Drip Irrigation

1.0 Introduction

Drip irrigation, also known as "trickle" irrigation, is one of the methods of water management. Under this system, water is carried to the plant under low pressure, through small diameter plastic pipes and delivered at the root zone, drop by drop through drippers. Drip irrigation is widely practised and established method of irrigation in developed countries and is slowly gaining popularity in India. It is most suited for horticulture crops, vegetables etc. and finds applicability in hard rock areas where groundwater is scarce and helps in optimisation of the limited water resources. The system has its advantages and limitations. Its advantages are in terms of savings of water (50-60%) of that required for flow irrigation, effective use of fertilizers, less labour and energy cost. The limitation for adopting of this method is its high initial cost which is beyond the purchasing capacity of small and marginal farmers and thus mainly adopted by large farmers.
As a policy to encourage use of such systems, the Govt. of India announced the Centrally sponsored Micro Irrigation Scheme during 2005-06. The total cost of the scheme is being shared between Central Government, the State Government and the beneficiary either through his/her own resources or soft loan from financial institutions in the ratio of 40%, 10% and 50% respectively. Bankable schemes have to be formulated for availing bank loans. This model gives broad guidelines for scheme formulation by banks for financing drip irrigation systems.

2.0 SCHEME REQUIREMENTS

Scheme formulation for installation of drip irrigation systems against bank loan requires both technical and financial details. This should briefly give the command area, type of plant/tree, required spacing between plants, land scope etc. and general topographic features. The important items that should be included in a scheme for drip irrigation system are given bellow :

2.1 Soil

The general nature of the soil and its characteristics should be indicated. Soils have a bearing on the water requirements of crops and setting up the irrigation schedule. A drip system is not suitable for clayey or gravely soils as would be seen from table 4. Best results with this system are obtained with medium textured soils.

2.2 Climate and Rainfall

The climatic condition and rainfall of the area governs the irrigation requirements of the crops. The evapo - transpiration data is also important. The normal monthly evaporation data as per Indian Meteorological Department (IMD) should necessarily be given which would greatly help in determining the daily water requirements and irrigation needs in different seasons.

2.3 Groundwater quality

Groundwater quality in the scheme area should be given. Its suitability for irrigation may be indicated in sodium absorption ratio, total dissolved solids etc.

2.4 Designs of Drip System

The designs of the drip system especially the layout, size and length of mains, sub-mains, laterals etc. based on land slope and field plot layout should be given in the scheme.

Emitter selection, number of emitters to the plant, water discharge through the emitter and total pumping schedule should be indicated.

2.5 Well Capacity

The source of water should be indicated. If the source of water is a groundwater structure, the diameter, depth and well yield together with HP of the pump set already installed may be given. This is necessary to decide the discharge available from the well and its optimum utilisation.

2.6 Economics

The economics of investment should be given in detail to justify the loan. The scheme should also give details about repayment period, rate of interest, subsidy available etc.

2.7 Basic Data Information

A drip irrigation system requires certain basic data information to plan its layout and ensure trouble free operation. A format for the required information is given in the Annexure I which necessarily should be provided in the scheme.

3.0 TECHNICAL ASPECTS

3.1 Design Parameters

The design of a drip Irrigation system involves estimation of the following parameters.

1. Area to be irrigated, type of plants, their spacing and numbers per hectare.
2. Peak water requirement of a plant per day. For estimation of total water requirement for a given area, the number of emitters required per plant, amount of water discharged per hour through each emitter and the total number of hours water is available should be known/estimated.
3. Design of Main and Lateral Drip Lines. This depends upon friction head loss which in turn is governed by the type of plantation/crop and field configuration.
4. Water required to be pumped from the well. This depends upon hydrogeological conditions in the area and water requirement of plants/crop.
5. Horse Power of Pump set depends upon discharge and total head including friction losses over which water is to be lifted/pumped.
6. Unit cost.

3.1.1 Command Area

A command area map giving systems layout is necessary to plan and design a drip irrigation system. It may not be necessary to have a detailed contour plan but it is helpful if a plan showing the highest and lowest points along with well location is given in the scheme. This enables proper design of main line and laterals to suit the spacing and number of plants.

The recommended spacing and population of some of the important plants/crops are given in the Table 1 below.

Table 1 : Spacing and Plant Population of Important Plants/Crops

Sr.No	Crop	Spacing (m)	Plant Population (Nos/ha)
1	**Grapes**	3.0 x 3.0	**1,100**
2	**Mango**	10.0 x 10.0	**100**
3	**Oranges**	5.0 x 5.0	**400**
4	**Lime**	6.0 x 6.0	**270**
5	**Coconut**	7.5 x 7.5	**175**
6	**Banana**	1.5 x 1.5	**4,400**
7	**Cotton**	1.3 x 1.3	**5,900**
8	**Tomato/Brinjal**	1.0 x 0.5	**20,000**
9	**Sugarcane**	1.0 x 0.3	**33,000**
10	**Litchi**	6.0 x 8.0	**208**

3.1.2 Water Requirement of crops/plants

Water requirement of crops (WR) is a function of surface area covered by plants, evaporation rate and infiltration capacity of soil. At first, the irrigation water requirement has to be calculated for each plant and thereafter for the whole plot based on plant population for the 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.

WR = **A** X **B** X **C** X **D** X **E**.................Equation (1)

Where : WR = Water requirement (lpd/plant)

A = Open Pan evaporation (mm/day)

B = Pan factor (0.7)

C = Spacing of crops/plant (m2)

D = Crop factor (factor depends on plant growth for fully grown plants = 1)

E = Wetted Area (0.3 for widely spaced crops and 0.7 for closely. spaced crops)

The total water requirement of the farm plot would be **WR** x **No.of Plants**

The daily water requirement pf various crops per plant for different pan evaporation readings are given in Table 2.

Table 2 : **Water requirement of Crops/Plants on the Basis of Pan Evaporation Data**

Crops	**Spacing (m)**	**Pan Evaporation (mm/day)**				
		2	**4**	**6**	**8**	**10**
		Water Requirement(lpd /plant)				
Grapes	3.0 x 3.0	3.7	7.6	11.3	15.1	18.9
Mango/Sapota	10.0 x 10.0	42	84.0	126.0	168.0	210.0
Oranges	5.0 x 5.0	10.5	21.0	31.5	42.0	52.5
Coconut	6.0 x 6.0	15.1	30.2	45.4	60.5	75.6

Banana	7.5 x 7.5	24.2	48.5	72.8	97.0	121.3
Cotton	1.5 x 1.5	1.7	4.4	6.6	8.8	11.0
Tomato/Brinjal/Chillies	1.3 x 1.3	0.5	3.3	5.0	6.6	8.3
Sugarcane	1.0 x 0.3	0.3	1.0	2.5	2.0	2.5
Litchi	6.0 x 8.0	35	42	65	69	

The water requirement for different seasons can be calculated using Equation 1 given above. The maximum discharge required during any one of the three seasons is adopted for design purposes.

3.1.3 Design and Performance of emitter

The design, number of emitters required for plant and their discharge are important factors in designing a drip irrigation system. Various emitters are designed for controlled release of water to the plants. It is necessary for manufactures of drip system to state optimum operating pressure and discharge and the emitter is so selected that application rate equals to the absorption rate of soil so that no water stagnation takes place on the surface of the soil. In some systems a short length of flexible plastic tubing of small diameter is used as emitter. This tubing is generally of 0.96mm diameter and is inserted through holes in walls of the laterals. This is commonly known as micro tube system. The flow from different lengths of 0.96mm polyethylene tubing under various pressure is given in Table 3.

Table 3 : Flow from polythelene Tube emitters of 0.96 mm diameter(lph)

Length of tubing	**Pressure in supply line (Atmosphere)**						
(mm)	0.1	0.2	0.3	0.5	0.75	1	1.5
7.5	6.1	10.4	13.9	20.2	27.2	33.2	44.7
15.5	4.1	6.7	9	12.8	17	20.7	27.4
25	2.9	4.7	6.3	8.9	11.8	14.4	19
35	2.3	3.7	4.9	7	9.3	11.3	15
50	1.8	2.9	3.8	5.5	7.3	8.8	11.7
75.5	1.4	2.2	2.9	4.2	5.6	6.8	9
100	1.1	1.8	2.4	3.4	4.5	5.5	7.3
125	0.96	1.6	2	2.9	3.9	4.7	6.3
150	0.84	1.4	1.8	2.6	3.4	4.2	5.5
175	0.75	1.2	1.6	2.3	3	3.7	4.9
200	0.69	1.1	1.5	2.1	2.7	3.3	4.4
250	0.6	0.97	1.3	1.8	2.4	2.9	3.8
300	0.53	0.85	1.1	1.6	2.1	2.6	3.4

Another method of releasing water from laterals is through small perforations in the walls which are sometimes called "soakers".

3.1.4 Performance of Emitter

Water from emitters fall on ground and is absorbed by soil. The wetted area depends upon the soil type and rate at which water comes out of emitters. The infiltration rate for various types of soil and the surface area wetted due to drippers at various flow rates are given in Table 4&5.

In orchards having widely spaced plants, two or more line of laterals may be required for each row. Sometimes a loop with 3 to 4 emitters is placed around each plant to provide the required wetted area. This should be away from the plant stem.

Table – 4 : Infiltration Rate of Soil

Sr.No.	Texture	Infiltration Rate (cm/hr)
1	Coarse Sand	2.0 to 2.5
2	Find Sand	1.2 to 2.0
3	Fine Sandy loam	1.2
4	Silty loam	1.0
5	clay loam	0.8
6	clay	0.5

Table – 5 : Surface Area Flooded by Emitters

Sr.No.	Emitter flow Rate (lph)	Soil infiltration rate (Cm/hr)					
		0.25	**0.5**	**0.75**	**1.0**	**1.25**	**1.50**
Wetted Area (sqm)							
1	1.0	0.4	0.2	0.13	0.1	0.08	0.07
2	2.0	0.8	0.4	0.27	0.2	0.16	0.13
3	3.0	1.2	0.6	0.40	0.3	0.24	0.20
4	4.0	1.6	0.8	0.53	0.4	0.32	0.27
5	5.0	1.0	1.0	0.67	0.5	0.40	0.33
6	6.0	1.2	1.2	0.80	0.6	0.48	0.4
7	7.0	1.4	1.4	0.93	0.7	0.56	0.47
8	8.0	1.6	1.6	1.07	0.8	0.64	0.53

3.1.5 No. of emitters

The number of emitters is based on the volume of wetting for each plant. Generally, 30-70 percent of the area is wetted dependent upon plant spacing, nature & development of root zone. The number of emitters required per plant is estimated as the ratio of rate of irrigation requirement to the emitter discharge. If single emitter is provided, it must be placed 15-30 cm. from the base of the plant.

4.0 LAYOUT OF DRIP SYSTEM

The main Line in a drip system should follow land contour as closely as possible. If there is a slope, should be made for pressure differences due to change in elevation. A fall of 1 m in elevation is equivalent to an increase in pressure of about 0.1 atmosphere. Where main lines are laid down on a slope, the increase in pressure due to elevation change may partly compensate the friction head loss. To provide nearly uniform pressure at each emitter, the tubing should be of sufficient diameter to avoid excess friction losses. The water delivered in the supply line is released through emitters spaced along the supply line. The total friction head loss due to lateral openings can be calculated by multiplying the head loss over the total length by a **Reduction Co-efficient** given in Table 6. However, the additional head loss on account of diversion of flow from the main/laterals into the emitters has to be separately added while estimating the total head for purpose of calculating hp of the pump set. Friction head loss for various flow rates in plastic tubing of different sizes are given in Table 7.

The allowable pressure drop in mainline and laterals depend upon the operating pressure required at emitters. The pressure difference between the proximate and distant point along the supply line should not exceed 20% which will keep the variation of discharge within 10% of its value at the first emitter.

Table - 6 Reduction Co-efficient F for Multiple Outlet Pipeline Friction Loss Co-efficient

No.of outlets	F	No of outlets	F
1	1	8	0.42
2	0.65	10 to 11	0.41
3	0.55	12 to 15	0.40
4	0.50	16 to 20	0.39
5	0.47	21 to 30	0.38
6	0.45	21 to 37	0.37
7	0.44	38 to 70	0.36

Table - 7 Friction Head Loss in Meters per 100 m. Pipe Length

Flow (lph)	Inside diameter (mm)						
	9.2	**11.7**	**12.7**	**13.9**	**15.8**	**18.0**	**19.0**
Head loss in meters per 100 m 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
1,000	--	--	45.0	30.0	16	8.3	6.2
1,200	--	--	--	42.0	21.0	11.0	8.8
1,400	--	--	--	56.0	28.0	16.0	11.0
1,600	--	--	--	--	36.0	20.0	15.0
1,800	--	--	--	--	45.0	25	19.0
2,000	--	--	--	--	54.0	30.0	23.0

4.1 Mainline

To design the main line, the pressure required at proximate end of laterals and the maximum friction loss at that point should first be determined. Friction losses due to valves, risers, connectors, etc., should be added to this. Sometimes, two or more laterals simultaneously operate from the mainline and these have to be properly accounted for in the design.

The friction head loss in mains can be estimated by Hazen-Williams formula is given bellow.

hf = 10.68x(Q/C) xD x(L+Le)

Where : hf = Friction head loss in pipe (m)

Q = Discharge (M /sec)

C = Hazen Willian constant (140 for PVC pipe)

D = Inner dia of pipe (m)

L = Length of Pipe (m)

Le = Equivalent length of pipe and accessories

4.2 Laterals

The design of lateral pipe involves selection of required pipe size for a given length to meet the required quantity of water to the plant. This is the most important component of the system as large amount of pipe per unit of land is required and the pipe cost is such that system is economically viable.

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

4.3 Design Criteria

The pressure head of emitter of any lateral should be calculated based on discharge requirement of each emitter.

1. It should be ensured that the head loss in the lateral length between the first and last emitter is within 10% 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 8 and equivalent lengths of straight pipe in meters giving equivalent resistance to flow in pipe fittings in Table 9.

Table-8 : Friction Losses for Flow of Water (m/100m) in smooth Pipes(c=140)

Discharge (lps)	**Bore diameter (mm)**									
	20	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**
0.5	16.4	5.5	1.6	0.56	-	-	-	-	-	-
1	-	10	6	2	0.68	-	-	-	-	-
1.5	-	-	12.7	4.3	1.45	0.4	-	-	-	-
2	-	-	16	7.3	2.5	0.68	0.25	-	-	-

3	-	-	-	15.5	5.2	1.45	0.53	-	-	-
4	-	-	-	26.4	6.9	2.5	0.9	0.3	-	-
5	-	-	-	-	13.4	3.8	1.36	0.46	-	-
6	-	-	-	-	18.8	5.2	1.9	0.64	0.22	-
7	-	-	-	-	-	6.9	2.5	0.84	0.29	-
8	-	-	-	-	-	8.9	3.2	1.1	0.37	0.15
9	-	-	-	-	-	11.1	4	1.36	0.46	0.19
10	-	-	-	-	-	13.4	4.9	1.65	0.55	0.32

For other type of pipes (new) multiply foregoing figures by factor given below

Sr no	Particulars	C	Multiplication factor
1	Galvanised iron	120	1.33
2	Uncoated cast iron	125	1.23
3	Coated cast iron, Wrought iron coated steel	130	1.07
4	Coated spun iron	135	1.07
5	Uncoated Asbestos cement and concoated steel pipes	140	1
6	Coated asbestos cement spun concrete or bitumem lines	145	0.94
7	Smooth pipes (lead, brass, copper, stainless steel, glass, PVC	150	0.86

Table - 9 : Length of Straight Pipe in Meter giving Equivalent Resistance to Flow in Pipe Fittings [IS : 2951 (Part II) - 1965] (Equivalent Length in Mtrs.)

Sr. No.	Pipe size (mm)	Elbow Bend	90 Bend	Standard Tee	Sluice valve	Foot or Reflux valve
		(Ks=0.7)	(ks=0.12)	(Ks=0.4)	(Ks=0.4)	(Ks=3.5)
1	25	0.536	0.396	0.704	0.077	2.04
2	40	0.997	0.569	1.131	0.142	3.05
3	50	1.296	0.741	1.704	0.185	3.96
4	65	1.814	1.037	2.384	0.259	5.18
5	80	2.241	1.281	2.946	0.320	6.10
6	100	2.959	1.691	3.889	0.422	8.23
7	125	4.037	2.307	5.306	0.576	10.0
8	150	5.125	2.928	6.735	0.732	12.0

5.0 UNIT COST

The unit cost of Drip Irrigation system depends upon the shape and size of command area, spacing and number of plants and their water requirement. The unit cost should include the cost of following main items.

1. Mainline/Submain
2. Laterals
3. Drippers/micro-tubes
4. Lateral connectors
5. Straight connectors
6. Filters (Screen or Gravel)
7. Bends/end plugs, couplers, joint, tees
8. Pressure gauge, water meters
9. Water regulators
10. Installation charges

The average unit costs of drip irrigation system for different crops are given in Table-10. This is for guidance only.

Table - 10 Unit Cost of Drip Irrigation System

Sr.No.	Crop	Spacing (m)	Cost (Rs/ha)
1	Coconut	8 x 8	23790/-
2	Sapota/Mango	10 x 10	17030/-
3	Oranges/Guava	6 x 6	28010/-
4	Pomegranate	4.5 x 2.7	32010/-
5	Grapes	2.7 x 1.8	54370/-
6	Banana/ Papaya	1.8 x 1.5	73010/-
7	Sugar Cane	[(0.75m+1.25m) x 0.15m] lateral spacing-2.25m	60440/-
8	Vegetables	0.6 x 0.45	103020/-
9	Mango	5 x 5	32060/-
10	Litchi	6 x 8	42000/-

The Estimated cost of drip irrigation system for Litchi cultivation on 1 ha plot is given in **Annexure-I**

6.0 Lending terms & Conditions

6.1 Margin Money : The beneficiaries may contribute towards down payment/margin money ranging from 5 to 25% depending upon their category, i.e., small and other farmers in accordance with the NABARD's norms. Beneficiary's own labour can also be taken as his contribution towards the margin money requirement.

6.2 Security : As per RBI norms.

6.3 Interest Rate : The rate of interest to be charged to the ultimate borrowers would be decided by the financing banks as per the RBI guidelines from time to time. However, for working out the financial viability and bankability of the model project, the rate of interest is assumed as 12%.

6.4 Repayment Period : Gestation period can be considered while fixing the repayment period. The repayment of interest shall commence from the end of the Gestation period onwards and would continue till the entire principal and interest thereon is repayed.

Appendix : II

MODEL FOR A SCHEME OF DRIP IRRIGATION

This model scheme for drip irrigation system to avail loan assistance give details about estimation of water requirement of plantation crops, system design, HP of pumping unit, unit cost and financial viability of the investment. Let us assume that the beneficiary has an open well of 4m dia and 25 m depth fitted with 5 HP electric pump set. The area has a land slope of 0.5m/100m and the soil is clayey loam. The farmer proposes to install drip irrigation system for a new citrus plantation on a 1ha plot.

a. Design parameters

Scheme formulation for installation of drip irrigation system against bank loan requires both technical and financial details. The important items that should be included in a scheme for drip irrigation system are given bellow :

b. Command area

A command area map giving systems layout is necessary to plan and design a drip irrigation system. It may not be necessary to have a detailed contour plan but it is helpful if a plan showing the highest and lowest points along with well location is given in the scheme. This enables proper design of main line and laterals to suit the spacing and number of plants.

The present scheme is prepared for application of drip irrigation on one hectare farm of Litchi.

c. Spacing and Plant Population of Litchi in one ha.

The No of plants required for cultivation of 1 ha litchi with above spacing would be 100m x 100m /6 m x 8 m = 208 plants. However, the plant spacing adopted by earlier farmers was planting at 8x8m to 12x12m.

d. Water requirement for litchi plants.

Water requirement for litchi crop (WR) is a function of surface area covered by plants, evaporation rate and infiltration capacity of soil. The irrigation water requirement for each plant has been calculated for each plant and thereafter for the whole plot of 1 ha based on plant population for the 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.

WR= **A** X **B** X **C** X **D** X **E** ....Equation (1)

Where : WR= Water requirement (lpd /plant)

A= Open Pan evaporation (mm/day)

B= Pan factor (0.7)

C= Spacing of plant (m2)

D= Crop factor (factor depends on plant growth for fully grown plants = 1)

E= Wetted Area (0.3 for widely spaced crops)

The total water requirement of the farm plot would be **WR** x **No.of Plants** .

e. Estimation of Water Requirement

The irrigation water requirement is determined using IMD pan evaporation data. The average season wise pan evaporation data for the area is given below.

S.No.	Season	Days (Nos)	Total Pan (evaporation during the season (mm)	Avg. Daily Pan Evaporation (mm/day)
1	Kharif (15/6 to 15/10)	122	506.30	4.15
2	Rabi (16/10 to 15/4)	183	649.65	3.55
3	Summer (16/4 to 14/6)	60	408.00	6.45

The daily water requirement of plants using above equation has been worked out as under.

Sr.No	Season	Evaporation (mm/day)	Water requirement	
			Lpd /plant	M3/ day/ha
1	Kharif	4.15	41.83	8.31
2	Rabi	3.55	35.78	7.44
3	Summer	6.45	65.07	13.53

Therefore, the drip irrigation system has to be designed for the maximum requirement of 65.07 litre /day/plant during the summer season and for this the water required would be 13.53 m3/ day/ha of plantation. If the average working hour of pump set is taken as 4 hours per day, the discharge required would be as below :

Pumping rate per hectare = 13.53 m3 /day/ha = 3.38 m3 /hr/ha = 0.94 LPs or say 1 LPs. As required discharge is only 13.53 m3 /day/ha, it can be pumped for one hour only from a well giving a discharge of 5-6 lps. This is also the normal well yield in the scheme area using a 3-5 HP pump set. For the estimated water requirement of 1 lps only, an arrangement to divert excess water to irrigate other crops would be provided, especially during Kharif and Rabi periods. Alternatively, a tank of 14 m3 capacity can be provided where necessary so that uninterrupted irrigation may continue even in areas where power shut down are frequent.

f. Emitters

Depending upon the type of emitter and discharge required their number can be estimated. For a pressure head of 4m and discharge at 17.5 litre /hour the number of emitters required are :

No. of emitters/plant = Rate of Pumping/hour/plant /Avg. discharge of one emitter
= 13.53/4 = 3.38 or say 4 emitters/ plant

The plot is square and of 1 ha. As such the mainline would be 100 m long and laterals would also be 100 m in length. As plant spacing is 6m x 8m, a total of 13 laterals would be required.

Each lateral would serve approximately 16 plants and there would be 4 emitters per plant. Thus, the total number of emitters per lateral would be 16x4 = 64 nos.
As the total length of one lateral is 100m the emitters would be spaced at 1.5 m i.e. 100/64.

g. Main Line
The main line is designed to carry the maximum discharge required for total number of plants in the farm plot.
Maximum discharge required = No. of plants x peak discharge per plant
= 208x 13.53 = 2814 lph =0.78 or say 1 LPs

h. Friction Head loss in Pipes (m)
Total length = 100.0
Equivalent length of 13 straight connectors = 6.5
Equivalent length of tee, bends etc = 5.5.
Total =112.0 m.

The value of coefficients has been taken from tables given below. It would be seen from table 1 that for a discharge of 1 LPs through a pipe of say 40 mm diameter, the friction loss would be 2 m per 100 length or 2.2 m for 112 m equivalent length. Friction Losses for Flow of Water (m/100m) in smooth Pipes(c=140)

i. Discharge| Bore diameter(mm)

(lps)	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**
0.5	16.4	5.5	1.6	0.56	-	-	-	-	-	-
1	**-**	**10**	**6**	**2**	**0.68**	-	-	-	-	-
1.5	-	-	12.7	4.3	1.45	0.4	-	-	-	-
2	-	-	16	7.3	2.5	0.68	0.25	-	-	-
3	-	-	-	15.5	5.2	1.45	0.53	-	-	-
4	-	-	-	26.4	6.9	2.5	0.9	0.3	-	-
5	-	-	-	-	13.4	3.8	1.36	0.46	-	-
6	-	-	-	-	18.8	5.2	1.9	0.64	0.22	-
7	-	-	-	-	-	6.9	2.5	0.84	0.29	-
8	-	-	-	-	-	8.9	3.2	1.1	0.37	0.15
9	-	-	-	-	-	11.1	4	1.36	0.46	0.19
10	-	-	-	-	-	13.4	4.9	1.65	0.55	0.32

For other type of pipes (new) multiply foregoing figures by factor given below
Friction head loss = 2.2 x 0.88 = 1.94 or say 2.0
Conversion factor = (0.88)
As the proposed system uses multiple openings, the friction loss is taken as 1/3 of the total friction loss i.e. 2.0/3 i.e. 0.66 m. Thus, the loss in mains is within 1.0 m/100 m and a pipe of 40 mm diameter is ideal in the layout.

j. Laterals

A lateral is so selected that the pressure difference from the proximate end to the last emitter do not exceed 10% of the normal operating head which in the present case is 4m. The maximum permissible variation in friction loss in the pipe is 4x10/100 = 0.4 m for a lateral of 100 m length. The land slope is 0.5 m/ 100m. Thus the total friction loss allowable is 0.4 + 0.5 = 0.9 m.

In addition to 100 m length of laterals there is additional loss due to connectors. This is generally taken as 0.1 to 1m (on an average 0.5) of the equivalent length of an emitter. The equivalent length of 64 emitters would thus be 64x0.5 = 32 m. Thus, total equivalent length for calculation of friction loss in laterals would be 132 m (100+32). The total flow in laterals is 256 lph i.e. 4 x 4 x16. It may be seen from Table No 4 that for 200 LPs flow the friction loss in 13.9 m length would be 2.25 m. It is a general practice that friction losses are taken at 1/3 of the total equivalent length of pipes with multiple emitter/connections. Thus, the friction loss works out to 1/3 x 2.25 = 0.75 m which is within the maximum permissible limit of 0.9 m. Therefore, 14 mm (outer dia) lateral pipe of 100 m length is suggested in this scheme.

The friction loss in micro tubes need not be considered as a minimum of 4m head is prescribed which includes friction loss.
Friction Head Loss in M per 100 m. Pipe Length

Flow (lph)	**Inside diameter (mm)**						
	9.2	11.7	12.7	**13.9**	15.8	18.0	19.0
	Head loss in m per 100 m 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
1,000	--	--	45.0	30.0	16	8.3	6.2
1,200	--	--	--	42.0	21.0	11.0	8.8
1,400	--	--	--	56.0	28.0	16.0	11.0
1,600	--	--	--	--	36.0	20.0	15.0
1,800	--	--	--	--	45.0	25	19.0
2,000	--	--	--	--	54.0	30.0	23.0

k. HP of Pump set

The HP of pump set required is based upon design discharge and total operating head. The total head is the sum of total static head and friction losses in the system.

(i) Static Head. The total static head is the sum total of the following (m).

Depth to water (bgl)	16 m (assumed)
Draw down	3 m (assumed)
Height of Delivery pipe (agl)	1 m
Friction loss in pipes, bends, foot valves etc.	2.25m
Total	**22.25 m**

(ii) The friction loss in the drip unit as under (m)

Friction loss in main pipe	2.2 m
Friction loss in laterals	0.75 m
Minimum head required over emitters	4.0 m
Total	**6.95 m**

Total Head = Static Head + Friction head loss = 22.25 + 6.95 = **29.20 m or say 30 m**
The required HP of the pumpset has been calculated as per the following formula.
Hp of pump set= Q x H/ 75 x e
Where Q = discharge (lps)
H = Head (m)
e = Pumping efficiency (o.6) **HP** = 1x30 /75x.6 = 0.66 or say 1 HP. **<u>Appendix - III</u>**

CHECK LIST
MINOR IRRIGATION - DRIP IRRIGATION
(To be completed by the Executive/Officer of the bank forwarding the scheme) NOTE : Tick (/) across the line to signify that the relevant information has been furnished in the scheme.

GENERAL

- Specifications of the scheme area
- Nature and objective proposed development
- Name(s) of the financing bank(s) / branch(s)
- Approval of the schemes by the competent authority, including State Government in the case of SLDB. Coverage of the loans under the Guarantee Schemes of Deposit Insurance and Credit Guarantee Corporation
- Status of beneficiaries (individuals/partnership firms/company/Corporation/Co-operative Society) and the coverage of borrowers in weaker sections like small (as per norms given by National Bank) or marginal farmers/SC/ST, etc.
- Land-use pattern, source-wise irrigated area, present cropping pattern, yield and income per acre, land holding distribution, land tenure system etc. in scheme area
- Capability/experience of the persons/institutions implementing the scheme

TECHNICAL ASPECTS

- Command area map with levels
- Type of soil
- IMD Normal Annual Rainfall
- IMD Monthly Evaporation

- Proposed cropping pattern with plant spacing and number of plants per hectare for a modal farm
- Peak water requirements per plant/day and per plant/season
- Designed discharge and water availability in hours per day
- Existing pumping equipment
    i. Range of HP
    ii. Whether electric/diesel
- Water availability
    i. Geology of the area
    ii. Category of block
    iii. Chemical quality of water
    iv. Design of well (dia/Depth)
    v. Well discharge
- Design of Drip system for a model
    i. Main line
    ii. Sub main
    iii. Laterals
    iv. Emitters/Micro tubes
    v. Lateral/Straight connectors
    vi. Filters/screens
    vii. Fertilizer unit
    viii. Bends/end plugs, joints etc.
    ix. Pressure gauge, water m
    x. Water regulators
    xi. Item-wise break-up of unit cost
    xii. Comments on technical feasibility of the project

FINANCIAL ASPECTS

- Lending terms : rate of interest, grace period, repayment period, down payment, nature of security, availability of Government guarantee for bank loan/refinance (if necessary), source and extent of availability of subsidy etc.
- Year-wise physical and financial programme, bank loan and refinance requirement
- Income "without project and "with project" with reference to the representative of the holdings in the scheme area and the estimate of incremental income
- Comments on the financial viability of the project along with cash flow, BC Ration, net present worth, financial rate of return (IRR) etc.
- Comments on the financial position of the borrowers/implementing agency. In the case of partnership firms/companies/Corporation or Society an analysis of their financial position, debt-equity ratio and profitability along with copies of audited financial statements for the last three years.

INFRA STRUCTURAL FACILITIES

- Sources of availability of capital assets/drip irrigation system, the approximate distance and arrangements for their maintenance/servicing

- Arrangements for availability of raw-material, improved seeds/fertilizers, pesticides, etc., for agriculture
- Agencies providing crop loans/maintenance expenses to the beneficiaries and the adequacy of the arrangements.
- Availability of technical staff for implementation of the scheme with the bank/implementing authority.
- Details of technical guidance, government support/extension service available and whether budgetary provision has been made for the same.
- Supervision and monitoring arrangements available with the financing institution.
- Availability of power and diesel.

Signature and Designation of the Bank Officer

Drip Irrigation Annexure II

Drip Irrigation Annexure III