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CRRI-Soil Permeameter



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Introduction

Hydraulic conductivity (K) of soil is a measure of how easily water can move through pore spaces. Different instruments and methods are used to check it depending on whether it is under saturated or unsaturated soil conditions.

The hydraulic conductivity of soil is a critical parameter in agriculture because it governs how water moves into, through and out of the soil profile. Water is the most important input for crop growth, and its availability in the root zone depends directly on the soil's ability to transmit it. By checking hydraulic conductivity, farmers and agricultural planners can understand how efficiently soils can absorb irrigation water or rainfall and make better decisions on water management.

Importance of soil saturated hydraulic conductivity

For Crop Growth

- ▶ Ensures good **aeration in root zone** → prevents waterlogging & oxygen deficiency
- ▶ Promotes **root respiration & nutrient uptake**
- ▶ Supports stable **soil structure & deeper root penetration**
- ▶ Encourages **microbial activity** → better nutrient cycling



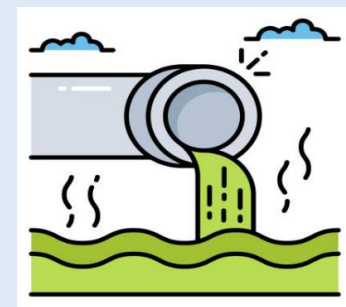
For Irrigation Planning

- ▶ Guides irrigation scheduling, prevents runoff and deep percolation losses
- ▶ Determines infiltration rate and correct water application
- ▶ Helps in choosing appropriate irrigation method:
 - ✦ Drip → low K_{sat} soils
 - ✦ Sprinkler → moderate K_{sat} soils



For Drainage Planning

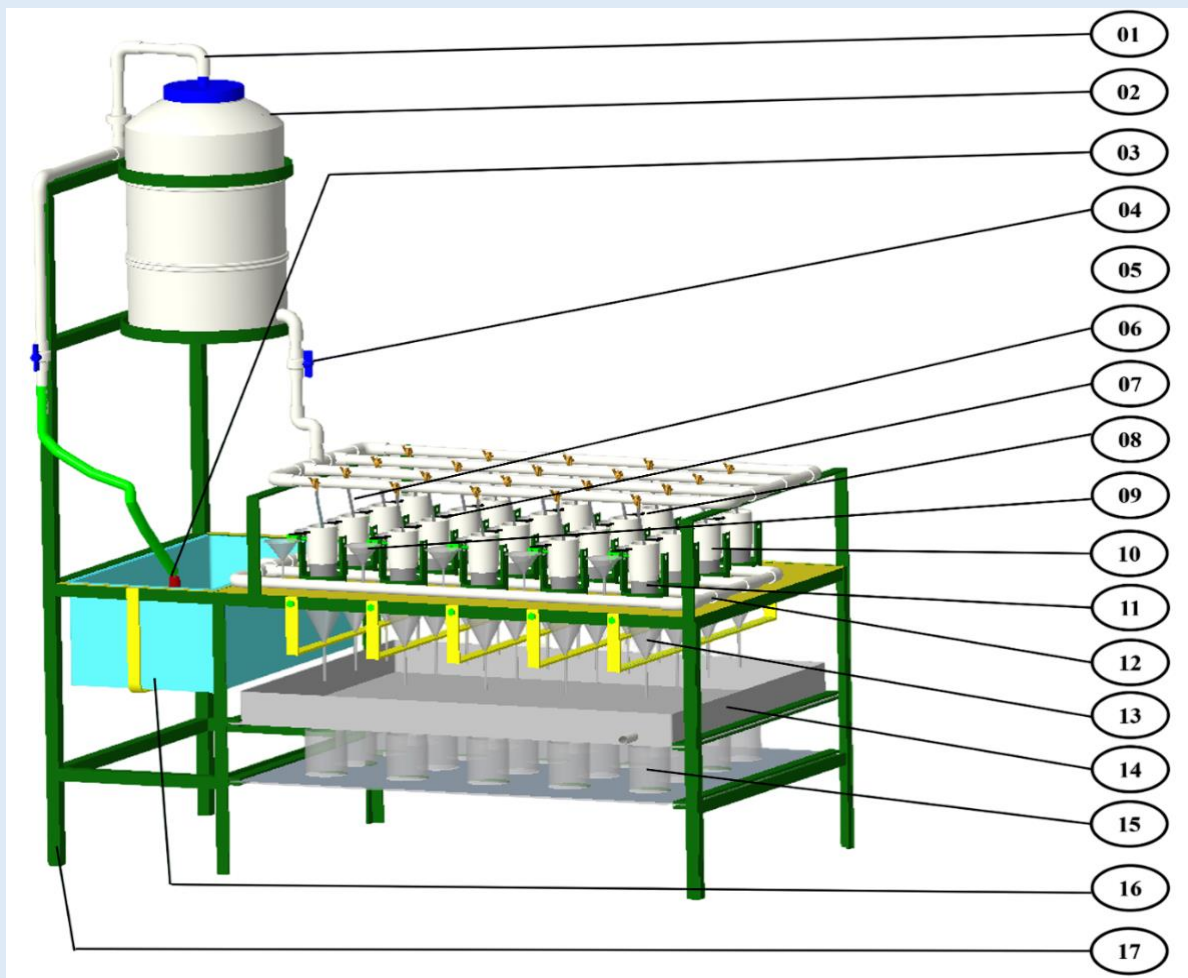
- ▶ Helps in Determining depth and spacing of drains
- ▶ Ensures quick removal of excess water → prevents root damage
- ▶ Prevents salinity build-up by aiding leaching of salts
- ▶ Reduces crop loss in heavy rainfall areas



Limitations of existing permeameters

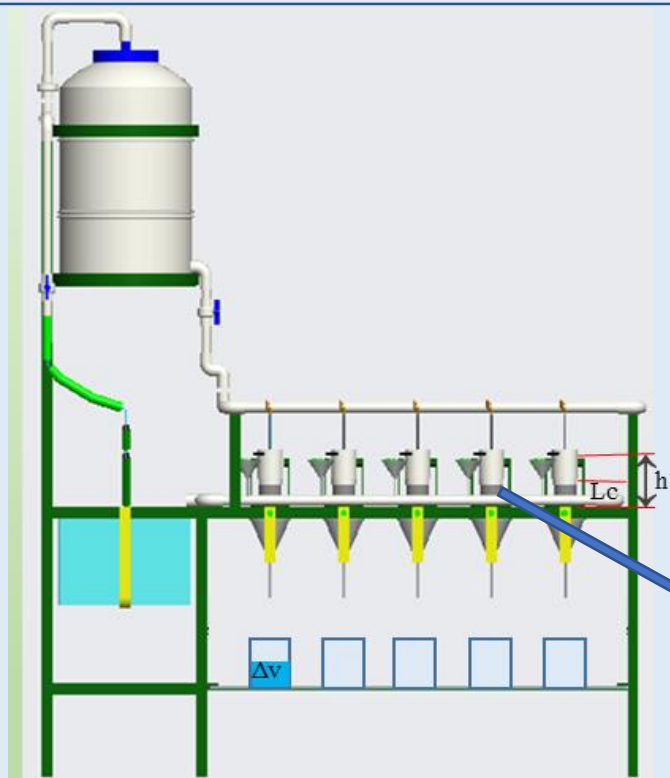
- ▶ Not portable in general
- ▶ Not suitable for all soil types
- ▶ Multiple sample analysis facility not available
- ▶ Higher cost involvement

Components of CRRI-Soil Permeameter



SL. No.	Parts Name
01	Water inlet to Tank
02	Water Tank
03	Pump unit
04	Control valve
05	Flow control for maintaining constant head
06	Water inlet tube
07	Overflow tube maintaining constant head
08	Water distribution pipes to Constant water head unit
09	Overflow collection funnel
10	Constant water head unit
11	Core Sampler
12	Overflow collection pipes
13	Funnel guiding sample water to beaker
14	Sliding water tray
15	Sample water collection beaker
16	Overflow collection tray
17	Main frame

Equation for estimating saturated hydraulic conductivity (K_s) of the developed permeameter



Dimensions/ measurements:

Length of core sampler (L_c) = 5 cm

Internal Diameter of core sampler (D_c) = 4.8 cm

Constant head maintained (h) = 11.5 cm



According to Darcy's law:

Water flux moving through the soil sample = Q/A

Where, $Q = VA = K \cdot (h/L_c) \cdot A$ [$V = K \cdot i$] (Equation 1)

Here, Q = measured volume of water in the measuring jar below the core sampler over time = $(\Delta v / \Delta t)$ (Equation 2)

For the developed permeameter the K_s for any soil sample from above equations,

$K = (\Delta v / \Delta t) \cdot L_c \cdot \{1 / (h \cdot A)\}$ [Units for L_c , h and A are m, m², respectively.]

$= (\Delta v / \Delta t) \cdot 0.05 \cdot \{1 / ((0.0115 \cdot (\pi / 4 \cdot 0.0048^2)))\}$

$= \{\Delta v \cdot 6 / (10^3 \cdot \Delta t) \cdot 0.05312253$

$K = 0.009562 \cdot (\Delta v / \Delta t)$ (Equation 3)

Where, Δv is amount of water collected in measuring jar in ml, Δt is the time in minutes for collection of Δv . Unit for K is cm/h from Equation 3.

Equation 3 is to be used for K_s calculation while using the developed permeameter. When three consecutive readings for K_s for a soil sample comes same, this is to be considered as the final value for K_s for that soil.

Novelty of CRRI- Soil Permeameter:



The unique design of the permeameter enables the maintenance of a constant head irrespective of soil type.

No other portable permeameter is currently available that can analyze up to 20 samples per batch.

Estimation of K_s

- ▶ Collect the soil sample of respective depths under study using the core sampler of the developed permeameter.
- ▶ Saturate the soil along with core sampler for about 24 hours.
- ▶ Place the core sampler bearing saturated soil in the permeameter beneath the flow control valve.
- ▶ Open the flow control valve above each core sampler, adjust until a constant water head is maintained above the core sampler.
- ▶ Take repeated measurements of the water collected in the measuring jar placed beneath the core sampler over a fixed time interval until at least three consecutive readings of identical volume are obtained for each soil sample.
- ▶ Calculate the saturated hydraulic conductivity (K_s) for each soil sample (Eq.3).



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