**Lecture 24 Economic Viability of Micro Irrigation in Different Crops**

Micro irrigation (MI) includes drip and micro sprinklers. Since micro irrigation is effective method for conserving water resources, the Government of India considered all the water emitting devices used for irrigation, such as overhead sprinklers, mini and micro sprinklers, drip emitters, sprayers, water jets, bubblers, foggers, spitters, etc. under micro irrigation system for providing financial supports to Indian farmers. The high cost of installation, operation and maintenance of micro irrigation systems remains a major constraint to micro irrigation expansion. Only crops with highest return are considered implementation of micro irrigation.

International Committee on Irrigation and Drainage (ICID) conducted a survey in 1991 and reported that an average installation cost for micro irrigation system was USD $ 2000-4000 (Bucks, 1995). Estimates of operation and maintenance cost of MI ranged from USD $ 100-800 per hectare per year. This large range of variation was due to variable labor cost, large variation in crop types, and difference in age of MI system.

The estimated cost of installing drip irrigation system as per government of India guidelines prepared for different lateral spacings for calculation of subsidy is given in Table 24.1 (NMMI, 2010) for different crops.

The relative cost of drip installation decreases with increase in area, since certain essential components remain the same irrespective of the area covered. Further, the cost of installation will reduce for close growing vegetable crops by using laterals in paired row system. The life of materials and accessories of the system is normally considered as 5 to 10 years.

**Table 24.1. Estimated cost of drip system for various crops with different spacing**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sl. No. | Fruit crops | Lateral for crop spacing,  m x m | Estimated cost, Rs. | | |
|  | *Wide spacing* | 0.4 ha | 1 ha | 5 ha |
| 1. | Mango/Sapota | i) 12 x 12 | 13785 | 18820 | 73611 |
|  | ii) 10 x 10 | 14277 | 20041 | 79831 |
| 2. | *Moderate spacing* |  |  |  |  |
|  | Mango / Sapota | i) 6 x 6 | 16605 | 26551 | 109129 |
|  | ii) 5 x 5 | 17977 | 30143 | 126925 |
|  | Orange and citrus species |  |  |  |  |
| 3. | Pomogranate | 4 x 4 | 18621 | 31793 | 135459 |
|  | Grapes | 3 x 3 | 20048 | 36551 | 153441 |
|  | Ber | 3 x 3 | 20048 | 36551 | 153441 |
| 4. | Banana | 2 x 2 | 31616 | 63598 | 305797 |
|  | Papaya | 2 x 2 | 31616 | 63598 | 305797 |
| 5. | Closed spaced vegetable crops |  |  |  |  |
|  | Brinjal | 1.5 x 1.5 | 35973 | 74737 | 360002 |
|  | Tomato | 1.2 x 0.6 | 43816 | 97548 | 474070 |
|  | Chilli | 1.2 x 0.6 | 43816 | 97548 | 474070 |

(Source: National Mission of Micro Irrigation Operational Guidelines, GoI, Ministry of Agriculture, Deptt. of Agri. and cooperation, New Delhi 2010)

**24.1 Economic Evaluation of Drip Irrigation**

To evaluate the economic viability of drip investment both the Net Present Value (NPV) and Benefit Cost Ratio (BCR) are computed by utilizing discounted cash flow technique. The net present value (NPV) is the difference between sum of present value of benefits and that of costs covering items like capital and depreciation costs of drip system. In terms of the NPV criteria, the investment on drip set can be treated as economically viable, if the present value of benefits is greater than present value of costs. The BCR is also related to NPV as it is obtained just by dividing the present value of benefit stream with that of cost stream. Generally, if the BCR is more than one then, the investment of that project can be considered as economically viable.A BCR greater than one obviously implies that the NPV of the benefit stream is higher than that of cost stream. The NPV and BCR can be defined as follows:





where,         Bt= benefit in year, t

                   Ct= cost in year, t

                   t = 1, 2, 3…, n

                   n = project life, years

                   i = rate of discount (or opportunity cost of investment)

Since, the drip irrigation involves fixed capital, it is necessary to take into account the income stream for the whole life span of drip investment. It is difficult to generate the cash flows for the entire life span of drip investment in the absence of observed temporal information on benefits and cost, we need to make few assumptions so as to estimate both cash inflows and outflows for drip investment. These assumptions are:

i) The life period of drip set is considered as 5 to 10 years depending upon type of crop. Considering 5 years for banana, papaya and 10 years for Mango, Sapota etc.

ii) The income stream from drip set is uniform and constant over its entire life for the crops. However, this assumption is relaxed at later stage by considering alternative scenarios; where in cash out flows are allowed to increase by 2% and 5% per annum over the corresponding cash inflows.

iii) Differential rates of discount (interest rate) are considered to undertake sensitivity of investment to change in capital cost. These are assumed at 10, 12 and 15% as alternatives representing various opportunity costs of capital.

iv) Finally, the crop cultivation technology is to be assumed constant for considering same group of crops.

**24.2 Economic Analysis Considering Optimal Spacing of Laterals**

The major limiting factor in large scale adoption of drip irrigation is its high initial investment. Physical factors such as field dimensions, shape and topography will influence the layout of pipe networks. Cost of the lateral and drippers are the main factors that influence the system cost. Any effort made to reduce the length of lateral and number of drippers in a drip system will cause reduction in the system cost.

**a.)  Water front advance studies for optimizing the spacing of laterals**

Water front advance under a point source dripper depends on soil type, dripper discharge and the operation time of the drip system. Larger operation time results into larger lateral spacing but may simultaneously result into deep percolation losses because of *consequential* larger vertical movement of water into soil. Horizontal advance corresponding to the operation duration of the system that results into vertical advance equal to the root zone depth should therefore be considered as maximum allowable lateral spacing. Patel and Rajput (2001) determined the optimal spacing of laterals and appropriate number of drippers for irrigating Okra crop in sandy loam soil. They obtained optimal operation durations of drip system with dripper discharges of 2, 4 and 6 Lh-1 as 720, 480 and 240 minutes, respectively based on the horizontal and vertical advance of soil moisture. They also reported drip system with 4 L h-1dripper discharge capacity for a lateral spacing of 92.5 cm apart is most economical system for a irrigating Okra crop.

Jaiswal et al. (2001) conducted experimental study to determine the optimal length of lateral for various emitter discharge and emitter spacing. They reported optimal length of lateral 28.76, 59.7 and 171.1 m for the dripper capacity of 4 Lh-1 at 0.6, 1.2, 1.8 and 2.4 m emitter spacing, respectively. For 8 l h-1 emitter at 0.6, 1.2 and 2.4 m emitter spacing optimal length of lateral were 20.2, 33.6, and 49.8 and 63.8 m,respectively. They concluded that 4 Lh-1 emitters resulted in more optimal length of lateral as compared to 8 lh-1emitter capacity.

**b.) Economic studies considering planting geometry**

Tiwari et al. (1997) conducted field experiment to study the effect of crop geometry on biometric growth and yield of banana considering groups of 1 plant, 2 plants, 3 plants and 4 plants nearer to each other by placing each plant in a separate pit and adjusting their row to row and plant to plant spacing such that area under each plant is 4 m2. The required amount of water estimated using modified Penman method was applied to the banana crop.  Standard agronomic practices were followed to carryout experiment. The biometric response and yield data were observed for two crop seasons. The cost of cultivation as per prevailing rate during experimental period (1994-95 and 1995-96) was worked out as Rs. 26,300 per hectare. The planting geometry (2 m x 2 m) responded highest yield. This planting geometry requires total length of laterals as 4900 m and results in B.C. ratio as 2.97 for one hectare area. Among all the planting geometry, the planting geometry 1.33 m x 3 m requires lateral length 3290 m resulted in highest B.C. ratio as 3.09. Hence, plant to plant spacing of 1.33 m with one plant in each pit and row to row spacing of 3 m (lateral to lateral spacing) recommended for dwarf Cavendish variety of banana cultivation to minimize the cost of drip irrigation system.

**24.3 Economic Analysis of Experimental Field Trials under Drip Irrigation**

Large numbers of field experiments were conducted in Precision Farming Development Centre projects sponsored by National Committee on Plasticulture applications in Horticulture (NCPAH), Ministry of Agriculture, Government of India to evaluate the benefit cost analysis of drip/micro irrigation on various fruits, vegetables and other horticultural crops. The biometric and yield responses of these horticultural crops were recorded for different amount of water application through drip and conventional irrigation (ring basin, check basin or furrow) methods. The amount of water to be given to the crop was estimated by FAO56 (Penman Montieth) or using USWB open pan evaporation method. The economic analysis of the data recorded from long term field experiments 3 years for seasonal vegetables and fruit crop such as Banana, Papaya and Pine apple and 5-6 years for perennial fruit crops (Mango, Sapota, Guava crops) were analyzed. The steps followed to carry out economic analysis are stated below:

1. Determine the fixed cost of drip system

a) Use life of drip/micro irrigation system (i.e. 7 to 10 years).

b) Determine the depreciation cost.

c) Determine the interest (use prevailing bank interest rates for agriculture).

d) Determine the annual repair and maintenance cost (1% of annual cost).

e) Determine the total cost (b+ c +d).

1. Determine the cost of cultivation, Rs.

The cost of cultivation includes field preparation, seedlings, planting, intercultural operations, cost of fertilizers and manures and their application, plant protection chemicals and their application, harvesting and other relevant operations.

1. Determine the seasonal total cost (1(e) + 2.
2. Determine the amount of water applied through drip system and by conventional methods. This is the water estimated by FAO56 or Pan evaporimeter and, considering the wetting factor for drip system.
3. Estimate the yield response under drip (micro irrigation) and conventional method of irrigation.
4. Determine the prevailing market selling price.
5. Estimate the income from production (5 x 6) due to drip/micro irrigation or conventional irrigation.
6. Estimate the net seasonal income due to drip/micro irrigation and conventional irrigation (7-3).
7. Estimate the additional area cultivated due to saving of water.
8. 10.  Estimate the additional expenditure due to additional area (3 X 9).
9. 11.  Estimate the additional income due to additional area (7X 9).
10. 12.  Estimate the additional net income (11-10).
11. 13.  Determine the gross cost of production (3+10).
12. 14.  Determine the gross income (7+11).
13. 15.  Determine the gross B.C. Ratio, (14/13)
14. 16.  Determine the net extra income due to drip irrigation system over conventional irrigation (12+8 (drip)-8(conventional).
15. 17.  Determine the net profit per mm of water used (8/4).
16. 18.  Determine the yield per mm of water used, (kg/ha/mm).

Precision Farming Development Centre located at Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur, India conducted research experiments on fruits and vegetable crops under drip/ micro sprinkler irrigation. The salient results in terms of amount of water applied, yield, water use efficiency and B. C. ratio of some of the crops are presented in Table 24.2

**Table 24.2. Salient findings of experimental trials of fruits and vegetable crops under drip irrigation.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No** | **Fruit crop** | **Yield, t/ha** | **Water applied, mm** | **Fixed cost, Rs.** | **WUE, kg/ha mm** | **B. C. Ratio** | **Source** |
| 1. | Banana  ( 2 m X 2 m) | 39.53 | 1059 | 45000 | 37.32 | 4.49 | Tiwari et al., 1998 |
| 2. | Guava  ( 5 m X 5 m) | 37.70 | 206.0 | 30200 | 183.0 | 4.40 | Singh and Tiwari, 2007 |
| 3. | Pine apple | 70.00 | 1085.0 | 84000 | 64.5 | 6.85 | Tiwari et al., 2005 |
| 4. | Mango  (5 m X 5m) | 20.9 | 512.0 | 28210 | 54.42 | 7.01 | Anonymous, 2004 |
| 5. | Sapota  ( 5 m X 5 m) | 15.6 | 232.5 | 10929 | 6.71 | 3.55 | Anonymous, 2012 |
|  | **Vegetable crops** |  |  |  |  |  |  |
| 6. | Turmeric  (Intercrop to Sapota)  0.5 m X 0.25 m | 14.10 | 483.5 | 86674 | 29.16 | 2.25 | PFDC, Annual Report, 2013 |
| 7. | Potato  0.3 m X 0.5 m | 250.86 | 220.0 | 118320 | 114.02 | 1.75 | Tiwari et al., 2009 |
| 8. | Okra  0.6 m X 0.3 m | 13.06 | 665.0 | 65666 | 19.64 | 1.77 | Tiwari et al., 1998 |
| 9. | Tomato  (0.6 m X 0.6 m) | 70.28 | 560.0 | 65000 | 125.5 | 6.79 | Tiwari et al., 1998 |
| 10. | Cabbage | 106.68 | 400.0 | 95279 | 266.7 | 6.99 | Tiwari et al., 2003 |
| 11. | Capsicum | 13.57 |  |  | 282.71 | 6.38 | Tiwari et al., 1998 |
| 12. | Brocolli | 19.63 |  |  | 48.05 | 2.79 | Tiwari et al., 2003 |

Rao and Singh (1998) conducted field experiments on tomato crop under drip and check basin irrigation to evaluate the economic feasibility of drip irrigation. Drip method consisted of two treatments.  i) one emitter in the center of 4 plants (double pair wise) ii) one emitter between two plants (single pair wise) iii) one micro tube for each plant. The present worth of total cash inflows, out flows, payback period and benefit cost ratio were estimated for all these treatments. The least payback period of 13.28 years and maximum benefit cost ratio of 1.882 was obtained for double pairwise followed by micro tube drip treatment as 13.68 years and 1.826, respectively. They recommended using pair wise drip system layout for irrigating tomato.

Singh (2008) studied economic viability of drip irrigation for growing capsicum based on discounted cash flow technique (NPV and BCR). The experiment was conducted with different amount of water application through drip system to capsicum crop. Highest yield of 14.5 t ha-1 was found under full amount of water applied through drip with plastic mulch. The net present value was highest under drip with full amount of water application and with B.C. ratio of 3.12.

**Summary**

The micro irrigation has its advantages and limitations. Its advantages are in terms of saving of water (50-60%) of that for conventional irrigation, effective use of fertilizers, less labour and energy cost. Based on the economic analysis carried out, the micro irrigation system is highly remunerative for high value crops. The limitation of this method is its high initial cost, which is beyond purchasing capacity of small and marginal farmers, that’s why it is normally adopted by large land holdings farmers. As a policy to encourage the use of such system, the Ministry of Agriculture, Government of India, provides subsidy to the tune of 50% to small and marginal farmers under National Mission on Micro Irrigation.