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DESIGN OF DRIP IRRIGATION SYSYTEM FOR ANJLAV VILLAGE

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Abstract - *The micro irrigation in general and drip irrigation in particular has received considerable attention from policy makers, researchers, economists etc. for its perceived ability to contribute significantly to ground water resources development, agricultural productivity, economic growth, and environmental sustainability. In this paper, the design of drip irrigation system has been done for Anjlav village in terms of Laterals, mains and manifolds. The drip method of irrigation has been found to have a significant impact on resources saving, cost of cultivation, yield of crops and farm profitability in this way it can be very effective for villagers.Villagers don't have much knowledge about drip design, effectiveness and long term benefits they only have concern about initial cost of the drip system. Hence, the policy should be focused on promotion of drip irrigation in those regions where scarcity of water and labour is alarming and where shift towards wider-spaced crops is taking place. So that most of the villagers can be benefited in long term.*

Key Words: Drip Irrigation, Village development, Micro irrigation, High crop yield, effective irrigation

1. INTRODUCTION

Developing infrastructure for the water resources and their management have been the common policy agenda in many developing economies, particularly in the arid and semi-arid tropical countries like India. A study by the International Water Management Institute (IWMI) has shown that around 50 per cent of the increase in demand for water by the year 2025 can be met by increasing the effectiveness of irrigation (Seckler et al., 1998).

The review of past studies lucidly shows that the solution to the problem of growing groundwater scarcity and persistent groundwater resource degradation across regions is two-fold. The first is the supply side management practices like watershed development, water resources development through major, medium and minor irrigation projects, etc. The second is through the demand management by efficient use of the available water both in the short-run and long-run perspectives. This includes drip irrigation and other improved water management practices at village level. Recognising the importance of sustainable water-use efficiency in agriculture, a number of demand management strategies (like water pricing, water users association, turnover system, etc.) have been introduced since the late-1970s to increase the water-use efficiency, especially in the use of surface irrigation water. One of the demand management mechanisms is the adoption of micro irrigation such as drip and sprinkler methods of irrigation. Evidences show that the water-use efficiency increases up to 100 per cent in a properly designed and managed drip irrigation system (INCID, 1994; Sivanappan, 1994). Drip method of irrigation helps to reduce the over-exploitation of groundwater that partly occurs because of inefficient use of water under surface method of irrigation. Environmental problems associated with the surface method of irrigation like water logging and salinity are also completely absent under drip method of irrigation (Narayanamoorthy, 1997). Drip method helps in achieving saving in irrigation water, increased water-use efficiency, decreased tillage requirement, higher quality products, increased crop yields and higher fertilizer-use efficiency (Qureshi et al., 2001; Sivanappan, 2002; Namara et al., 2005).

Though the potential benefits generated by the drip irrigation methods are apparent, the adoption of drip irrigation is yet to be widely promoted across regions, states and elsewhere especially to village people. It is found that the most ideal policy environment for promotion of micro irrigation technologies in the well-irrigated areas would be in proportion to pricing of electricity, which would create direct incentive for efficient water use (Kumar, 2005). Adoption of micro irrigation systems is likely to pick up fast in the arid and semi arid, well-irrigated areas, where farmers have independent irrigation sources, and where groundwater is scarce. Further, large size of farm and individual plots, and a cropping system dominated by widely-spaced row crops, which are also high-valued, would provide the ideal environment for the same (Kumar et al., 2005). Evidences show that many researchers have attempted to study the impact of drip irrigation (Narayanamoorthy, 2005; Qureshi et al., 2001; Namara et al., 2005; Kulecho and Weatherhead, 2005; Narayanamoorthy, 2003; Dhawan, 2002; Verma et al., 2004; Magar et al., 1988; Cuykendall et al., 1999) and have found that drip irrigation produces the desired positive impacts. It is evidenced that the drip irrigation technology is technically feasible, particularly when the farmers depend on groundwater sources (Dhawan, 2000). Still, the studies on impacts of drip irrigation on the farming system as a whole are scanty and yet to be explored much.

In this context, the drip irrigation has received much attention from policy makers and others for its perceived ability to contribute significantly to groundwater resources development, agricultural productivity, economic growth, and environmental sustainability. Yet in many parts of the country and elsewhere, these have yet to be adopted widely. Keeping these issues in view, the present paper has addressed the following important issues: (i) what changes the drip irrigation brings to the farming system?, (ii) Design of laterals, mains and manifolds of the drip system (iii) Detailed layout of drip system for 100m x100m area of Anjlav village.

2. Study Area

The study was conducted in the Anjlav village of valsad district of Gujarat state where groundwater resource degradation is more. A 100 m x 100 m area is selected for design purpose. As drip irrigation system is not widely used in the village area or nearby area so drip system design is selected. A particular farm area from the village is selected for design. To examine the feasibility and impact of drip irrigation on resource use, agricultural production and farm income this design is done. The primary purposes are to aware people about design of drip irrigation system and make them comfortable about its use. A particular farm at the centre of the village is selected to demonstrate more and more people about its usage. Also, we enumerated the list of farmers adopting drip irrigation after discussions with the villagers and private firms dealing drip irrigation systems but we find very few villagers knowing about it. The Data For the purpose of the study, both secondary and primary information was collected from different sources. The secondary information included trend in rainfall, growth in the number of wells, number of wells functioning and wells defunct, cropping pattern, crop yields, occupational structure and area irrigated. The general particulars of the area were collected from the village Sarpanch and village talathi. Interview schedules were formulated and pre-tested. The needed information from the respondent group was gathered personally administering the interview schedule. The primary information collected from the farm households included details on well investment, groundwater use, extraction and management, crop production including input use and output received, farm income, adoption of drip irrigation, and investment on drip irrigation. This also included asset position, education and other socioeconomic conditions.

3. Drip System Design

A typical drip irrigation system is shown in Fig-1 and consists of the following components:

- Pump unit
- Control head
- Main and submain lines
- Laterals
- Emitters or drippers.

The pump unit takes water from the source and provides the right pressure for delivery into the pipe system.

The control head consists of valves to control the discharge and pressure in the entire system. It may also have filters to clear the water.

Common types of filter include screen filters and graded sand filters which remove fine material suspended in the water. Some control head units contain a fertilizer or nutrient tank.These slowly add a measured dose of fertilizer into the water during irrigation. This is one of the major advantages of drip irrigation over other methods. Mainlines, sub mains and laterals supply water from the control head into the fields. They are usually made from PVC or polyethylene hose and should be buried below ground because they easily degrade when exposed to direct solar radiation. Lateral pipes are usually 13-32 mm diameter. Emitters or drippers are devices used to control the discharge of water from the lateral to the plants. They are usually spaced more than 1 metre apart with one or more emitters used for a single plant such as a tree. For row crops more closely spaced emitters may be used to wet a strip of soil. Many different emitter designs have been produced in recent years. The basis of design is to produce an emitter which will provide a specified constant discharge which does not vary much with pressure changes, and does not block easily.

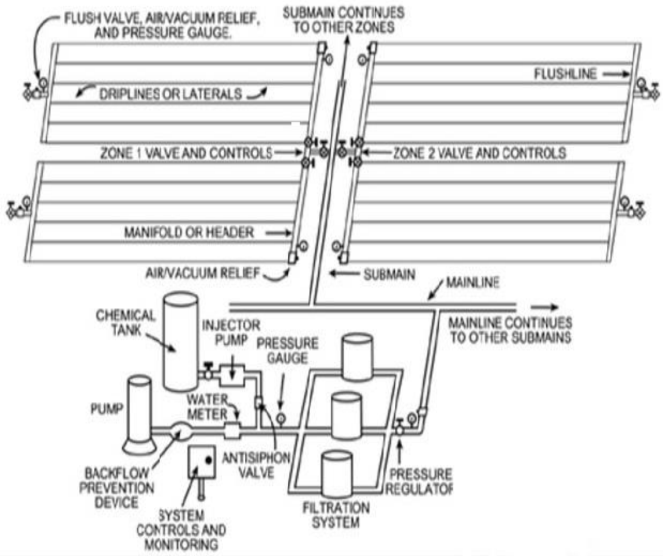

Fig- 1: Drip irrigation system

Design of a drip irrigation system for the following data	
Crop	Banana
Spacing	1.5 m x 1.35 m
Area	1 ha (100 m x100 m)
Slope	0.3 to 0.4%

Water Source	Well
Static Head	10 m
Pan Evaporation	12 mm/day
Soil characteristics	Clay soil
	Field capacity: 48%
	Wilting Point: 25%
	Bulk Density: 1.3 g/cm3
	Effective Root Zone Depth: 60 cm
Wetted Area:	60%
Maximum Pump Discharge:	2.5 lps

3.1 Drip Irrigation laterals:

- Laterals deliver water from main lines and submains to the emission devices
- Material: Polyethylene and PVC commonly used
- Diameter: For point source emitters 10-20 mm ,For line source emitters >20 mm
- Designed to maintain an acceptable variation of emission device discharge along their length
- Manufacturer's coefficient of variation (discharge) determines the acceptability.

Calculation of depth of irrigation	ETcrop= ET0×Kc = Ep×Kp×Kc = (12) ×(0.7) ×(1.0) = 8.4 mm/d
Volume of water to be applied	Area × Depth =(1.5×1.35) ×(0.6) ×(8.4) = 10.21 m^3
Number of Emitters per plant	Number of Emitters per plant is to be selected (based on layout) Say, One emitter per plant (4 l/h Capacity)
Irrigation Time	Irrigation time =Volume/Discharge rate =10.21/4 =2.55 h say 2.5h

Number of Emitters per lateral	Length of field =100 m
	The submain is laid at the centre (layout), hence lateral length = 50 m
	Emitter spacing on lateral = Plant spacing =1.35 m
	Number of emitters per lateral =50/1.35=37
Size of lateral	
Darcy Weisbach Equations ,Let us take 16 mm lateral	
$H1 = KCLQ^m \div D^{2N+n}$ $= 2.73 \times 10^{-3} \times 277778 \times 58.14 \times 4.93^2 \div (12^{2\times2+1})$ $= 1.02m$	
$h_1 = FH_1 + M_1 = 0.338 \times 1.02 + 0 = 0.35$ **m** (<0.5 m)	
Acceptable for 37 outlets, Thus, Lateral Size = 16 mm	

3.2 Drip Irrigation Manifolds:

Size of Manifold
Qmanifold = Qlateral× No. of lateral per manifold
= 148 × 34 = 5032 l/hr
Assume Manifold Diameter = 50 mm
$V = Q \div A = \frac{5032l}{h} \div [(\pi \div 4) \times (50mm^2)]$ $= 71.18cm/sec$
$N_R = \rho V d \div \mu = 35502$
$H1 = KCLQ^m \div D^{2N+n}$ $= 1.92 \times 10^{-3} \times 277778 \times 50 \times 83.86^2 \div (50^{2\times2+1})$

$= 0.06m$
= $FH_1 + M_1$ = 0.347 × 0.06 + 0 =0.22m For 34 outlets
Head loss in manifold = **0.21 m**
Head at inlet of manifold = Hemitter +Hlateral+Hslope+ Hmanifold
= 10 + 0.35 + 0.18 + 0.21
= 10.74 m

3.3 Drip Irrigation Mains:

Size of main
Length of main = 100 m F (well location)
Qmain = Qmanifold = 5032 l/hr = 1.4*10-3 m3/sec
Assume main diameter = 50 mm
$V = Q \div A = \frac{5032l}{h} \div [(\pi \div 4) \times (50mm^2)]$ $= 71.18cm/sec$
$N_R = \rho Vd \div \mu = 35502$
Since NR is between 2000-105 use Reynolds number (turbulent flow) equation to compute f (f = 0.023)
$H1 = KCLQ^m \div D^{2N+n}$ $= 1.92 \times 10^{-3} \times 277778 \times 150 \times 83.86^2 \div (50^{2\times 2+1})$ $= 1.815m$
$h_1 = FH_1 + M_1$ = 0.469× 1.21 + 0 = 0.851 m**for 4 outlets**
Total Head
Total Head = Head manifold inlet + Hmain+ Hstatic+ Hlocal

= 10.74+0.851+10+2.16
= 23.75 m
Hlocal is continued as 10% of all other heads)
Pump Horse Power
$h.p. = \gamma \times h \times Q \div 75 \times \eta$
$1000 \times 23.75 \times (1.4 \times 10^{-3}) \div (75 \times 0.70)$
$= 0.63 \sim 1$ hp

4. Layout of Drip system

Based on the design the layout for the Anjlav village drip irrigation system is made it consists of the laterals, manifolds, mains and the other necessary details for a 100 m x 100 m area.

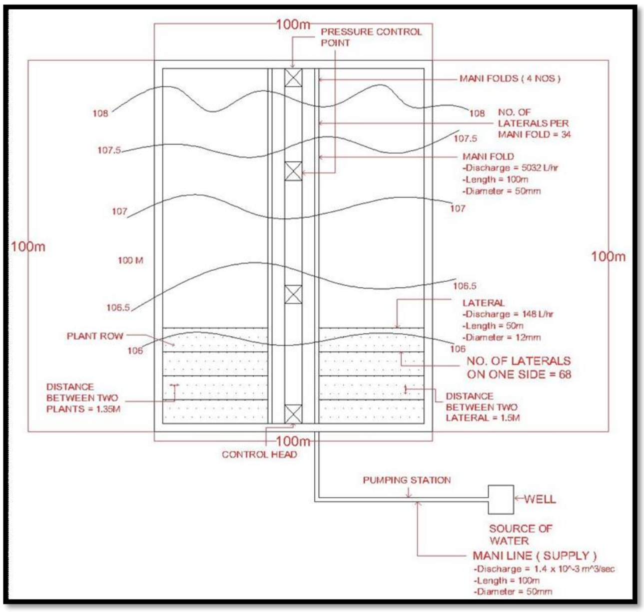

Fig- 2: Layout of Anjlav drip irrigation system

5. CONCLUSIONS

The design is basically done to encourage and educate the villagers about the use of drip irrigation system. The system is having some initial cost but in long term the benefits are far more than the initial cost. Without drip system farmers face lots of trouble to supply water to their individual crops and sometimes the crops may get damaged because of improper irrigation practices. Drip irrigation system not only saves huge amount of water but it also provide ease for the farmers to provide water to their crop at any time of the day. Drip system saves water and increase crop yield and it can be shifted to other farms also depending on the requirement. Low cost and high crop yield is the output which results in more cost benefits. This kind of design will give a better exposure to farmers to adopt drip irrigation system in their farms.

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