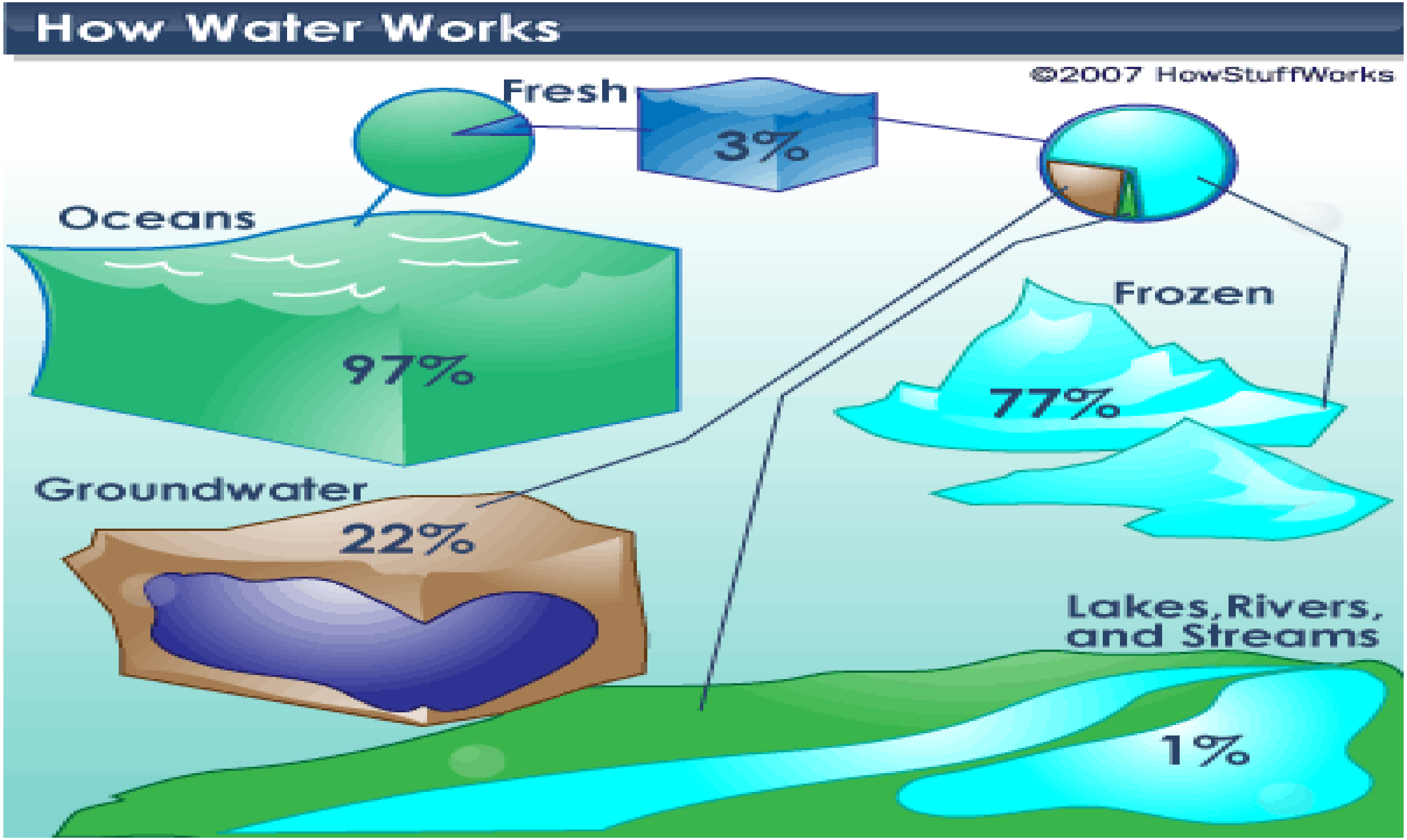
Water management and Micro-irrigation

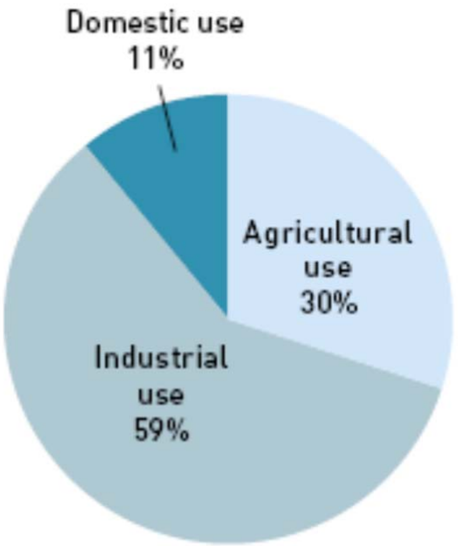
AVRDC 34rd at KU-Kampangsaen
September 2015

NETAFIM™
GROW MORE WITH LESS

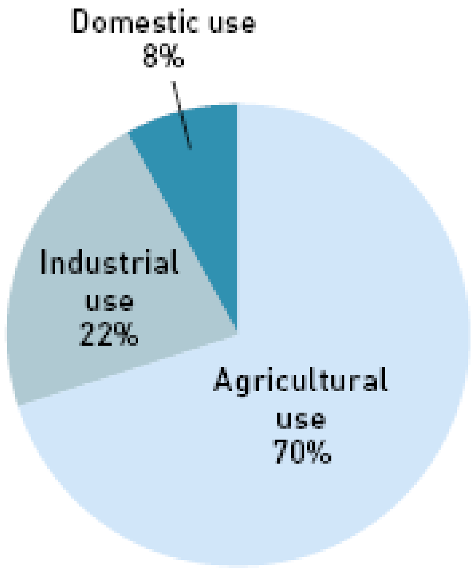
Water situation



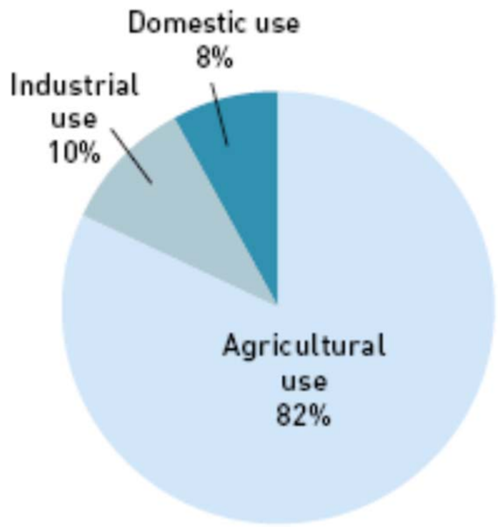
Water situation



Competing water uses
(high-income countries)



Competing water uses
(world)



Competing water uses
(low- and middle-income
countries)

Water situation

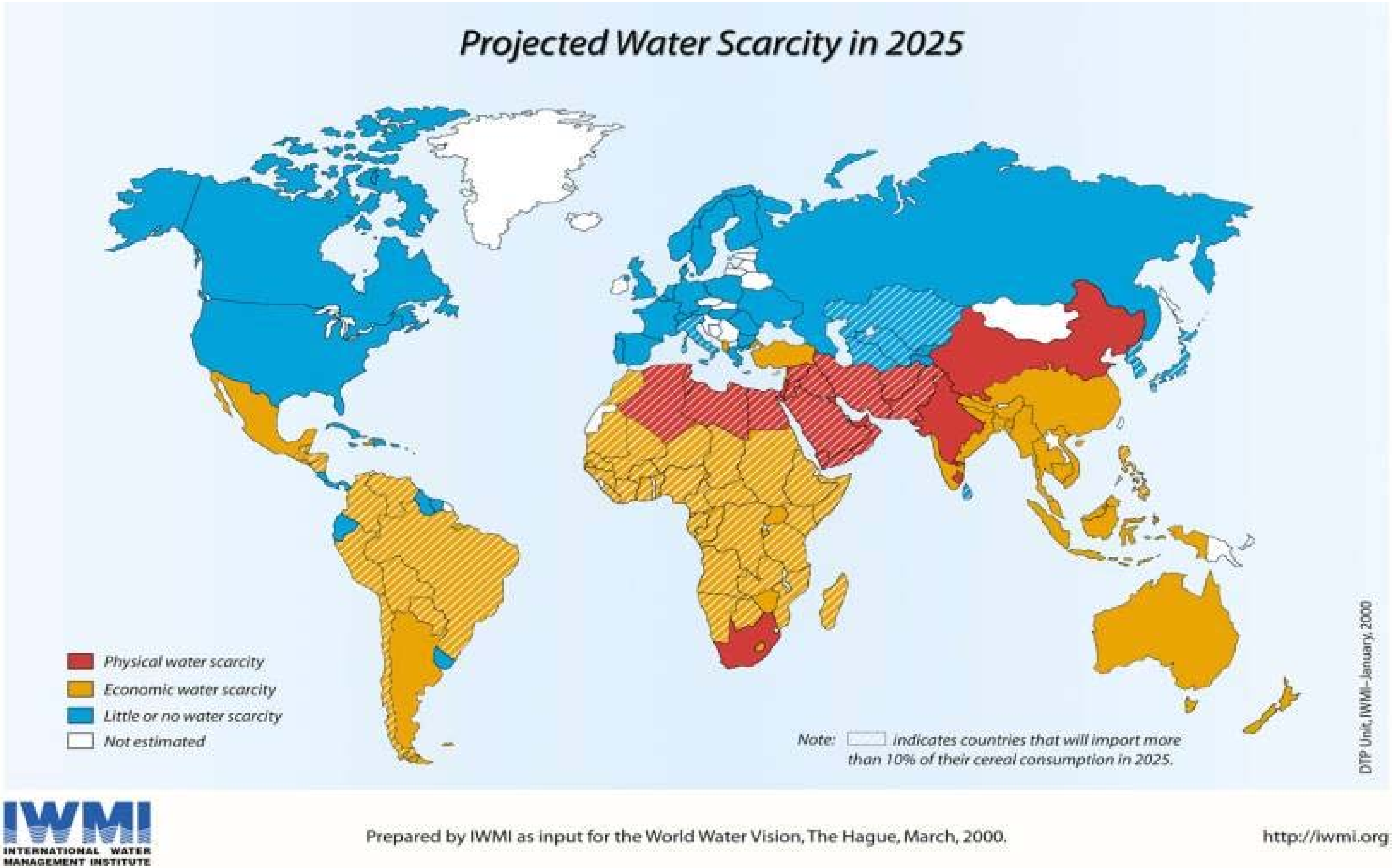
- Agriculture is the single largest use of freshwater.
- 18% of global agricultural land is irrigated but this land produces 40% of the world's food.

THE SOLUTION TO THE WATER CRISIS LIES WITH AGRICULTURE !!

How can agriculture help ?

- Raising agricultural water productivity

- Modernisation of irrigation


Projected Water Scarcity in 2025
Physical water scarcity
Economic water scarcity
Little or no water scarcity
Not estimated
Note: indicates countries that will import more than 10% of their cereal consumption in 2025.
DTP Unit, IWMI–January, 2000
IWMI
INTERNATIONAL WATER MANAGEMENT INSTITUTE
Prepared by IWMI as input for the World Water Vision, The Hague, March, 2000.
http://iwmi.org

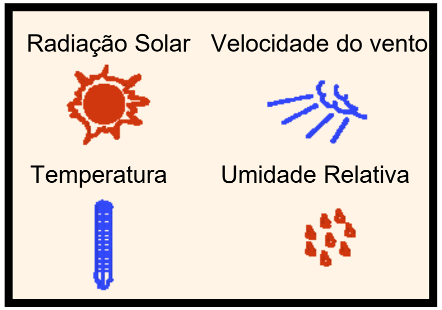
HOW MUCH WATER NEEDED?

Plant water requirement

Water requirement = Evapotranspiration x Crop coefficient)

(mm/day) (Eto) (Kc)

=



x

Potential Evapotranspiration- PET (=ET_0)

The evapotranspiration of a uniform short green healthy crop completely shading the ground with adequate water status in the soil profile.

• <u>Class "A" evaporation pan.</u>
Standard unit (Pan size, net cover, height, location.

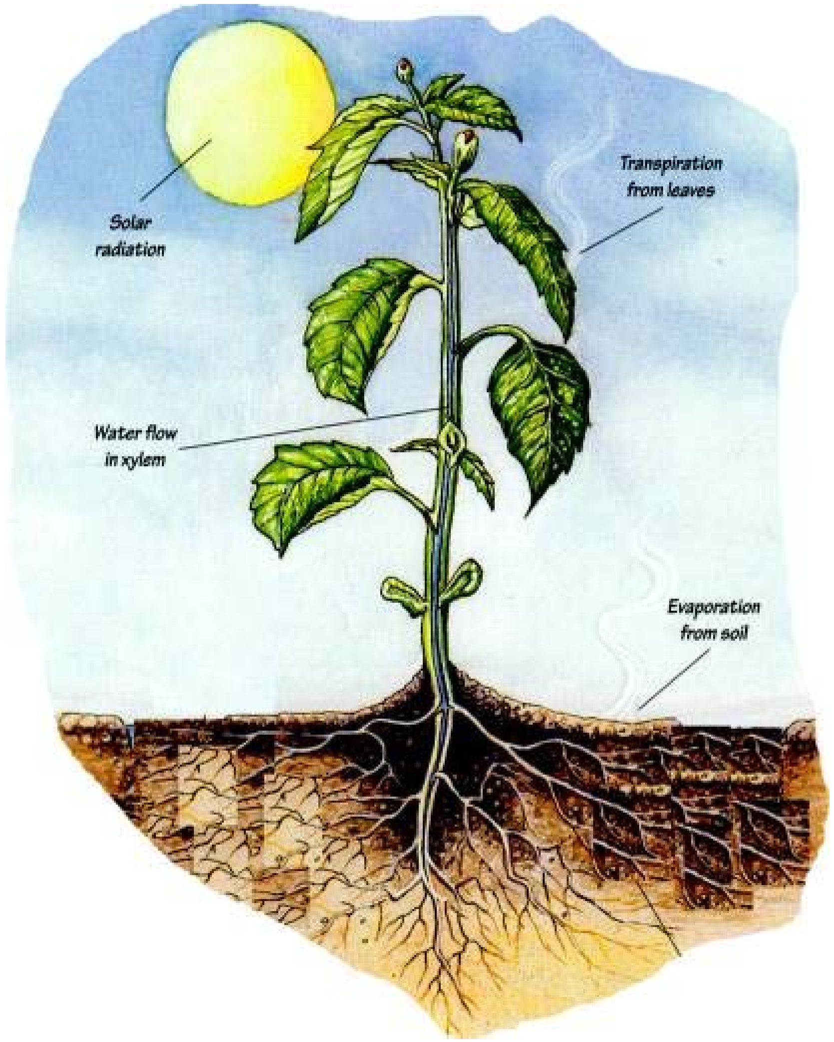
• <u>FAO Penman Montheis equation</u>

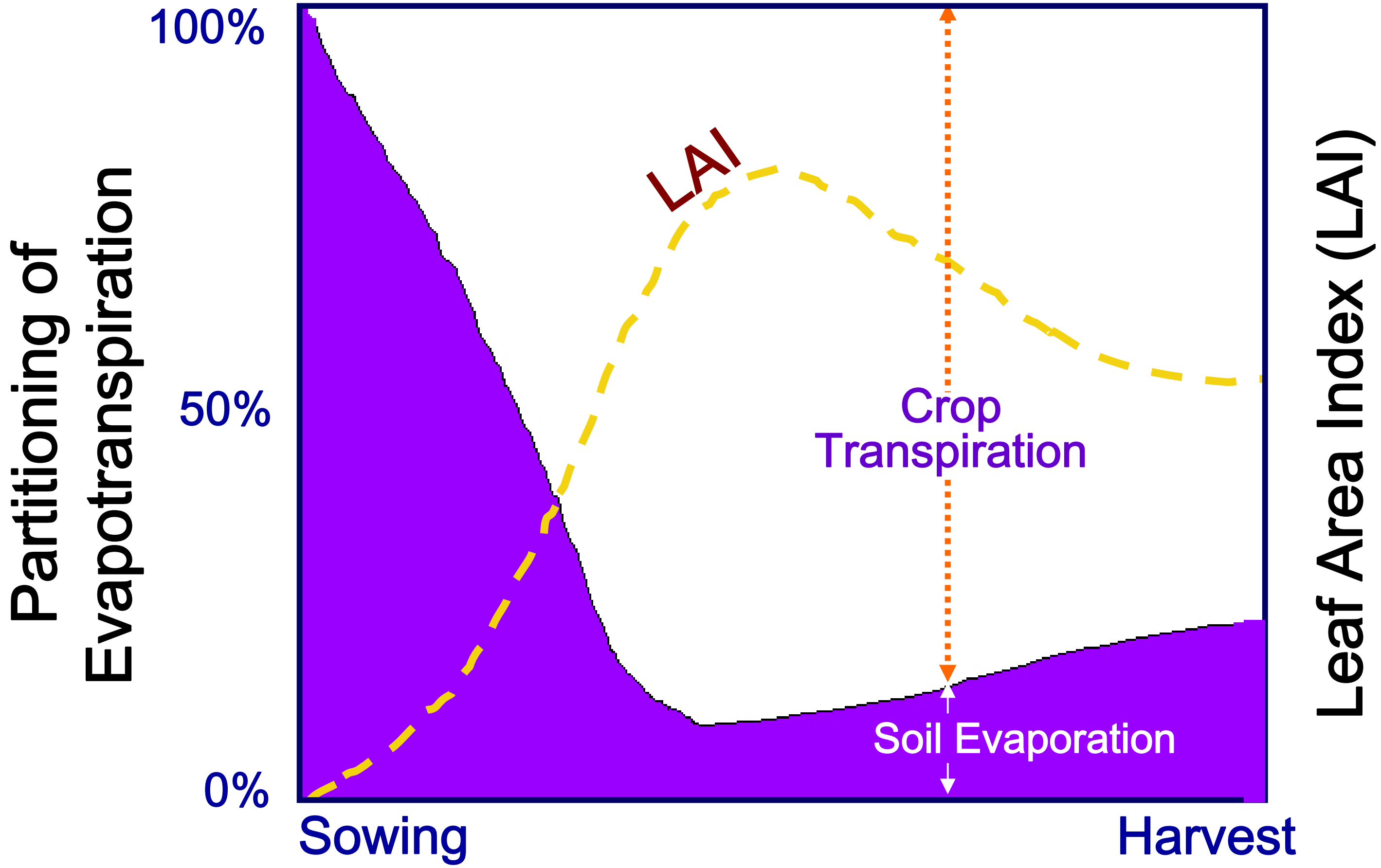
Soil Evaporation (E)

+

Plant Transpiration (T)

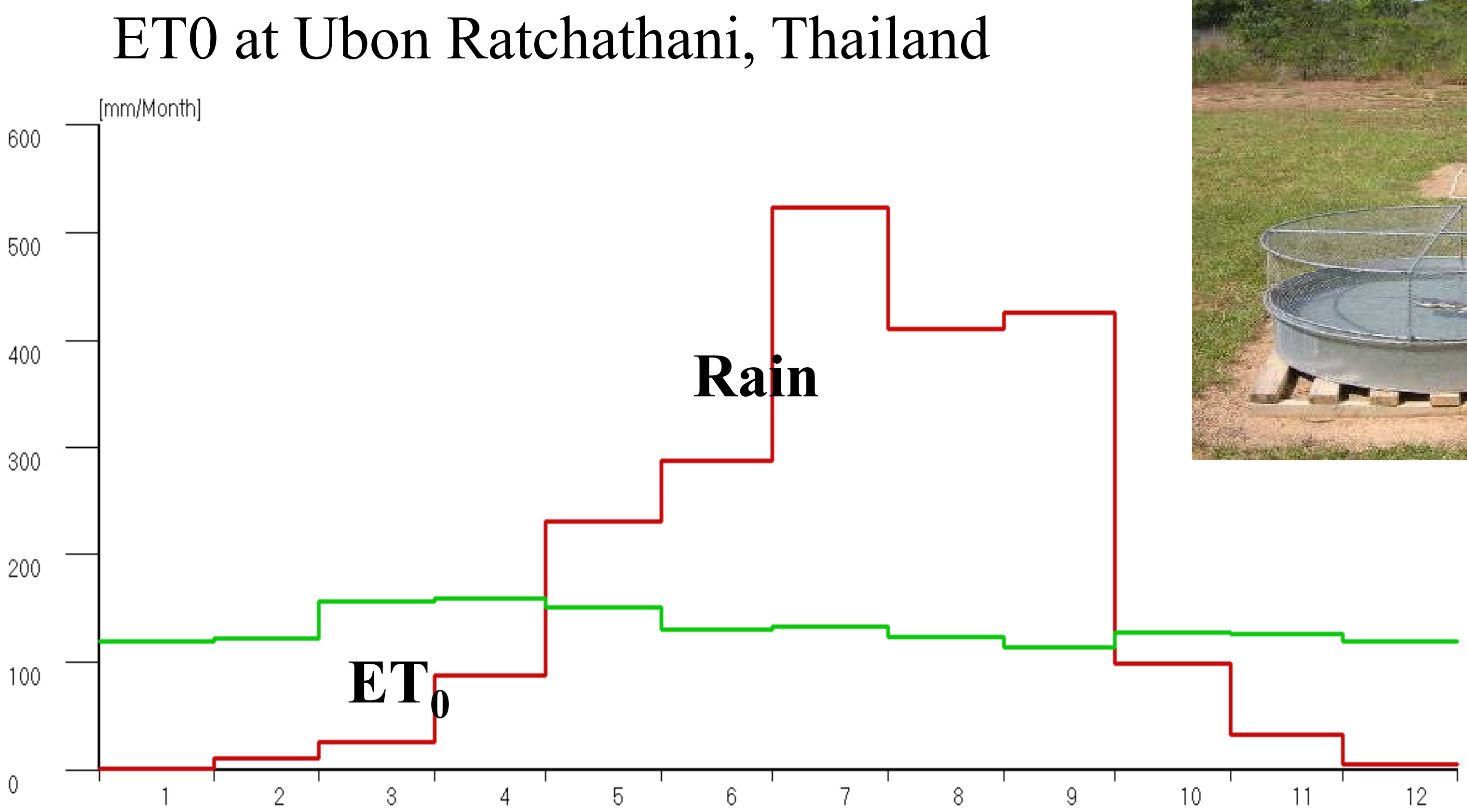
Evapotranspiration



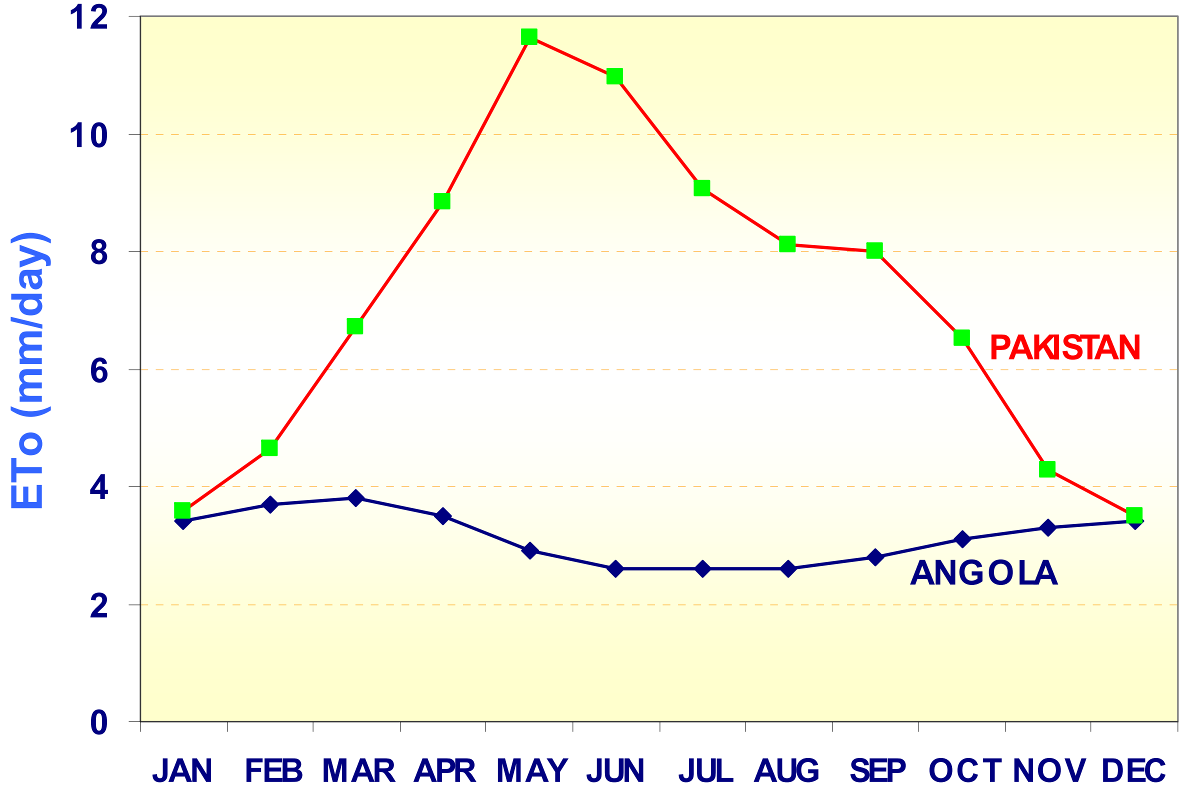


The Partitioning of ET into E & T over the growing period for an annual field crop

Evapotranspiration (ET_0)



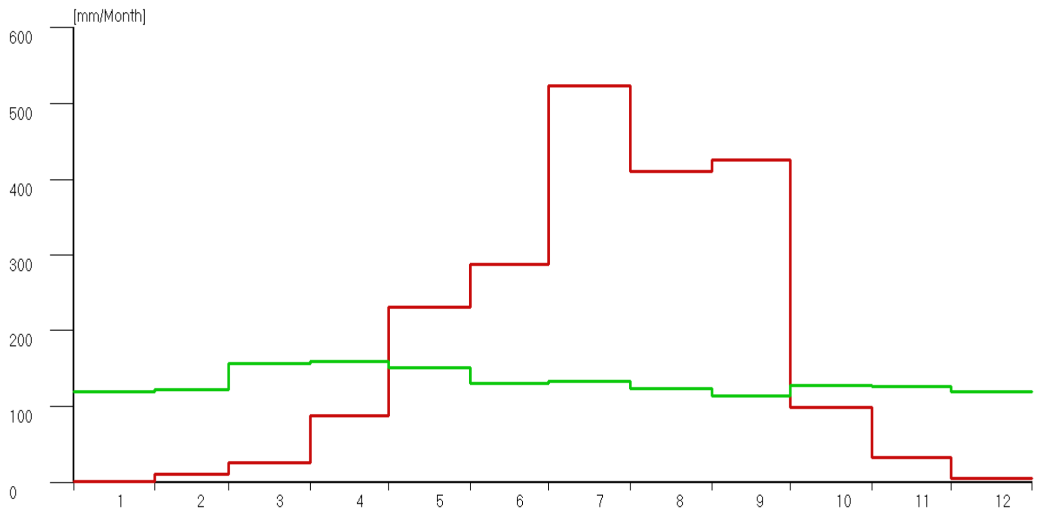
Hyderabad, Pakistan V.S. Cabinda, Angola



Climate / water requirement

	ET0	E-Rain	Daily deficit
Jan	119	0	3.8
Feb	122	0	4.4
Mar	157	16	4.5
April	160	44	3.9
May	152	161	
Jun	131	200	
Jul	134	205	
Aug	124	246	
Sept	114	223	
Oct	127	50	2.5
Nov	127	0	4.1
Dec	120	0	3.9

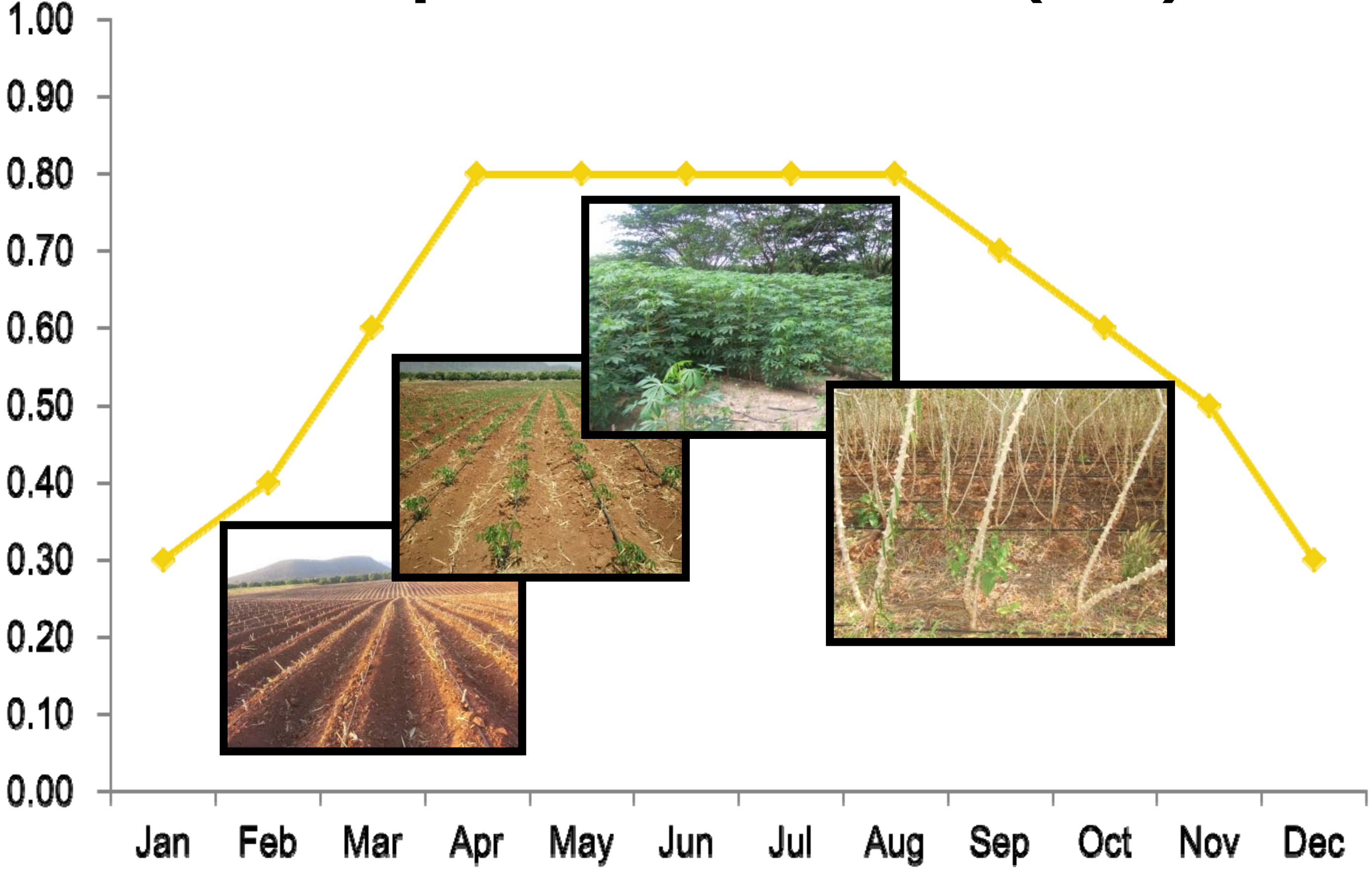
Peak water requirement



Crop coefficient (Kc)

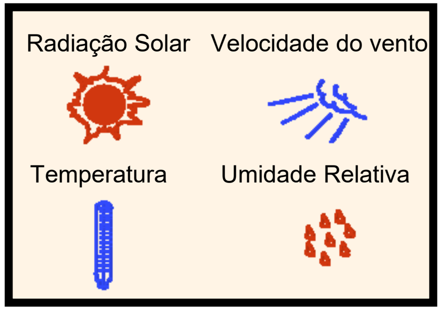
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	0.3	0.4	0.6	0.8	0.8	0.8	0.8	0.8	0.7	0.6	0.5	0.3

Crop Coefficient (Kc)



From this example, water requirement would be:

=



X

Water requirement = (Evapotranspiration x Crop coefficient)
(mm/day) (Eto) (Kc)

= **4.5** mm/day x **0.8**

= **<u>3.6 mm/day</u>**

HOW OFTEN DO WE IRRIGATE?

Water movement :what are the influencers?

- Soil type.
- Soil structure.
- Soil compaction.
- Soil moisture.
- Cultivation practices.
- Plant's roots.

O Organic horizons (> 17% organic carbon) found in Organic soils and commonly at the surface of wet mineral soils.

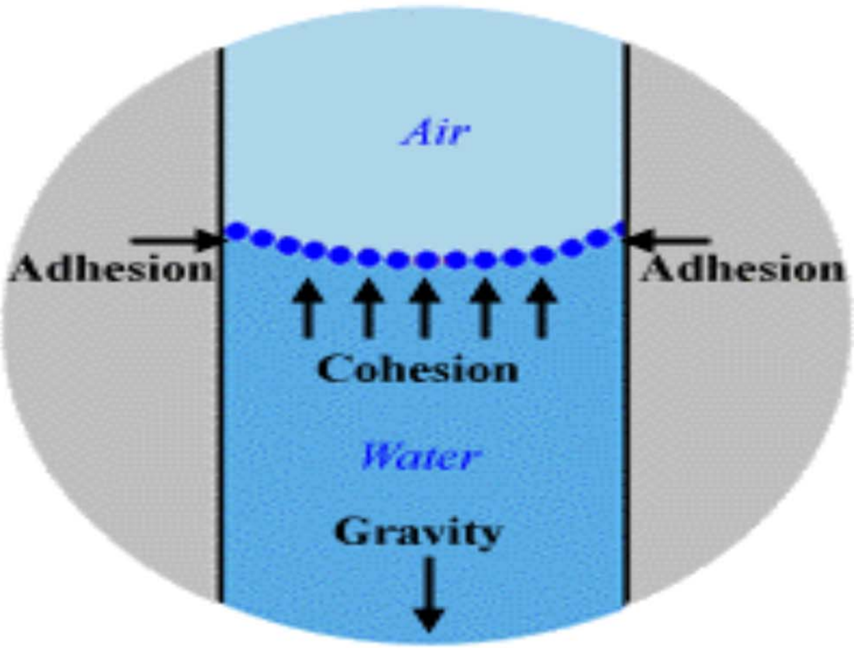
A Surface or near surface mineral horizons showing evidence of eluviation and / or in situ organic matter accumulation.

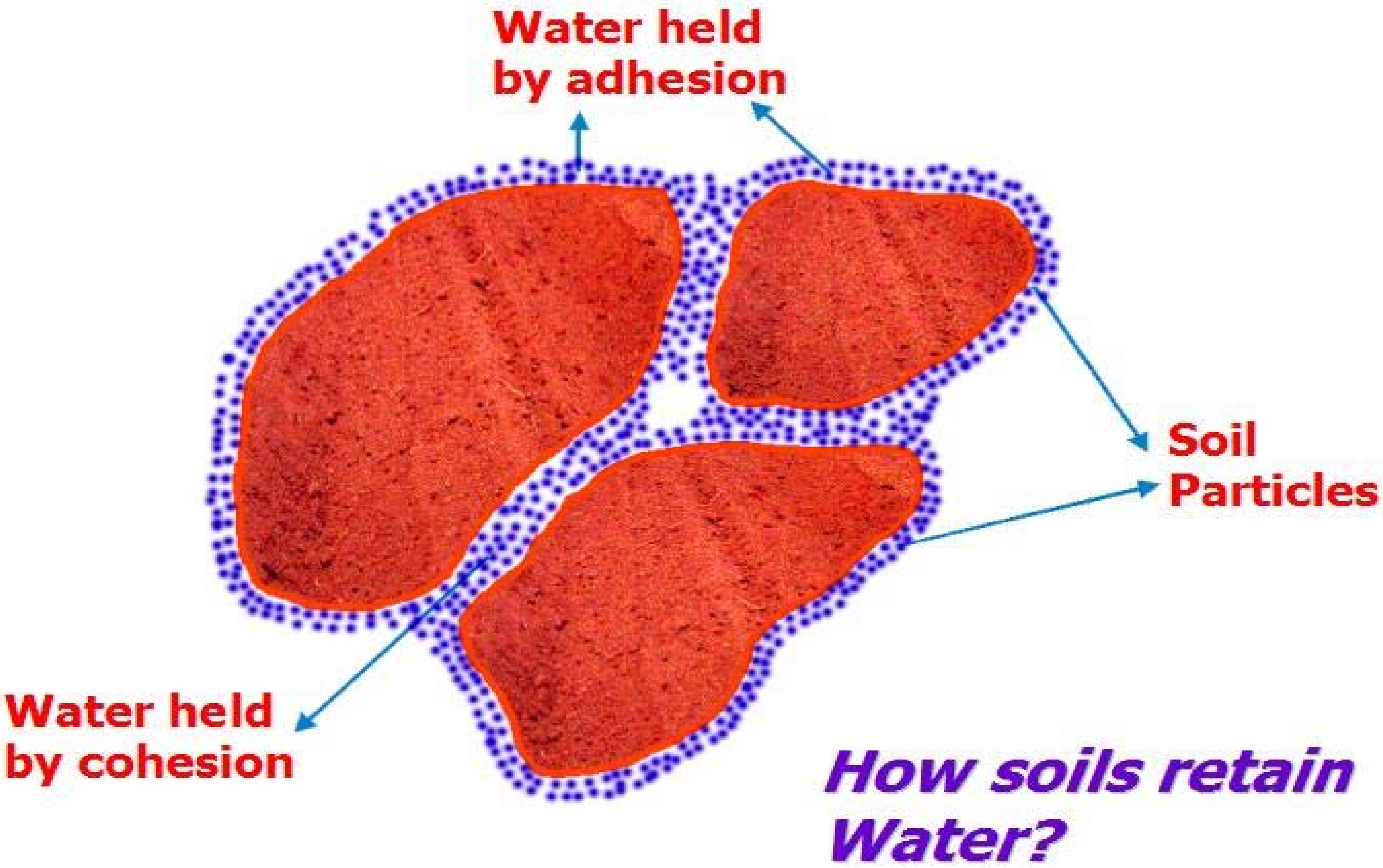
B Mineral horizons characterized by enrichment of illuvial organic matter, sesquioxides, or clay; or by the development of soil structure; or by a change in coloring denoting hydrolysis, reduction, or oxidation

C Mineral horizons unaffected by pedogenic processes except for gleying and accumulation of carbonates and soluble salts.

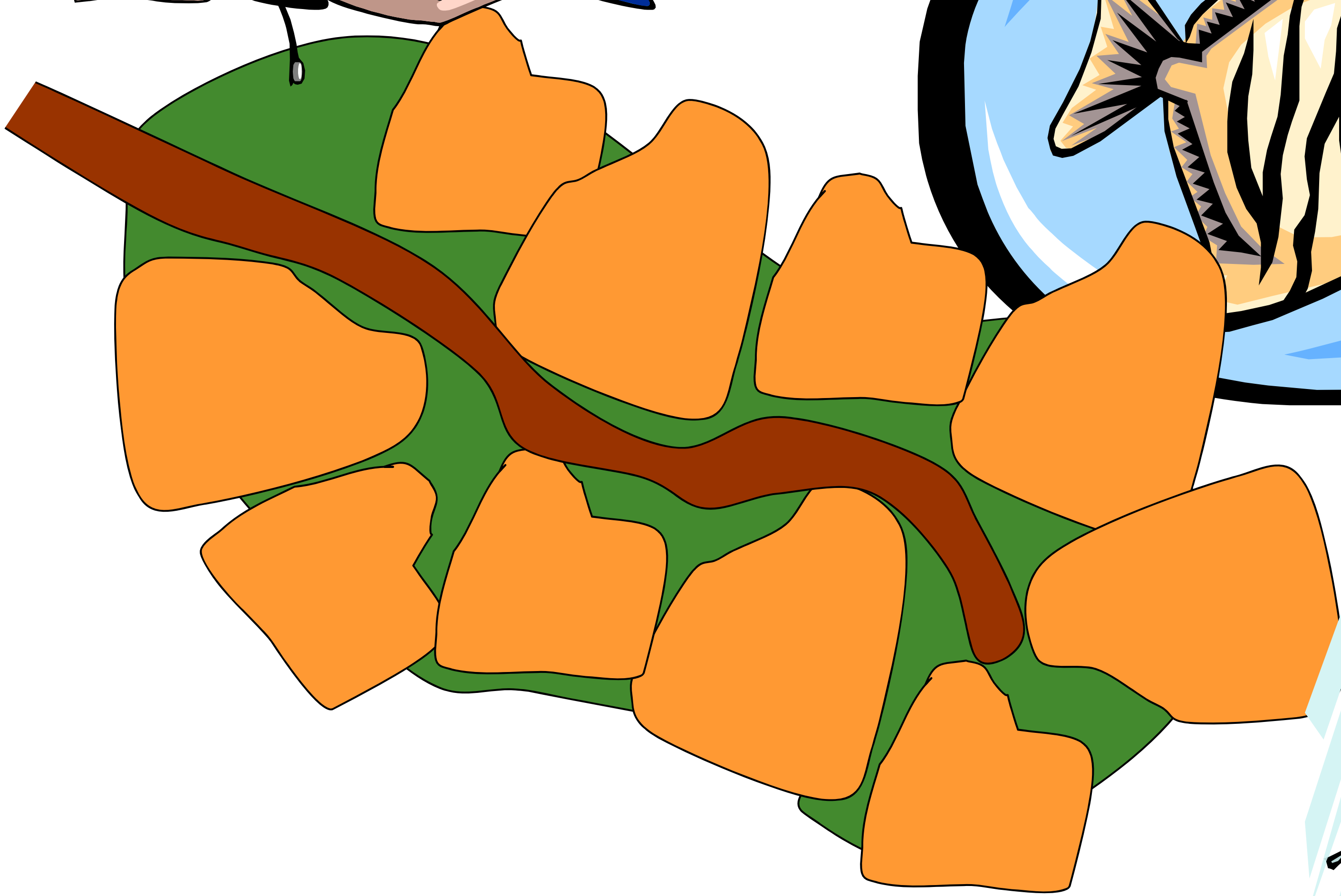
Relationship between adhesion and cohesion in a capillary

(adapted from Brady and Weil, 1996)

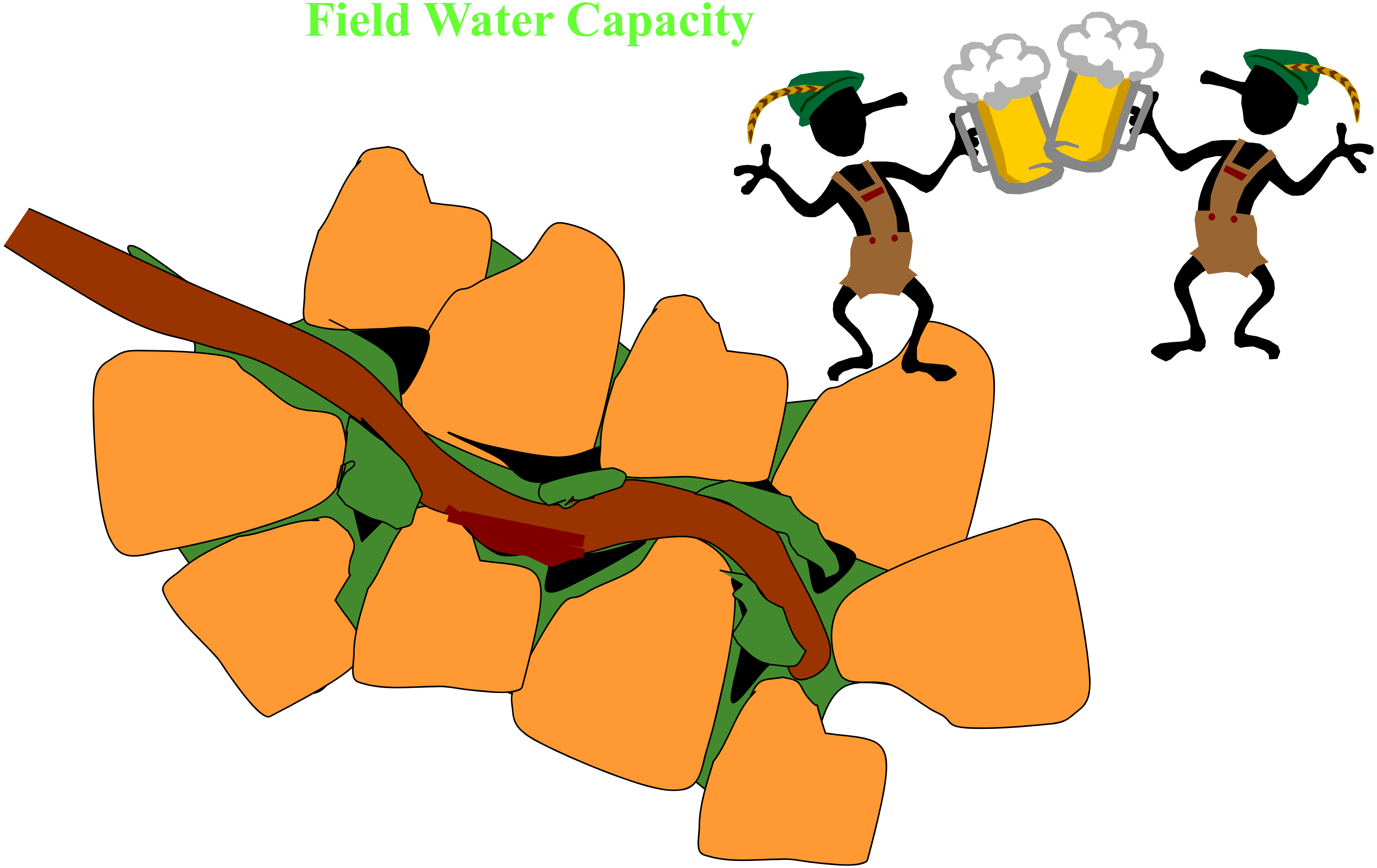



Water held
by adhesion
Soil
Particles
Water held
by cohesion
How soils retain
Water?

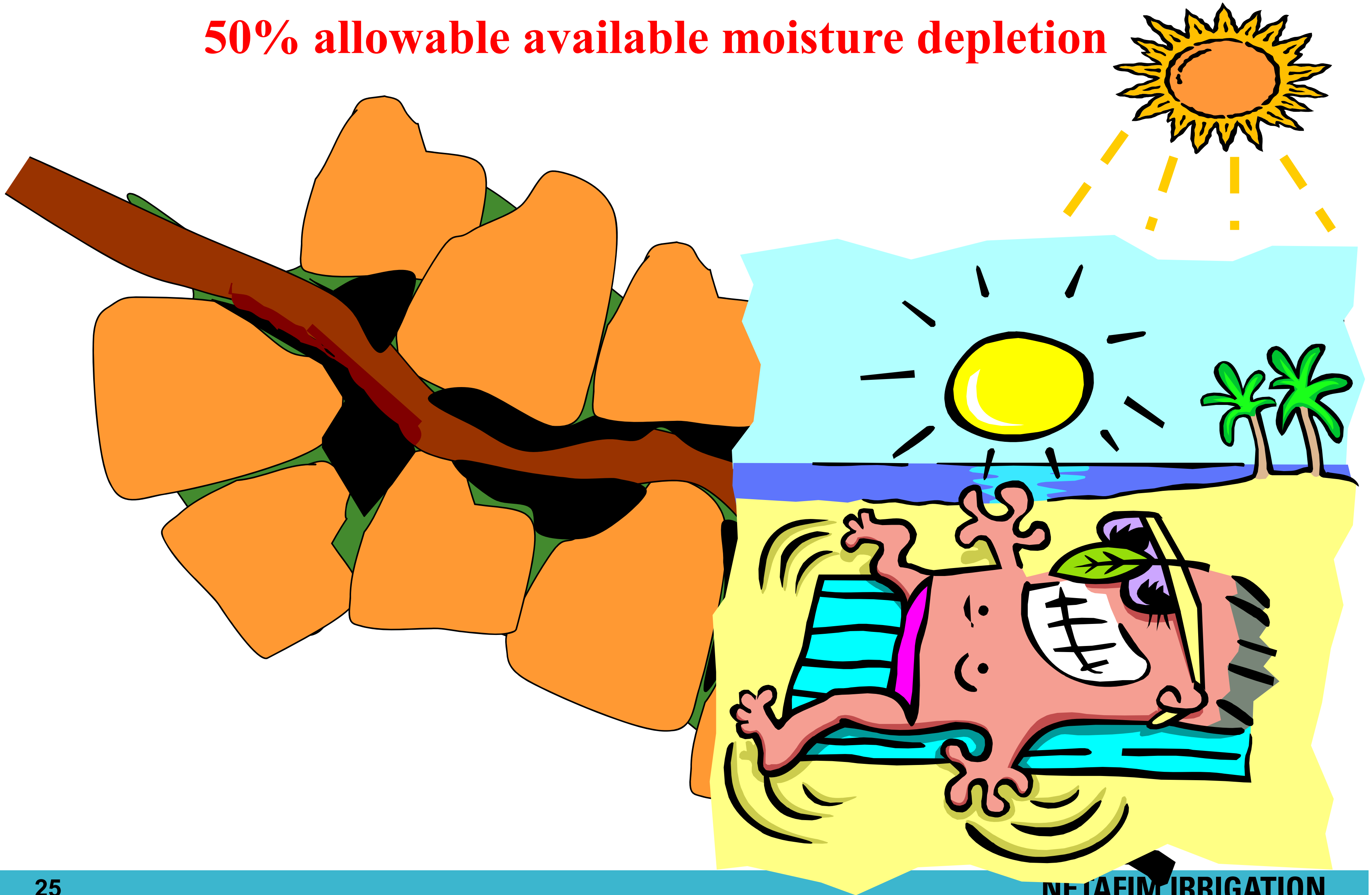
Saturated Soil Conditions



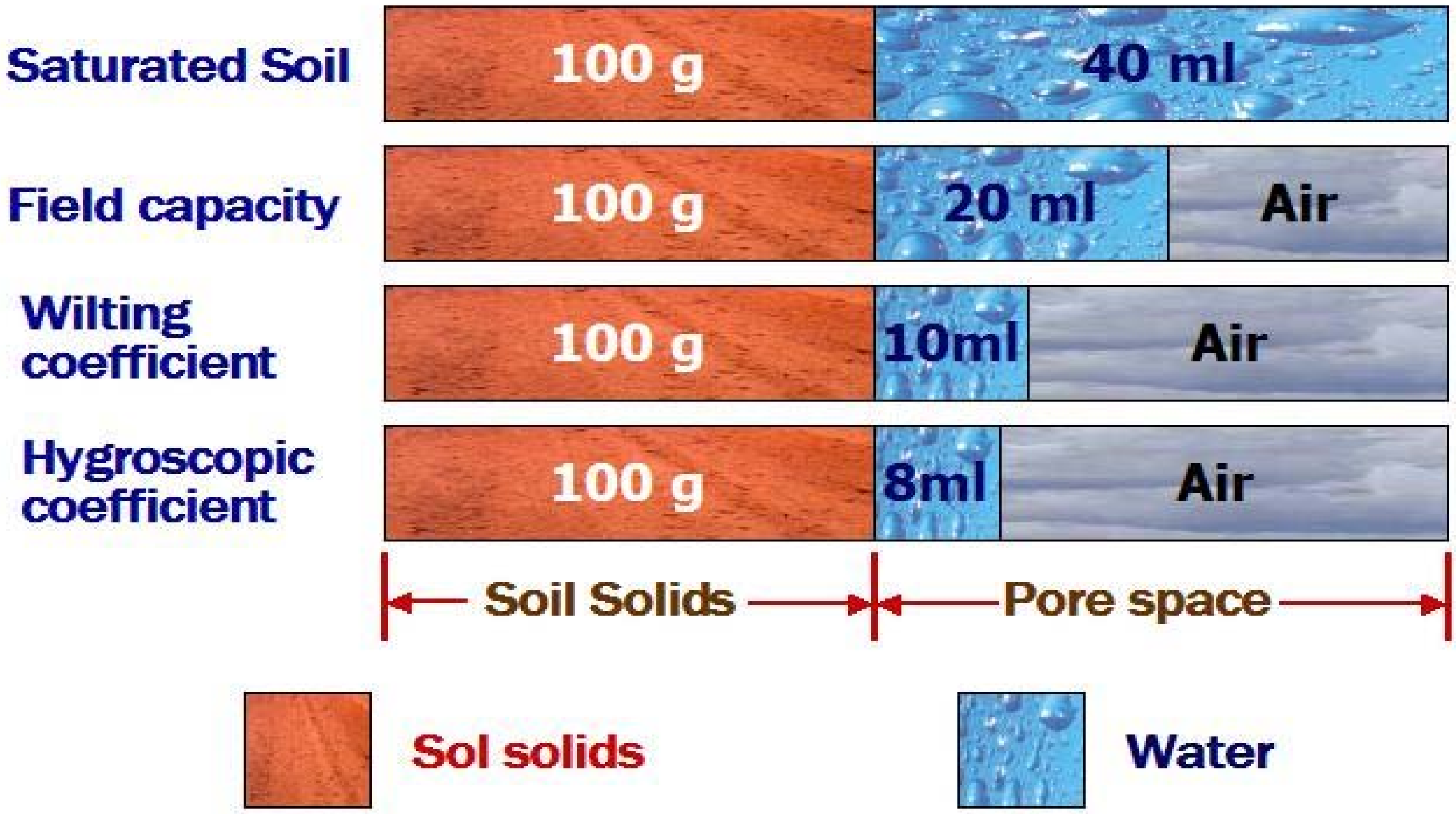
Field Water Capacity



50% allowable available moisture depletion



Volumes of water and Air associated with 100 g of a silt loam soil at different moisture levels



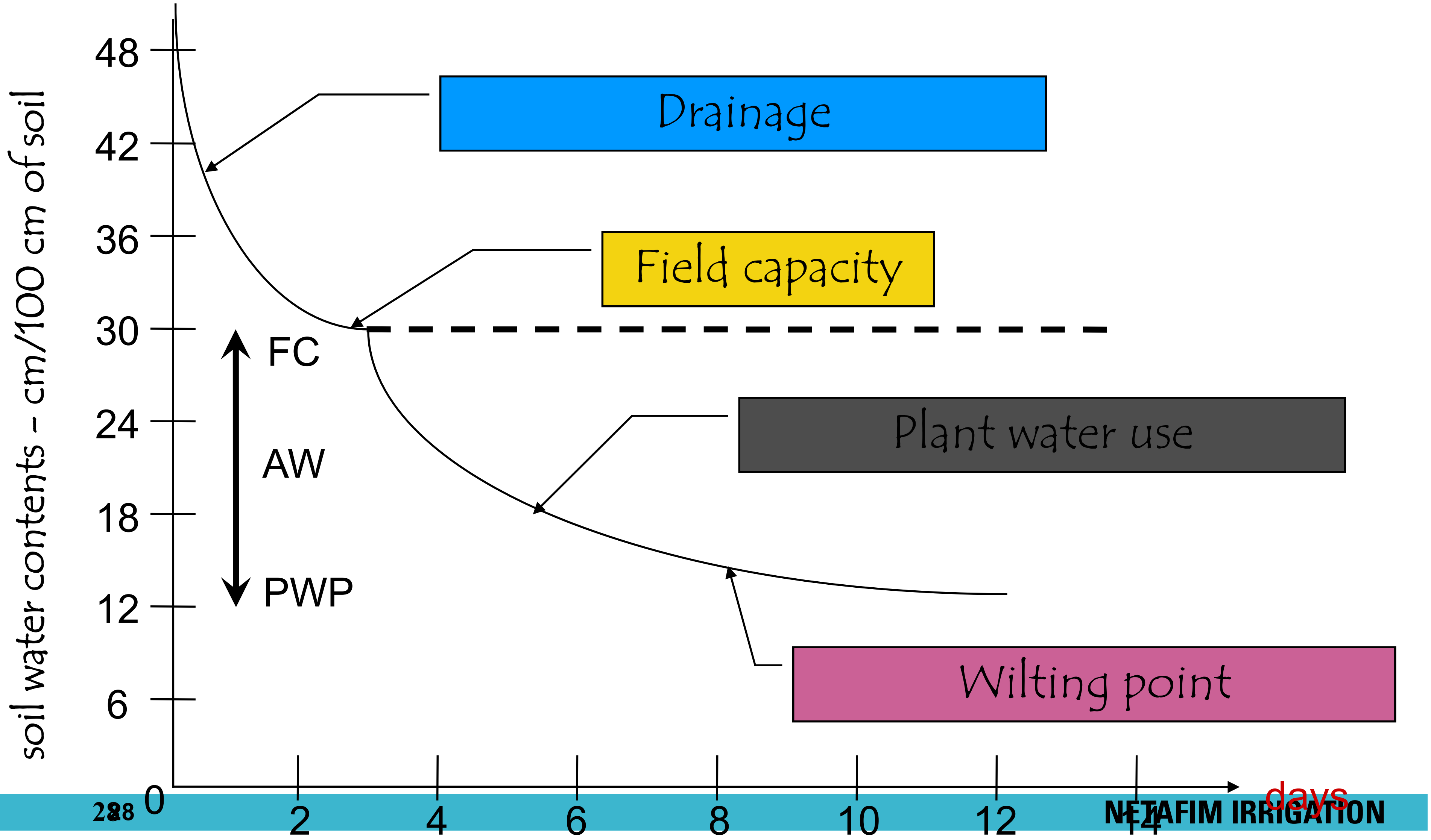
Percolation – infiltration rate

Sand / Gravel soils - 25- 200 mm/h.

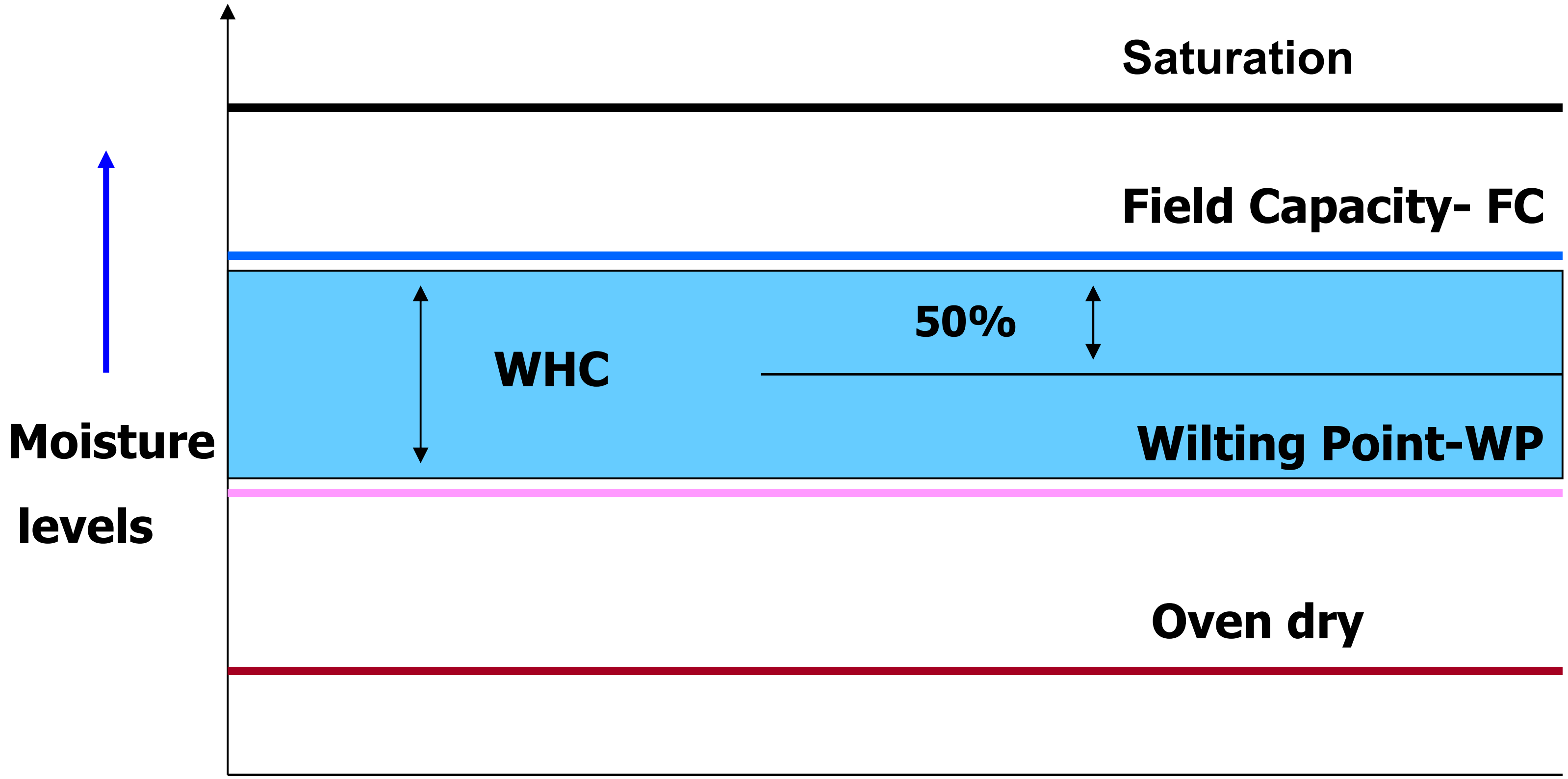
Silt / loam -   fine texture – 4-7 mm/h.

Clay / loam * - 5-10 mm/h.

WATER status in Soil



Soil water holding capacity WHC



<u>Water Holding Capacity</u>

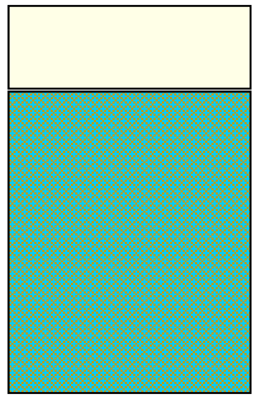
Water volume between FC & WP

Soil water holding capacity WHC

Soil Classification specific WHC- mm of water per 1meter of soil layer.

Light - Sandy: 40 - 80 mm /m

- Medium - Loamy: 80 - 120 mm /m
- Heavy - Clayey : 120 - 180 mm /m



X mm of water

1m=1000mm depth of soil

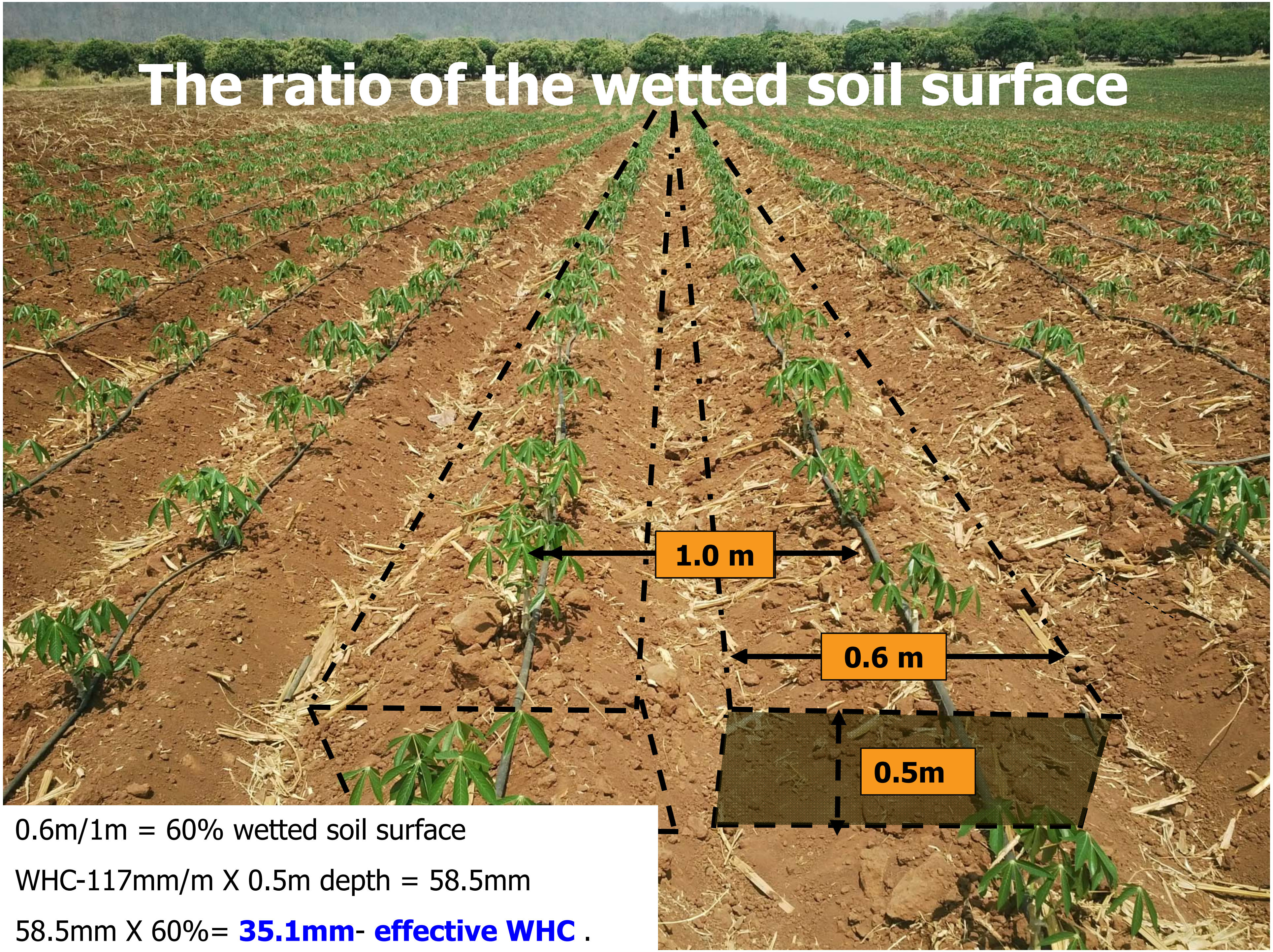
"**Old school**" -Water availability is uniformly high until 50% of WHC

Estimated water Holding Capacity of Soils

UCCE , Kern County - USA

		FC		WP		Available
	inc/ft	mm/m	inc/ft	mm/m	inc/ft	mm/m
Sandy	1.2	**100**	0.5	**42**	0.7	**58**
Loamy sand	1.9	**158**	0.8	**67**	1.1	**92**
Sandy Loam	2.5	**208**	1.1	**92**	1.4	**117**
Loamy sand	3.2	**267**	1.4	**117**	1.8	**150**
Silt Loam	3.6	**300**	1.8	**150**	1.8	**150**
Sandy Clay loam	3.5	**292**	2.2	**183**	1.3	**108**
Sanday Clay	3.4	**283**	1.8	**150**	1.6	**133**
Clay Loam	3.8	**317**	2.2	**183**	1.7	**142**
Silty Clay Loam	4.3	**358**	2.4	**200**	1.9	**158**
Silty Clay	4.8	**400**	2.4	**200**	2.4	**200**
Clay	4.8	**400**	2.6	**217**	2.2	**183**

The ratio of the wetted soil surface

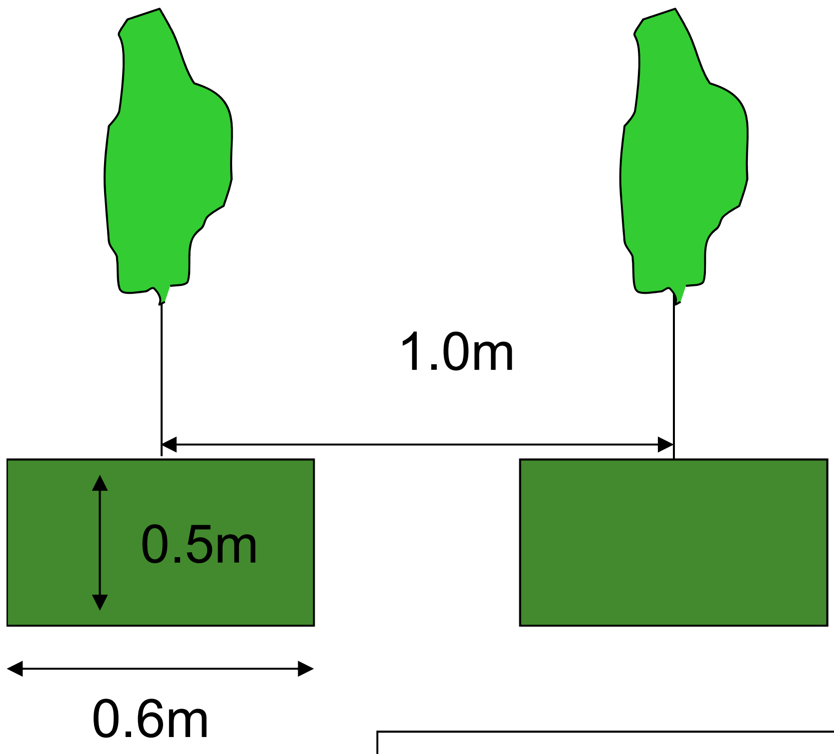


0.6m/1m = 60% wetted soil surface

WHC-117mm/m X 0.5m depth = 58.5mm

58.5mm X 60%= **35.1mm- effective WHC** .

Irrigation scheduling- Drip (cassava)

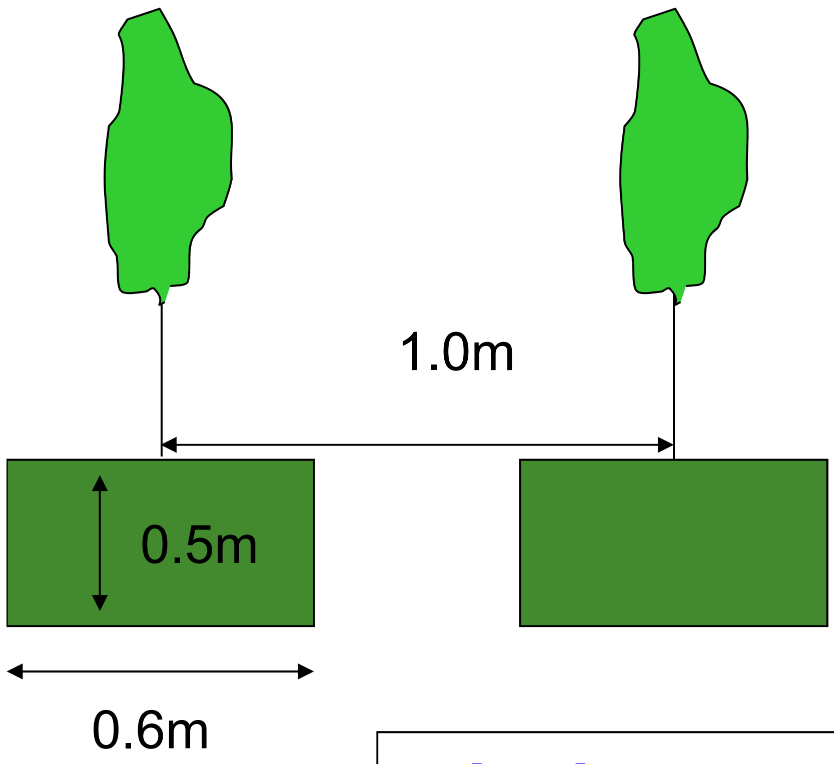


1. Sandy loam - WHC 117 mm/m
2. Wetted surface–(0.6/1) 60%
3. Root/wetted depth – 0.5m
4. Daily deficit – 3mm/day
5. Allowed depletion – 50%

Irrigation Interval, days

$$\frac{117\text{mm/m} \times 0.5\text{m} \times 0.60 \times 50\%}{3\text{mm/day}} = \sim\mathbf{6\ days}$$

Irrigation scheduling- Drip (cassava)



1. Sandy - WHC 58 mm/m
2. Wetted surface–(0.6/1) 60%
3. Root/wetted depth – 0.5m
4. Daily deficit – 3mm/day
5. Allowed depletion – 50%

Irrigation Interval, days

$$\frac{58\text{mm/m} \times 0.5\text{m} \times 0.60 \times 50\%}{3\text{mm/day}} = \sim 3 \text{ days}$$

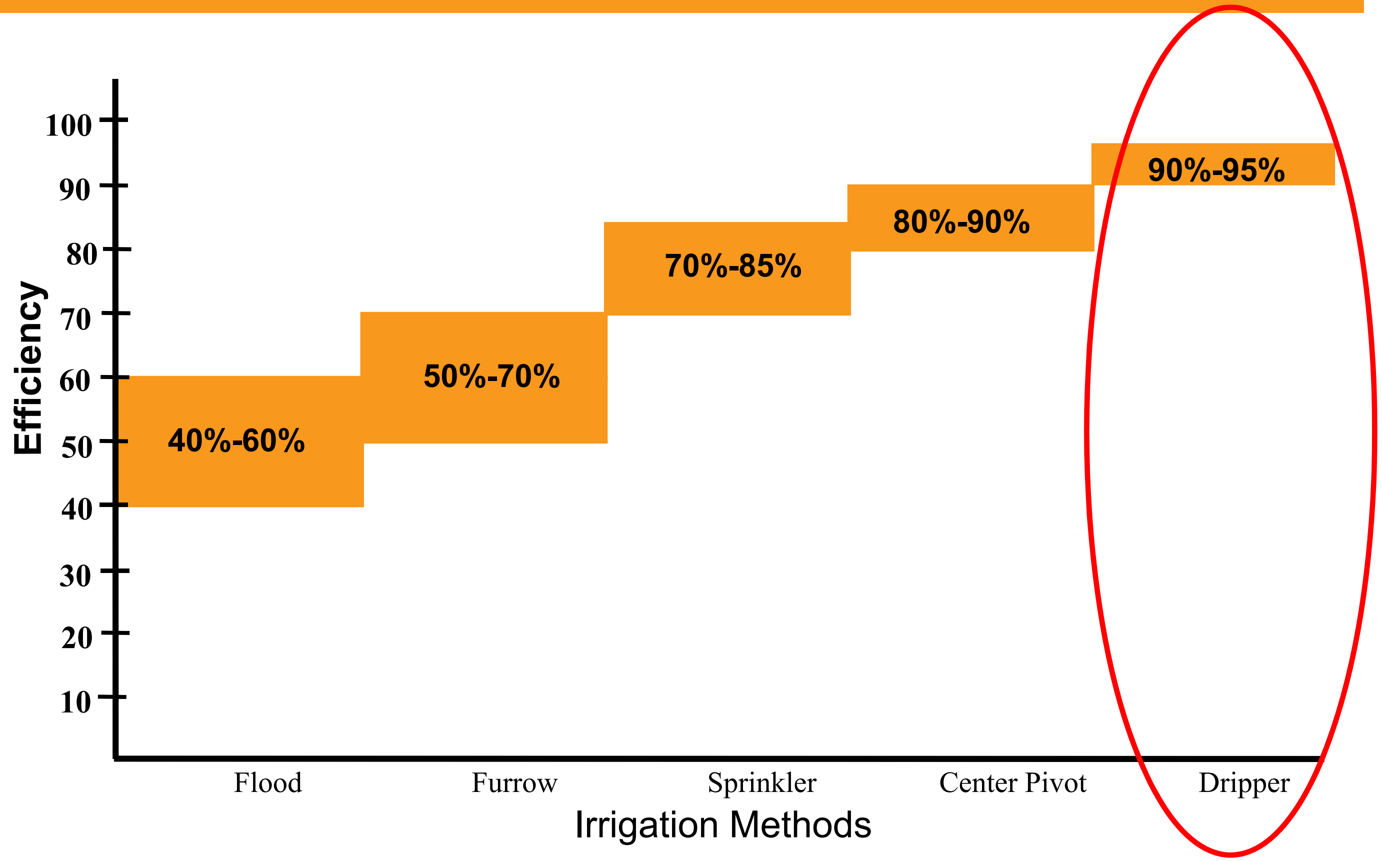
Watering methods:

1. **Flood irrigation : 35% - 50%**
2. **Good flood irrigation : 60%.**
3. **Furrow irrigation : 55% - 60%**
4. **Surge irrigation in furrows : 80% - 85%.**
5. **Under-tree basin irrigation in orchards : 75%-80%**


THE GOAL:
To irrigate the plants and NOT the soil

IRRIGATION EFFICIENCY

EFFICIENCY MEASURED BY YIELD INCREASE
AND SAVING ON WATER AND AGRICULTURAL GOODS



Drip irrigation efficiency >40% better than flood and furrow

AREA IRRIGATION

HIGH ENERGY CONSUMPTION

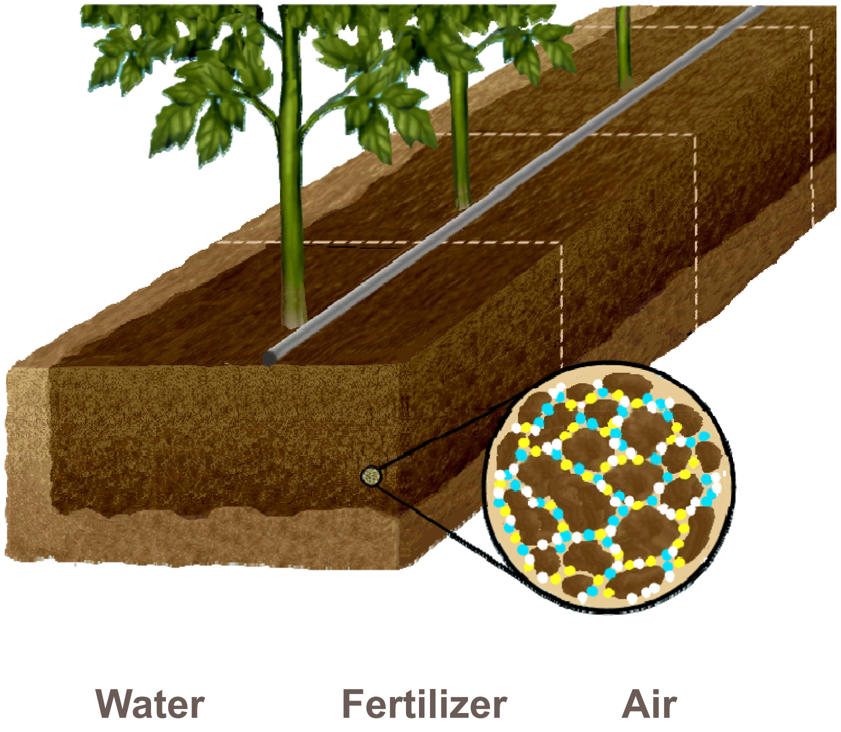
Flat area

Undulated area

Drip Irrigation

Drip irrigation low discharge delivers:

- Optimal and uniform moisture.
- Excellent aeration conditions.
- Efficient uptake of water.
- Effective absorption of nutrition.



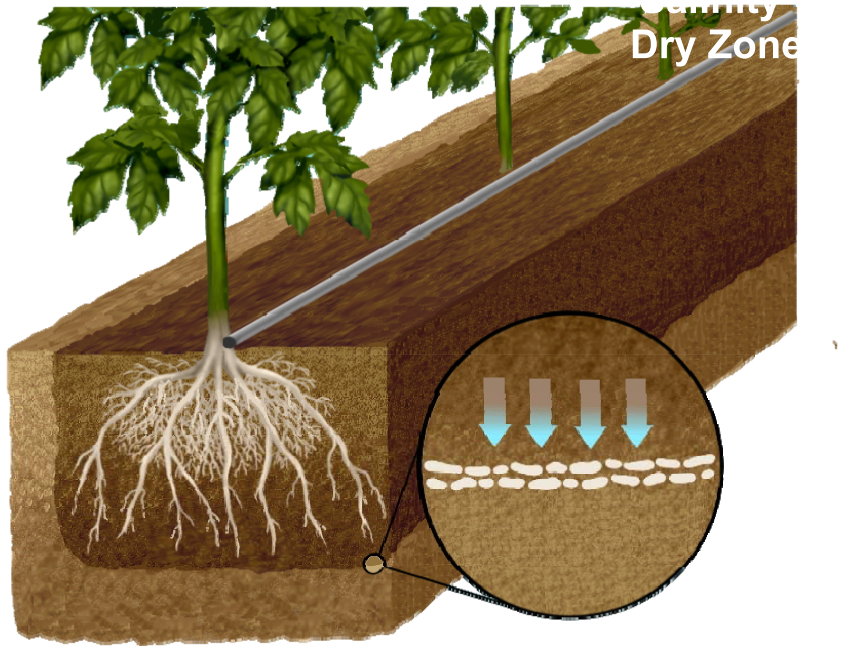
DRIP IRRIGATION VS. FLOOD IRRIGATION

Wet Zone

- Continuous moisture along the plants' roots.

- Allows air to remain in the wetted area.

- Concentrates plant roots within the wetted area.

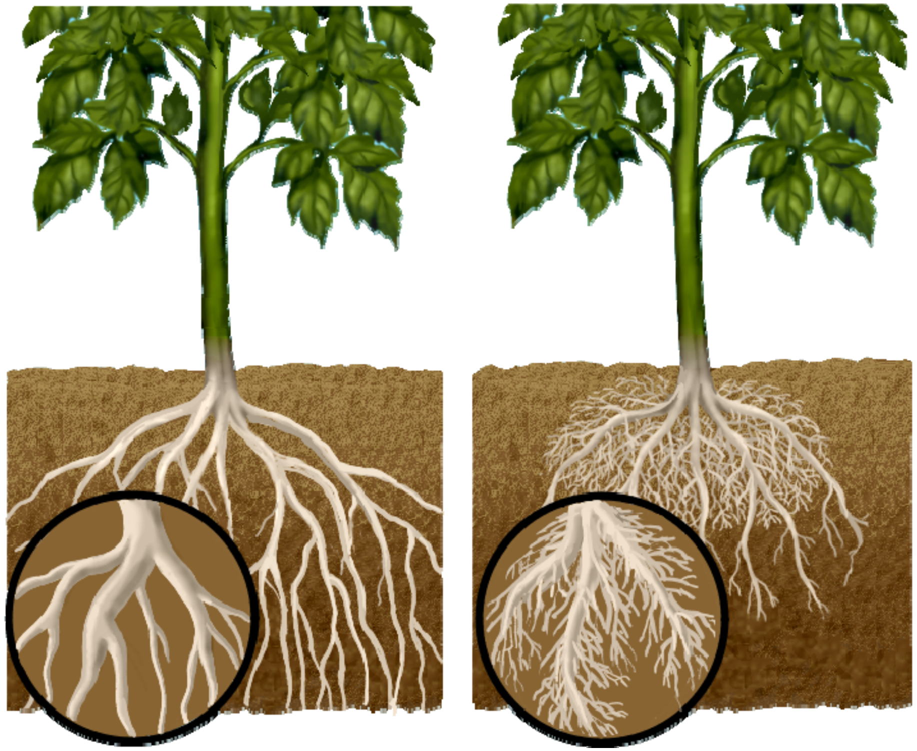


- Continuous wet strip builds sufficient root volume.

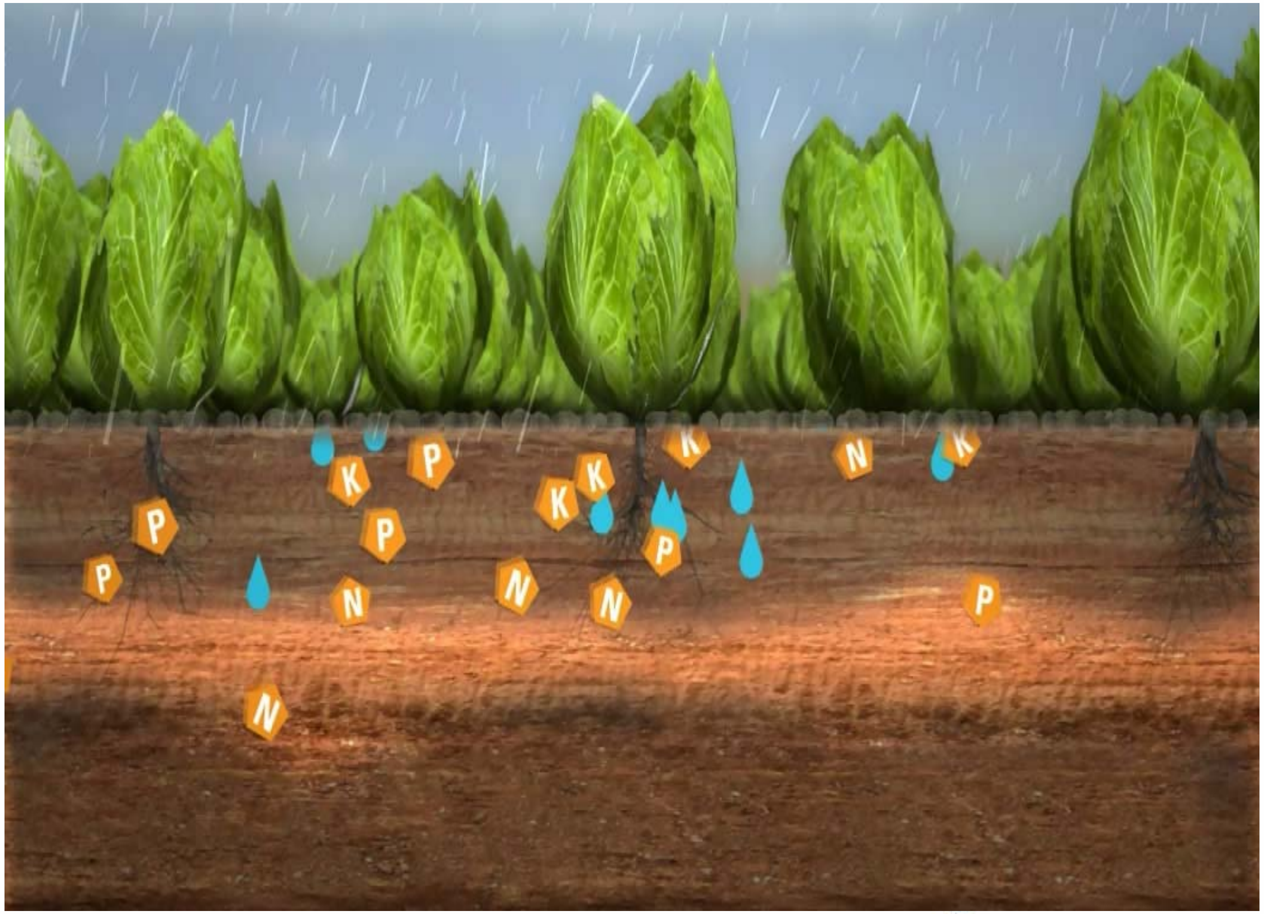
- Prevents salinity build up within the wetted strip.

Compact & Effective Root Zone

- Concentrates the roots in a defined volume of soil thus saving the plant's energy.
- Improves the uptake efficiency of water and nutrients.
- Develops optimal moisture and aeration conditions.

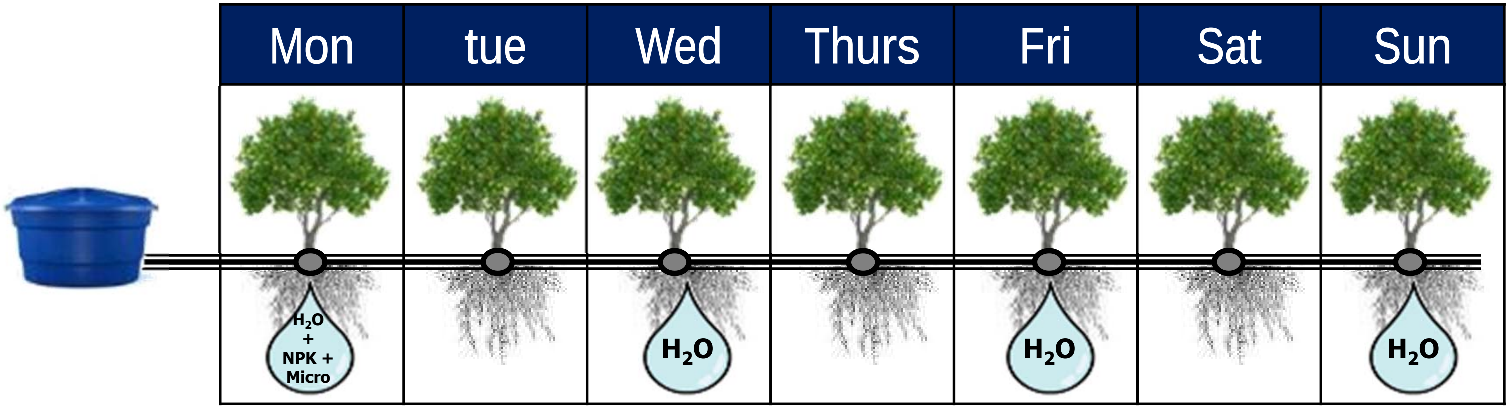


FERTIGATION

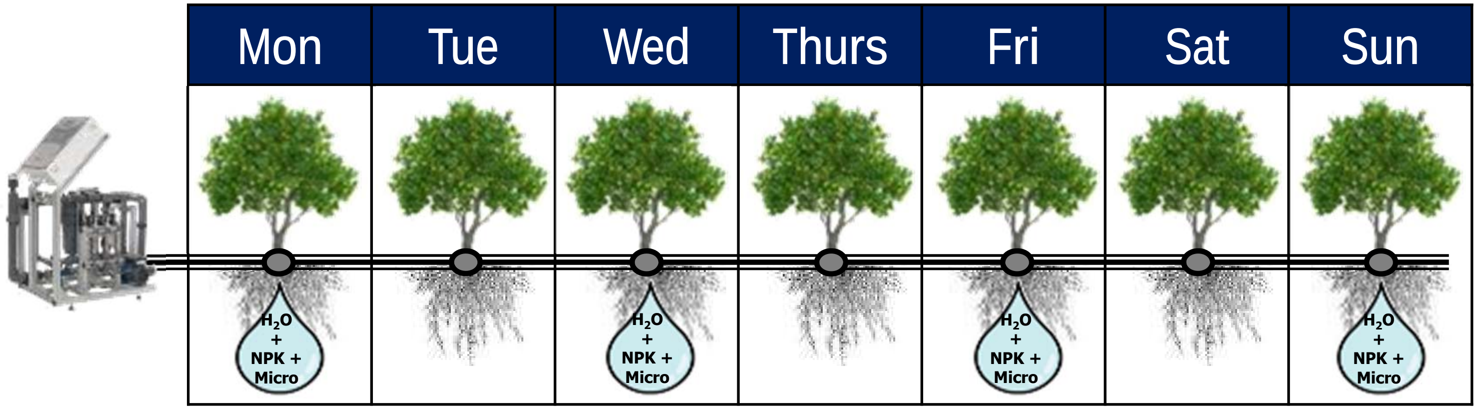


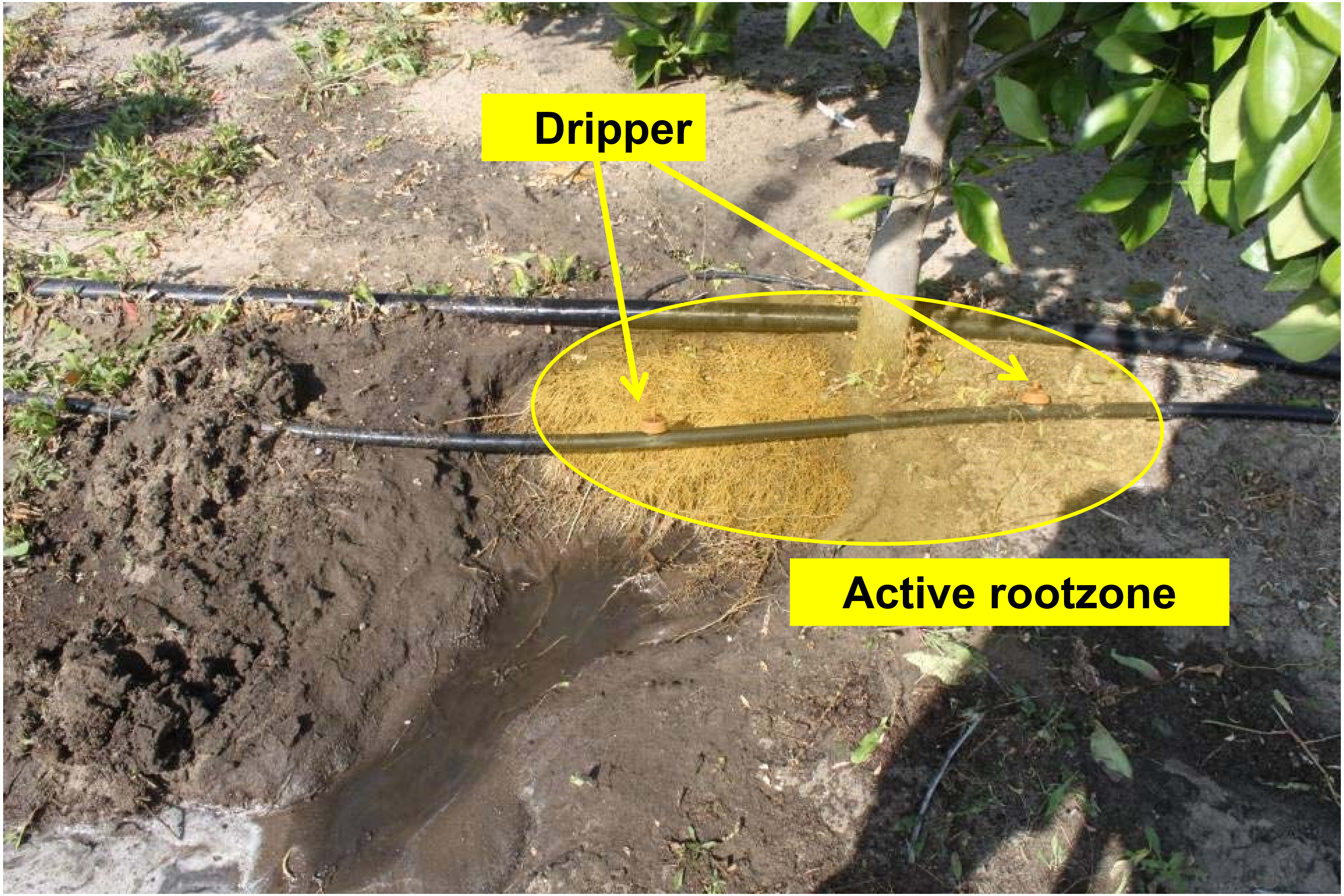
Spoon Feeding

Fertigation™



Nutrigation™

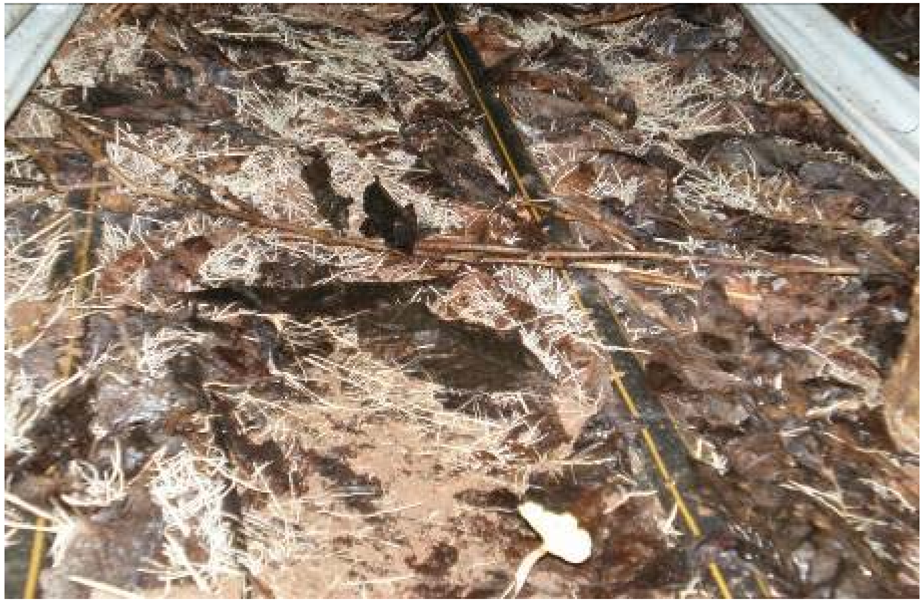




Dripper
Active rootzone

Active Root Zone

Regardless the Plant/ species, the most active root zone is at Horizon A, close to the surface



High Oxygen / Lower physical resistance to roots growth?

Nutrigation-Active Root Zone

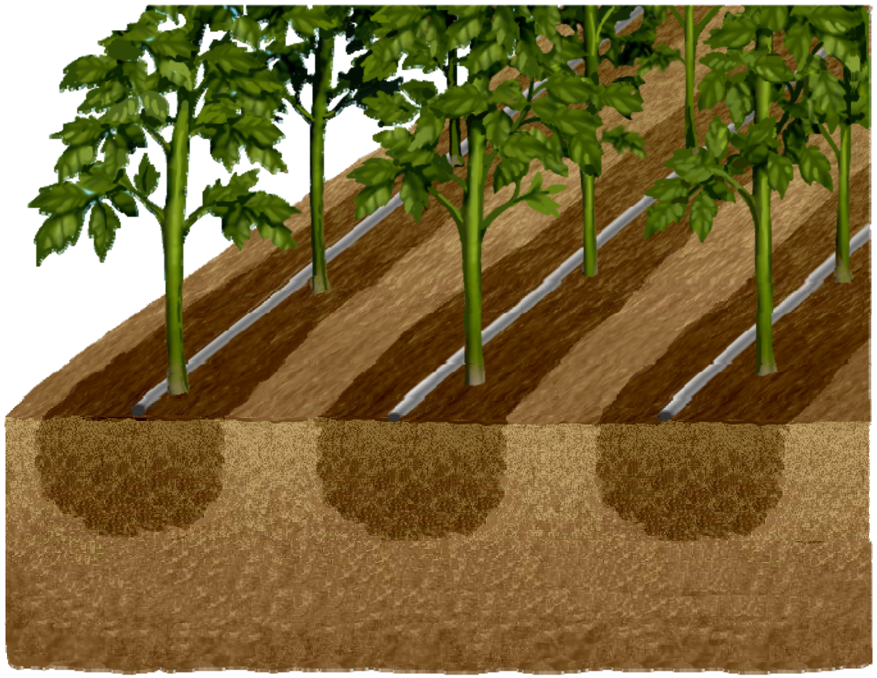
Location: Njombe, Tanzania

Crop: Tea **Fine root:** 0-20cm subsurface


08/11/2010

Advantages of the Dry Zone

- Reduces weeds.
- Saves labor, machinery and weed control expenses.
- Gives easier passage to farm equipment.
- Prevents soil erosion between plants.

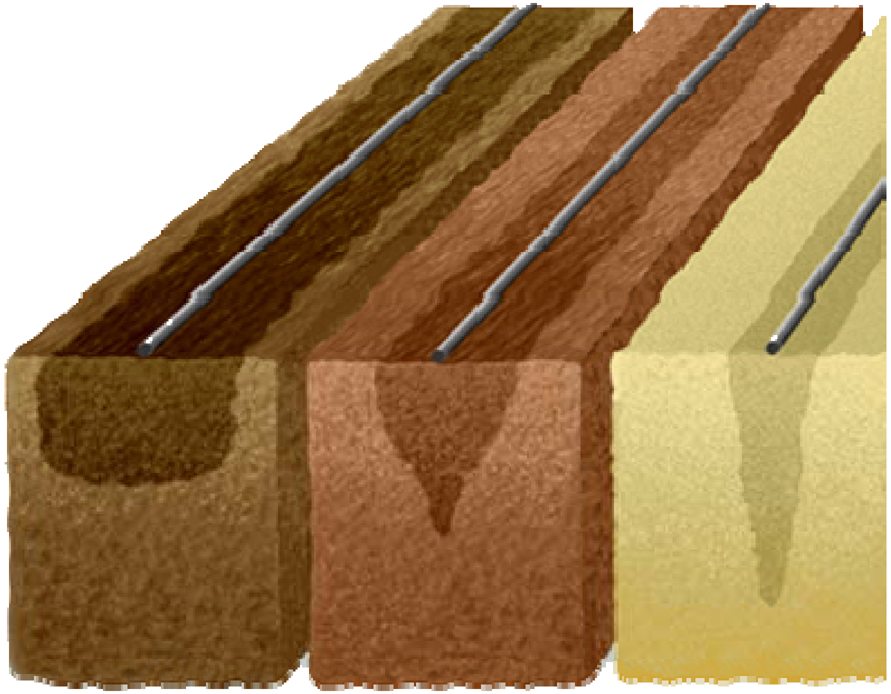


Wet Soil Types

- Shape of the wetted zone depends on physical properties of the soil.

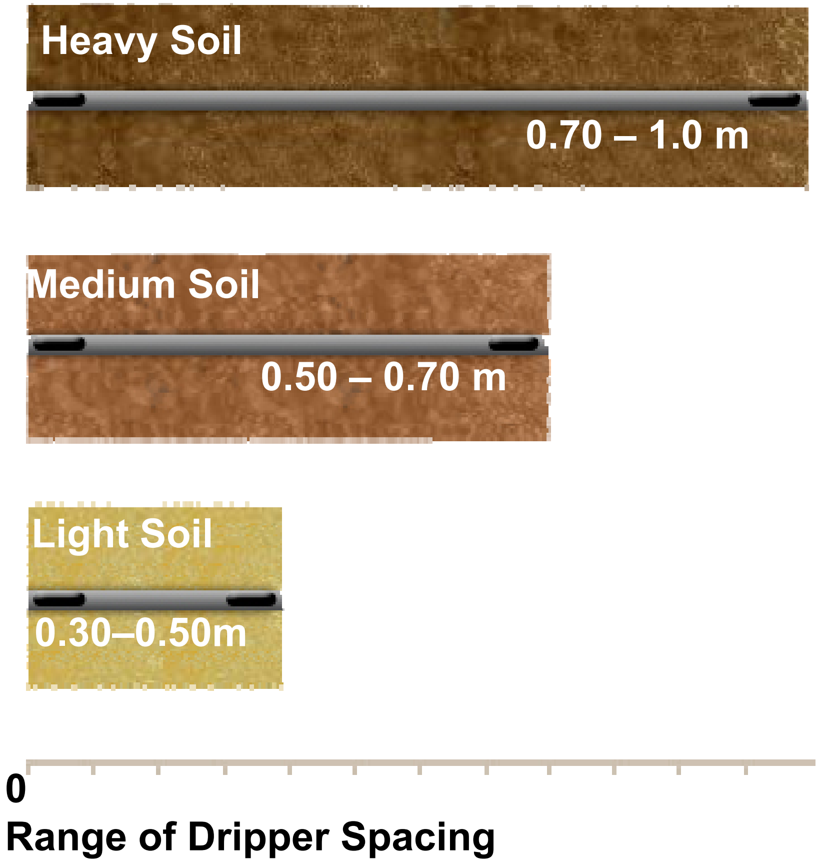
- In light soil, water distribution is narrower and deeper.

- In heavy soil, water distribution is relatively spherical in shape.



Spacing Between Drippers

- Recommended distance for heavy soil : 0.75 to 1.00 m.
- Recommended distance for medium soil: 0.50 to 0.75 m.
- Recommended distance for light soil: 0.30 to 0.50 m.
- Dripper distance must consider soil texture and crop needs.



Advantages of drip irrigation

<u>Advantages of water distribution</u>

- **Prevention of run-off**
- **Prevention of water leakage under the root system (deep percolation)**
- **Prevention of Evaporation from Exposed soil**
- **Equal distribution of water in the field**
- **Prevention of influence from winds**

Yield Increases and Water Saving

Under Drip Irrigation*

Crop	Yield (tons/ha)			Water Use (mm)		
	conventional	Drip	% Yield	conventional	Drip	% water
Banana	57.5	87.5	52	1760	970	45
Grapes	26.4	32.5	23	532	278	48
Sweet Lime	100	150	50	1660	640	61
Tomato	32.0	48.0	50	300	184	39
Watermelon	24.0	45.0	88	330	210	36
Chili peppers	4.2	6.1	44	110	42	62
Sugar Cane	128	170	33	2150	940	56
Cotton	2.3	2.9	26	90	42	53

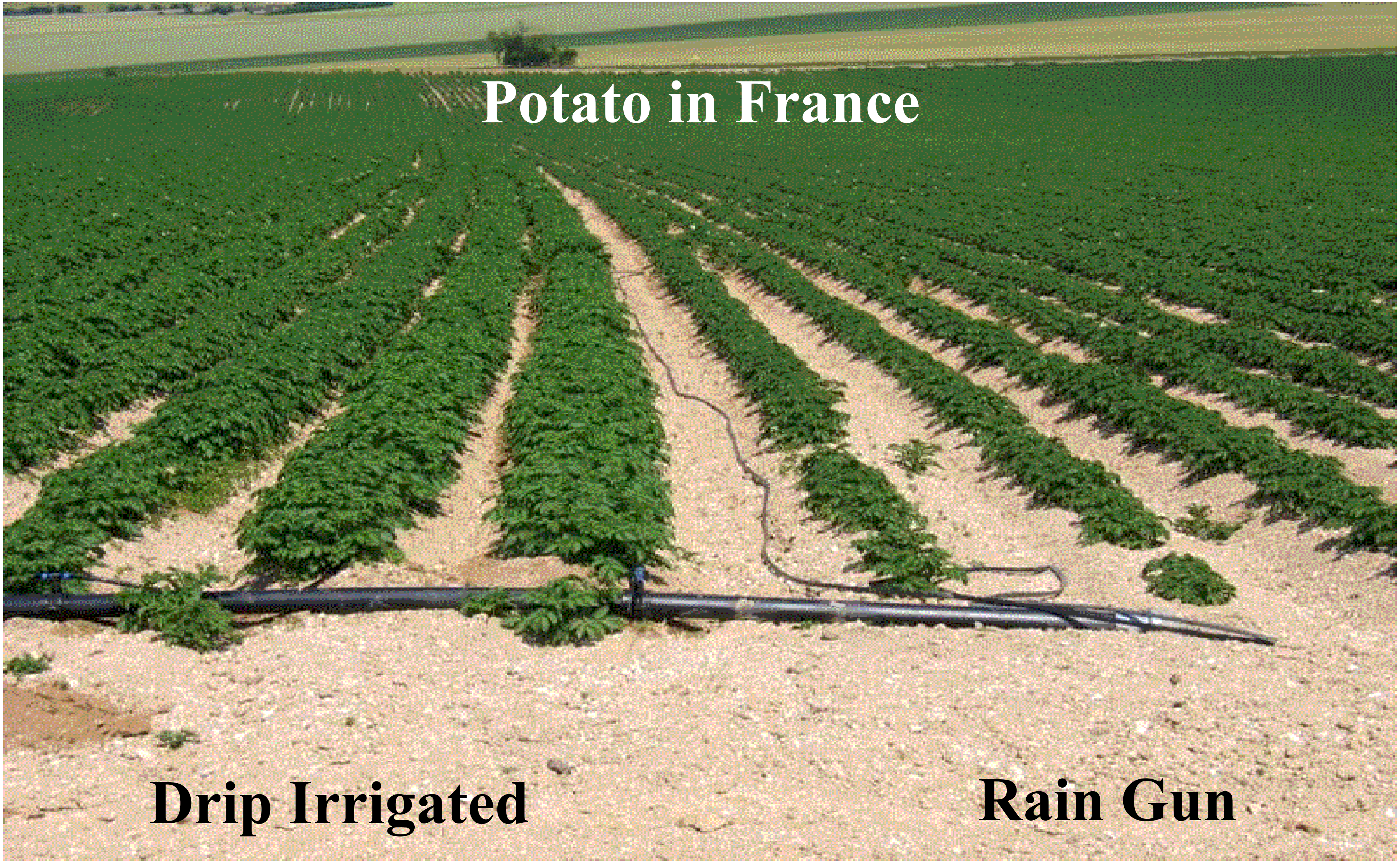
Disadvantages

- High initial cost
- Maintenance requirements (emitter clogging, etc.)
- Salt accumulation near plants (along the edges of the wetted zone)

Simple

1 Acre plot

Carrot – 3 laterals per bed


Potato in France
Drip Irrigated
Rain Gun


Failed dripperline spacing.




SOIL PREPARATION

Cassava

Cassava

Drip VS Rain-fed at 5 months

7 months

Drip irrigated

Rain fed

Ubonratchathan



Processing Chile Pepper 50 Ton/ha
Compared to 32 Ton/ha under Sprinkler.


Tomato : 130 Ton/ha compared to 50 Ton/ha
(Nakonratchasima, TH)





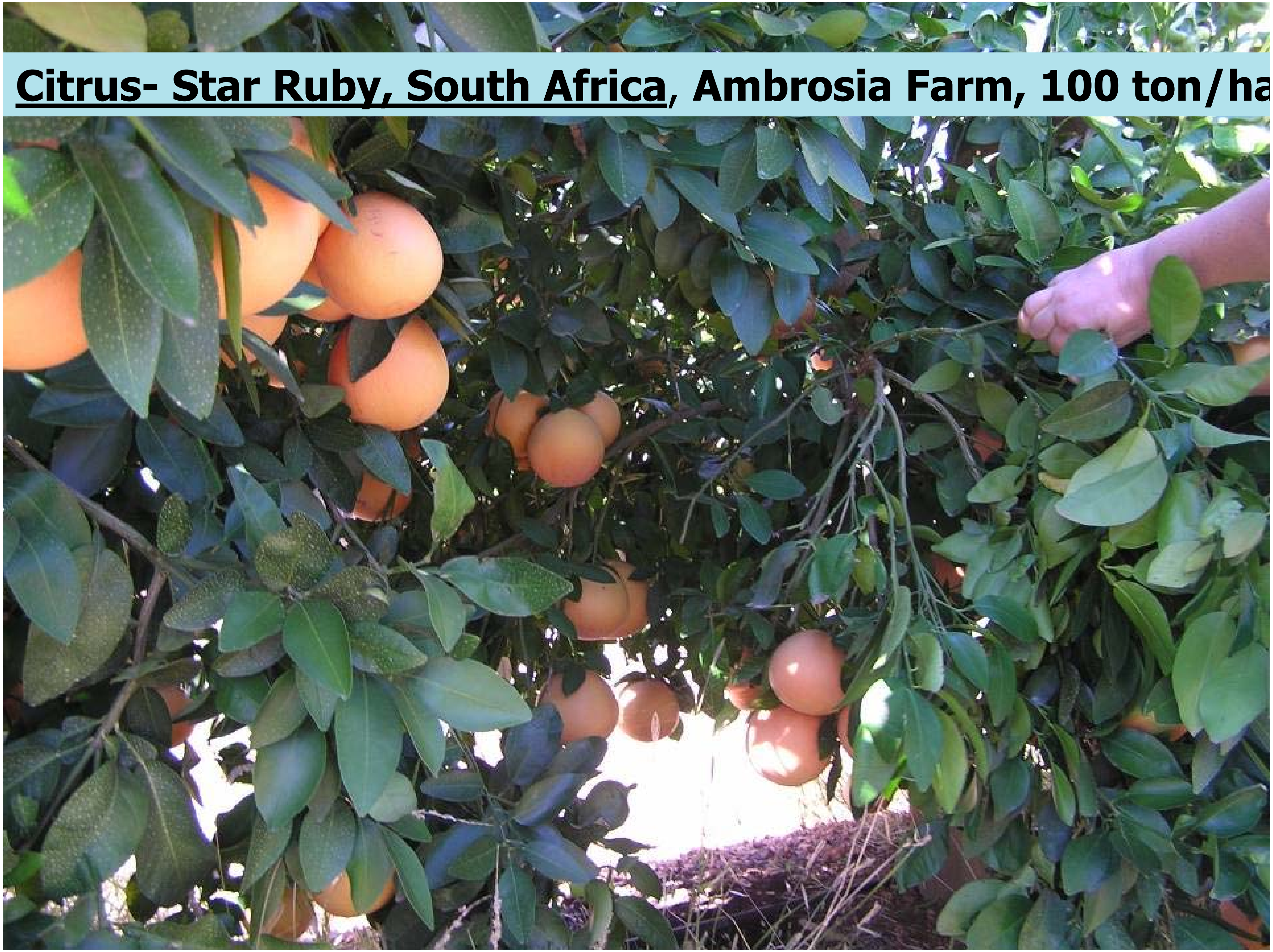







ON

Citrus- Star Ruby, South Africa, Ambrosia Farm, 100 ton/ha



Cassava- Argentina , Drip 43 ton/ha Vs. 27 ton

Apple -Starking, 70 ton/ha, Israel


Ukraine, Drip 16 ton/ha Vs.
Sprinklers- 10 ton/ha

Cocktail Tomato - Simple Plastic **GH**
Habsor- Israel, **300 ton/ha**

Strawberry. Israel
80-90 t/ha

Alfalfa, Merrigum N.Victoria Australia

Bert Dixon. SDI- 20cm. 3rd year- 25 ton/ha

Table grapes, **Thompson seedless, 55 ton/ha**

Lachis Israel


Onion, Turkey,
80-100 t/ha
03/02/2011

Potato, France

45-60 t/ha

Carrot, Israel,
120-140 t/ha

Pomegranate, 45 ton/ha. Kfar Menahem, Israel


Sugar Cane- Agrovalle – Brazil
2100ha – drip nutrigaton, 6 ratoons, 139 ton/ha

Eucalyptus pulpwood Brazil- Veracel, Bahia State

MAI 70 m3/ha/yr,@ 30 months


Black Pepper farm in Vietnam, 4.8 ton/ha
2.5m X 2.5m, 1600 Poles/ha


Oil Palm, Drip irrigated, Univanich Thailand
FFB 35 t/ha, O/B 27%
Rain fed –FFB 20t/ha ,O/B 23%
08/04/2010

Tanzania, Drip 5.8 ton/ha V.s Rain-fed 3.2 ton/ha


Rubber Tree
Cambuhy- SP, Brazil , increase 50% in production

<u>Nutrigated Arabica Café-</u> Brazil, MG

63 sac/ha =3800kg/ha

Rain fed Arabica- 1700kg/ha

<u>**Robusta Café -**</u> Espirito Santo, Brazil,

Average 100-sac/ha, 6000kg/ha

Average rain fed -40 sac/ha 2,400kg/ha

COCOA, South of Bahia – Brazil, 3000kg/ha
Rain fed – 800kg/ha

Cocoa in the spacing of 3,8 x 2m.

TOMMY- 50 ton/ha
Israel


Wetting Pattern of a Subsurface Drip Lateral

Dripperline burying

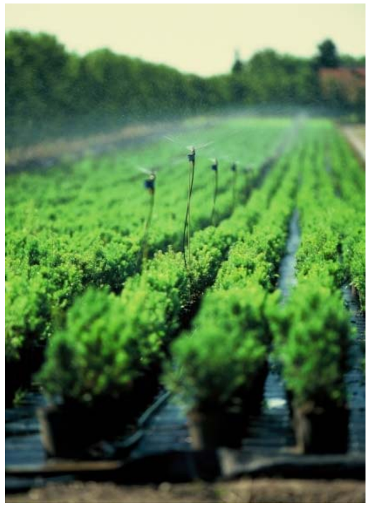
Salad field

Lettuce –SDI

Types of Systems Contd…

Sprinkler

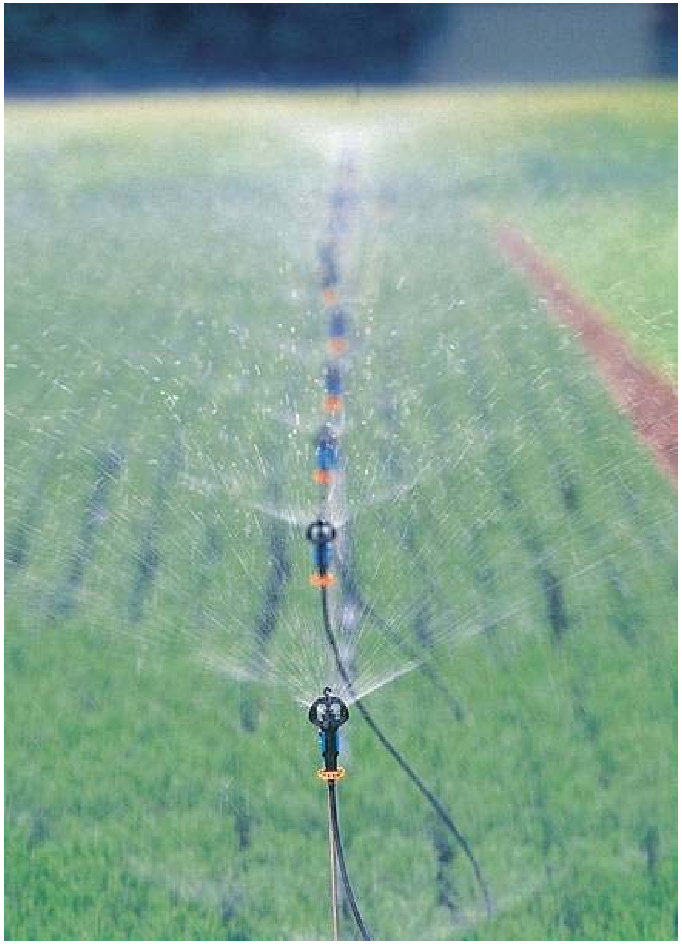
- Water applied (spray, jet, fog, mist) to the soil surface
- Aerial distribution of water as opposed to soil distribution
- Reduced filtration and maintenance requirements because of higher flow rate

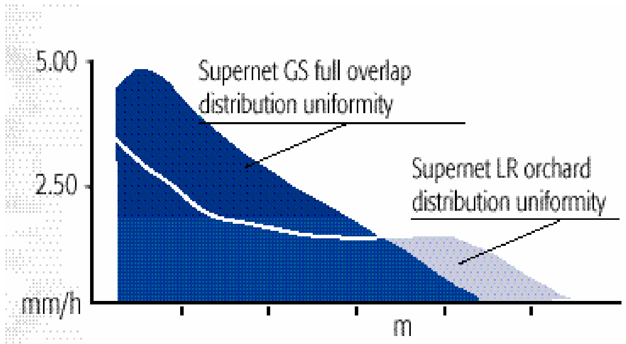


SpinNet™

Crop : Strawberries
Spacing 2 x 5 meter
Flow rate 70 l/h.
Humidification

SuperNet™ GS




5.00
2.50
mm/h
m
Supernet GS full overlap distribution uniformity
Supernet LR orchard distribution uniformity

SuperNet™ UD

CoolNet™

CoolNet™ perfectly humidifies heated greenhouses where air is dry due to the heating system, mushroom habitats, tropical pot nurseries, etc,

Rooting cuttings and shoots require highly precise humidified environment. CoolNet™ is perfect for this purpose.

CoolNet™

Crop : Vanilla
Spacing 3 x 2 meter
Flow rate 4*7.5 l/h.
Cooling

Crop : Gerbera
Spacing 3 x 3 meter
Flow rate 4*7.5 l/h.
Cooling and humidification

CoolNet™

Crop : Strawberries
Spacing 3 x 3 meter
Flow rate 4*7.5 l/h.
Cooling and humidification

THANK YOU

NETAFIM™
GROW MORE WITH LESS