

Deficit Irrigation Implication to Drainage

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What is the Deficit Irrigation ?



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Deficit Irrigation

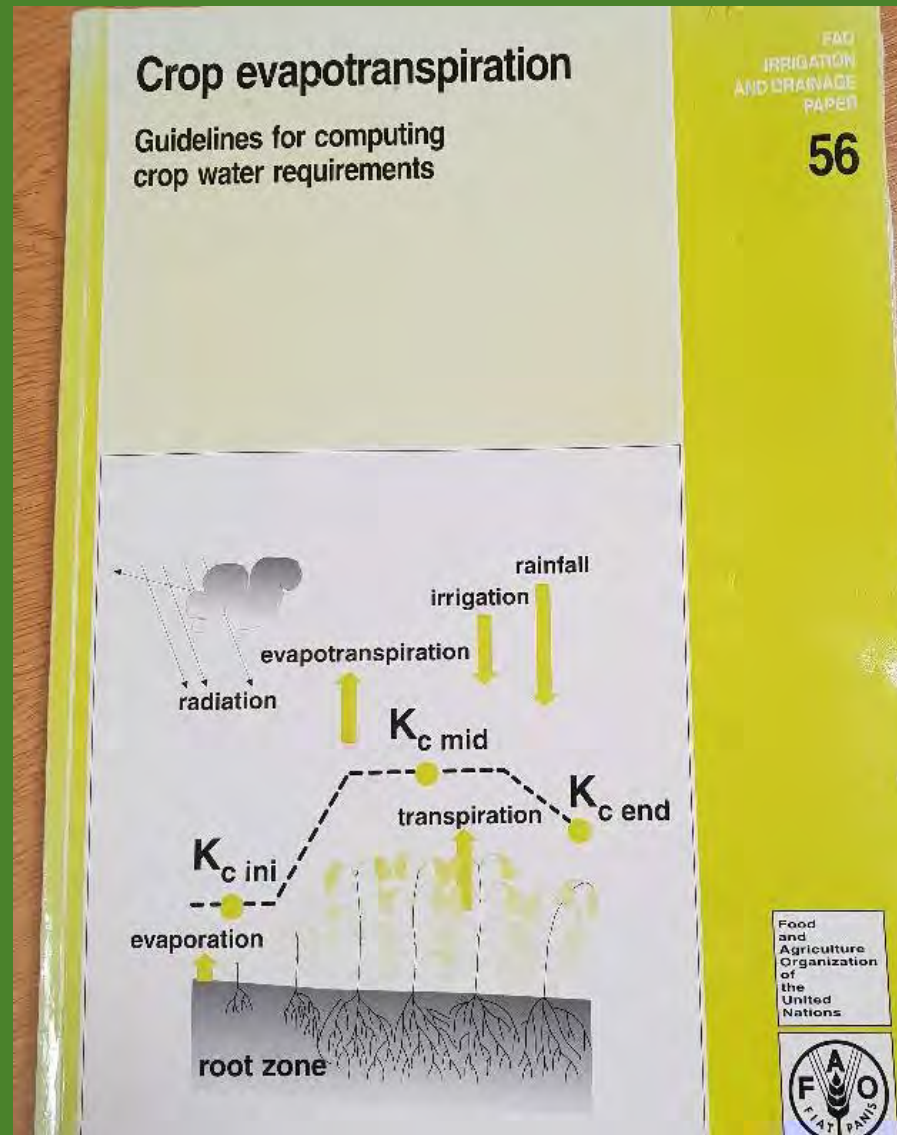
Usually defined as a reduced irrigation water amount that represents a % of the Full Crop Water Requirement CWR.

CWR can be measured (e.g. Lysimeters, SMD, etc.) or calculated from equations such as FAO-56 Penman- Monteith equation as:

$$\text{Full CWR} = ET_c = ET_o (K_{cb} + K_e)$$

Deficit Irrigation= A % < 100 of ETc (e.g. 90% ETc, 80% ETc)

FAO Modified Penman-Monteith Equation



Penman-Monteith Evapotranspiration (ET)

In presence of stomata / canopy surface resistance data, one could use the widely used equation Penman-Monteith (1965) in the following form:

where r_s and r_a are the bulk surface and aerodynamic resistances ($s\ m^{-1}$).

$$\lambda E_p = \frac{\Delta R_n + \rho C_p \frac{(e_s - e)}{r_a}}{\Delta + \gamma(1 + \frac{r_s}{r_a})}$$

The Penman-Monteith Equation was a unique equation as it did include the presence of the plant instead of focusing only on weather data (radiation or temperature) to determine ET. However, the difficulty in getting the plant parameter (canopy resistance) confined it to a limited application by mostly academics.

Evapotranspiration

Penman - Monteith, FAO-56 (1998)version

$$ET_o = \frac{0.408\Delta (R_n - G) + \gamma \frac{900}{T + 273} U_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34U_2)}$$

$$ET_c = ET_o (K_{cb} + K_e)$$

$$rs = 70s/m$$



Deficit Irrigation –Drainage relation

- Deficit irrigation is expected to reduce the amount of water going to the drains.
- Deficit irrigation might not sufficiently generate saturated flow below the root zone towards the drains
- Drainage system and its capacity should be adapted to Deficit irrigation.
- Deficit irrigation might affect the water table level and subsurface irrigation (controlled drainage).
- Deficit irrigation might lead to salinity build up which might require leaching possibly by the end of the season before next crop sowing.
- On the positive side, Deficit irrigation saves water and energy

How accurate the Deficit Irrigation calculation is?



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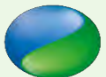


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Why we need an accurate estimate of crop water requirement

Accurate estimate of Crop water requirement has impact ?

- Adding more water
 - = adding more salts (if irrigating with brackish/saline water)
 - = more leaching of nutrients & fertilizers
 - = decreasing soil and groundwater qualities
 - = decreasing water productivity and WUE
 - = Irrigating less area
 - = wasting water resource, labour, energy and money
 - = increasing drainage water volume



Field Instrumentation-accurate estimation of crop water requirement



COSMOS



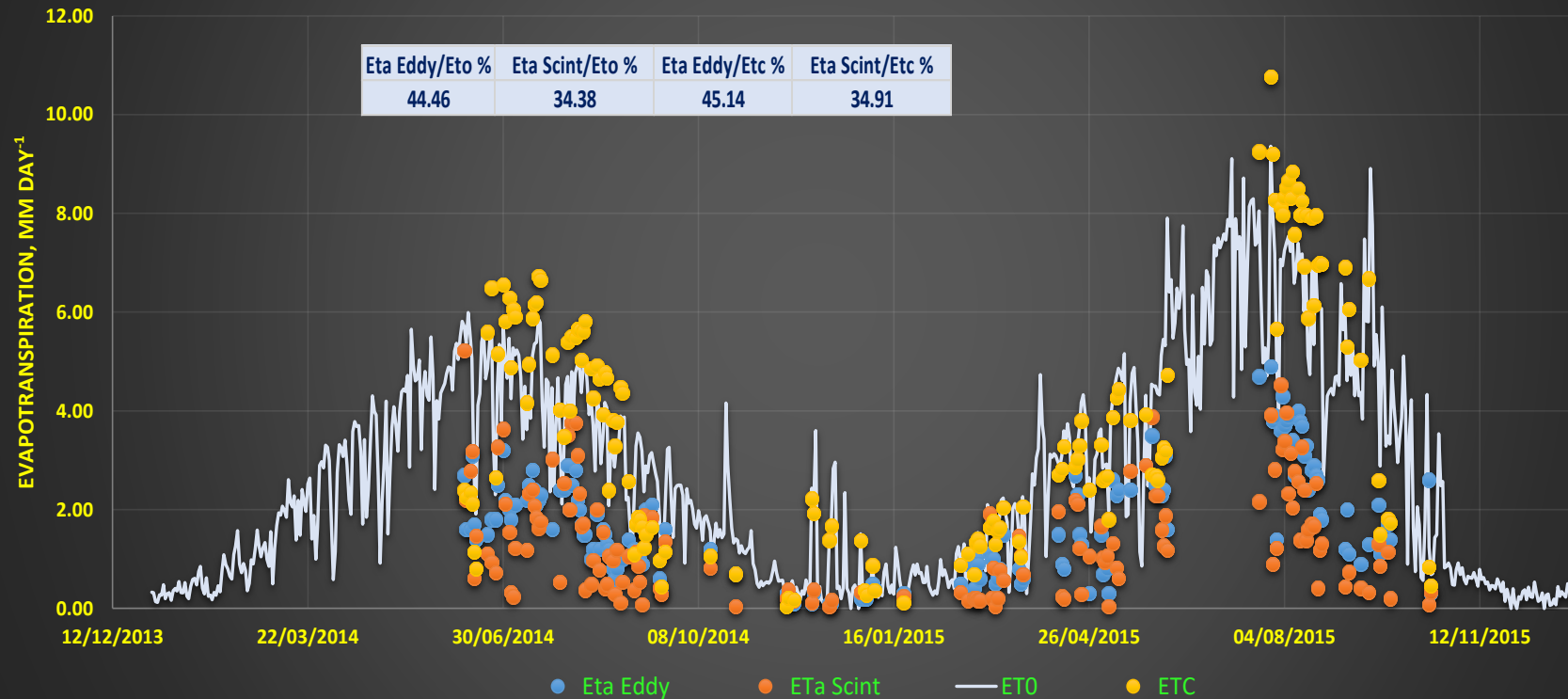
Scintillometer



Eddy Covariance



Reference Evapotranspiration, ETo, Crop Evapotranspiration, ETc , Actual Evapotranspiration by Eddy Covariance, ETa Eddy and by Scintillometer, ETa Scint

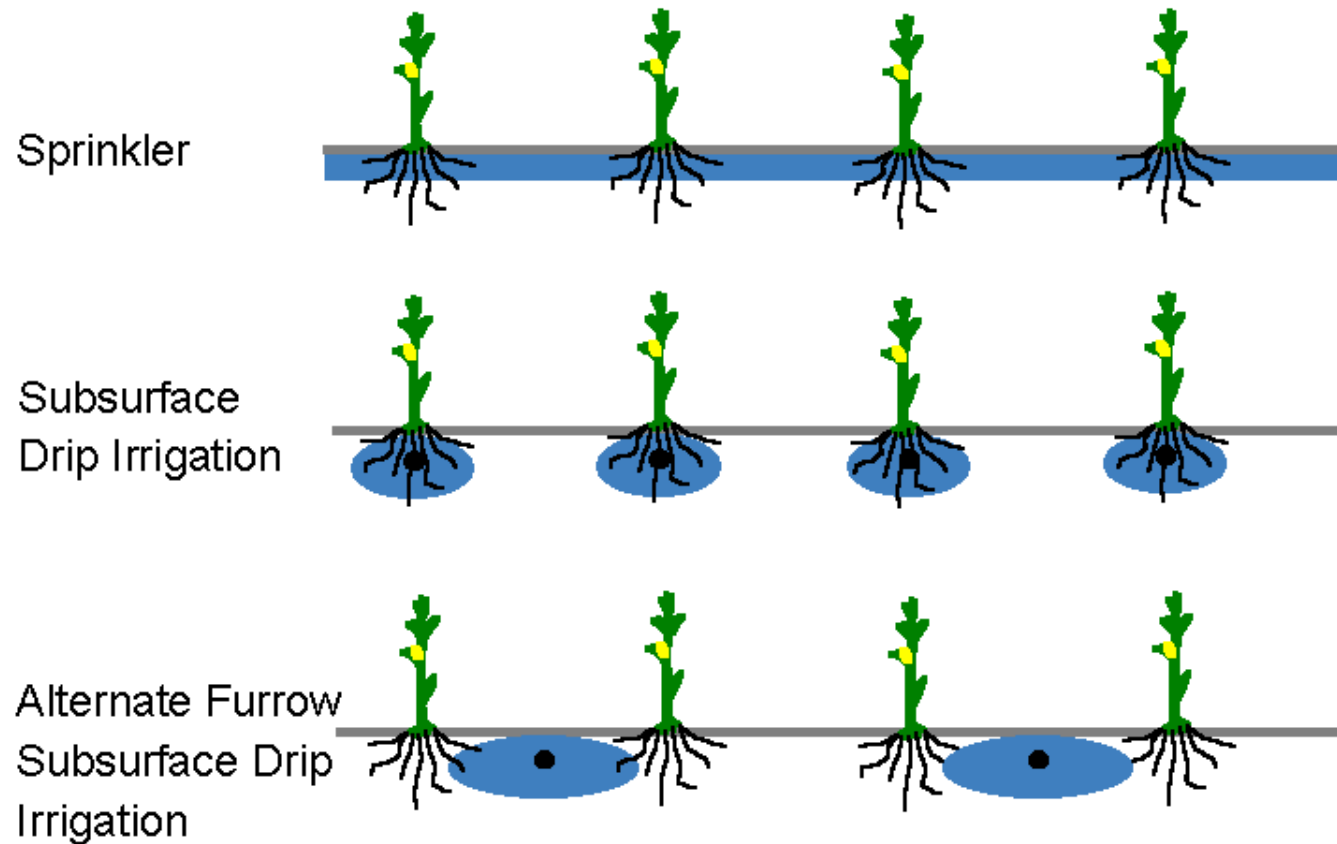


Comparison between actual evapotranspiration measured by Eddy Covariance and Scintillometer, reference evapotranspiration estimated from Penman-Monteith equation and crop evapotranspiration calculated from ETo and the weighted mean of the crop coefficient Kc.

How different irrigation systems affect the drainage volume.



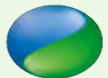
Deficit Irrigation can be applied using different irrigation systems



Progress in Irrigation Technology



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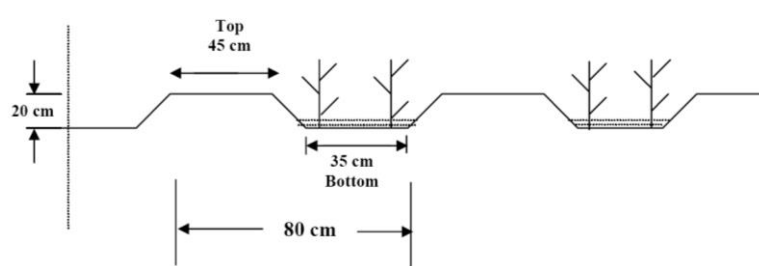


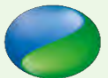
Fig (1) : Strips of Furrows Diagram (80 cm wide).

Water saving in rice cultivation



Increasing water use efficiency and productivity- selecting efficient irrigation system – less drainage

Sugarcane - Mauritius



PRODUCTIVITY UNDER DRIP FERTIGATION

UDUMALPET, TAMIL NADU (2008)



Method	Yield (t/ac)	Water use (million liter/ac)	Power Use (units/ac)
Flood	3.1	9.5	467
Drip	3.8	3.2	226
Difference%	22.5	66.3	52



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Rice with Drip

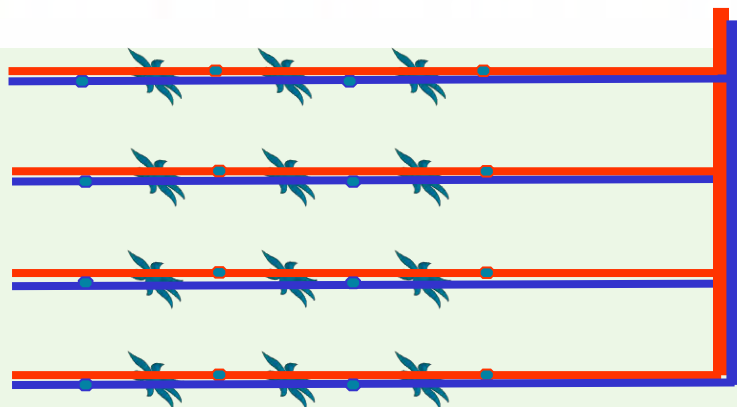
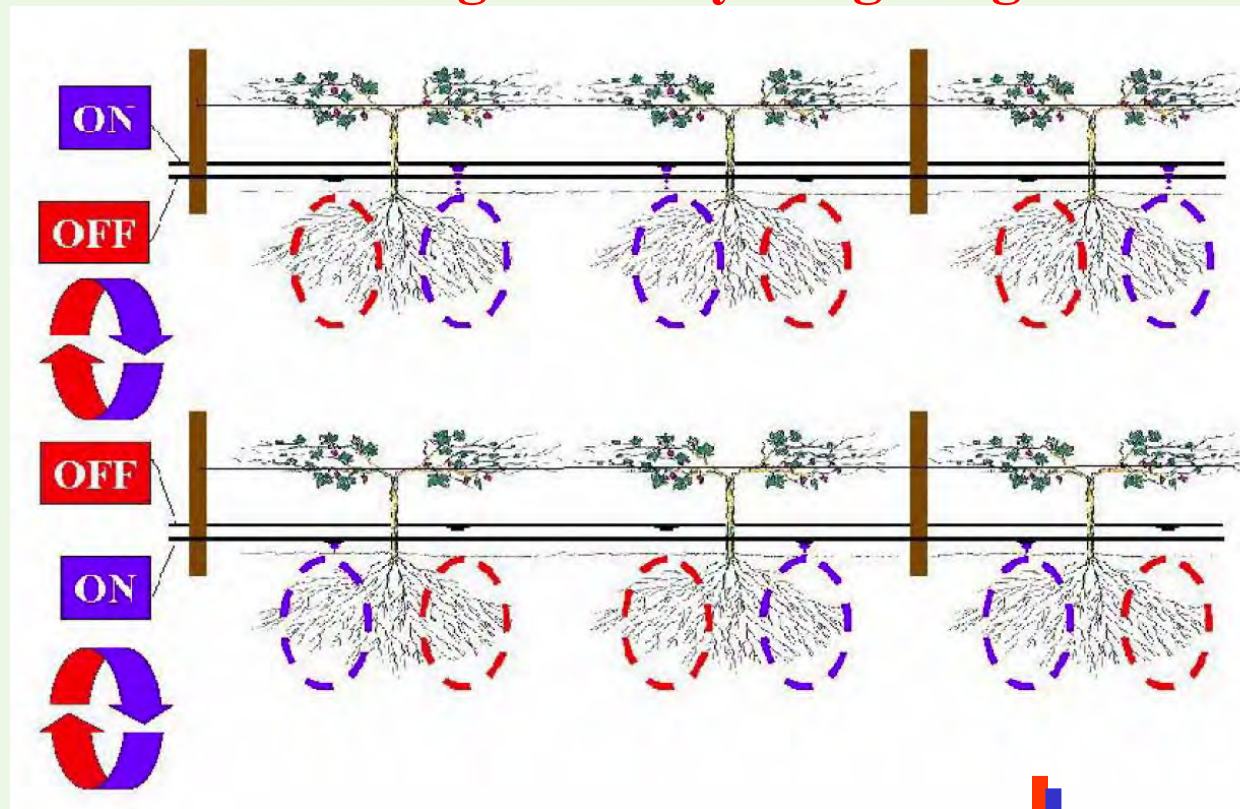
- Once adopted the technology would benefit several million farmers globally.
- Rice yield increased up to 40 %
- Water saved up to 70%
- Energy conservation up to 60 %
- Increased efficiency of water & fertiliser usage to up to 80%
- Reduced skin, respiratory and mosquito related diseases
- No or low methane emission
- Reduced amount of nitrate leaching into water bodies
- Soil health protection leading to consistent crop production
- less drainage

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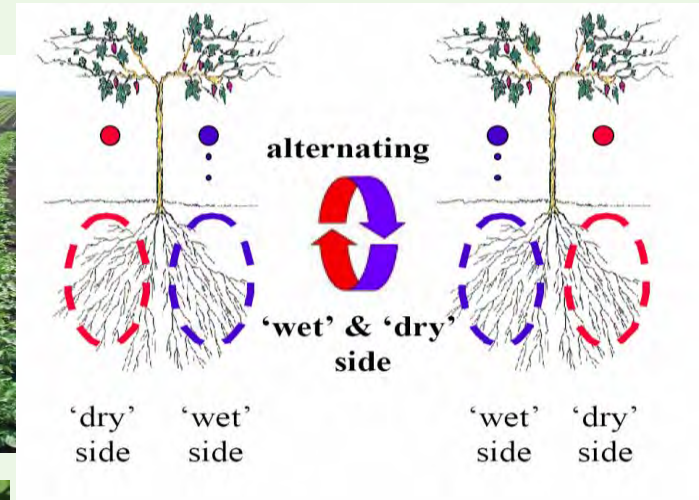
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Saving water by irrigating half of the root zone, the PRD method

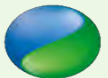


Partial Root Drying , PRD

The results of Italy on tomato: PRD would allow water saving of 26% and 44% if used instead of normal drip & sprinkler systems, respectively.



Food security requires production of more crop per water drop. Water saving through irrigation with drip subsurface irrigation system and PRD technique (only one half of the vertical root zone is irrigated at a time then alternate irrigation with the dry half). Saving in water is significant ~ 40% which means 40 % more food can be produced.



Using Nano-Irrigation

In theory, nanotechnology and nanoscience is the study, manufacture and handling of structures, mechanisms and materials on a scale of less than 40 nanometres.

Nano Irrigation is a new technology which by way of slowly releasing a small amount of water, it continuously moistens the soil, enabling 24 hour crop irrigation. The core technology of Nano Irrigation is the MOISTUBE: The inner layer is a semi-permeable membrane.

Installed under the ground, it is made of semi-permeable membranes with 100,000 nanopores per cm². These release a continuous small quantity of water near the roots, thus preventing the undesirable effects of percolation and evaporation.

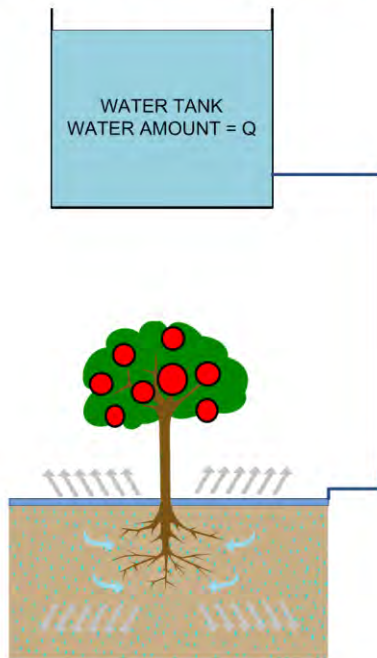
The use of this method reduces repeated human interventions and thus ensures great efficiency in terms of cost and optimisation of irrigation management for farming operations, agro-industrial companies and green spaces, particularly public spaces, tourist areas, lawns, gardens and golf courses, municipalities and private properties.



Meryam El Ouafi, co-founder of the GEMS company, is based in Agadir, in the Souss region. She is a recipient of EU co funding.

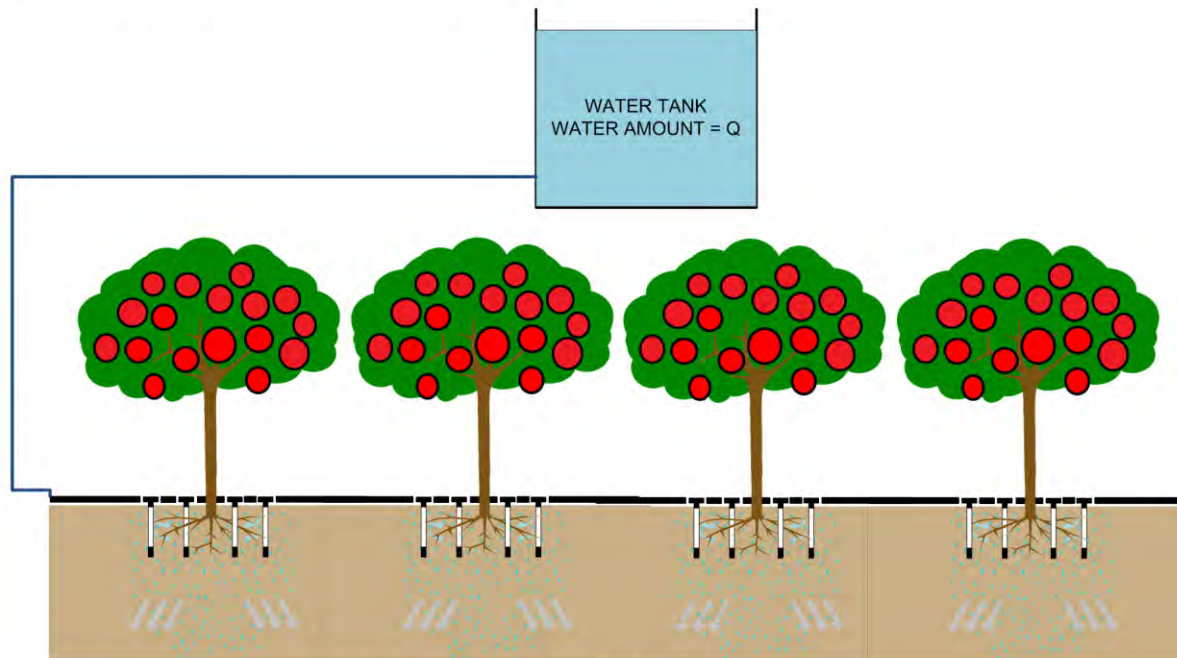
SURFACE IRRIGATION SYSTEM VS NANOTUBE IRRIGATION SYSTEM

WITH THE SAME AMOUNT OF WATER USED FOR 1 TREE OR PLANT IN THE SURFACE IRRIGATION SYSTEM, WE CAN IRRIGATE UP TO 4 TREES OR PLANTS, AND INCREASE PRODUCTION FOR EACH BY 30% USING THE NANOTUBE IRRIGATION SYSTEM



PLANT USE 15% - 20%
WATER WASTE 80% - 85%

SURFACE IRRIGATION SYSTEM



PLANT USE 95%
WATER WASTE 5%

NANOTUBE IRRIGATION SYSTEM

Nano irrigation system
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Enhancing the Efficiency in Irrigation Systems

INNOVATION ULTRA LOW DRIP IRRIGATION

ULDI :

- Flow 0.1 to 0.3 l/h
- Longer period of water release
- Higher use efficiency
- Low water tension in the soil
- No percolation
- Excellent water saving (~30%)

Traditional Micro Irrigation:



Ultra Low Drip Irrigation:



Source: Marco Arcieri , VP-ICID



How land tillage affect the drainage volume.

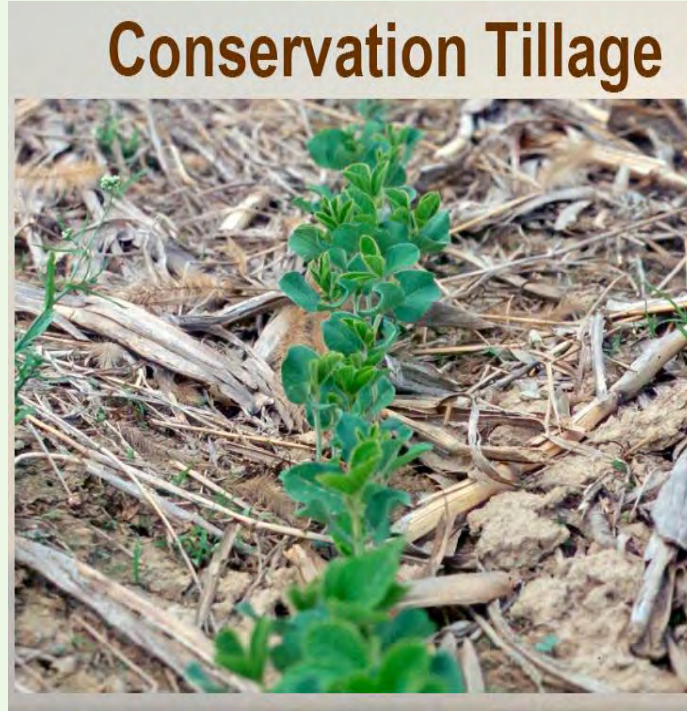


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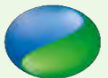
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Land Management to save water



ASA -
Crop
World
2010

- Reduces soil evaporation– increases water availability
- Increases organic matter
- Reduces soil erosion – increases nutrient availability
- Reduces agrochemical use (through recycling crop residues), labour, machinery,
- Improves wild life



A photograph of a small waterfall in a lush green forest. The water is cascading over rocks, creating a misty spray at the bottom. The surrounding vegetation is dense and vibrant green.

Thank You!

