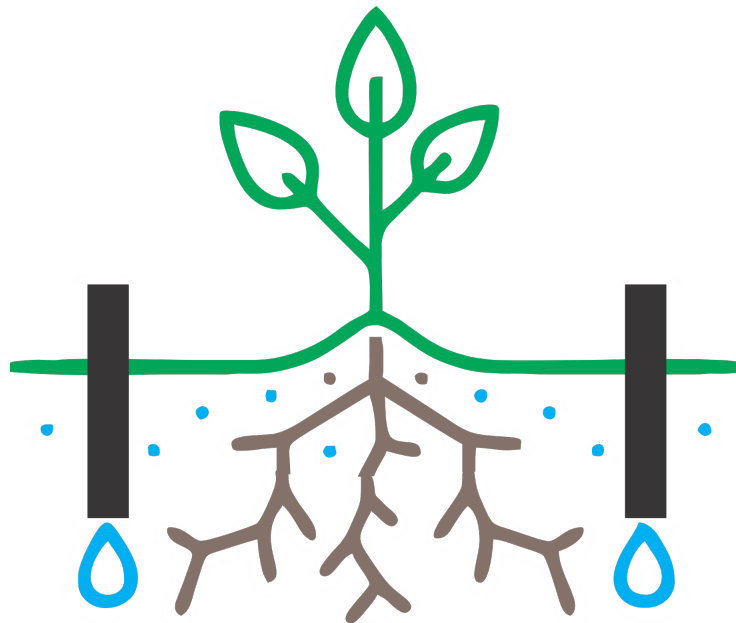




Climate-smart farmer field school catalogue

# Subsurface irrigation



Heat tolerance



Water saving



Extreme weather event



CO<sub>2</sub>



CH<sub>4</sub>



Energy saving



Increased productivity

Adaptation

Mitigation

Productivity

Funded by



## ADAPTATION



Subsurface irrigation doesn't directly address heat stress in plants, it can help maintain soil moisture and reduce evaporative cooling, indirectly aiding plants during hot periods.



Subsurface irrigation optimizes water use efficiency by delivering water directly to the root zone, reducing evaporation losses and minimizing water wastage.



The localized and controlled water delivery of subsurface irrigation systems mitigates the impacts of extreme weather events such as droughts or heavy rainfall by maintaining soil moisture levels.

## MITIGATION



Subsurface irrigation systems showed reduced energy consumption compared to surface methods, resulting in lower CO2 emissions.



Additionally, by minimizing waterlogging and nutrient runoff, they also mitigate methane emissions.



Subsurface systems often require less energy for pumping and distribution compared to some surface irrigation methods.

## PRODUCTIVITY



Subsurface irrigation significantly increased crop yields by up to 25 percent compared to surface methods, demonstrating its potential for enhancing productivity (Bhattarai *et al.*, 2004).

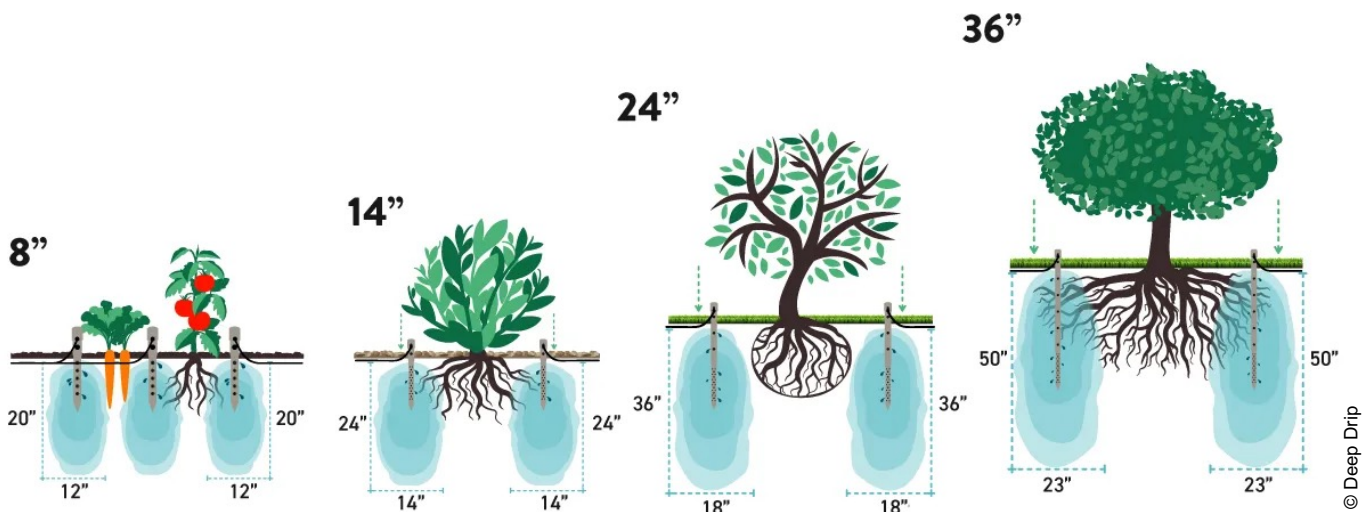


## Description

Sub-surface irrigation involves delivering water directly to the plant root zone through a network of buried pipes, lines, or porous materials. This method offers several advantages over traditional surface irrigation, including significantly reduced water loss due to evaporation and runoff, healthier root development, and minimized weed growth. Some of the common techniques within sub-surface irrigation are:

- Subsurface drip irrigation (SDI) – This uses strategically placed drip lines or tapes to deliver precise amounts of water and fertilizer directly where needed.
- Deep root irrigation (DRI) – Specialized tubes or emitters deliver water to deeper root zones, encouraging strong root systems and improving drought tolerance—this technique is most appropriate for Jordan.
- Porous pipe irrigation – Buried porous pipes or hoses allow water to slowly seep outwards along their entire length, providing even moisture distribution to the surrounding soil.

Sub-surface irrigation systems require careful planning and may have a higher initial cost, but their potential for water conservation and improved plant health make them a valuable investment for many agricultural operations.



Note: Measurements are only for general consideration, not specific and final.

Source: Green King Incorporation. 2024. Deep drip watering stakes. [Cited 20 August 2024]  
<https://www.deepdrip.com/how-it-works/>



© Permaculture Plants/Samiksha

Source: Permaculture Plants. 2024. Clay pot olla irrigation. [Cited 14 August 2024]  
<https://permacultureplants.com/olla-irrigation/>

## Benefits

- Increased water productivity by up to 27.72 percent compared to surface irrigation (Guo *et al.*, 2023).
- Subsurface irrigation maximizes crop, water, and irrigation productivity with 50–100 percent less volume than surface methods, saving up to 50 percent water (Guo *et al.*, 2023).
- Save up to 25–50 percent of water regarding to surface irrigation (Leonor and Maria, 2012)
- compared to surface irrigation.
- Increase yields by 10–25 percent (Bhattarai *et al.*, 2004).
- Reduce weed pressure through less surface moisture
- Allows precision in nutrients delivery by applying fertilizers directly to the root zone.
- Less maintenance compared to surface irrigation.

## Challenges

- Higher initial cost as installation and materials can be more expensive than traditional surface irrigation.
- Clogging risk in case of using emitters in drip lines, which can become clogged by soil particles, roots, or mineral deposits.
- Repairs and adjustments to buried systems can be more labor-intensive.
- Burrowing animals can damage in case of use of underground lines.
- SDI might not be ideal for crops with shallow roots or frequent crop rotations.

## Adoption feasibility

High due to:

- well suited for water scarce areas.
- High potential for significant water savings.
- feasible for all size of farms including urban agriculture.
- requires only basic understanding of principles.
- applicable to various plant types.

## Other climate-smart agriculture practices combined

- Composting
- Integrated pest management
- Mulching
- Improved varieties

Source: Native Revegetation. 2024. An integrated approach to establishing native plants and pollinator habitat. [Cited 14 August 2024]  
[http://www.nativerevegetation.org/learn/manual/ch\\_10\\_4.a.spx](http://www.nativerevegetation.org/learn/manual/ch_10_4.a.spx)

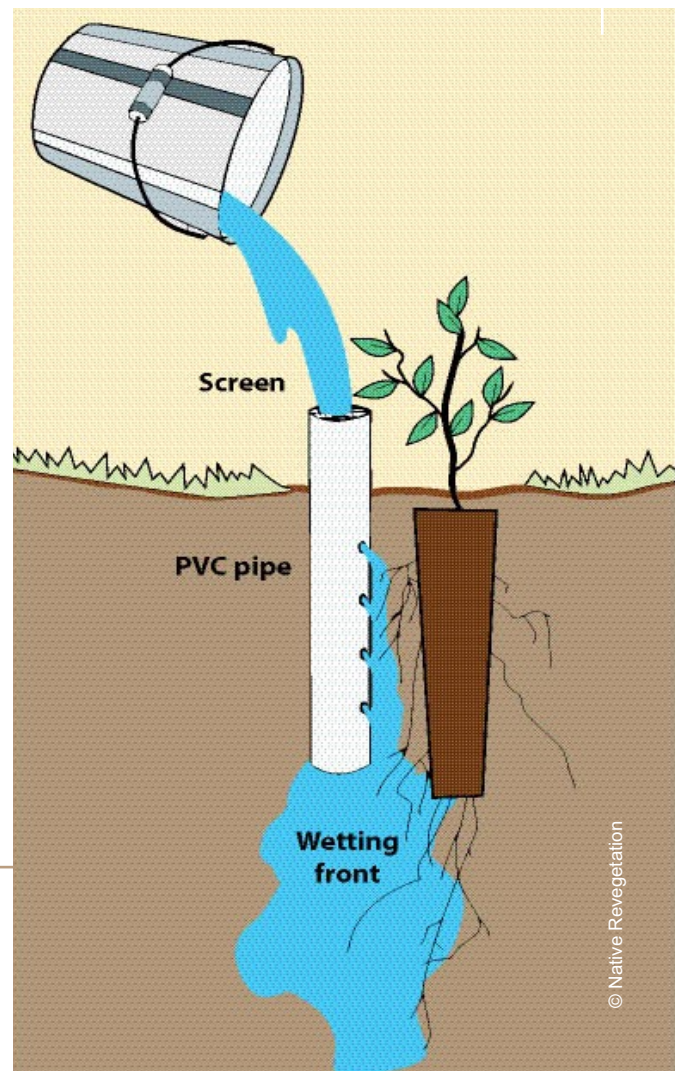
## Why this has not been practiced?

- Lack of awareness and trainings.
- Initial investment may deter adoption.
- Limited access to materials or resources.
- Perceived complexity or unfamiliarity with concept.

## Enabling services

Agreement of climate smart farmer field school community with the local (public and private) service providers for quality service provision for:

- subsurface irrigation training provision.
- technology and technical assistance provision.
- quality seed and plants provision.



## Key requirements

### Subsurface drip irrigation (SDI)

- High-quality filtration – essential to prevent clogging of drip emitters with small openings. Multiple filtration methods (e.g., screen filters, sand filters) may be required.
- Pressure regulation – precise pressure control is needed to ensure uniform water distribution along the drip lines.
- Robust drip lines/tapes – choose durable lines/tapes resistant to damage from roots, burrowing animals, and soil pressure.
- Air & vacuum release valves – prevent backflow and air pockets that would disrupt water flow.

### Deep root irrigation (DRI)

- Specialized emitters/tubes – designed to deliver water to specific depths in the soil.
- Pressure compensation – maintains consistent water flow despite variations in elevation or distance from the source.
- Access points – surface access is needed for periodic maintenance and flushing of DRI tubes.

### Porous pipe irrigation (PPI)

- Suitable soil type – works best in soils with moderate drainage – too sandy may drain too quickly, while too much clay may not allow water to seep out effectively.
- Root barrier – a geotextile fabric barrier might be needed to prevent root intrusion into the porous pipe.
- Slope management – installation should be planned to manage water flow downhill if there is a slope.

### General requirements for all techniques

- Water quality testing – understanding water quality is crucial to manage issues like mineral buildup (affects clogging potential).
- System design – careful design by an experienced irrigation professional considers soil type, crop needs, spacing, and water source.
- Regular maintenance – includes flushing lines, filter system upkeep and monitoring for potential damages.



## Field school learning experiments

(Select at least two options for comparison)

Option 1

Option 2

Deep root  
irrigation with  
pipes supported  
by drip irrigation  
for orchards  
  
(1 dunum)

Conventional  
cultivation  
method (drip  
irrigation)  
  
(1 dunum)

Source: Authors' own elaboration.

## Additional participatory learnings

- Deep rooted irrigation
- Subsurface drip irrigation
- Porous pipe irrigation
- Sand/stones bags deep irrigation
- Pitcher irrigation

## References

- 1 **Guo, Jin, Lijian Z., Juanjuan M., Xufeng L., and Ruixia C.** 2023. "Meta-Analysis of the Effect of Subsurface Irrigation on Crop Yield and Water Productivity" *Sustainability* 15, no. 22: 15716. [Cited 1 August 2024] <https://doi.org/10.3390/su152215716>
- 2 **Leonor R. S. and María G. R..** 2012. A Review of Subsurface Drip Irrigation and Its Management. Research Group "Hydraulic of Irrigation" Technical University of Madrid. Spain. 10.5772/30702.
- 3 **Bhattarai S.P., Huber S., and Midmore D.J.** 2004. Aerated subsurface irrigation water gives growth and yield benefits to zucchini, vegetable soybean and cotton in heavy clay soils. *Annals of Applied Biology*. ;144(3):285-298. DOI: 10.1111/j.1744-7348.2004.tb00344.x.
- 4 **Martínez d. A. P., Andrés, Jorge D. R. S. J., José R. K., Juan M. D. H., and Francisco J. S. R.** 2022. Methods for Watering Seedlings in Arid Zones. *Forests* 13, no. 2: 351. [Cited 1 August 2024] <https://doi.org/10.3390/f13020351>

## Project

Building resilience to cope with climate change in Jordan through improving water use efficiency in the agriculture sector

## Partners

Ministry of Agriculture, Jordan  
Ministry of Environment, Jordan  
Ministry of Water and Irrigation, Jordan  
United Nations Development Programme

## Funded by

Green Climate Fund

## Geographic coverage

Ma'an, Tafileh, Karak and Madaba  
Governorates



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These documents were produced with the assistance of the FAO Regional Office for Near East and North Africa under the project building resilience to cope with climate change in Jordan through improving water use efficiency in the agriculture sector funded by Green Climate Fund.

**Acknowledgment:** We sincerely thank everyone involved in developing the climate-smart farmer field school catalogue – Subsurface irrigation. Special thanks to Nabil Assaf, Mohamed AlHamdi and Maysoon AlZoubi for their guidance. We deeply appreciate Jam Muhammad Khalid, Rania Wajdi Ibrahim, Nicholas Molyneux and Rand Alamoush for their invaluable expertise in developing the document. We extend our thanks to the technical team and representatives from the ministry of agriculture for their insightful feedback.

Document and cover design: © FAO/Jam Khalid

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