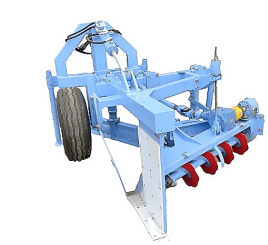
Shallow sub-surface drainage constructed with "Cut-soiler" mitigates soil salinity

In the Indo-Gangetic Plain, groundwater irrigation dramatically improved agricultural production. However, salinization has become a serious issue due to the high salinity of irrigation water and poor drainage. Construction of open and/or sub-surface drainage is effective at mitigating salinization, but it is difficult for farmers to implement due to the high cost. Therefore, towards developing sustainable drainage measures that farmers can practice, we conducted research and created a low-cost method of constructing shallow sub-surface drainage using a Japan-built tractor attachment called the "Cut-soiler."

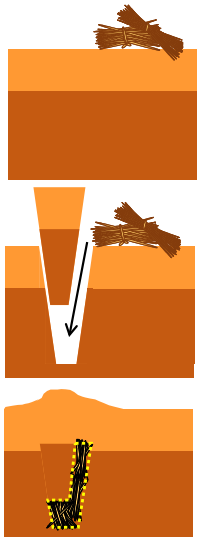
Conventionally, when constructing a material-filled sub-surface drainage, it is necessary to prepare the hydrophobic material to be buried in the soil and load it into the construction machine. This method does not require these works, and harvested residues such as rice and wheat straw scattered on the field can be buried underground simply by running a tractor equipped with the Cut-soiler. The method involves cutting the soil into an inverted trapezoid, then lifting it up to make space from the ground surface to a depth of 40 to 60 cm. The crop residue, spread to a width of 120 cm, is then pushed into this space to make a shallow sub-surface drainage (Fig. 1). Shallow sub-surface drainage (60-cm depth) constructed with the Cut-soiler reduced soil salinity (ECe: electrical conductivity of the solution extracted from the saturated soil) by 8% (no significant difference) and 32% (P=0.047) at 4 and 16 months after construction, respectively (Fig. 2). Meanwhile, the yield improved by 4% (no significant difference) and 23% (P=0.048) in the dry season crop (November to March: mustard) and in the rainy season crop (June to September: pearl millet), respectively (Fig. 3).

The construction method has been compiled into a manual, titled "Cut-soiler constructed Preferential Shallow sub-surface drainage for mitigating salinization User's Guide," and is now available on the JIRCAS website for its further extension. It is expected to be used for salinization countermeasures by the Central Saline Soil Research Institute (CSSRI) in India. Regarding the method and equipment, the following should be noted. The drainage condition should be checked in advance as this method depends on the drainage condition around the field. Then, a suitable construction method should be chosen. The Cut-soiler does not have wheels, so it must be loaded onto a truck when transporting long distances. The estimated useful life of the Cut-soiler is around 7 years covering 30–50 ha of construction area per year. If there is no problem with the frame, it can be used continuously by simply replacing consumables.

(J. Onishi, K. Koda, K. Matsui, T. Anzai, K. Okamoto, G. Lee, T. Watanabe, K. Omori, I. Kitagawa [National Agriculture and Food Research Organization], Chaudhari S.K. [Indian Council of Agricultural Research], Yadav R.K. [ICAR-Central Saline Soil Research Institute], Yadav G. [ICAR-CSSRI], Neha [ICAR-CSSRI], Rai A.K. [ICAR-CSSRI], Kumar S. [ICAR-CSSRI], Narjary B. [ICAR-CSSRI], Sharma P.C. [ICAR-CSSRI])



Cut-soiler



The shredded residue (straw, stems, and leaves) and compost are left on the field after harvesting.

Driven by a tractor, the Cut-soiler cuts the soil into an inverted triangular (V) shape and lifts the soil to open a trench. At the same time, the surface materials are collected and pushed towards the narrow groove formed during trench opening.

The lifted soil is backfilled over the filling material, creating a groove-shaped, shallow sub-surface drainage.

Since the ground is raised after construction, the field should be leveled with a rotary or leveling disc harrow, etc.

Fig. 1. Method of constructing a shallow sub-surface drainage with the Cut-soiler

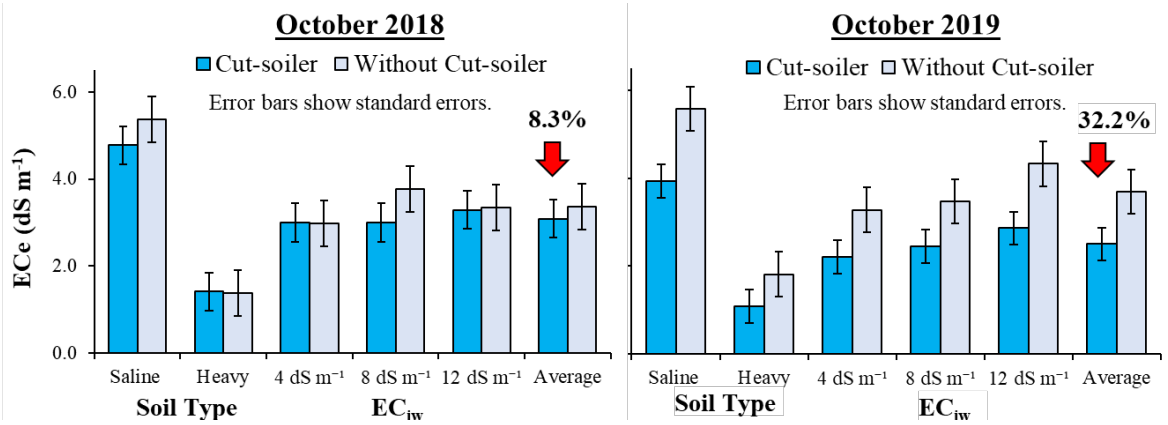


Fig. 2. Changes in soil salinity

EC_{iw} is the electrical conductivity of irrigation water.
Average is the average of 12 plots with and without Cut-soiler construction.

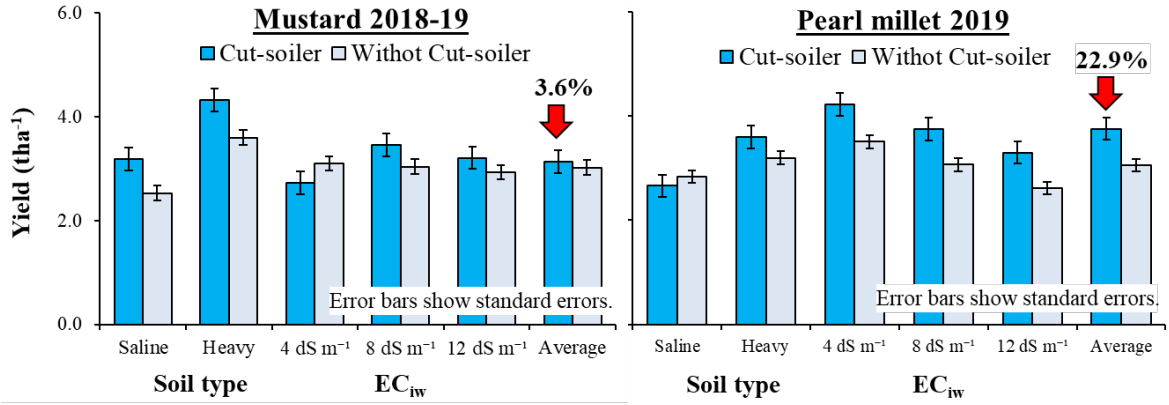


Fig. 3. Yield of dry season crop (mustard) and rainy season crop (pearl millet)

EC_{iw} is the electrical conductivity of irrigation water.
Average is the average of 12 plots with and without Cut-soiler construction.

References: Fig. 1. NARO Research Highlight (2015); Figs. 2 and 3. Neha et al. (2022) *Journal of Arid Land Studies* 32(S): 117–122. https://doi.org/10.14976/jals.32.S_117