

## Technical manual for mitigating soil salinization with preferential shallow sub-surface drainage and sub-surface irrigation

In the Indo-Gangetic Plain (IGP) of northern India, soil salinization is a serious problem due to irrigation using high-salinity groundwater and residual salt accumulation resulting from poor drainage. While improving drainage and adopting water-saving practices are effective countermeasures, the construction of open drainage and sub-surface drainage networks and the introduction of drip or sprinkler systems require significant initial investment and maintenance costs. Shallow sub-surface drainage using a "Cut-soiler" (a tractor attachment developed in Japan), sub-surface irrigation using "water drop tubes," and water-saving gains through improvements in furrow irrigation are relatively inexpensive and easy to implement compared to conventional drainage and water-saving technologies. These promising and sustainable measures, which can be integrated into farming, have been compiled into a technical manual to promote extension activities.

The technical manual, structured into four chapters (Table 1; Fig. 1), is an 80-page, A4-sized booklet that makes extensive use of photographs and illustrations to facilitate understanding. Regarding drainage mitigation, the manual details the structure and construction method of shallow sub-surface drainage with the Cut-soiler, alongside the effects on desalination and pH improvement. It also identifies the optimal construction interval (JIRCAS Research Highlights, FY2022 A11 and FY2024 A10). Furthermore, the manual analyzes seasonal fluctuations in groundwater levels, which share a strong causal relationship with soil salinization, to indicate the optimal construction timing for Cut-soiler drainage. The Cut-soiler's break-even point is clarified (Fig. 2) and a rural adoption system is proposed. As water-saving measures, sub-surface irrigation with water drop tubes, skip furrow irrigation (irrigating every other furrow), and simplified surge flow irrigation (supplying water twice at a one-day interval) (Fig. 3) are introduced. Additionally, the manual identifies soil sodification (an increased proportion of sodium ions) as a primary cause of serious drainage problems and proposes relevant countermeasures.

The technical manual can be used in trainings and/or seminars for widespread dissemination of the effects of shallow sub-surface drainage and sub-surface irrigation. The distribution of the manual is expected to facilitate rapid information sharing among government officials, local organizations, and farmers. While shallow sub-surface drainage and sub-surface irrigation are distinct technologies, if applied together, a greater effect is expected. Although the manual is based on verification within the IGP, it is applicable to similar regions based on an evaluation of irrigation and drainage conditions.

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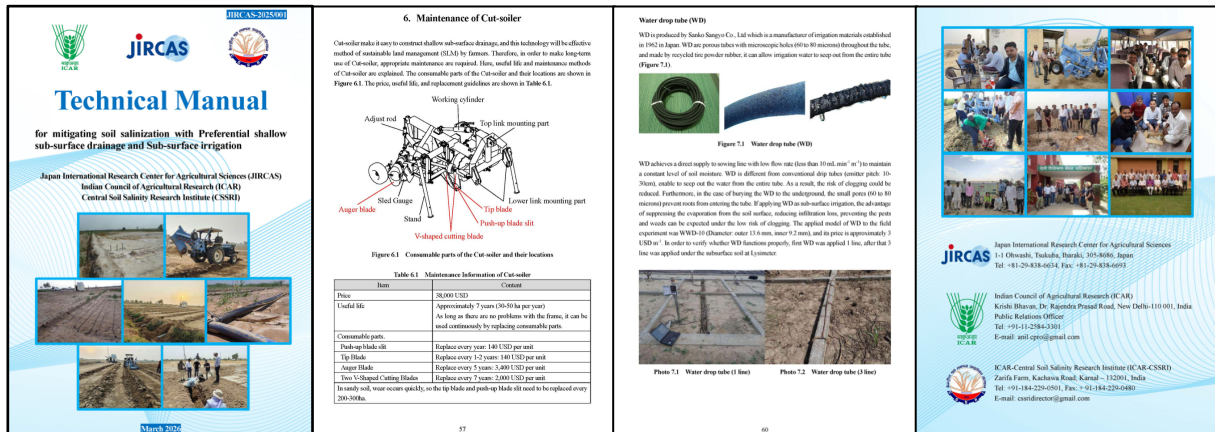


Fig. 1. Technical manual for mitigating soil salinization

Table 1. Contents of technical manual

Chapters	Title	Contents
Chap. 1	Introduction	Status of irrigated agriculture and salinization, Purpose of joint research
Chap. 2	Salinization	Classification of salt-affected soils, Explanation of sodic soils, Salinization in India: Cause and countermeasures
Chap. 3	Cut-soiler	Drainage types, Construction methods using Cut-soilers
Chap. 4	Effect of Cut-soiler	Effects in lysimeter and field trials
Chap. 5	Applicability of Cut-soiler	Economic evaluation of Cut-soiler, Proposed rural adoption system
Chap. 6	Maintenance of Cut-soiler	Service life and maintenance methods for Cut-soilers
Chap. 7	Water-saving	Effects of sub-surface irrigation with water drop tubes, Water-saving skip furrow irrigation and simplified surge flow irrigation

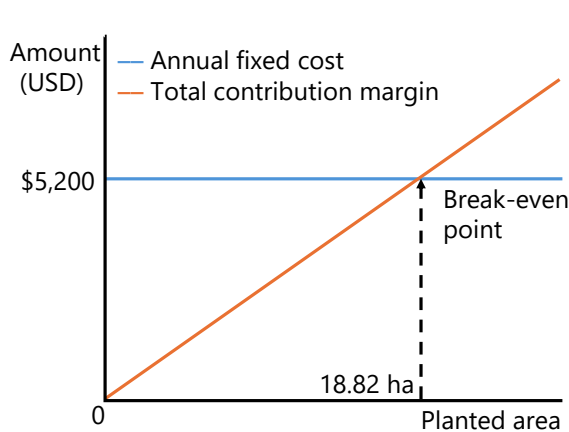


Fig. 2. Break-even point for Cut-soiler

Annual fixed cost: \$5,200, calculated by annualizing the purchase cost of approximately \$39,000 using a 10% discount rate and a 15-year useful life (Converted at ¥160/USD).

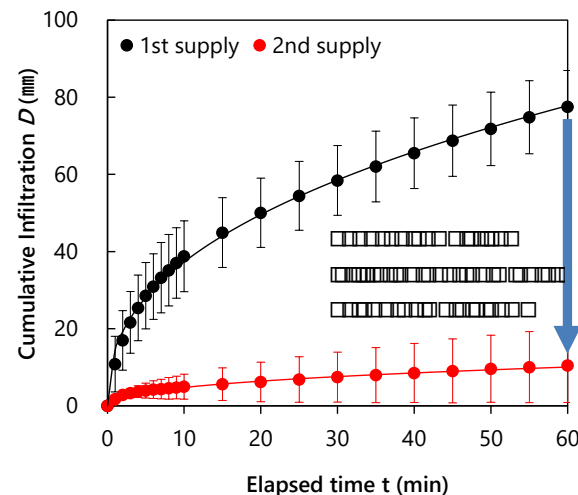


Fig. 3. Furrow infiltration under simplified surge flow irrigation

By wetting the furrow with the first water application under simplified surge flow irrigation, cumulative infiltration over 60 minutes during the second water application on the following day is reduced by approximately 87%.

References: Lee et al. (2025) *PLOS One* 20: e0320775. © Authors 2025  
Onishi et al (2021) *Journal of Soil Salinity and Water Quality* 13: 157–163. © Indian Society of Soil Salinity and Water Quality 2021

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