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Economics of Drip Irrigation in Sugarcane Cultivation: Case Study of a Farmer from Tamil Nadu

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I

INTRODUCTION

Sugarcane is one of the water-intensive crops cultivated predominantly in different parts of the country. As of 2000-01, sugarcane is cultivated on about 4.30 million hectares in India, which accounts for about 2.23 per cent of the gross cropped area. Among the different states, sugarcane is cultivated predominantly in states like Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh. While these five states together accounted for about 81.63 per cent of the total area of sugarcane in India in 2000-01, Uttar Pradesh and Maharashtra together alone accounted for nearly 60 per cent of the total area during the same period (Government of India, 2002). Despite being a water-intensive crop, area under sugarcane continued to grow at a rate of over 1.81 per cent per annum even during the nineties, from 1990-91 to 1999-2000 (Government of India, 2002).[1]

Apart from being a water intensive crop, sugarcane has been cultivated mainly under surface method of irrigation, where water use efficiency is very low (35-40 per cent) owing to substantial evaporation and distribution losses (Sivanappan, 1994; Rosegrant, 1997; Rosegrant and Meinzen-Dick, 1996). Given the water scarcity for irrigation and fast decline of available irrigation potential, it has been discussed or debated at different forums whether cultivating sugarcane under surface method of irrigation is desirable for achieving sustainable agricultural development. Considering the water scarcity, one of the methods introduced to increase the water use efficiency recently in Indian agriculture is drip method of irrigation (DMI). Unlike surface method of irrigation, under drip method of irrigation, water is supplied directly to the root zone of the crops through a network of pipes, which saves enormous amount of water by reducing evaporation and distribution losses. The water saving capacity of the drip method of irrigation has been demonstrated by various studies using experimental as well as field survey data in India (INCID, 1994; Narayanamoorthy, 1996 a, b; 1997 a, b, c; 2001). The on-farm irrigation efficiency of the properly

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designed and managed drip irrigation system is about 90 per cent whereas the same is only about 40 per cent for surface method of irrigation (INCID, 1994). Besides water saving, it also significantly increases the productivity of crops that too with reduced cost of cultivation in different operations.

Sugarcane is one of the important crops, which is highly suitable for drip method of irrigation. Though sugarcane has been cultivated under DMI by farmers at different places in various states, its coverage is very limited as of today mainly due to poor awareness about the importance of drip method of irrigation in sugarcane cultivation. Drip irrigation technology requires relatively higher amount of fixed capital and therefore, farmers are often reluctant to invest in it. Moreover, because of the absence of credible field level studies focusing on the advantages of this technology, the farmers often ask the questions such as: what will be the pay-back period of drip investment? Is investment in drip technology viable? What is the benefit-cost ratio of drip investment? How much will be the water saving? What will be the productivity gains? Will there be any major problem in operating the system at the field level? Though some studies have already answered some of these questions using experimental data (AERT and DSI, 1988; INCID, 1994; VSI, 1998), not many studies seem to have answered these important questions using farm level data. It is essential to answer these questions using farm level data as the conditions under which crops are cultivated in the farmers' field are totally different from the conditions that are prevailing at the experimental stations. Keeping this in view, in this case study,[2] an attempt is made to study the economic aspects of drip method of irrigation by selecting a model farmer from Sivagangai district of Tamil Nadu. As the main objective of the study is to capture the impact of drip method of irrigation on sugarcane cultivation, a comparison is made between drip irrigated sugarcane and flood irrigated sugarcane on different parameters. In order to avoid the soil and other agro-climatic variations, the farmer who has cultivated sugarcane using both drip irrigation as well as flood irrigation separately with the same well water has been selected purposively for this case study.

II

PROFILE OF THE FARMER

S. Ramanathan (54) belonging to Okkur village of Sivagangai district, Tamil Nadu has been selected purposively as a sample farmer for this case study. This farmer has an educational qualification of SSLC and has a farming experience of about 30 years. Besides farming, he is also involved in money lending business jointly with his relatives for the last several years. Presently, he is also a member of the Village Panchayat Board.

The total landholding size of the farmer is 40 acres, of which 22 acres are under cultivation and the remaining 18 acres are barren and uncultivable land. The main source of irrigation of the farmer is two dug (open) wells, which were constructed in

1999 and 2001, respectively. While the well constructed in 1999 is operated using 5 HP electric pumpset, the other well constructed in 2001 is connected with 6 HP diesel pumpset. The cropping pattern of the farmer is restricted to three crops. Out of 22 acres currently under cultivation, sugarcane is cultivated in 20 acres and the remaining 2 acres are allotted for chillies and mango. Though the available water from his two wells is enough to cultivate the desired crops, the farmer was not able to provide enough water during the summer period, which significantly reduced the yield of sugarcane earlier. This is one of the reasons why the farmer opted for drip method of irrigation for cultivating sugarcane, which obviously reduces water consumption substantially. He also feels that if the erratic pattern of rainfall continues for another 2-3 years, the water scarcity may aggravate further. While searching for a suitable technology which can reduce water consumption in crop cultivation without affecting the yield of crop, the farmer got an opportunity to attend a demonstration seminar on drip method of irrigation jointly organised by Jain Irrigation System Ltd., Jalgaon and Sakthi Sugar Industry at Sivagangai, Tamil Nadu. Impressed by the demonstration seminar and the performance of crops cultivated under drip irrigation at different farmers' fields, he decided to adopt drip method of irrigation for cultivating sugarcane. For the first time during the year 2002, the farmer cultivated one acre of sugarcane under drip method of irrigation. After seeing the productivity gains and water saving from his own field, he has brought an additional area of 14 acres of sugarcane under drip method of irrigation during the year 2003 even without any subsidy from the government schemes. The comparative economic and other advantages of drip method of irrigation in sugarcane cultivation realised by the sample farmer are presented in the following section.

III

ECONOMICS OF DRIP IRRIGATION

Though drip irrigation technology is primarily introduced in agriculture for increasing the water use efficiency or saving water, it also significantly increases the productivity of crops and also reduces electricity consumption as well as cost of cultivation. However, unfortunately, the studies carried out using experimental data have brought out only the impact of drip irrigation on water saving and productivity gains. In this case study, besides focusing on productivity gains and water saving, it has also brought out the other benefits realised by the farmer due to drip method of irrigation.

Cost of Cultivation

The cost of cultivation of the crops under drip method of irrigation is less when compared to the crops that are cultivated under surface method of irrigation. Cost reduction is generally realised more in labour intensive operations like ploughing, weeding, irrigation, etc. Since water is supplied at the root zone of the crops, the lands that are used for drip method of irrigation do not require many ploughing as in the case of surface method of irrigation. Similarly, since water is supplied only at the root of the crops, weed problem is less and thus the cost required for weeding operation reduces significantly. Cost of irrigation (both labour cost and other costs) is substantially less under drip method of irrigation because of the following two reasons: First, the requirement of labour is less for managing irrigation under drip method of irrigation. Second, since water saving is very high under drip method, it substantially reduces the working hours of pumpset which extensively reduces the cost on electricity/diesel. The operation-wise cost of cultivation of the sample farmer presented in Table 1 clearly shows that cost reduction is very high in operations like weeding and irrigation as expected. The total cost reduction (excluding harvesting and transportation) comes to about 18 per cent (Rs. 3,450/acre) due to drip method of irrigation when compared to flood method of irrigation. Though the farmer has used liquid form of fertilisers (only urea and phosphate), he did not reduce deliberately the consumption of fertiliser as he felt that any reduction of fertilisers might affect the yield of crop. However, after releasing the effect of liquid fertilisers in his farm, he accepted the fact that the efficiency of fertiliser increases significantly by supplying fertilisers through water. He was of the opinion that if fertiliser is used through water, the amount of fertilisers can be reduced to a considerable extent when compared to the application methods like top dressing and basal, which are commonly followed under flood method of irrigation.

TABLE 1. COST OF CULTIVATION IN DRIP AND FLOOD METHOD IRRIGATED SUGARCANE

(Rs./acre)

Operation (1)	Drip (2)	Flood (3)	Cost saving over flood method (per cent) (4)
1. Ploughing and preparatory works	1,040	1,040	-
2. Furrow and bunding	400	400	-
3. Seed and seed sowing	4,440	4,440	-
4. Fertilisers	3,500	3,500	-
5. Farm yard manure	1,500	1,500	-
6. Pesticides	335	335	-
7. Weeding and interculture	1,200	2,400	50.00
8. Irrigation:			
(a) Labour cost	1,500	3,000	50.00
(b) Other cost	500	1,250	50.00
9. Harvesting and transportation	16,830	10,890	-54.60
10. Others	1,000	1,000	-
Cost of cultivation excluding harvesting and transportation	15,415	18,865	18.30
Total cost of cultivation	32,245	29,755	-8.40

Source: Sample farmer's data.
Note: Figures are rounded off to the nearest integer.

Water Saving

Water use pattern under drip method is totally different from flood method of irrigation. Unlike FMI, since water is supplied at a regular interval and at a required time for sugarcane under DMI, not only is the over irrigation avoided completely but the evaporation and distribution losses are almost absent. Table 2 presents the water use pattern of the sample farmer. Though the number of irrigation used for drip irrigated crop is substantially higher (240 irrigation) than flood method of irrigation (48 irrigation), the hours required to irrigate one acre of sugarcane under DMI is only one hour as against 12 hours under flood method of irrigation. The total horse power (HP) hours[3] of water used for drip irrigated sugarcane is about 1200, while on the contrary the same comes to as much as 2880 HP hours for flood method of irrigation. That is, adopting drip method of irrigation from each acre of sugarcane can save over 58 per cent (1,680 HP hours) of water. This indicates that with the same amount of water used for irrigating one acre of sugarcane under FMI, about 2.40 acres of sugarcane can be irrigated using DMI. In other words, an additional area of 1.40 acres can be brought under drip method irrigation from the saving of water realised through DMI. There are two reasons for water saving under DMI. First, since it supplies water only at the root zone of the crop, the time required for each turn of irrigation is less. Second, since water is supplied through a network of pipes, evaporation and distribution losses are completely controlled under DMI as mentioned earlier.

TABLE 2. WATER USE PATTERN UNDER DRIP AND FLOOD METHOD OF IRRIGATION

Particulars (1)	DMI (2)	FMI (3)
1. Number of irrigation	240	48
2. Hours required for each turn of irrigation	1	12
3. HP of the pumpset	5	5
4. Total HP hours of water used (1 x 2 x 3)	1,200	2,880

Source: Sample farmer's data.
Note: HP- horse power.

Electricity Saving

Electricity saving is one of the important advantages of drip method of irrigation. DMI substantially reduces the working hours of pumpset by reducing the water consumption. As a result, electricity required for irrigating one acre of land also reduces significantly. Our estimate[4] reported in Table 3 clearly shows that about 1260 kwh (saving of about 58 per cent) can be saved from each acre of sugarcane cultivation by adopting drip method.[5] Even if we assume a tariff rate of Rs. 2/kwh, the cost saving on account of electricity saving would come to about Rs. 2,520/acre from sugarcane cultivation by adopting DMI.

Productivity Gains

Similar to water saving, productivity gain is also very high under DMI when compared to flood method of irrigation. Our sample farmer reported that he could harvest 85 tonnes of sugarcane per acre under DMI as against 55 tonnes of sugarcane under FMI, a gain of 55 per cent (see, Table 3). The farmer attributes the higher yield of sugarcane under DMI to the following three reasons. First, the growth of sugarcane was very good under DMI mainly due to less moisture stress. Second, the weed growth is less because of supplying of water only at the root zone of the crop. Third, since fertilisers are supplied through water (fertigation), the efficiency of fertilisers was very high as losses occurring through evaporation and leaching with water are less under DMI. Because of higher productivity of sugarcane under DMI, the efficiency of water use along with the efficiency of cost as well as electricity is also found to be significantly higher under drip irrigated sugarcane when compared to the same cultivated under FMI.

TABLE 3. PRODUCTIVITY GAINS, WATER SAVING AND ELECTRICITY SAVING BY DRIP OVER FLOOD IRRIGATION IN SUGARCANE

(per acre)

			Gains over FMI	
Particulars (1)	DMI (2)	FMI (3)	Per cent (4)	Value (5)
1. Productivity (tonnes)	85	55	54.55	30.00
2. Water consumption (HP hours)	1,200	2,880	58.30	1,680.00
3. Electricity consumption (Kwh)	900	2,160	58.30	1,260.00
4. Water use efficiency (HP hours) (water used per tonne of sugarcane)	14.10	52.40	73.00	38.20
5. Cost efficiency (Rs.) (production cost per tonne of sugarcane)	379.35	541.00	29.90	161.65
6. Electricity efficiency (Kwh) (electricity used per tonne of sugarcane)	10.60	39.30	73.00	28.70

Source: Sample farmer's data.
Note: Figures are rounded off to the nearest integer.

Input and Output Pattern

In order to complete the analysis of relative economics of two methods of irrigation, we have calculated the relative profit levels of sugarcane cultivated under DMI and FMI. Here, while calculating the profit of sugarcane per acre, the total cost was calculated by considering only the variable cost but not fixed cost components like interest rate and deprecation. That is, the total cost of cultivation is subtracted from the gross value of production to get profit of sugarcane cultivated under DMI and FMI. The gross income of sugarcane is calculated by multiplying total yield with the price received (Rs. 782.70/tonne) by the farmer from Sakthi sugar factory. As per the data provided by the farmer, the per acre profit without any discount comes to about Rs. 34,284 under DMI, whereas the same comes to only about Rs. 13,293 for flood method irrigated sugarcane. This means that the profit of drip irrigated sugarcane is about Rs. 20,991/acre higher than the crop cultivated with flood method of irrigation. This higher profit is purely because of yield effect under DMI and not because of price effect as sugarcane cultivated under both DMI and FMI fetches the same price from the sugar factory. However, the farmer argues that there is a clear case for giving higher price for sugarcane cultivated under DMI, as scientific studies conducted using the samples collected from a fellow farmer's field proved that the recovery rate of sugarcane cultivated under DMI is considerably higher than that of the crop cultivated under FMI.[6] Obviously, the benefits of higher recovery rate of sugarcane realised due to DMI goes to the sugar factory but not to the farmers.

Benefit-Cost Analysis

Though the profit of sugarcane cultivated under drip method of irrigation is significantly higher than the crop cultivated under flood method of irrigation, it cannot be treated as the effective (real) profit of sugarcane cultivated under DMI because it does not account for the capital cost of the drip set, its depreciation and interest accrued on the fixed capital while calculating the net profit of sugarcane. The life period of drip-set is one of the important variables which determine the per hectare profit. Moreover, since it is a capital-intensive technique, the huge initial investment needed for installing drip systems remains the main deterrent for the widespread adoption of DMI. To what extent this discouragement effect is real and to what extent such effect can be counterbalanced by government subsidy are important policy issues requiring empirical answers.

Therefore, in order to find out the economic viability of drip investment in the context of sugarcane crop, we have computed both the Net Present Worth (NPW) and the Benefit-Cost Ratio (BCR) by utilising the discounted cash flow technique. Since the NPW is the difference between the sum of the present value of benefits and that of costs for a given life period of the drip set, it collates the total benefits with the total costs covering items like capital and depreciation costs of the drip set. In terms of the NPW criterion, the investment on drip set can be treated as economically viable if the present value of benefits is greater than the present value of costs. The BCR is also related to NPW as it is obtained just by dividing the present worth of the benefit stream with that of the cost stream. Generally, if the BCR is more than one, then, the investment on that project can be considered as economically viable. A BCR greater than one obviously implies that the NPW of the benefit stream is higher than that of the cost stream (Gittinger, 1984). The NPW and BCR can be defined as follows:

$$\text{NPW} = \sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+i)^t}$$

$$BCR = \frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{t=n} \frac{C_t}{(1+i)^t}}$$

where, B_t = benefit in year t,

C_t = cost in year t,

t = 1,2,3,…….n,

n = project life in years,

i = rate of interest (or the assumed opportunity cost of the investment).

Drip method of irrigation involves fixed capital and therefore, it is necessary to take into account the income stream for the whole life span of drip investment. However, since 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 costs, we need to make few realistic assumptions so as to estimate both the cash inflows and cash outflows for drip investment. The assumptions followed for estimating NPW and BCR are:

(1) The life period of the drip set is considered as ten years for sugarcane based on the experience gathered from different parts in the country.

(2) While the income generated using drip method of irrigation is assumed constant during the entire life period of drip set, the cost of cultivation is assumed to be less by Rs. 7,380/acre for ratoon crop, as the costs for operations like ploughing and preparatory works, furrow and bunding, seed and sowing as well as FYM are not required for ratoon crop.

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

(4) The crop cultivation technology is assumed constant for sugarcane during the entire life period of drip set.

The magnitude of capital requirement for DMI varies with crop depending upon the nature of the crop. Generally, wide spaced crops require relatively low fixed investment and narrow spaced crops need higher fixed investment. Table 4 presents the details of capital cost, subsidy (assumed), production cost (cost of cultivation)[7] and gross value of production for sugarcane. Since DMI is a capital-intensive technology, states like Maharashtra through a state sponsored scheme has been providing nearly 50 per cent of the capital cost as subsidy to encourage the adoption of drip irrigation for different crops including sugarcane.[8] However, despite being a water-intensive crop, subsidy schemes for sugarcane crop are not available in Tamil Nadu. Therefore, the capital cost of drip set comes to Rs. 28,000/acre for the sample farmer without subsidy. One of the important issues of drip irrigation is the role of subsidy in increasing the viability of drip investment. Therefore, only for the purpose of calculation, we have assumed that the farmer gets a subsidy of 30 per cent of the capital cost, which comes to Rs. 8,400/acre. After deducting the subsidy, the fixed capital cost of drip set comes down to about Rs. 19,600/acre. Now, let us analyse the benefit-cost pattern of drip investment using discounted cash flow technique.

TABLE 4. CAPITAL COST, PRODUCTION COST AND PROFIT (FARM BUSINESS INCOME) FOR DRIP AND FLOOD METHOD IRRIGATED SUGARCANE

(Rs./acre)

Particulars (1)	DMI (2)	FMI (3)
1. Capital cost of drip set[a]		
(a) Without subsidy	28,000.00	-
(b) With 30 per cent subsidy	19,600.00	-
2. Production cost[b]		
(Cost of cultivation)	32,245.00	29,755.00
3. Gross value of production	66,529.50	43,048.50
4. Profit without discount[c]	34,284.50	13,293.50

Source: Calculated from sample farmer's data.
Notes: a - it does not include pump-set cost.
b - production cost (A_2) includes the operation and maintenance cost of drip set and pump-set.
c - This is the difference between gross value of production and production cost (A_2).

Though the sample farmer has not received subsidy for installing drip technology in sugarcane cultivation through government scheme, we have computed both the NPW and the BCR separately by including subsidy and by excluding subsidy in the total fixed capital cost of drip set. This is done to assess the potential role that subsidy plays in the adoption of DMI. Financial viability analysis under different rates of discount would indicate the stability of investment at various levels of the opportunity cost of investment. Although the BCR is sensitive to discount rate and the degree of such sensitivity depends on the pattern of cash flows, it is interesting to observe the sensitivity of the BCR when there is simultaneous change in both subsidy and discount factor.

Table 5 presents the results of sensitivity analysis computed for the entire life period of drip set by following the assumptions mentioned above. As expected, the NPW of the investment with subsidy is marginally higher than that under 'no subsidy' option. For instance, at 15 per cent discount rate, the NPW of drip investment is about Rs. 164,938/acre without subsidy but Rs.172,247/acre with subsidy. This means that the subsidy enables the farmers to get an additional benefit of Rs. 7,309/acre. It can also be observed that the difference between the NPW under 'with subsidy' and 'no subsidy' scenarios is decreasing along with each increase in discount rate. For instance, the NPW under without subsidy condition increased from Rs. 164,938/acre at 15 per cent discount rate to Rs. 206,750/acre at 10 per cent discount rate. Similarly, under subsidy condition, the NPW increased from Rs. 172,247/acre at 15 per cent discount rate to Rs. 214,394/acre at 10 per cent discount rate.

TABLE 5. NET PRESENT WORTH AND BENEFIT-COST RATIO FOR DRIP IRRIGATED SUGARCANE UNDER WITH AND WITHOUT SUBSIDY CONDITION

Particulars (1)	Without subsidy (2)	With subsidy (3)
1. Present Worth of Gross Income (Rs./acre)		
At 15 per cent discount rate	333,911.60	333,911.60
At 12 per cent discount rate	375,958.20	375,958.20
At 10 per cent discount rate	408,757.25	408,757.25
2. Present Worth of Gross Cost (Rs./ acre)		
At 15 per cent discount rate	168,972.70	161,664.70
At 12 per cent discount rate	187,545.40	180,044.20
At 10 per cent discount rate	202,006.80	194,362.80
3. Net Present Worth (Rs./ acre)		
At 15 per cent discount rate	164,938.30	172,246.80
At 12 per cent discount rate	188,412.80	195,914.00
At 10 per cent discount rate	206,750.50	214,394.50
4. Benefit-Cost Ratio:		
At 15 per cent discount rate	1.97	2.06
At 12 per cent discount rate	2.00	2.09
At 10 per cent discount rate	2.02	2.10

Source: Computed using discounted cash flow technique.
Note: Figures are rounded off to the nearest integer.

The BCR computed with different discount rates clearly demonstrates that drip investment in sugarcane crop is economically viable. Under without subsidy condition, the BCR varies from 1.97 at 15 per cent discount rate to 2.02 at 10 per cent discount rate. Similarly, under with subsidy condition, the BCR varies from 2.07 to 2.10. The relatively higher BCR realised with subsidy condition indicates the important role of subsidy in increasing the economic viability of drip irrigation. Though there are variations in BCR at different discount rates, on the whole, the BCR unequivocally authenticates that drip investment in sugarcane remains economically viable even without subsidy.

The important issue in the context of DMI adoption in sugarcane is the number of years needed to fully recover the capital costs involved in drip installation. The results of the NPW for sugarcane clearly shows that farmers can recover the entire capital cost of the drip set from the income of the very first year itself even without any subsidy from the schemes operated by the government. For the purpose of ready reference, we have presented the year-wise trends in net present worth estimated under without subsidy condition using different discount rates in Figure 1. The findings of NPW clearly discards the common misapprehension that the capital cost recovery for drip investment takes more time. More importantly, if the farmer can recover the capital costs within a year, the role of discount rate as a device to capture the time preference of the farmers seems to be of considerably lesser importance than one might think. However, in order to have a more definite answer to the economic and social viability of DMI, we need to carry out a social cost-benefit analysis rather than the private cost-benefit analysis, which is attempted here. A comprehensive evaluation can be done by incorporating the social benefits in the form of water saving, additional irrigation benefits, higher recovery rate of sugarcane, lower soil degradation and retention of soil fertility as well as the social costs in terms of the negative food and fodder implications of crop pattern shift and labour displacement (Narayanamoorthy, 1997b).

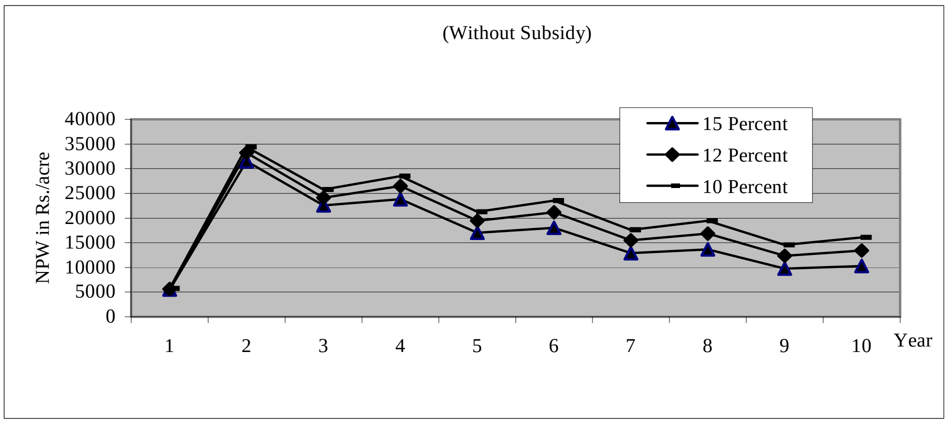

Figure 1. Trends in NPW at 15, 12 and 10 per cent Discount Rate

V

CONCLUDING REMARKS

Though drip method of irrigation is highly suitable for water-intensive crops like sugarcane, not many studies have brought out its economic viability using data collected from the farmers' field. In this case study, therefore, an attempt has been made to study the various economic advantages of drip method of irrigation in sugarcane cultivation by selecting a model farmer from Sivagangai district in Tamil Nadu. The data collected from the sample farmer clearly show that drip method of irrigation has many advantages over flood method of irrigation in sugarcane cultivation. While the productivity gains due to drip method of irrigation is about 54 per cent (30 tonnes/acre), water saving due to DMI comes to about 58 per cent over flood method of irrigation. Owing to less consumption of well water, the farmer is able to save about 1260 kwh/acre of electricity, which is used for lifting water from wells. Besides these advantages, the farmer could reduce the cost of cultivation to the tune of Rs. 3,450/acre particularly in operations like weeding, interculture and irrigation cost (both labour and other costs). Discounted cash flow analysis employed for studying the economic viability of drip investment in sugarcane cultivation clearly suggests that drip investment in sugarcane cultivation is economically viable even without subsidy. The benefit-cost ratio varies from 1.98 to 2.02 under without subsidy condition and the same varies from 2.07 to 2.10 with subsidy (30 per cent) at different discount rates. Further, the results of net present worth indicate that the farmer can recover the entire capital cost of drip set from the income of the very first year itself even without subsidy.

Though the investment on drip method of irrigation in sugarcane cultivation is economically viable without subsidy, one cannot say that the adoption of drip method of irrigation can be increased without subsidy. The sample farmer suggests that since many farmers are reluctant to adopt drip method of irrigation because of the high fixed capital, a nominal subsidy is perquisite to increase the widespread adoption of drip method of irrigation especially among the resource poor farmers. Besides advocating for a nominal subsidy, the sample farmer suggests four important points to increase the area under drip method of irrigation in crops like sugarcane. First, the importance about the drip method of irrigation has not reached among majority of the farmers so far and therefore, its water saving capacity and productivity gains has to be demonstrated clearly and effectively through a quality extension network. Second, credit facility provided by the banks by following the norms of NABARD is not enough for installing drip set and therefore, the amount of credit should be revised periodically based on the cost of drip set. Third, per acre/hectare capital cost required for drip set appears to be very high for all those farmers who want to adopt DMI and therefore, it is essential to find out ways and means to reduce the capital cost of drip set. The cost of drip set can be brought down by introducing measures such as zero sales tax or value added tax (VAT), removal of excise and other duties imposed on raw materials used for manufacturing the drip system. Fourth, as service facilities (technical and agronomic advises) with quality (timely as well as regularly) are essential for the successful operation of drip irrigation system in any crop cultivation, farmers should purchase the drip system from those companies/agencies which can provide necessary services whenever needed.

Though the results of the study amply suggest that drip method of irrigation is economically viable even without subsidy in water-intensive crops like sugarcane, one cannot generalise the results of the study, as it is a case of one farmer. Case study has its own limitations, despite the fact that it allows an in-depth understanding of the issues and solutions for drip irrigation development. Therefore, the results and evidences presented here are to be taken with extra care, not to be generalised too much. Studies using data from relatively large sample survey need to be carried out to corroborate the advantages (both economic and non-economic) of drip method of irrigation in water-intensive crops like sugarcane.

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NOTES

1. The growth rate of area under sugarcane is very high when compared to many principal crops even during the nineties. For instance, while the growth rate of area under total foodgrains was negative (-0.17 per cent), the same was only about 1.37 per cent per annum for the total non-foodgrains area. For more details about the growth rate of individual crops for different time periods see, Government of India (2002).

2. The important reason for carrying out this case study is that it allows a deeper and sharpened understanding of the issues associated with drip irrigation development, which may not be always possible in a study based on large sample survey data. Whether the results arrived from a case study can be regarded as sufficiently typical or representative facts affording a secure basis for making a policy decision is a major question that has been debated by the economists for quite some time.

3. Studies based on research station data have measured water consumption in terms of centimeter (CM) in drip irrigation. But, measuring water use in terms of CM is not an easy task at farm level because of various obvious reasons. Therefore, we have measured water consumption in term of horse power (HP) hours of irrigation. HP hours of water is computed by multiplying HP of the pumpset with hours of water used by the sample farmer.

4. It is a known fact that for every hour of operation of pumpset, 0.750 kwh of power is used per HP (Shah, 1993). Therefore, to estimate the electricity consumption, we have multiplied the HP hours of the pumpset with assumed power consumption of 0.750/kwh/HP to arrive at per acre electricity consumption.

5. Studies carried out among three crops (grapes, banana and sugarcane) utilising field survey data from Maharashtra also show similar kind of findings. For more details on this see, Narayanamoorthy (1996 a; 1997 c and 2001).

6. A scientific study carried out jointly by Jain Irrigation Systems Limited (JISL), Jalgaon and Sakthi Sugars Limited (SSL), Sivagangai in a farmer's field (Shri K.K.R. Tamilarasu of Chokkanathapuram village) at Sivagangai district shows that the recovery rate of sugarcane cultivated under DMI (12.16 per cent) is about 0.35 per cent points higher than that of flood irrigated sugarcane (11.81 per cent). The author is thankful to both JISL and SSL for sharing the results of their scientific study. The other parameters of the scientific study are presented below for the purpose of comparison:

Details	No. of IN	IN length (cm)	Cane girth (cm)	Cane length (m)	IN cane weight (kg)	NMC/acre (numbers)	Brix (Juice) %	Pol (sucrose) %	Purity %	Recovery %	Yield (tonne/acre)	CCS (tonne/acre)
DMI	33	9.87	2.79	3.26	2.01	53,568	19.21	17.07	88.90	12.16	59.00	7.17
FMI	30	8.17	2.67	2.41	1.61	45,953	19.86	16.78	86.67	11.81	36.00	4.25

Notes: IN - intermodal; NMC - net millable canes; CCS - commercial cane sugar.

7. This cost refers to Cost A_2 which includes all actual expenses in cash and kind incurred in production by owner plus rent paid, if any, for leased in land. Details on various cost concepts generally used in the analysis of cost of cultivation can be seen in Government of India (2001).

8. Maharashtra is the only state, which has been providing subsidy for sugarcane through a state-sponsored scheme since 1986. This alongwith the favourable cropping pattern prevailing in the state helped to increase the area under drip method of irrigation from 236 hectares in 1986-87 to 2,17,447 hectares in 2001-02.

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