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Economic evaluation of sub surface drainage system under Tungabhadra irrigation command

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Abstract
The work was conducted for two years (2020-21) to check the efficacy of different spacing of SSD system on soil quality parameters, land and crop performance in Tungbhadra irrigation command, Karnataka. The SSD system was laid in 7.0 ha plot with two treatments which consisted of different SSD (Subsurface drainage) spacing *viz*., 50 (3.0 ha) and 60 m (4.0 ha) each with a depth of 1.0 m. After installation of SSD system the lands were improved by resulted the maximum reduction in soil salinity was observed under 50 m drain spacing than 60 m and thereby increases in paddy yield of 58.7 and 50.3 percent under 50 and 60 m spacing respectively. Looking into economics part of the SSD system like the investment and returns, Benefit-Cost ratios was greater than one with positive NPV, greater IRR and lesser payback period, indicating that the investment on SSD system profitable even though the investment was high on reclaiming saline soils.

Keywords: Payback period, benefit cost ratio, SSD system, spacing

Introduction
Tungabhadra irrigation command 0.96 lakh ha (CADA Report, 2013) [1] of land has been affected by salinity and waterlogging mainly due to violation of cropping pattern and poor water management practices. To reclaim these lands SSD system proposed to be the best option to reducing soil salinity and waterlogging problem which helps to increase the crop yield. To considering this point, SSD system was installed with two spacing (50 and 60 m) at Agriculture Research station, Gangavathi with the financial assistance under RKVY project. In the present study attempts to worked out investment and returns of the SSD system.

Data and Methodology
The SSD system was laid in 7.0 ha plot at Agricultural Research Station, Gangavathi under Tungabhadra Project (TBP) command area. The study area were dominantly covered with clay loam soils of 1.0m depth of murrum (Manjunatha *et al.*,2004) [5]. The treatments consisted of two different SSD spacing *viz*., 50 (3.0 ha) and 60 m (4.0 ha) each with a lateral depth of 1.0 m which were covered with synthetic nylon. The collector drains (100 mm diameter PVC corrugated plastic pipe) were laid at perpendicular to surface drain at 1.10 m depth. The slope of lateral drain was 0.1 to 0.2% and connected to the collector drains whose slope was 0.2 to 0.3% which directly drains into *nala* through man hole (Karegoudar *et al*., 2022) [4].
The soil samples were collected before and after harvesting of the paddy crop upto 90 cm depth, with 15 cm interval and analyzed (Tandon, 2017) [7] for soil salinity (EC_e). The drainage water was measured manually and the same samples were analyzed a salinity (EC_w). The crop cutting data was collected in a unit area of 1 sq.mt at three places and later it compared with actual yield (qha^{-1}) after harvesting of crop under 50 and 60m spacing plots.

Drainage installation and land reclamation costs
The investment on SSD work is divided into five components (Datta, *et al*.,2000) [2] such as
i) Installation costs ii) Connection costs iii) Land development costs iv) Other costs and v) Annual operation and maintenance costs. In the following sections discussed details about investment cost per each component.

Economics of subsurface drainage system

There are three methods (Tripathi, 2009; Raju *et al*., 2016) [8, 6] were used to calculate the investment cost on SSD system like payback period, the simple rate of return and the internal rate of return (IRR).

Fixed cost

Fixed cost is nothing but the cost of material used it for SSD system and depreciation cost of material to be consider as per the prevailing bank interest rates (12%). To worked out depreciation as follows.

$$D = \frac{I - S}{L}$$

where, D = depreciation per annum, Rs; I = initial cost of system, Rs; S = salvage value (10% of initial cost), Rs; and L = economic life period, yr (For SSD system 20 year was considered).

Operating cost

The operating cost is nothing but directly paid by the investor for laid out of SSD system including interest at the rate of 12 per cent.

Total cost

$$\text{Total cost} = \text{Fixted cost} + \text{Operating cost}$$

Benefit-cost ratio

$$\text{B-C ratio} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

Generally marketing rate of paddy rates of ₹ 1,800 for 1quintal bag of paddy considered for calculating gross return.

Net present value (NPV)

To calculate Net present value, the estimated future cash flows are discounted to their present value, accounting for the time value of money. These present values are added up. The initial investment is subtracted from this sum. Net present value was expressed in terms of rupees, while internal rate of return was expressed interms of percentage.

$$NPV = \sum_{i=1}^{PL} \frac{(B_i - C_i)}{(1 + RI)^i}$$

where, B_i = benefits in the i^{th} year (Rs.); C_i = cost in the i^{th} year (Rs.); RI = rate of interest (%) and PL = life of SSD project (yr).

Internal rate of return (IRR)

IRR is defined as the rate of discount, which makes the present value of the sum of annual nominal cash inflows equal to the initial net cash outlay for the investment.

$$\sum_{i=1}^{PL} \left[\frac{B_i}{(1 + RI)^i} \right] = \sum_{i=1}^{PL} \left[\frac{C_i}{(1 + RI)^i} \right]$$

where, B_i = benefits in the i^{th} year (Rs.); C_i = cost in the i^{th} year (Rs.); RI = rate of interest (%) and PL = life of SSD project (yr).

Payback period

The payback period is defined as the time (years, months) it takes for an investment cash inflows to equal its initial cost

$$\text{Payback period} = \frac{\text{Total investment}}{\text{Net profit}}$$

where, Net profit = Gross returns - Cost of cultivation

Results and Discussion

Sub surface drainage installation costs

Earthwork Excavation

The excavation cost will be depends on type of soil, spacing, width and depth of excavation of the SSD system planned. As per the IDNP, 2002 [3] guidelines report the lateral trench were made across highest slope of the land with by maintaining 0.1 to 0.2 per cent slope, depth of the trench was 1.0 m and width of the trench was made 0.6m and trenches were connected to the concerned chamber. The collector pipes were made along the slope (0.2 to 0.3 per cent), with a width of 0.6 m and depth was 1.2 m. The construction of man hole/inspection chamber earthwork specification was made 2m x2m x1.5m = 6 cu.m and for guard wall 2m x 0.6m x1.8 m = 2.16 cu.m. The cleaning of existing nala/stream upto 500 m length with a depth of 2.5m with making trapezoidal shape. Inspection chamber/manholes were interconnected through trench of collector drains and finally connected to the outlet with made a provision of gravity flow. The cost of earthwork including excavation and refilling work was over. In this earth work excavation component not used any labour and the work was achieved through JCB machine (70hp) on per hour 35 cubic meter (cu.m) of earth work was achieved. The average earth work costs per hectare were ₹ 19509 and 20473 under 50 and 60m spacing respectively.

Supplying and laying of drain pipes

The cost of supplying material depends on the quality and quantity but laying of drain pipes depends on which type of SSD system adopted in the field. The 80 mm diameter corrugated pipe with synthetic envelope were used for the lateral drains. For the collector, 100 mm diameter PVC non-perforated pipes were used connect the nala. Above the Lateral drains pipe covered with sand/gravel material so that it will be helpful for preventing sedimentation. The actual cost of supplying drainage materials based on their least quotation supplied by the companies. The supplying of materials will be on running meter basis. The cost of lateral corrugated pipes required for each plot of ₹ 26200. The costs of collector pipes were ₹ 23371 and 27720 under 50 and 60 m spacing and the cost of ₹ 16800 of synthetic envelopes were required for every plot. The cost of laying of collectors and laterals were including sand and labour cost. The layout costs of lateral pipes were under each spacing was ₹ 22000. The layout costs of collector pipes were ₹ 6774 and 8836 under 50 and 60 m spacing respectively.

Accessories

The cost of accessories depends on size of lateral and collector drains. This component includes end caps, Tee, connectors and reducers and ₹ 2800 per ha worth of materials required under 50 and 60 m spacing respectively.

Connection costs

For each plot, requires one guard wall, one inspection chamber and one RCC hume pipe meant for the dispose of drainage water. The cost of RCC pipe hume was ₹ 1000, guard wall making charges ₹ 2200 and Inspection chamber (3ft dia with 5ft height Hume pipe) was ₹ 9000 for unit cost required for each plot.

Land development costs
The average land development costs per ha were ₹ 3500 and ₹ 4500 under 50 and 60 m spacing respectively.

Other costs
It includes day today unseen expenditure made by the owner during implementation period of ₹ 2000 required for both the spacing.

Operation and maintenance cost
It is very much necessary for smooth functioning of the system for sum of ₹ 8000 required every year for each plot.

Total cost
Almost 50% of the total costs were spent on pipes, synthetic nylon material, 20 per cent amount spent for laying of the pipes it includes sand and labour cost. The amount spent for making of trench (earthwork) for laterals, mains and also cleaning/desilting of nala was about 15 per cent and connection costs 10 per cent. The least amount spent (5 per cent) for land development because SSD was installed in existing cultivated land. The cost per hectare for installation of SSD system with 500 m of length of surface drain cleaning was ₹ 135154 and ₹ 143529 under 50 and 60 m spacing respectively.

Table 1: Component wise installation cost (Rs/ha) under 50 and 60 m spacing of SSD system

Sl. No.	Cost component	Spacing (m)			
		50		60	
		Average costs (Rs/ha)	Relative costs (%)	Average costs (Rs/ha)	Relative costs (%)
I	**Drainage installation costs**				
	i. Earth work	19509	14.43	20473	14.26
	ii. Cost of pipes				
	a) Lateral corrugated pipes (80mm)	26200	19.39	26200	18.25
	b) Collector pipes (100mm)	23371	17.29	27720	19.31
	c) Synthetic envelope	16800	12.43	16800	11.70
	iii. Cost of laying				
	1. Lateral corrugated pipes (80mm)	22000	16.28	22000	15.33
	2. Collector pipes (100mm)	6774	5.01	8836	6.16
	iv. Accessories	2800	2.07	2800	1.95
II	**Connection costs**				
	i. Providing and laying RCC pipe for outlets	1000	0.74	1000	0.70
	ii. Construction of Guard wall	2200	1.63	2200	1.53
	iii. Inspection chamber/Manhole	9000	6.66	9000	6.77
III	**Land development costs**				
	i. Land levelling and making of bunds	3500	2.59	4500	3.14
IV	Other costs	2000	1.48	2000	1.39
	Total investment costs	135154	100.00	143529	100.00
V	Annual maintenance costs (Including surface drain cleaning)	8000	-	8000	-

Benefits of subsurface drainage system
The installation of SSD system over two season soil salinity (0-15 cm) was reduced from 4.3 to 1.40 (67.4%) and 7.69 to 2.55 dSm^{-1} (66.9%) at 50 m and 60 m spacing respectively. The salt removal was 0.86 and 0.63 tonha^{-1} at 50 and 60 m spacing respectively. The increase in paddy yields was observed about 58.7 and 50.3 per cent under 50 and 60 m respectively are presented in Table 2.

Table 2: Benefits of SSD system in the study area

Sl. No.	Parameters estimated	After drainage	
		50 m	60 m
1	Reduction of soil salinity (%)	67.4	66.9
2	Removal of salt tonha^{-1}	0.86	0.63
3.	Paddy yield increase	58.7	50.3

Feasibility analysis
The success of any technology mainly depends on positive results on B:C ratio, NPV and IRR. The discounting techniques were used to appraise the economic viability of the subsurface drainage system. These techniques were used as they take into consideration of both the time element and market rate of interest of the investments made in the work. Economics analysis of SSD system for considering 20 years of life period are presented in Table 3.However, the B-C ratio, NPV was obtained higher (1.94, ₹ 493870.00) in case of 60m spacing as compared to 50 m spacing plot (1.78, ₹ 411385.00). Under both the spacings, IRR was showed better and found between 57 to 60 per cent. The Total costs of cultivation were ₹ 80350.00 and ₹ 78870 at 50 and 60 m spacing respectively. The payback period of the SSD system ranges between 1.94 to 2.34 seasons. The study reveals that under both the spacing the B-C ratios was found greater than one, positive NPV, higher value of IRR and with lesser payback period was found to be worth investing money on SSD works.

Table 3: Economics (20 years) of SSD system in Tungabhadra command

Spacing (m)	Total returns, Rs. ha^{-1}	Total cost of cultivation, Rs. ha^{-1}	Net returns, Rs ha^{-1}	Net Present Value, Rs ha^{-1}	BCR	Internal rate of return (%)	Payback period (seasons)
50	173387.00	80350.00	93037.00	411385.00	1.78	60	1.94
60	198640.00	78870.00	119770.00	493870.00	1.94	57	2.34

Conclusion

The performance and impact of the SSD system in these two spacing were monitored for two years with reduction in soil salinity from 64 to 67 per cent, removal of salt from 0.63 to 0.86 tonha^{-1} and also paddy yield were increased from 50.3 to 58.7 per cent under 50 and 60 m respectively. Looking at the economics by considering all the investment and returns, the B-C ratio was recorded highest in case of 60m (2.34) spacing as compared with 50 m (1.94) spacing. The NPV was found to be higher at 60 m spacing was ₹ 493870.00, whereas in 50m spacing NPV was ₹ 411385.00. Under both the spacing, IRR was showed better and found between 57 to 60 per cent. The Total costs of cultivation were ₹ 80350.00 and ₹ 78870 at 50 and 60 m spacing respectively. The payback period of the SSD system ranges between 1.94 to 2.34 seasons. The study reveals that under both the spacing the B-C ratios was found greater than one, positive NPV, higher value of IRR and with lesser payback period was found to be worth investing money on SSD works.

References

1. Command Area Development Authority (CADA). TBP project report. Karnataka, India; 2013.
2. Datta KK, de Jong C, Singh OP. Reclaiming salt-affected land through drainage in Haryana, India: a financial analysis. Agric Water Manag. 2000;46:55-71.
3. Indo-Dutch Network Project (IDNP). Computer modeling in irrigation and drainage. Karnal: CSSRI; Wageningen: Alterra-ILRI; 2002. p. 56.
4. Karegoudar AV, Viswanath J, Rajkumar RH, Anand SR, Polisgowdar BS, Ayyanagowdar MS, *et al*. Economic feasibility of subsurface drainage to control waterlogging and soil salinity under different scenarios in Tungabhadra Project command, Karnataka. Int J Irrig Drain. 2022;71:1063-1076. doi:10.1002/ird.2716.
5. Manjunath MV, Oosterbaan RJ, Gupta SK, Rajkumar H, Jansen H. Performance of subsurface drains for reclaiming waterlogged saline lands under rolling topography in Tungabhadra irrigation project in India. Agric Water Manag. 2004;69(1):69-82.
6. Raju R, Thimmappa, Parveen Kumar, Satyendra Kumar, Tripathi RS. Reclamation of saline soils through subsurface drainage technology in Haryana—An economic impact analysis. J Soil Salinity Water Qual. 2016;8(2):194-201.
7. Tandon HLS. Methods of analysis of soils, plants, waters, fertilizers and organic manures. New Delhi: Fertilizer Development and Consultation Organization; 2017.
8. Tripathi RS. Alkali land reclamation: A book for development. New Delhi: Mittal Publications; 2009.