25
15.00	03	06	04	07	05	08	07	10	10	15	12	18
20.00	02	04	03	05	03	06	05	08	06	10	08	15

(* For BHD Kits. ^ for Bucket Kit & Drum Kit)

Allowable Length of 14 mm and 16 mm Pipes (m):

Lateral SDR (lph/m)	Available Pressure Head											
	1 m		2 m		3 m		5 m		10 m		15 m	
	14 mm	16 mm	14 mm	16 mm	14 mm	16 mm	14 mm	16 mm	14 mm	16 mm	14 mm	16 mm
1.00	40	50	45	60	60	80	80	100	120	150	150	180
2.00	30	40	35	50	45	60	60	80	80	100	100	120
4.00	25	30	30	40	35	40	40	50	50	60	60	75
6.00 ^	15	20	20	25	25	30	30	40	40	50	50	60
10.00	10	12	12	15	15	20	20	25	25	35	35	45
15.00	08	10	10	12	12	15	15	20	20	30	30	35
20.00 *	04	08	05	10	10	12	10	15	15	20	20	25
25.00	02	04	02	04	05	08	08	10	10	15	15	20

(^ for HGK , and * for BHD Kits & VGK, KGK)

Note :

Above figures are for flat land and adjustment has to be made in length of pipe depending on slope, i.e. Shorter laterals for up slope and longer lateral for down slope so that total pressure variation is within given limit.

6.8 Design of Sub main :

Sub main pipe is designed in a similar way like lateral because it is also a perforated pipe like lateral and discharge in it reduces with respect to length of the pipe. Therefore limitation of 20 % pressure variation to calculate the length can be used. Depending on flow rate various sizes of PVC / HDPE / LLDPE pipes are used as sub main in micro irrigation system. For micro tube AMIT Kits 16 mm LLDPE pipe is used as sub main and for baffle hole drip 14 mm PVC flexible pipe is used. Allowable length at different pressure head and flow rates for 14 mm & 16 mm is given in above table and for 20 mm, 25 mm, 32 mm and 40 mm is given in tables below.

$$\text{Sub main SDR (lph/m)} = \frac{\text{Lateral SDR (lph/m)} \times \text{Length of the lateral (m)}}{\text{Spacing between two laterals (m)}}$$

$$= \frac{\text{Total Discharge from the Sub main (lph)}}{\text{Length of the sub main (m)}}$$

Allowable Length of 20 mm & 25 mm Pipes (m) :

Sub main SDR (lph/m)	Available Pressure Head											
	1 m		2 m		3 m		5 m		10 m		15 m	
	20 mm	25 mm	20 mm	25 mm	20 mm	25 mm	20 mm	25 mm	20 mm	25 mm	20 mm	25 mm
10	20	30	30	40	40	50	50	60	60	75	70	90
20	10	20	15	25	20	40	25	50	30	60	40	70
40	02	10	05	15	07	20	10	30	15	40	20	50
80		04		06		10		15		20		30

Allowable Length of 32 mm & 40 mm Pipes (m) :

Lateral SDR (lph/m)	Available Pressure Head											
	1 m		2 m		3 m		5 m		10 m		15 m	
	32 mm	40 mm	32 mm	40 mm	32 mm	40 mm	32 mm	40 mm	32 mm	40 mm	32 mm	40 mm
20	40	60	50	50	60	75	70	90	80	120	100	150
40	25	30	30	40	40	50	50	60	60	90	70	120
80	15	20	20	30	25	30	30	45	40	60	50	80
150	07	10	10	15	15	20	20	30	25	40	30	50
300		04		08		15		20		25		30

Note :

Above figures are for flat land and adjustment has to be made in length of pipe depending on slope, i.e. Shorter sub main for up slope and longer sub main for down slope so that total pressure variation is within given limit.

6.9 Design of Main Line:

Design of mainline involves determining diameter of pipe and class / thickness. It depends on flow rate, operating pressure, topography. As per irrigation scheduling of the sub main units, mainline flow can be determined by selecting sub mains operating at a time. The mainline size is selected so that allowable pressure variation due to friction loss is within limit for the economic pipe sizing. Frictional head loss can be calculated using Hazen-Williams equation as given below:

$$H_l = \frac{15.27\ Q^{1.852}\ L}{D^{4.871}}$$

where H_l is pressure loss due to friction (m),
Q is total discharge in the pipe (lps),
L is length of pipe (m) & D is inside diameter (cm).

Following table gives mainline sizes for different flow range and resulting frictional head loss in 10 m length of pipe.

Pipe Size (Out side diameter-mm)	16	20	25	32	40	50	63	75
Flow Range (lps)	0.01 to 0.07	0.07 to 0.15	0.15 to 0.25	0.25 to 0.50	0.50 to 1.00	1.00 to 2.00	2.00 to 3.50	3.50 to 5.00
Friction Loss (m per 10 m of pipe length)	0.01 to 0.35	0.10 to 0.38	0.13 to 0.32	0.10 to 0.32	0.10 to 0.30	0.11 to 0.40	0.11 to 0.32	0.13 to 0.30

6.10 Selection of Filter:

Filtration requirement depends on size of flow path in the emitter, quality of water and flow in the mainline. Screen filter is used in case of AMIT Kits as water is stored in a storage tank. For large system, depending on water quality, different filters or combination of filters can be used. For large flow requirements filters can be connected in parallel using manifolds so that pressure loss across the filter is within limit. Four types of filters are mainly available in different sizes (filtration area) as described below,

1. Screen (Mesh) Filter : It is made of plastic or metal and different sizes are available for different flow rates from 1 m3/hr to 40 m3/hr. It is used for normal water with light inorganic impurities. It is called surface filter.
2. Sand (Media) Filter : It is made of M.S. metal and available in different sizes similar to screen filter. It is used for water with suspended particles and organic impurities like algae. Either sand or gravel can be used as media for filtration. It is also called as depth filter. It is used in series with the screen filter.
3. Disc Filter: It is made of plastic and has round discs with micro water path, staked together in a cylinder so that impurities cannot pass through the discs. It gives combination of surface and depth filters.
4. Hydro-cyclone: It is made of M.S. metal and has a conical shaped cylinder to give centrifugal action to the flow of water so that heavy impurities settle down. It is used incase of sandy water along with the screen filter.

6.11 Selection of Pump / Total Head Requirement:

Head (pressure) required at the inlet of the mainline or filter is given below:

Head (m) = Operating pressure (m) + Mainline friction loss (m) + fittings loss (m) + Filter loss (m) + (-) Elevation difference (m).

Incase of centrifugal pump total head requirement is as given below:

Total Head (m) = Suction head (m) + Delivery head (m) + Operating pressure (m) + Mainline friction loss (m) + fittings loss (m) + Filter loss (m) + (-) Elevation difference (m).

Horse Power Requirement:

$$\text{Horse Power (HP)} = \frac{\text{Flow (lps) x Total Head (m)}}{\text{75 x Motor efficiency x Pump efficiency}}$$

Efficiency of the motor and pump differ for different model and make. Approximately motor efficiency can be taken as 80 % and pump efficiency as 75 % for mono-block pump. However in order to procure pump from the market, required flow and total head should be mentioned to the supplier / manufacturer so that he can select suitable model from the same or lower horse power category.

INSTALLATION & COMMISSIONING

Installation of AMIT Kits is very simple process as shown in the installation diagrams in the annexes. It can be divided in to three stages viz.

1. Installing water source (bucket, barrel, tank, pump etc.).
2. Laying of pipes and emitters / micro-tubes.
3. Commissioning

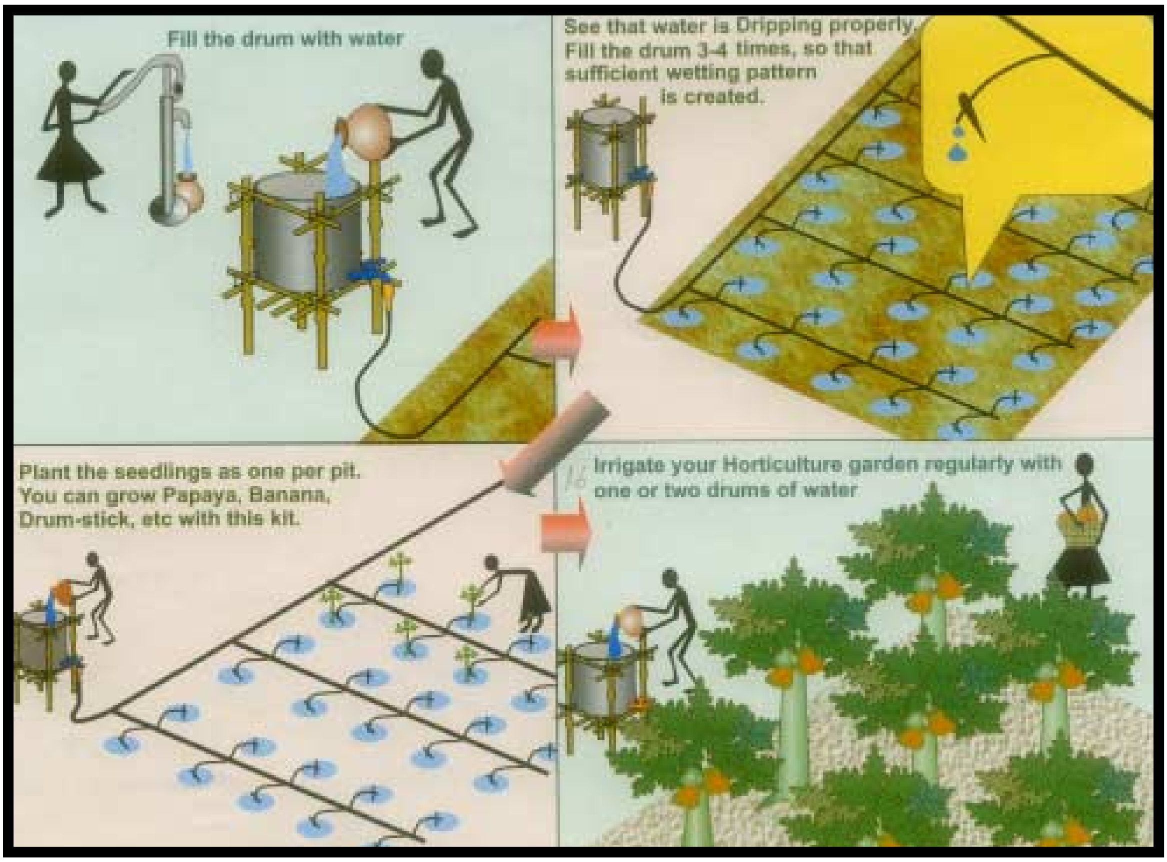
If there is no overhead tank then water source in terms of bucket, barrel, tank etc. has to be organized first locally. It has to be installed at an height above ground level on a stable support / platform (minimum 1 meter high) depending on the system requirement. The drip then can be connected to the water source. Micro-sprinkler and overhead sprinkler kits can be directly connected with equivalent discharge outlet of a pump or water supply system. Make sure that control valve and filter is connected to the system through mainline.

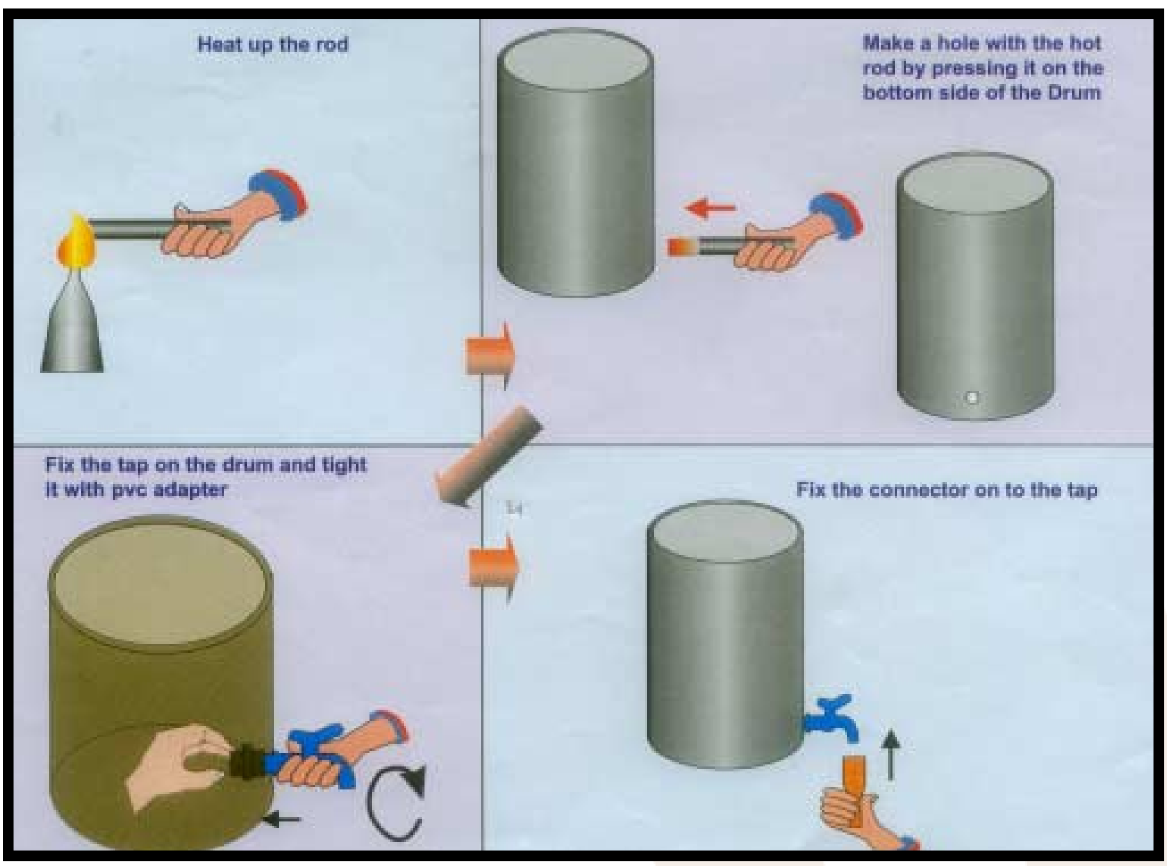
Lateral pipes are laid on the ground in straight line or along the plant rows. Emitters / micro-tubes are pre-fixed on the lateral. They are placed at equal spacing so that plants get uniform amount of water. Stakes are used incase of micro-tube and micro-sprinklers to place them properly. Care should be taken so that dirt, sand etc. does not enter in to pipes while making connections.

Before operating the system end caps at the end of laterals / sub main are released so that if there is dirt in the pipes it is washed away and air is also driven out. Open the control valve and let the water flow freely through the pipes for some time (flush the system). Then close the end caps and ensure that water is coming out from each emitter.

In general following activities are involved in the installation of AMIT System.

1. Study installation sketch.
2. Give layout for water tank / filter platform and trenches for pipes if required.
3. Check components in the kit / material at site as per the checklist / BOQ.
4. Install water storage tank, filter on the platform / stable support.
5. Connect filter to the water source / pump and the mainline.
6. Lying of mainline, sub main and lateral pipes.
7. Covering pipe trenches if required.
8. Placement / fixing of emitters.
9. Release all end caps / flush valves and open all control valves.
10. Flush the system.
11. Check pressure and discharge and ensure all emitters are working.
12. Operate as per schedule.


Fill the drum with water
See that water is Dripping properly.
Fill the drum 3-4 times, so that
sufficient wetting pattern
is created.
Plant the seedlings as one per pit.
You can grow Papaya, Banana,
Drum-stick, etc with this kit.
Irrigate your Horticulture garden regularly with
one or two drums of water


Heat up the rod
Make a hole with the hot
rod by pressing it on the
bottom side of the Drum
Fix the tap on the drum and tight
it with pvc adapter
Fix the connector on to the tap

MAINTENANCE & TROUBLESHOOTING

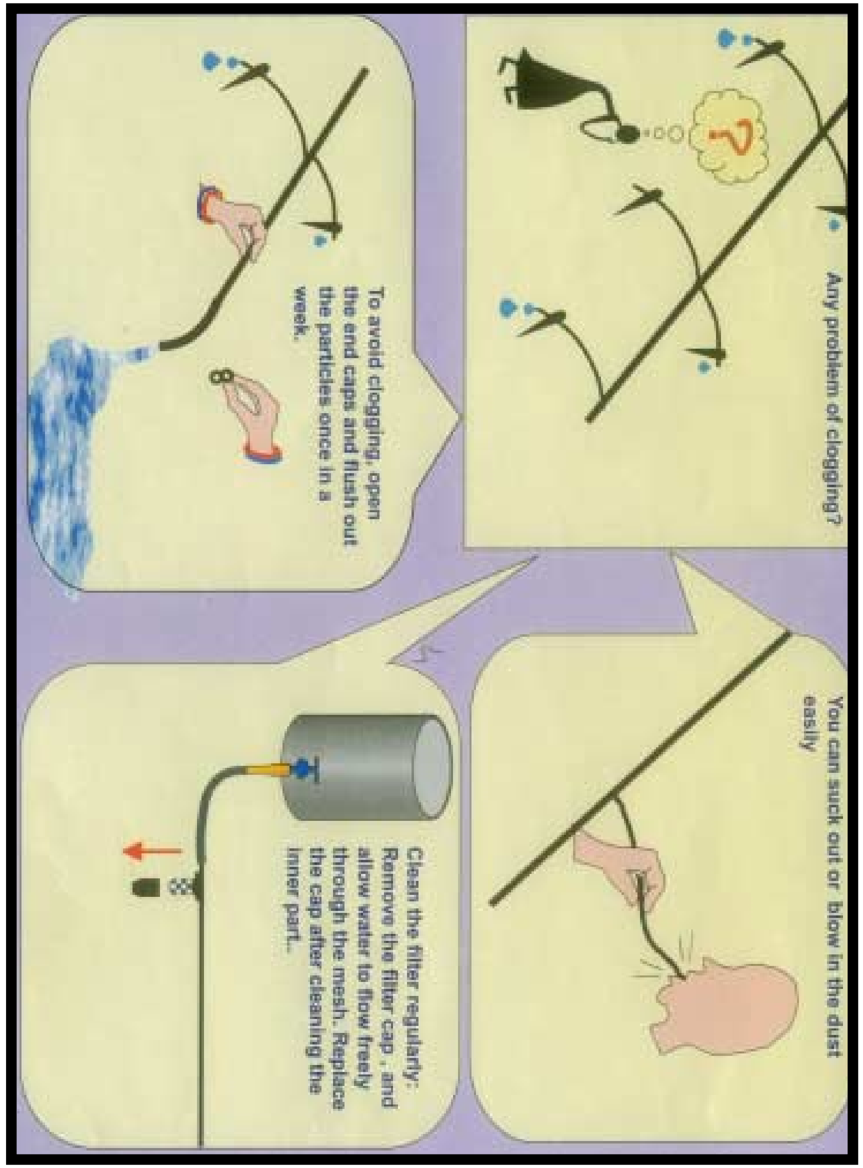
The biggest problem of any drip system is clogging of emitters. AMIT Kits use very simple emitters, which are less prone to clogging due to wider flow path. Therefore it requires less maintenance as compared to other drippers. However periodic and preventive maintenance is essential for smooth working of the system. Following general checks can be carried out periodically depending on the local condition and water quality.

1. Clogging of emitters / wetting pattern.
2. Placement of emitters / micro-tubes.
3. Leakages in pipes, valves, filter, fittings etc.
4. Flushing & cleaning of filter by opening and cleaning the screen.
5. Flushing of sub main & laterals by releasing the end caps.

Apart from physical impurities that can be separated by using screen filter, there are dissolved chemical (mainly salts) impurities and also biological impurities like algae, bacteria etc. present in some water source. If the dissolved salts are in higher concentration, they can accumulate and clog the emitters. Then hydrochloric acid can be applied to the emitters to flush the salts. Incase of clogging by bacteria or algae, chlorine treatment in the form of bleaching powder (2 mg per liter) can be given to clean the emitters and inhibit slime growth.

Some common problems faced by micro irrigation system, causes and trouble shooting required is given in the following table.

Problem	Cause	Troubleshooting
Micro-tube/ Emitter not delivering water.	Clogging due to impurities in water or air bubble in micro-tube	1. Take out micro-tube from lateral pipe and shake it or blow it so that dirt/air comes out. Incase of other emitter, open it and clean it with needle so that dirt is removed. Then fix the emitter and check it's working. 2. Check the filter screen and gasket for any possible leakage and if required replace them.
Leakage in lateral, sub- main or main pipe	Cut in pipe due to mechanicaldamage or rodent etc.	Cut the pipe at the place of damage and connect it by using joiner / connector. For large diameter pipes, if joiners are not available then service saddle also can be used.
Leakage in fittings of lateral pipe.	Expanded pipe end due to frequent use	Cut the pipe end for the expanded portion and insert the fitting in it again. If the fitting is too loose for the pipe diameter it can be adjusted by heating it.
Reduced flow of water from emitter.	1. Chocked filter 2. Pipe leakage 3. Open end cap	1. Clean the filter screen. 2. Repair pipe leakage as mentioned above. 3. Fix the end.


Any problem of clogging?
You can suck out or blow in the dust easily
To avoid clogging, open the end caps and flush out the particles once in a week.
Clean the filter regularly: Remove the filter cap , and allow water to flow freely through the mesh. Replace the cap after cleaning the inner part.

FREQUENTLY ASKED QUESTIONS ON AMIT

Questions	Answers
Water requirement incase of drip irrigation	It will depend on climate, soil, crop etc. Approximately it can be equal to Evapo-transpiration multiplied by canopy factor or percent wetted area.
Expansion / Customization of AMIT Kit	Lateral pipes can be increased in length as shown in table 5.1. Alternately additional kits can be attached to the same water source.
Life of AMIT components	The life of most plastic components is minimum five years. It can last up to ten years if maintained properly.
Water saving	Most drip systems save water application up to 50% as compared with traditional system.
Spacing of micro-tube / emitters	For closely spaced crops viz. onion, garlic drippers should be close enough to form the wetting strip (Between 30 to 45 cm). For widely spaced crop it can be given one or more per plant depending on plant spacing and wetting required.
Water storage required for AMIT Kits	The capacity of water storage for gravity system should be equal to one-day retention of the daily water requirement. It can be less if frequency of water filling is higher or continuous.
Root development incase of drip irrigation	The roots have tendency to reach for moisture content. Therefore the roots are very well developed incase of drip. It also provides proper soil-air-water ratio for root respiration.
Application of drip to existing plantation	Drip can be applied to existing plantation and it will give better yield. Care should be taken if moisture stress is required by some crops to induce flowering.
Water application at the time of sowing	It is better to provide enough water to form complete wetting so that all the seeds/seedlings have access to moisture.
Reasons for increase in yield / quality	Since water is given at regular but frequent intervals and at a required quantity as compared with traditional system, plants have better metabolism and produce better crop in quality and quantity. The soil-water-air ratio incase of drip is also favorable for most cash crops. Drip irrigations keeps the soil warmer than conventional type of irrigation.

Pressure head required for AMIT Kits	The pressure head or height of water source will depend on size of area covered or distance of remotest dripper from the source. Approximately 1m for 100 sq.m., 2 m for 500 sq.m. and 3 m for 1000 sq.m.
Use of AMIT Kits on undulated area	If there are terraces formed on hill slopes or undulated area, one or more drip kit should cover single terrace, which is evenly leveled. Separate kit should be used for terrace on upward or downward side. Operate one terrace at a time so that water is spread uniformly. If more terraces have to be irrigated at a time then flow for downward terraces should be decreased with the help of valve or orifice so that equal quantity of water is supplied to each terrace.
Length of micro-tube	For vegetables where microtube is provided on both sides of the lateral, it should be sufficient to reach each row. For widely spaced crops it should confirm to required discharge at a given pressure head.
Damage to lateral pipes due to rodent etc.	Lateral pipe should be cut and damaged portion has to be removed. Connect the lateral with the help of the connector.
Theft of AMIT Kits	Try to bury maximum length of pipes under the ground. The lateral and submain pipes being perforated with holes will be less prone for theft.
Shifting of Micro-tube system at the end the season.	After the crop has been harvested the drip system should be of stored properly so that it is not damaged mechanically or by rodents in the store / field. Hanging it on a wooden pillar can protect it from the rodents.
Use of AMIT Kit for different crops	The spacing of most vegetable crops is same or in multiple of the minimum. Therefore drip kit can be utilized for various spacing / crops.

APPENDIX

10.1 Glossary:

Abbreviation	Description
AMIT	Affordable Micro Irrigation Technology
IDE	International Development Enterprises
MIS	Micro Irrigation System
MDK	Micro-tube Drip Kit
BDK	Baffle Drip Kit
MSK	Micro-Sprinkler Kit
ET	Evapo-transpiration
hp	Horse Power
LPH	Liter per Hour
LPS	Liter per Second
LPH per meter	Liter per hour per meter
ha	Hector
ft	Feet
inch	Inches
mm	Millimeter
cm	Centimeter
m	Meter
Sq.m	Square meter
PVC	Polyvinyl chloride
PE	Polyethylene
HDPE	High Density Polyethylene
LDPE	Low Density Polyethylene
LLDPE	Linear Low Density Polyethylene

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