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Financial Viability of Sub-Surface Drainage Technology for Reclamation of Waterlogged Saline Soils

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Introduction

Crop production loss to the extent of 11.2 million tons (MT) annually occurs from nearly 2.95 million hectare (Mha) salinity affected area in India. It results in an annual monitory loss of INR 230.2 billion in 16 states/UTs of the country. Sub-surface drainage (SSD) is an effective technology for reclamation of waterlogged saline soil. The installation cost of SSD varies considerably from alluvial to heavy soils based on topography, drain depth and spacing, drainage outlet, drainage material, and pipe laying machineries etc. The guidelines and installation costs of SSD technology and viability of a project have been worked out as a basis for funding and implementing large scale drainage projects through state departments/ project implementing agencies as well as through public-private partnership (PPP) mode.

Scope

ICAR-CSSRI has been actively involved in research and extension of SSD technology across India since 1980s. The institute has standardized the technology for its large scale implementation. Of the 6.74 million ha salt-affected lands in India, severely waterlogged saline soils occur in about two million ha area in arid/semi-arid alluvial north-western states and about one million hectare in coastal and black cotton heavy soil (Vertisol) regions. The water-logging and soil salinity-related losses in irrigation commands of India are likely to increase to 13 million ha by 2025 and to 20 million ha by 2050 due to climate change and enforced use of saline/alkali groundwater in different parts of the country.

Till date, SSD has been implemented in around 75000 ha through various schemes and programmes in the country, which is merely ~3% of the total affected area. To treat the remaining affected area for acieving land degradation neutrality (LDN) goal of India, there is an urgent need to accelerate adoption rate of SSD technology.

Drainage Design Criteria

The SSD system consists of a network of underground perforated pipes, installed manually or by machine at a designed spacing and depth. The operation of SSD ameliorates waterlogging and soil salinity through removal of excess salts and water from the affected area. SSD is mainly recommended in those areas where groundwater is saline and water table depth is < 2.0 m below ground level. For designing of a SSD project, information such as drainage coefficient, drain spacing, drain depth, pipe size and slope and filter etc. for different climatic regions suggested by ICAR-Central Soil Salinity Research Institute are presented in Table 1, 2 and 3, respectively.

Table 1. Drainage coefficient (DC) and drain depth under different outlet conditions

Climatic region	DC Range (mm/day)	Optimum (mm/day)	Outlet depth (m)	Depth Range (m)	Optimum (m)
Arid	1.0-2.0	1.0	Gravity	0.9-1.2	1.0
Semi-arid	1.0-3.0	2.0	Pumped	1.2-1.8	1.5
Sub-humid	2.0-5.0	3.0			

Table 2. Guidelines for drain spacing under different soil textural groups

Soil texture group	Drain Spacing (m)	Optimum (m)
Light	100-150	100
Medium	50-100	60 & 67
Heavy including Vertisols	30-50	30

Table 3. Drain pipe size, slope and filter requirement

Pipe size (mm)	Grade (%)	Clay (%) & Sodium Absorption Ratio (SAR)	Filter requirement
80-100 (lateral)	0.10	< 30%	Yes
100-315 (collector)	0.09-0.05	30-40% and SAR > 8	Yes
		> 40%	No

Estimation of Cost of SSD Technology

Major components contributing to installation cost of SSD system includes preparation of detailed project report; drainage materials (lateral and collector pipes, synthetic filters, structures, pump set etc); pipe installation cost; supervision; operation & maintenance; and contingency charges; farmers' awareness & training and monitoring & evaluation charges. To quantify expenditure on different components required for implementation of SSD project, a model SSD block of 40 ha area was considered and, accordingly cost of the different components were worked out. Costs of lateral and collector pipes, synthetic filters, RCC pipes, structures and pump set etc. were taken as per procurement prices (2021-22) of the implementing agencies working in Haryana and Maharashtra. The PVC corrugated pipes of 80-294 mm size are being used in SSD installation. The price of pipes and filters required for drain spacing of 50-100 m (light and medium soils) was taken from Haryana operational pilot project (HOPP), while for heavy soils (20-40 m), the same was adopted from the implementing agencies working in Maharashtra. In general, in heavy soils, lateral pipe is pre-wrapped and collector pipe does not require any filter. In such soil (20-40 m lateral spacing), a manhole with a gate valve on collector was considered for each 5 ha block as a controlled section. For the pumped outlet, investment on solar operated 3 hp pump set was taken. The annual fixed and variable costs of the machineries involved in installation of the SSD technology were considered. The different types of machines commonly used by implementing agencies in Haryana and Maharashtra were taken into account for estimation of installation cost. Fixed cost includes annual depreciation, interest on investment, TIH (taxes, insurance, and housing), whereas components of the variable cost are annual repair and maintenance, fuel, lubrication and operator's charges and manpower involved in installation. The SSD installation cost was estimated for gravity as well as pumped outlet conditions prevalent in Maharashtra and Haryana, respectively. Any additional cost, if required, for laying HDPE pipe to carry drainage effluent from the project area to the suitable surface drain/outlet was also worked out considering the cost/ rates of the government agencies. The cost of SSD components required for its installation in one hectare area in heavy and medium texture soil with recommended 30m and 67m drain spacing, respectively is given in table 4. The expenditure on installation of SSD network with different drain spacings, outlet conditions are also summarized in table 5.

Table 4: Cost of SSD components with gravity/pumped outlet in heavy and medium texture soils

Sr. No.	Component of SSD	Cost (Rs/ha) and share (%) in parentheses			
		Heavy texture soil (30 m drain spacing)		Medium texture soil (67 m drain spacing)	
1	DPR	3599	(2.6)	2993	(2.5)
2	Pipes and filters	65713	(46.8)	50724	(41.2)
3	Fittings	3127	(2.2)	2450	(2.0)
4	Structures	3450	(2.5)	11997	(10.0)
5	Installation cost	47680	(34.0)	34608	(28.4)
6	Dewatering cost	0	(0.0)	5356	(4.4)
7	Supervision charges	4199	(3.0)	3492	(2.9)
8	Contingencies	5999	(4.3)	4989	(4.1)
9	Manpower	3179	(2.3)	2189	(1.8)
10	M & E	2399	(1.7)	1996	(1.6)
11	Farmers training	1000	(0.7)	1000	(0.8)
	Total	**140345**	**(100)**	**121794**	**(100)**

**Above SSD cost does not include tree removal, surface drain cleaning & deepening, approach road and land development & maintenance cost if any, and main drain from the project area to surface drain.*

Note: per ha cost was computed based on model SSD block of 40 ha.

Table 5: Cost estimate for SSD installation (Rs/ha) in different texture soils, drain spacing and outlet

Soil types/ Outlet type	Heavy textured soil including Vertisols (Clay >30%)			Light & Medium textured soil (Clay <30%)					
	20	30	40	50	60	67	80	90	100
Pumped outlet	203000	155500	128500	142000	132500	122000	113000	108500	100500
Gravity outlet	188000	140500	115500	127000	117500	107000	97500	93500	85000
With conveyance pipe*	254000	206500	182000	-	-	-	-	-	-

**About Rs 66000 per ha is included for HDPE conveyance (main) pipe if surface drain/outlet is available upto 1 km away from the SSD project site, under gravity outlet. Approximately Rs 23000/ha is required for each 1 km additional main pipe, which is in addition to Rs 66000/ha.*

Note: Cost escalation over the time may be considered ~5% per year or depending on the prevailing market prices while preparing DPR.

Financial Viability

Based on results of previously executed projects, the financial viability of the SSD technology was analysed considering improvement in crop productivity, as compared to without or before SSD installation, of rice–wheat and sugarcane dominant cropping systems in Haryana and Maharashtra, respectively. All costs and benefits of SSD were discounted at 12%, assuming the economic life of SSD as 30 years. Estimated values of net present value (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR) indicate that investment on SSD technology is viable for reclamation of waterlogged saline soils (Table 6).

Table 6: Financial viability of SSD technology

Indicator	Heavy texture soils (30m drain spacing)	Medium texture soils (67m drain spacing)	Viability/Sustainability Criteria
Net present value (Rs. /ha)	2,48,789	2,27,243	NPV> 0
Benefit: Cost Ratio	2.24	2.35	BCR>1
Internal rate of return (%)	34.07	35.86	IRR > Discount rate (12%)
Pay-back period (years)	3.56	3.45	-

Way Forward

The SSD technology is a technically feasible and financially viable option for rejuvenating waterlogged degraded land. Depending on the soil texture, drain depth and spacing, and drainage outlet, SSD installation cost differs significantly. These estimates may be utilized as a basis for the funding of large-scale SSD projects under various national/state programs to accelerate the reclamation pace of waterlogged saline lands in India.

Citation:

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