Prior to Irrigation

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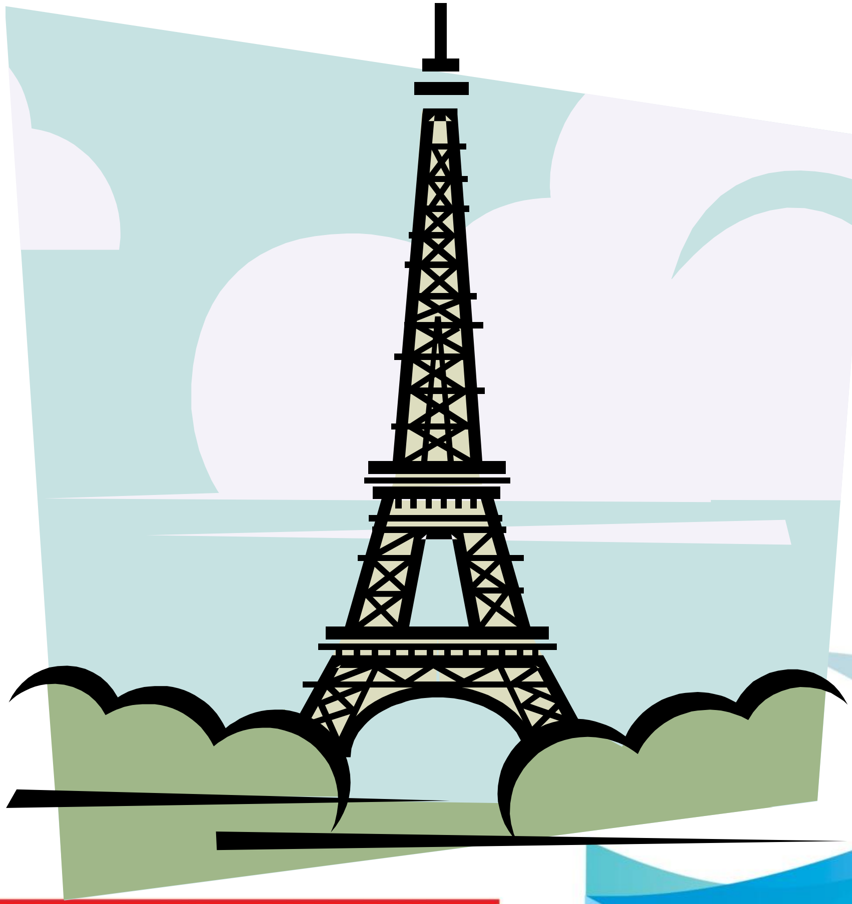
A Complete Irrigation Solution

France was the first country to adopt the metric system in 1791 by King Louis XVI.



Standards:

Several units have precisely defined standards. This ensures that everyone means the same thing when stating measurements.

The seven base scientific units are:

1. Mass: Kilogram (kg)
2. Length: Meter (m)
3. Time: Second (s)
4. Electric current: Ampere (A)
5. Temperature: Kelvin (K)
6. Luminous: Candela (cd)
7. Amount of substance: Mole (mol)

Prefix

The Prefix is a Greek number inserted before unit signifies multiply or fractions of that unit.

nano (n) = 1/1,000,000,000
micro (µ) = 1/1,000,000
milli (m) = 1/1,000
centi (c) = 1/100
deci (dc) = 1/10
Mono = 1
Deca (da) = 10
Hecta (h) = 100
Kilo (k) = 1,000
Mega (M) = 1,000,000
Giga (G) = 1,000,000,000
Tetra (T) = 1,000,000,000,000

The Greek Alphabet

Form			Name	Latin	
Α	α		alpha	A	a
Β	β		beta	B	b
Γ	γ		gamma	G	g, ng
Δ	δ		delta	D	d
Ε	ε		epsilon	E	e
Ζ	ζ		zeta	Z	z
Η	η		eta	E	e
Θ	θ		theta	Th	th
Ι	ι		iota	I	i
Κ	κ		kappa	K	k, C c
Λ	λ		lambda	L	l
Μ	μ		mu	M	m
Ν	ν		nu	N	n
Ξ	ξ		xi	X	x
Ο	ο		omicron	O	o
Π	π		pi	P	p
Ρ	ρ		rho	Rh	rh, r
Σ	σ	ς	sigma	S	s
Τ	τ		tau	T	t
Υ	υ		upsilon	Y	y, u
Φ	φ		phi	Ph	ph
Χ	χ		chi	Ch	ch
Ψ	ψ		psi	Ps	ps
Ω	ω		omega	O	o

Suffix

Suffix is a unit inserted after numbers signify the unit of this number.

LENGTH
mm – millimeter
cm – centimeter
m – meter
km - kilometer
in – inch
ft – foot

AREA
mm2 – square millimeter
cm2 – square centimeter
m2 – square meter
Ha – hectare

VOLUME
c.c. – cubic centimeter
l – liter
m3 – cubic meter
gal – gallon
ft3 – cubic foot

TIME
hr. – hour
min – minute
sec – second

FLOW RATE
l/s – liter per second
l/hr. – liter per hour
m3/hr. – cubic meter per hour
gpm – gallon per minute

WEIGHT
gr – gram
kg – kilogram
lb – pound

PRESSURE
kg/cm2 - kilogram per square centimeter
psi - pound per square inch
bar – bar
kPa – kilo Pascal

Unit definition

Length (L)

The Meter (**m**) is the scientific unit of length:
The length unit is the distance between two-point measures by straight line between them
1 km = 1,000 m
1 m = 10 dcm = 100 cm = 1,000 mm = 1,000,000 micron.
1 cm = 10 mm = 10,000 micron
1 mm = 1,000 micron

Area (A)

The area unit is two length unit multiply one by each other, mining length unit power 2
1hectare (ha.) = 10,000m^2 = 100,000,000cm^2 = 10,000,000,000mm^2
1m^2 = 10,000cm^2 = 1,000,000mm^2
1cm^2 = 100mm^2

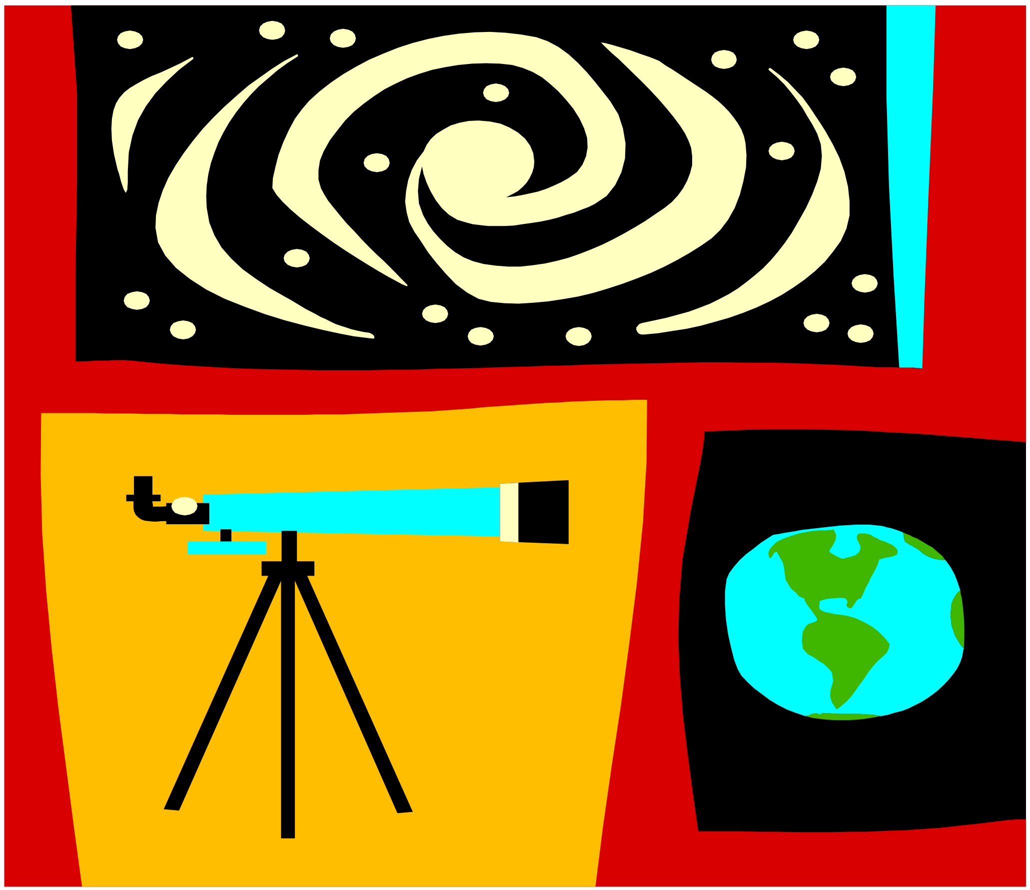
Volume (Vo)

The volume unit is three length unit multiply one by each other, mining length unit power 3
1m^3 (cubic meter) = 1,000dcm^3 (1,000 liter) = 1,000,000cm^3 (1,000,000c.c)
1dcm^3 = 1liter = 1,000cm^3 (1,000c.c) = 1,000,000mm^3.
1cm^3 = 1c.c (cubic centimeter) = 1,000mm^3.

Measurements

The measurements find the size of thing, length (distance), area, volume, angle etc.

Height and width dimension it's also length unit.



Data:

L = Length (1D)
W = Width (1D)
H = Height (1D)
R = Radius (1D)
Ǿ = Diameter (1D)
π = 3.1416
A = Area (2D)
V**O** = Volume (3D)

Formulas:

A circle = π x R^2
A circle = π x Ǿ^2 / 4
A = L x W (or L x H or W x H)
Vo = A x H
Vo = L x W x H

Time (T)

The second (**sec**) is the scientific unit of Time:
The time unit in our world base on the sun system, measure the world motion around the sun, one **year** is the time for earth to complete one cycle around the sun.
One **month** is the time to take our moon to complete one cycle around the world (earth).

1 year = 12 months = 52 weeks = 365 days
1 month = 28 – 31 days (4 weeks plus)
1 week = 7 days
1 day = 24 hours = 1,440 minutes = 86,400 seconds
1 hour = 60 minutes = **3,600 seconds**
1 minute = 60 seconds

Velocity (V)

The velocity unit is a speed of an object in a particular direction.

Data:

L = Length
T = Time
V = Velocity

Formulas:

V = L / T
L = V x T

1km/hr. = 1,000m/hr. = 100,000cm/hr.
1m/hr. = 100cm/hr.
1m/min = 100cm/min
1m/sec = 100cm/sec

Accelerate (a)

The Accelerate unit is velocity unit per time unit

Data:

V = Velocity

T = Time

a = accelerate

Formulas:

a = V / T

V = a x T

1m/sec^2 =100cm/sec^2

Force:

Newton (N) is the scientific unit of force

One Newton of force causes a mass of 100 gr to move with an acceleration of 1 m/sec^2

Data:

m = mass (gr)

a = accelerate (m/sec^2)

F = Force (N)

Formulas:

F = m x a

The force of gravity:

Gravity keeps our feet firmly on the ground. It is a force of attraction between all bodies of matter.
All objects experience and exert a certain amount of gravity, depending on their mass.

According to Newton's law, to find the force of gravity between two objects, you multiply their masses and divide the result by the square of the distance between them.

Weight and Mass (W), (m)

The Kilogram (kg) is the scientific unit of mass: One kg equal to ten Newton

Weight is the force exerted on an object by gravity.
An object's mass is the same on the moon as it is on Earth, but it weighs less, because the moon's surface gravity is weaker.

1 ton = 1,000 kg = 1,000,000 gr
1 kg = 1,000 gr
1 N = 100 gr

Specific Gravity (γ)

The specific gravity of material defines the weight of one volume unit from the material.

Data:

W = weight

Vo = Volume

γ (gamma) = specific gravity

Formulas:

$\gamma = W / Vo$

$W = \gamma \times Vo = \gamma \times A \times H$

The specific gravity of water is:

γ (Water) = 1 ton/m^3 = 1 kg/liter = 1 gr/cm^3

Specific Gravity: gr/cm^3

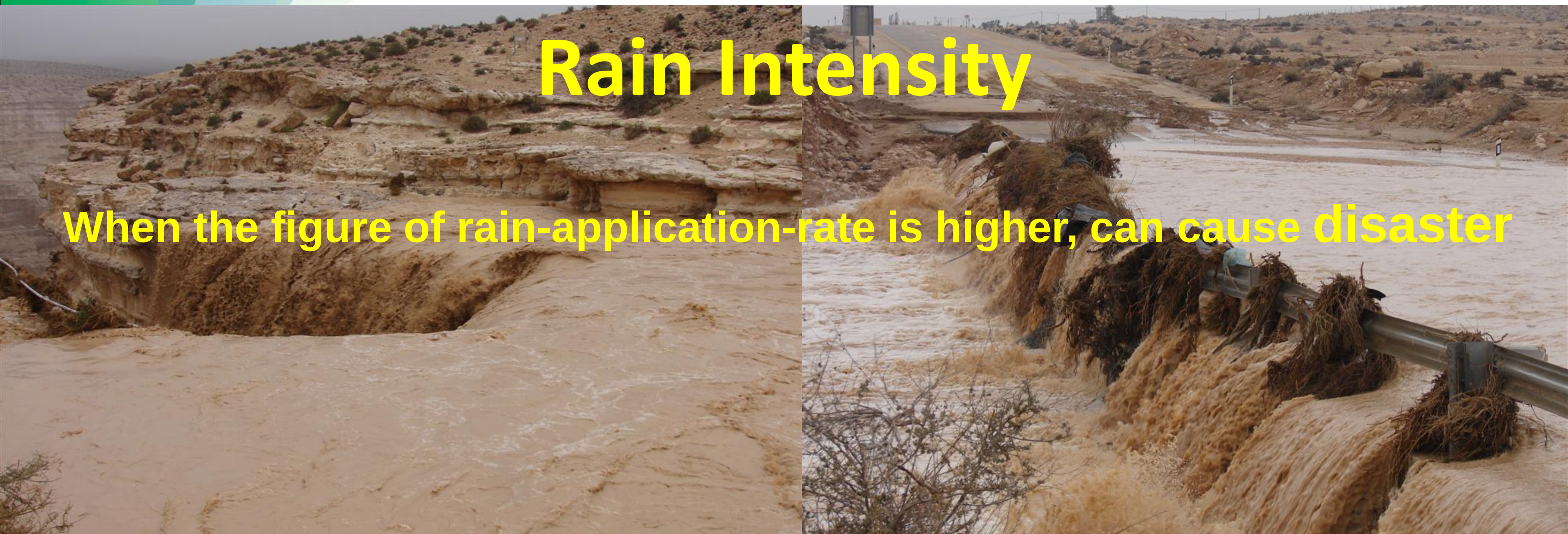
1. Water = 1.0
2. Dry soil = 1.4 – 1.7
3. Compost = 1.3
4. Gravel = 1.4 – 1.7
5. Concrete = 2.2 – 2.6
6. Wood = 0.7 – 0.9
7. Asphalt = 1.1
8. Limestone = 2.7
9. Volcanic rock = 2.9
10. Sand = 1.8
11. Asbestos = 2.4
12. Iron Steel = 7.8
13. Cast Iron = 7.3
14. Aluminum = 2.7
15. Copper = 8.9
16. Polyethylene = 0.9
17. P.V.C. = 1.5
18. Nylon = 1.05
19. Teflon = 2.1

Crop water use or plant/tree daily-water-consumption depends on many factors

Commonly factors use in open-field, plantation, orchard etc.,

- Precipitation/day
- Evaporation/day
- Crop-coefficient

Rain Intensity



When the figure of rain-application-rate is higher, can cause disaster

Rainfall measure by length unit (mm, inch) per time unit (hour, day month etc.)
The combination of the 2 units is: Rain application-rate (Length/Time) (Volume/Time/Area)

1mm/hr. of rainfall = 1liter/hr./m^2
1mm/hr. of rainfall = 10m^3/hr./ha.
1mm/hr. of rainfall = 1.6m^3/hr./Rai

Rainfall data: yearly, monthly, daily rainfall (if possible hr./day)
Standard soil can observe up to 10mm/hr. rain application-rate

Soil classification physical definition

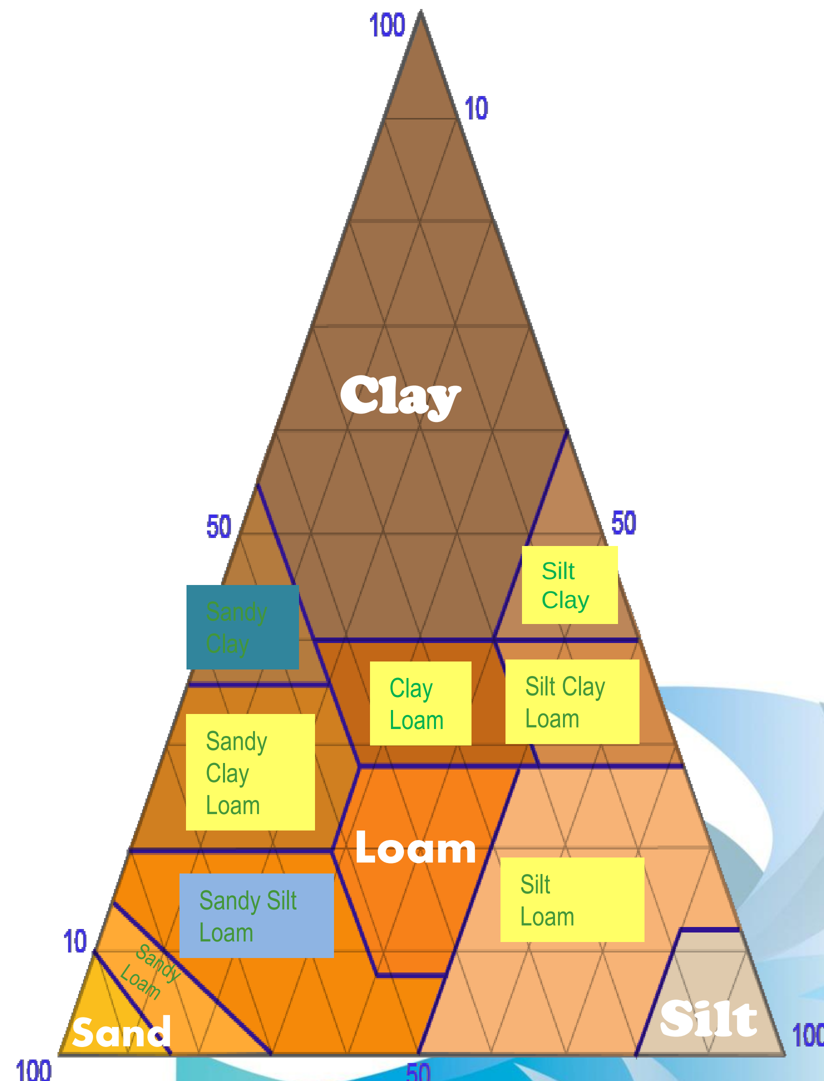
Sand: Particle size range: 0.1-1.0mm
High percolation, good for germination

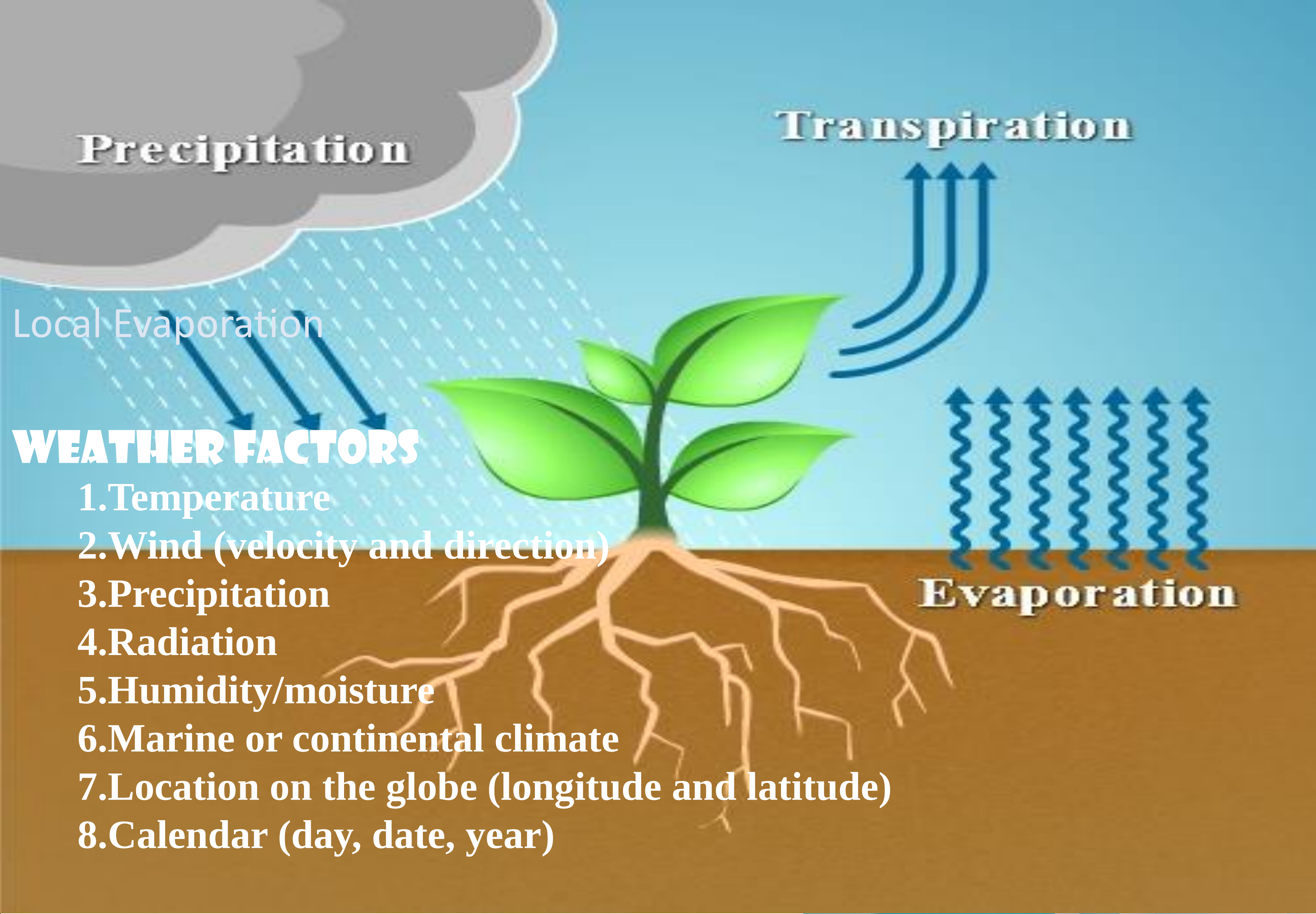
Loam: Sand, silt and clay in proportion mix.

Silt: Particle size range: 10-100 microns

Clay: Particle size range: 1-10 microns
Expand with water and shrink when dry

1mm = 1000micron





Local Evaporation

Weather Factors

1. Temperature
2. Wind (velocity and direction)
3. Precipitation
4. Radiation
5. Humidity/moisture
6. Marine or continental climate
7. Location on the globe (longitude and latitude)
8. Calendar (day, date, year)

Evaporation Pan: class-A

Evaporation we measure by mm per day

1mm/day = 1liter/m^2/day = 10m^3/ha/day

➢ **E.T.** "Evapotranspiration"

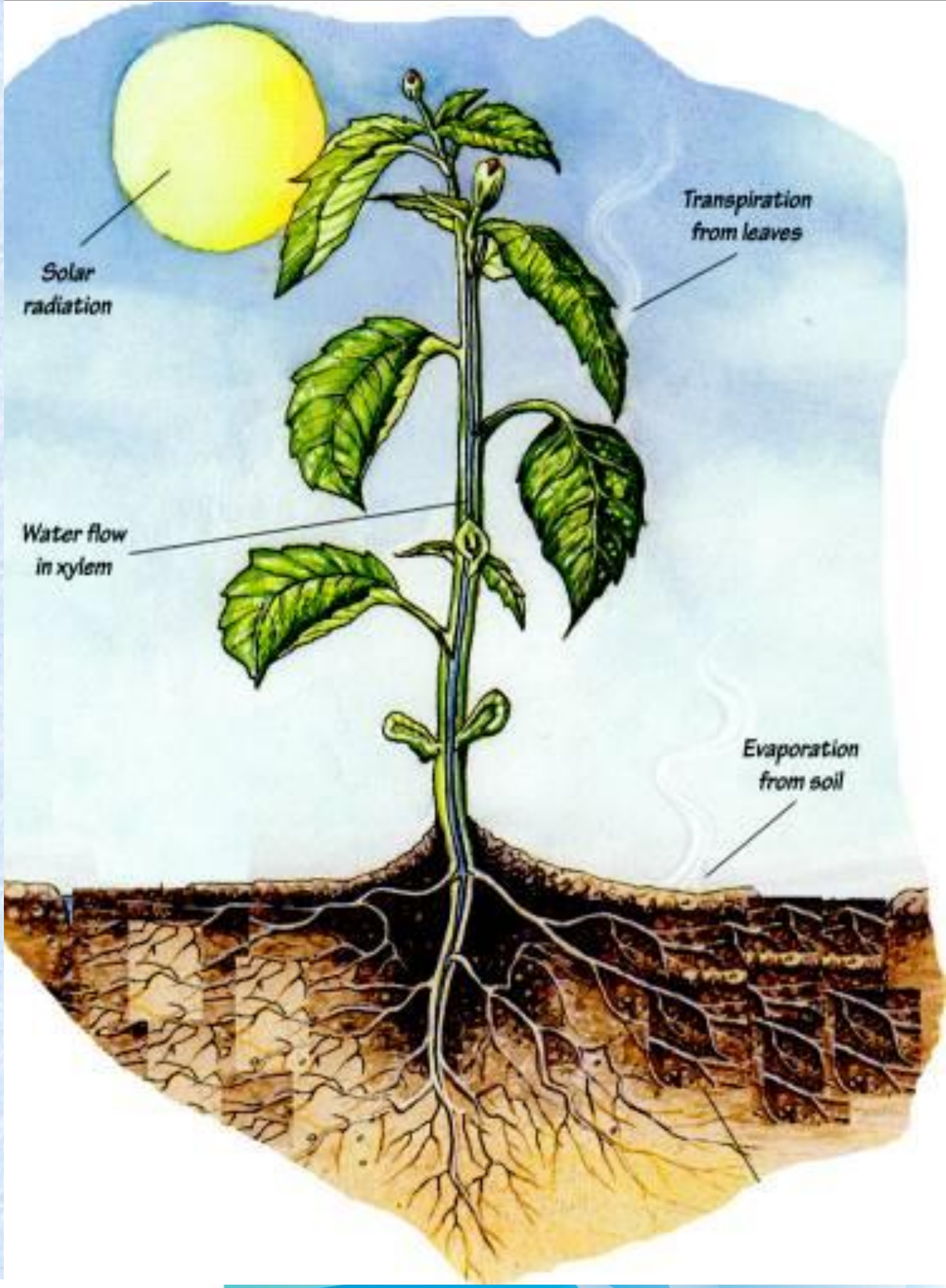
"Evaporation" from soil with "Transpiration" from plants, to describe the total water loss from a crop to the air.

Evaporation, water evaporates from any moist surface to the air as long as the air is not saturated.

Water surfaces in contact with the air, like lakes, moist soils, and even plant-leaves all evaporate water.

Transpiration is evaporation from plants, plant leaves evaporate water through tiny, adjustable-openings called **stomata's** that are scattered across leaf surfaces.

Water moves from the moist soil into plant roots, through the plant, and finally out through leaf stomata's.



Evapotranspiration is often called Crop-water-use.

Early in the season, when plants are small, most water loss is from soil evaporation.

When plants are large, most is from plant transpiration.

Crop-water-use determines how much water is needed by rain or irrigation

Smart irrigation management begins with knowing crop water use.

The goal is to give the plants exactly what they need when they need it

Too little irrigation: reduce crop yield

Less irrigation, than maximum crop water demand, lowers operating costs, but it also reduce yields, leading to losses US$1.5 per hectare for each 1mm of irrigation “save” (seasonally irrigation).

Approximately US$1 per hectare for each 1mm irrigation excess (seasonally irrigation).

Too much irrigation: Waste water, energy, nutrients and unnecessarily deplete the aquifer.

Summary:
Water has three functions in plants:

- ✓ **Cooling-evaporation**: cools leaves
- ✓ **Nutrient transport**: dissolved nutrients move through plants along with water
- ✓ **Hydration**: water in plant tissues keeps stems, leaves, and fruit firm. (approximately 1%)

Water, is more than 90 percent of the weight of most crops.

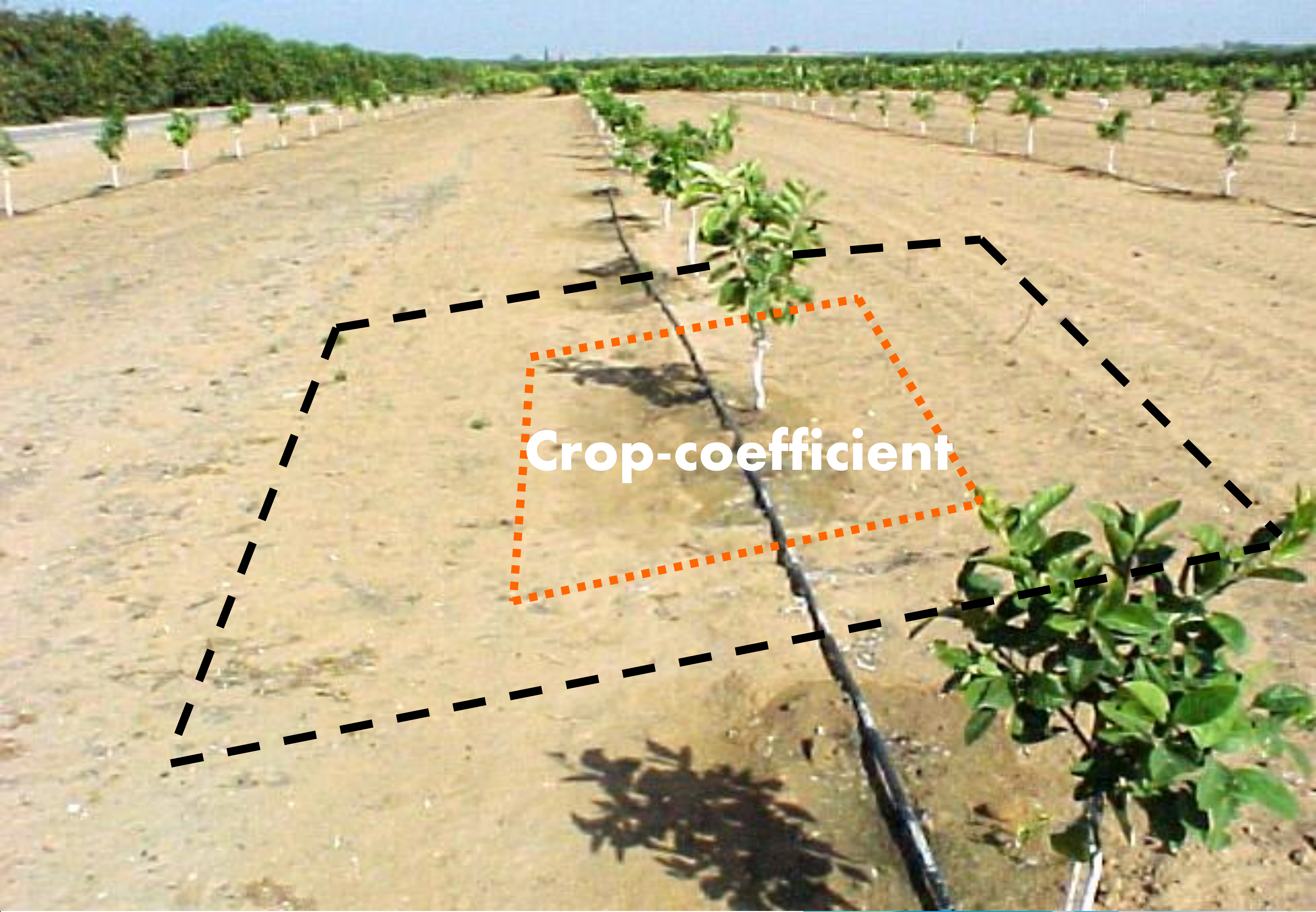
This shows how much water plants use for other purposes

Crop-coefficient depend on:

1. Tree canopy cover-area
2. Type of the plant/tree
3. Plant maturity

3.1. Calendar age (day, date, year)
3.2. Physiological age of the plant/tree
3.2. Plant leaves dry-matter (105C°)
3.3. Size of the plant (or total height)
3.4. Flower and fruit amount

Different types and varieties of plants are capable of moving water at different rates.
They also have different maximum rates of E.T. demand.
Even the same crop may have very different water-use rates depending on the stage of growth or the relative amount of canopy cover.


Crop-coefficient

Crop-coefficient in orchard/plantation:

- Measure the tree area: row distance x tree distance on the row
- Measure the tree shaded soil
- Find the % of the tree shaded area from the tree planting area

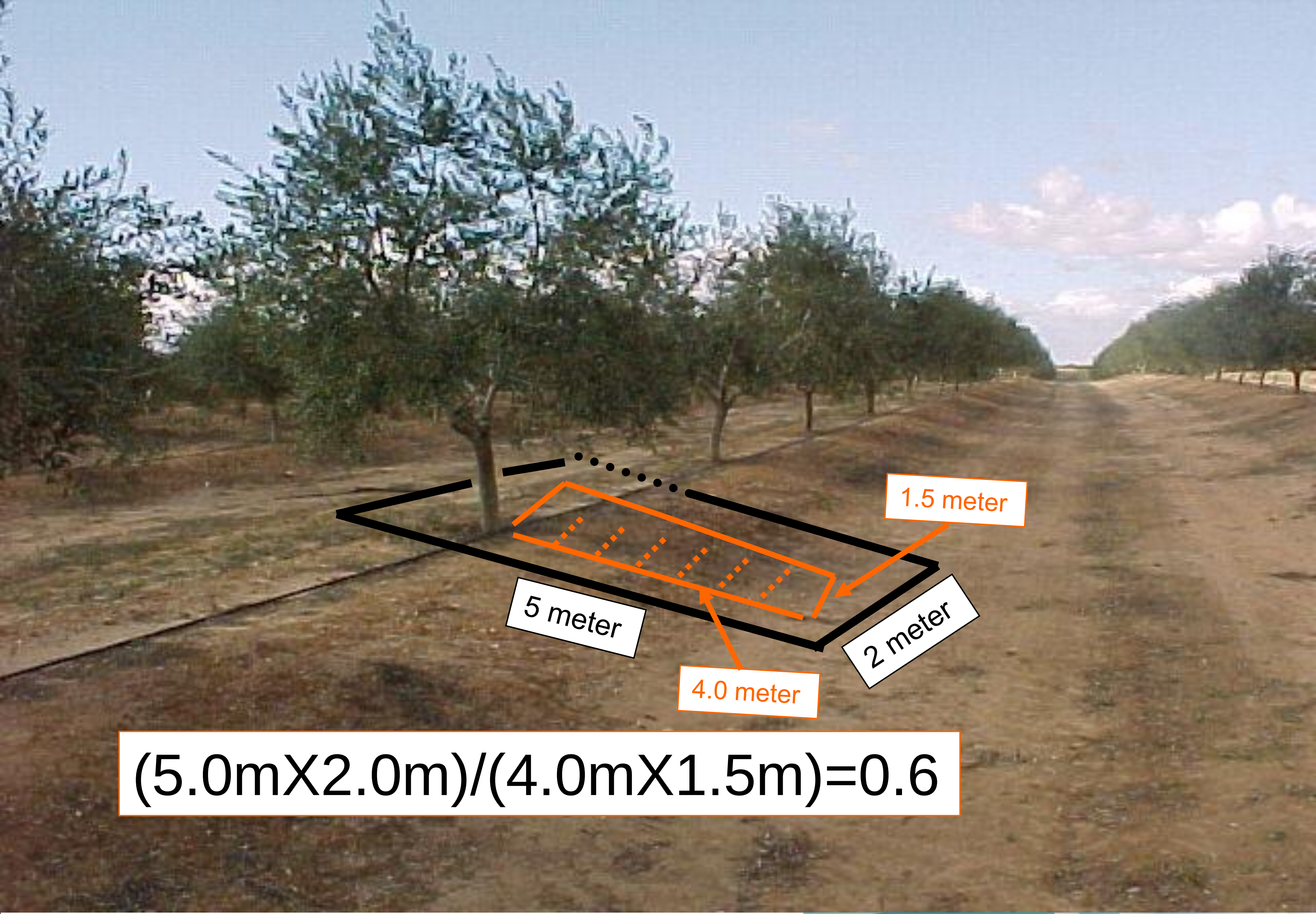
An example:

Tree planting area: 10m^2 (5.0m row distance x 2.0m tree distance on the row)

Tree average shaded area: 6m^2 (4.0m x1.5m)

Coefficient crop factor: 60% (6m^2/10m^2=0.60)

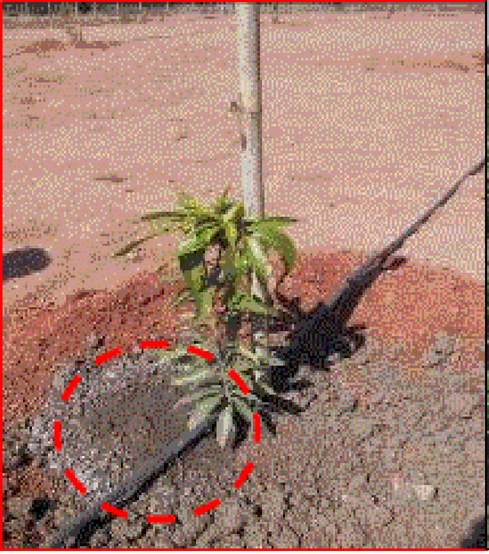
- During changing seasons, the crop-coefficient factor will change!!!
- In practice, other factors should be included: Crop Load, Stress Factor etc.,

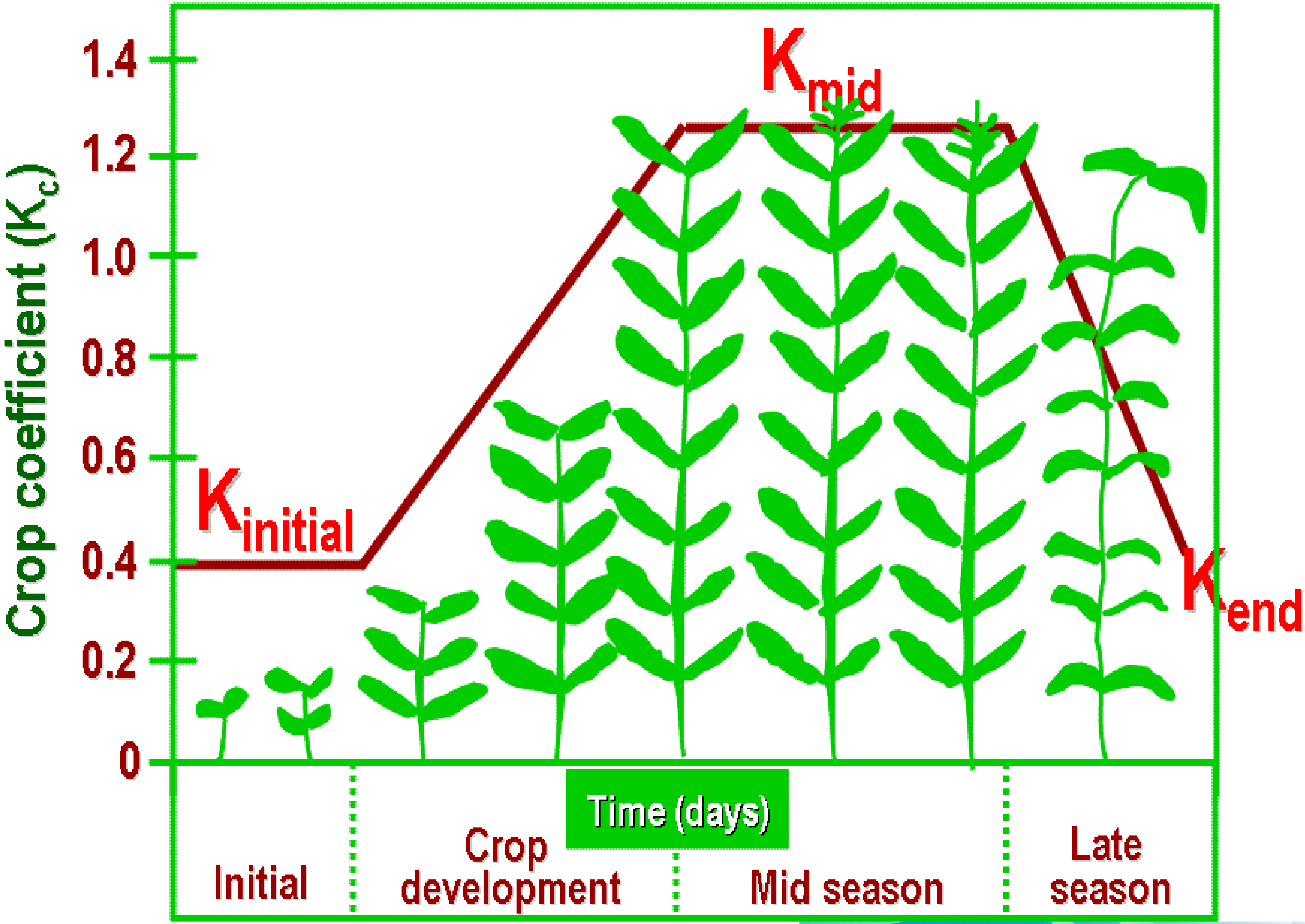

1.5 meter
5 meter
2 meter
4.0 meter
(5.0mX2.0m)/(4.0mX1.5m)=0.6


Furrow system


Micro-sprinkler system

Drip-system




1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Crop coefficient (K_c)
$K_{initial}$
K_{mid}
K_{end}
Time (days)
Initial
Crop development
Mid season
Late season

In practical irrigation we need to know…

1. When to irrigate (or not irrigate)
2. Plant-water-consumption per day

2.1. How many application per day

2.2. How much to irrigate per application

1. Plant condition, Tensiometer etc.,
2. Evaporation (mm/day) x Crop-coefficient

- Technical irrigation
- Flushing irrigation due to salinity

Summary

1. Evapotranspiration, or E.T., is a term that describes crop evaporation from both plants and soils, another term for E.T. is crop water use.

2. Plants need water to meet their E.T. requirements, if E.T. demand is not met, crop yield suffers. E.T. is an important factor in determining when and how much to irrigate.

3. Weather conditions determine how fast water evaporates from a crop.
Different crops may have a different E.T. for the same weather conditions.

4. E.T. can be determined on a daily basis to help producers, make irrigation decisions.

Calculating crop-water-consumption

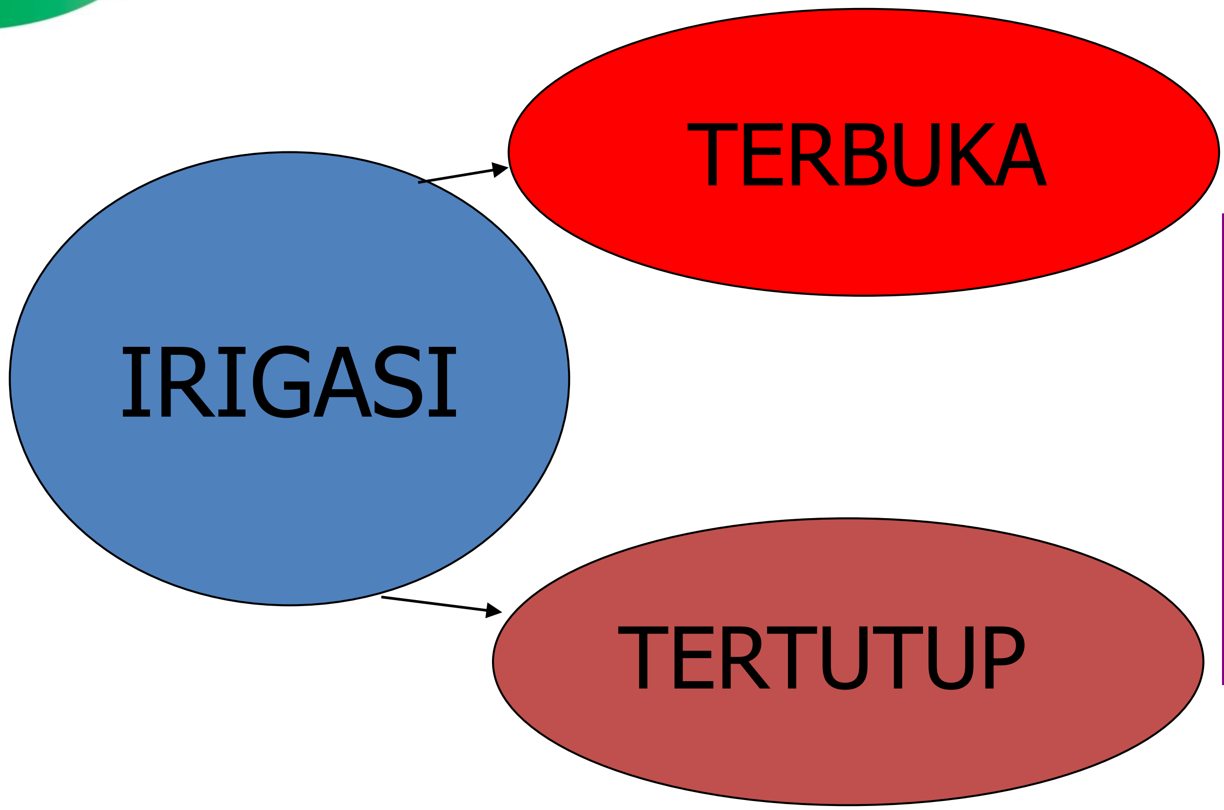
Plantation and Field-crop

An example-I:

- ❖ Crop: Banana-plantation
- ❖ Evaporation: 6mm/day
- ❖ Crop-coefficient: 1.2
- ➢ Banana water consumption: **7.2mm/day** (6mm/day x 1.2)

An example-II:

- ❖ Crop: Cotton-field
- ❖ Evaporation: 7mm/day
- ❖ Crop-coefficient: 0.8
- ➢ Cotton water consumption: **5.6mm/day** (7mm/day x 0.8)



KEUNTUNGAN
- EFISIEN AIR
- TEPAT SASARAN
- HEMAT WAKTU
- HEMAT ENERGI
- INFESTASI SESUAI HASIL

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IRIGASI TERTUTUP

- SPRINKLER & MICKRO SPRINKLER
- SPRAY
- TETES / DRIP IRIGATION

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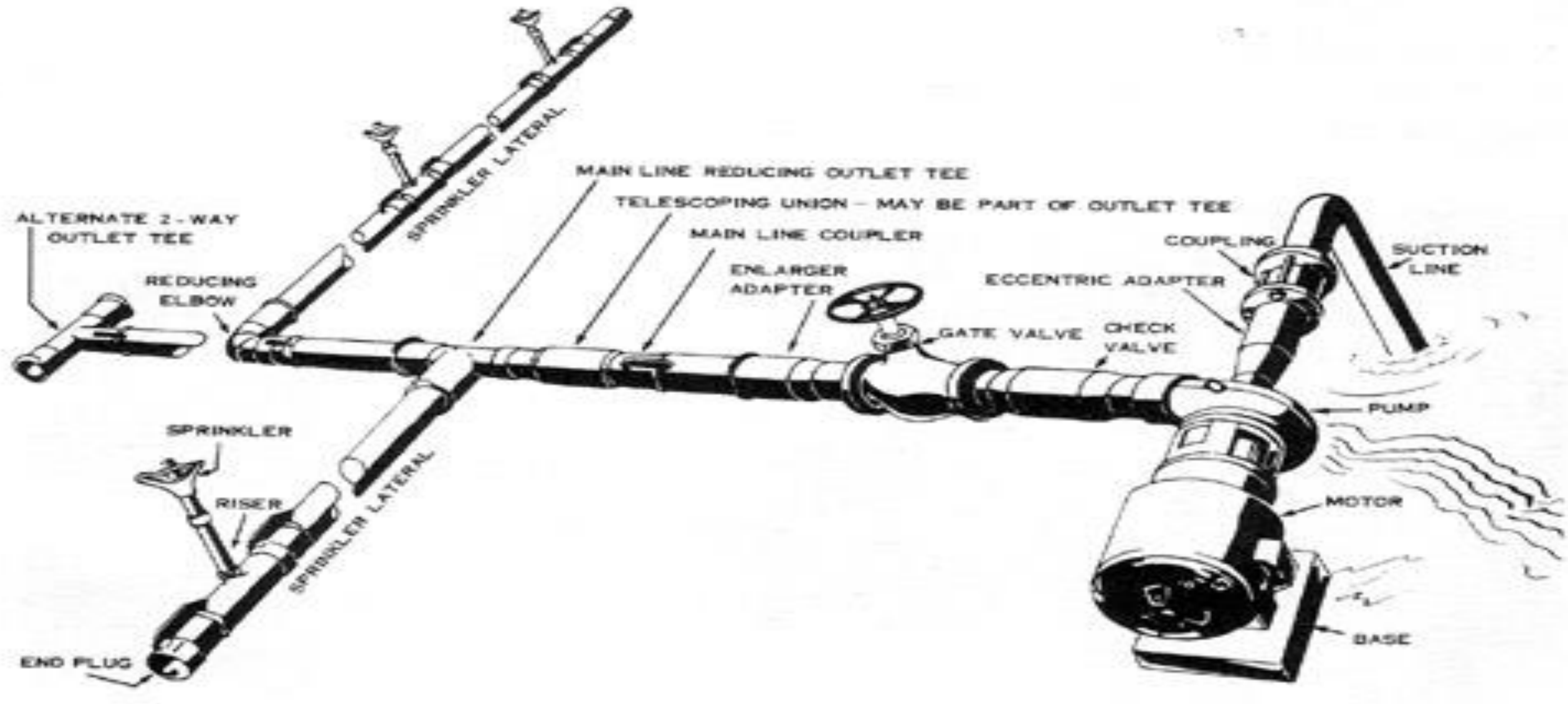
SPRINKLER & MICRO SPRINKLER

KOMPONEN SISTEM IRIGASI SPRINKLER



SPRINKLER

- Suatu alat yang mampu menyemprotkan air dalam jumlah dan radius penyiraman pada tekanan tertentu, dimana sprinkler ini bisa berupa sprinkler yang berputar, tetap, nozzle, maupun pipa yang berlubang.

- Untuk menjamin keseragaman penyiraman air maka jarak antar sprinkler dan pipa lateral harus overlap pada diameter penyiramannya, hal ini untuk menanggulangi pengaruh angin.

SPASI SPRINKLER

Pada kondisi normal pemasangan sprinkler dapat mengikuti kondisi umum sbb :

Kondisi angin :	Spasi Lateral :
- tidak ada angin	- 65% dari disain diameter
- kecepatan angin < 8,1 km/hour	- 60% dari disain diameter
- kecepatan angin 8,1 -16,1 km/hour	- 50% dari disain diameter
- kecepatan angin > 16,1 km/hour	- 22-30% dari disain diameter

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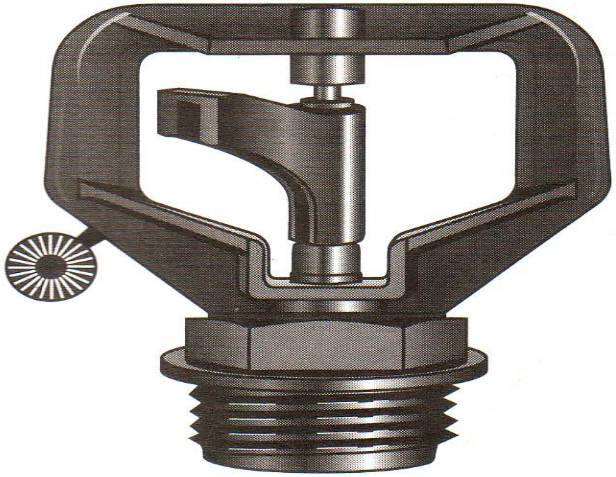
SPRINKLER

TYPE SPRINKLER BERDASAR TEKANAN KERJANYA

- **Rendah : 0.3 – 2 kg/cm^2 (bar)**

  Diameter pembasahan kecil, presitipasi relatif tinggi, butiran air agak kasar.

  Contoh : tanaman citrus, under tree orc



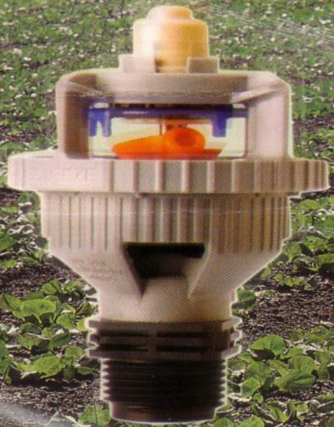
SPRINKLER

NELSON IRRIGATION CORPORATION

TYPE SPRINKLER BERDASAR TEKANAN KERJANYA

- **Sedang : 2 – 4 kg/cm^2 (bar)**

  Diameter pembasahan 18 – 40 mtr, daerah pembahasan lebih luas, butiran air lebih halus, distribusi air umumnya lebih bagus, presitipasinya 2,5 mm/hr, contoh : seluruh macam tanaman dan tipe tanah.



SPRINKLER

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TYPE SPRINKLER BERDASAR TEKANAN KERJANYA

- **Tinggi : 4,1 – 6,9 kg/cm² (bar)**

  Diameter pembasahan 18 – 40 mtr, presitipasi rate sekitar 8 mm/hr.

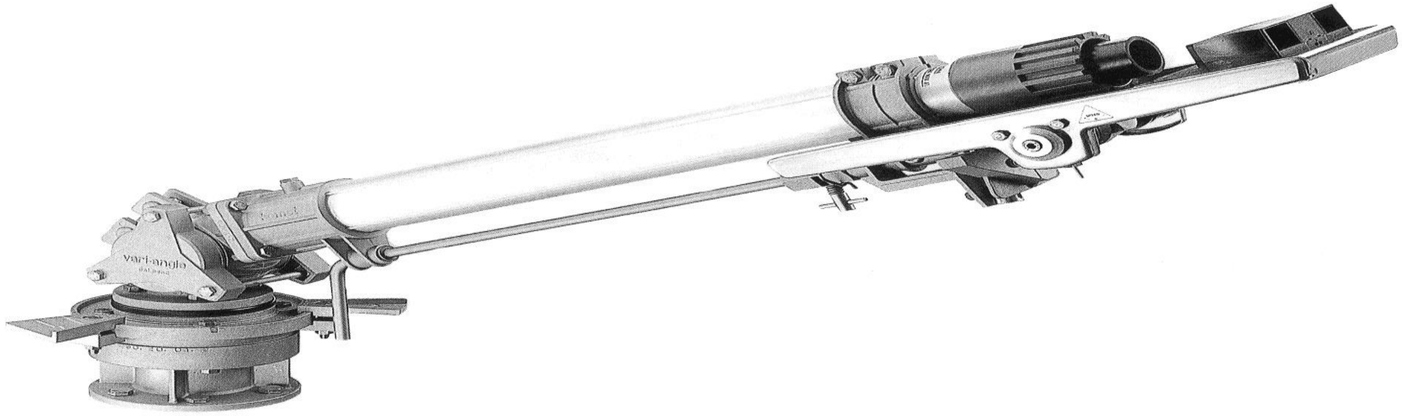
  Contoh : pembibitan kelapa sawit.

SPRINKLER

TYPE SPRINKLER BERDASAR TEKANAN KERJANYA

- **Besar : diatas 5,5 kg/cm^2 (bar) dengan kapasitas air 350 – 2.200 ltr/min. Diameter pembasahan +/- 100 mtr, presitipasi rate sekitar 10 mm/hr.**

Contoh : tebu, pisang, atau tanaman tropical dengan jarak tanam rapat.



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APLIKASI FIELD PORTABLE GUN SYSTEM









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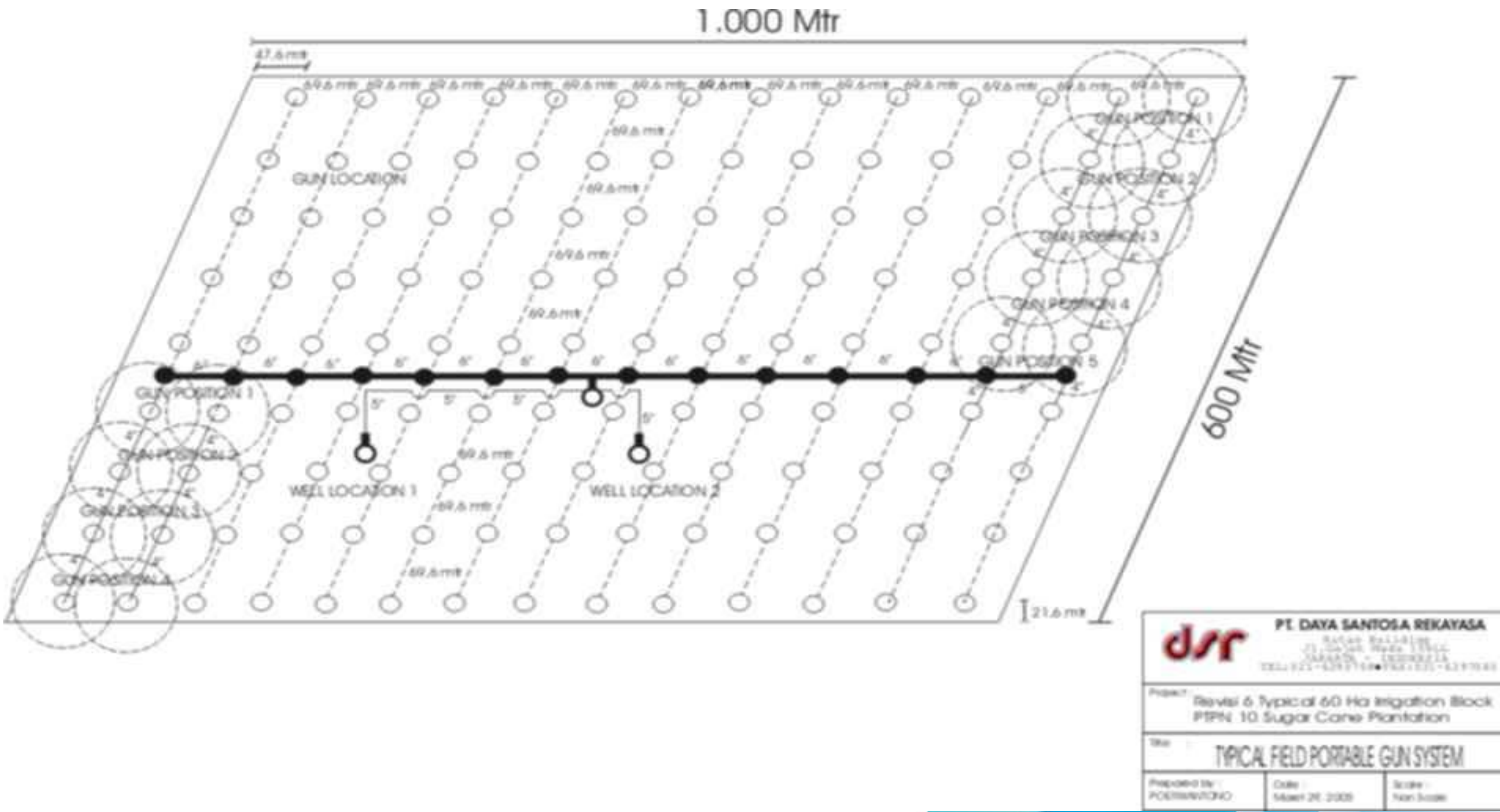
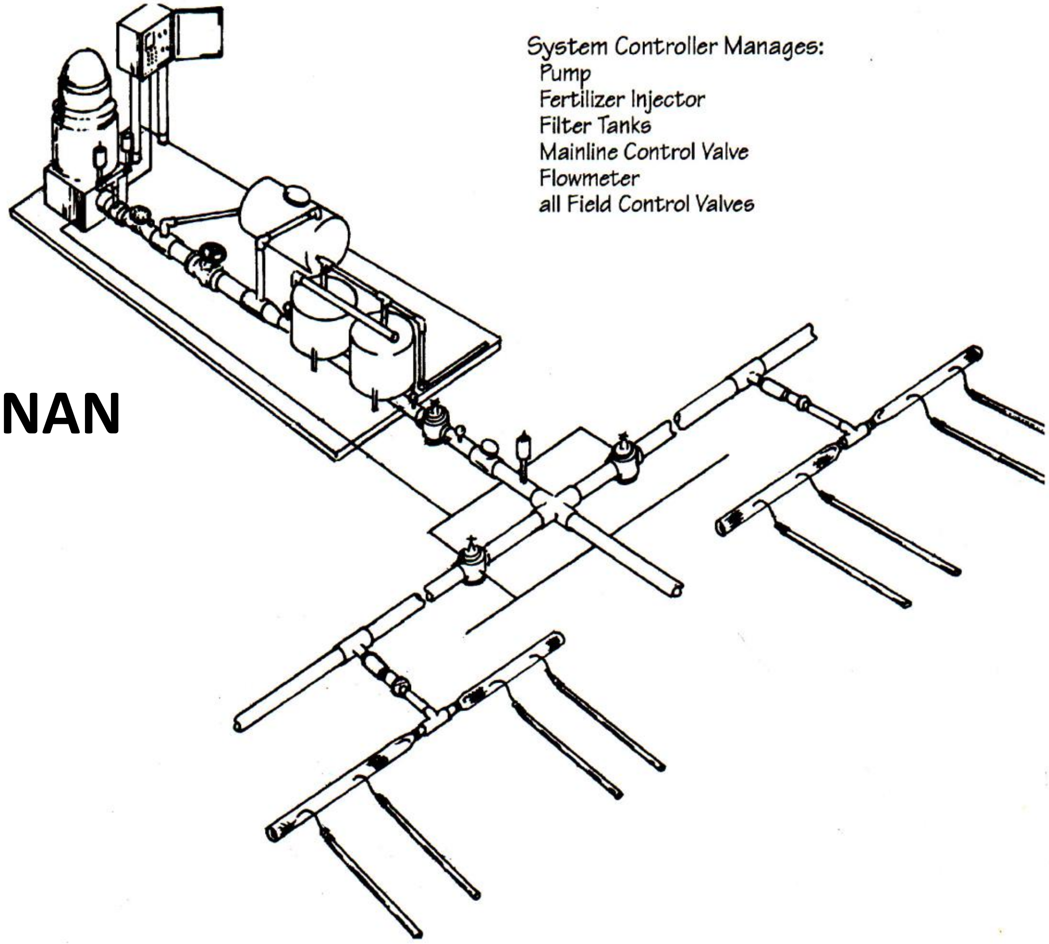
APLIKASI FIELD PORTABLE GUN SYSTEM



KOMPONEN SISTEM IRIGASI SPRAY

- EMITTER
- PIPA LATERAL
- PIPA UTAMA
- UNIT POMPA / BANGUNAN UTAMA



Emitter

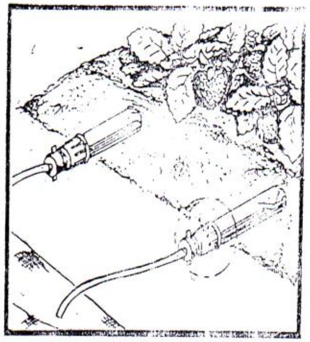
- **Sprayer**

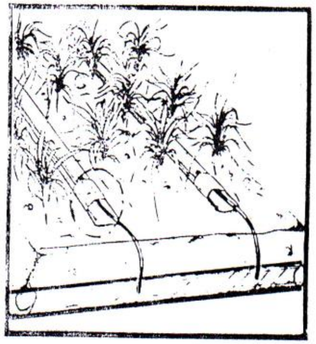
  Contoh : Spray Jet, XL Jet pada tanaman produksi buah-buahan, Mist pada perkecambahan tanaman dan pengaturan kelembaban rumah kaca, juga sebagai nozzle pada sistim aeroponik.

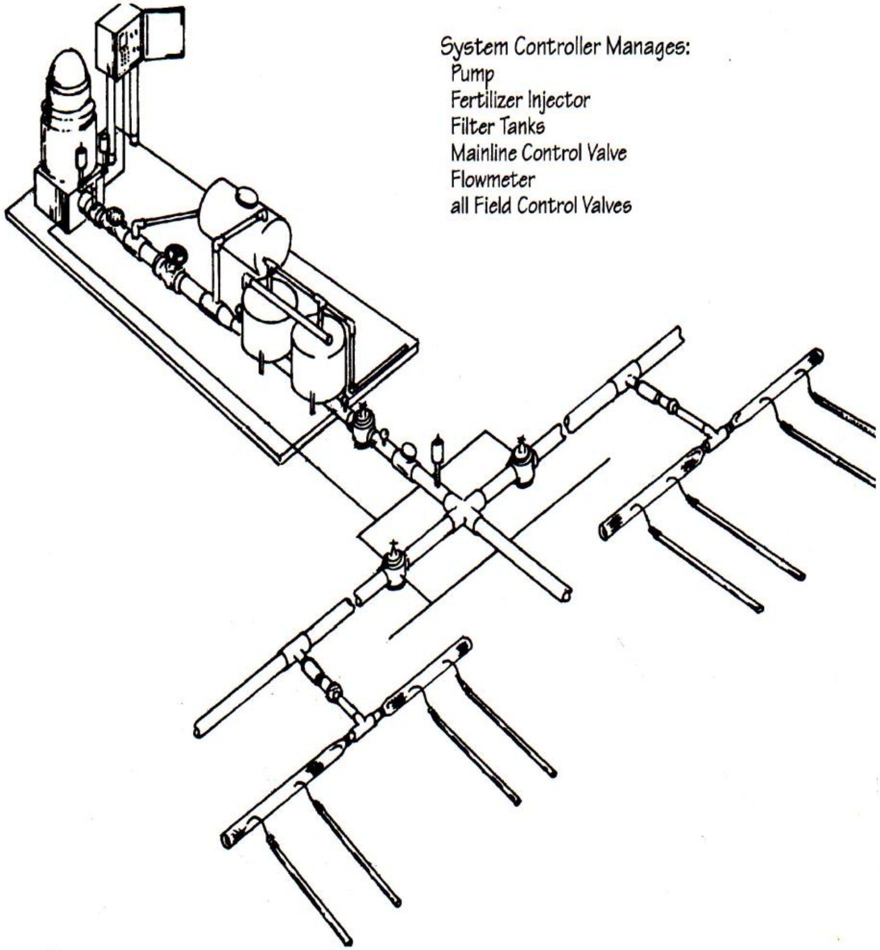
IRIGASI TETES

KOMPONEN SISTEM IRIGASI TETES

- **EMITTER**
- **PIPA LATERAL**
- **PIPA UTAMA**
- **UNIT POMPA / BANGUNAN UTAMA**







TETES

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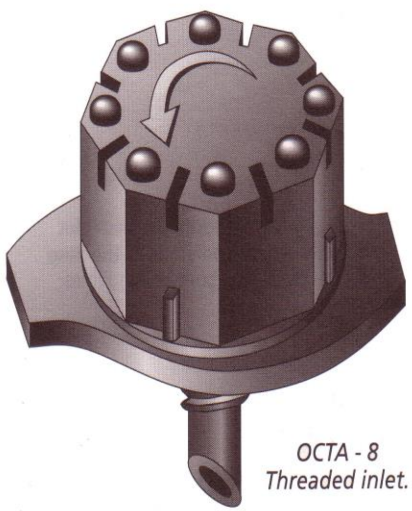
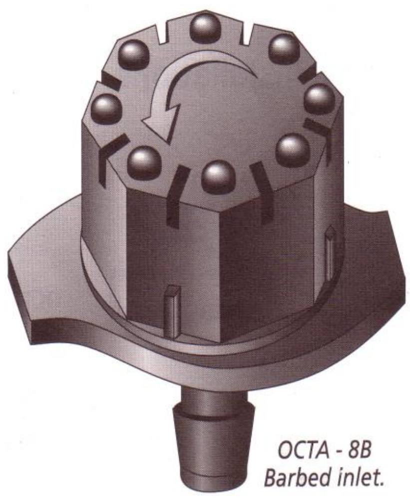
- **Point Source Emitter (Emitter Pembasahan Titik).**

Contoh : Dripper pada tanaman kakao, jeruk, mangga, dan regulating stick pada tanaman paprika, melon, tomat di dalam Green House.





TETES

- **Line Source Emitter (Emitter Pembasahan Garis).**

Contoh : Drip Pipe, Drip Tape, In Line Dripper pada tanaman di on farm (cabe, tomat, strawberry, semangka, melon, sayur-sayuran, bunga potong, dsb).

TETES

Tipe Pemakaian Emitter

- **Irigasi Permukaan (*Surface Irrigation System*).**

  Dimana Pipa Lateral dan Emitter terletak di permukaan tanah dan air di teteskan di permukaan tanah. Contoh pemakaian : pada tanaman buah-buahan, bunga potong, baik menggunakan dripper maupun sprayer.

- **Irigasi Dibawah Permukaan (Sub Surface Irrigation Systems).**

  Dimana Pipa Lateral dan Emitter terletak di bawah tanah dan air irigasi di teteskan di dalam tanah pada zone perakaran. Contoh pemakaian : pada tanaman strawberry, tebu, dll.

TETES

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Irigasi Permukaan (*Surface Irrigation System*)

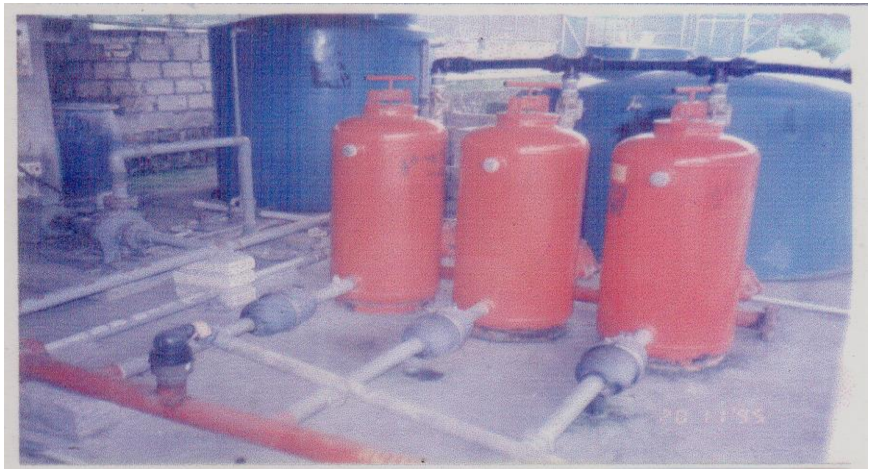
TETES

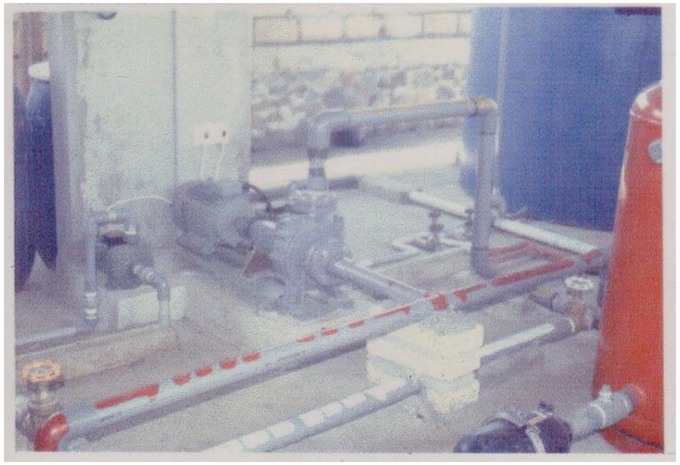
PT DAYA SANTOSA REKAYASA
A Complete Irrigation Solution

Irigasi Dibawah Permukaan (*Sub Surface Irrigation System*)

PT DAYA SANTOSA REKAYASA
A Complete Irrigation Solution

APLIKASI IRIGASI TETES



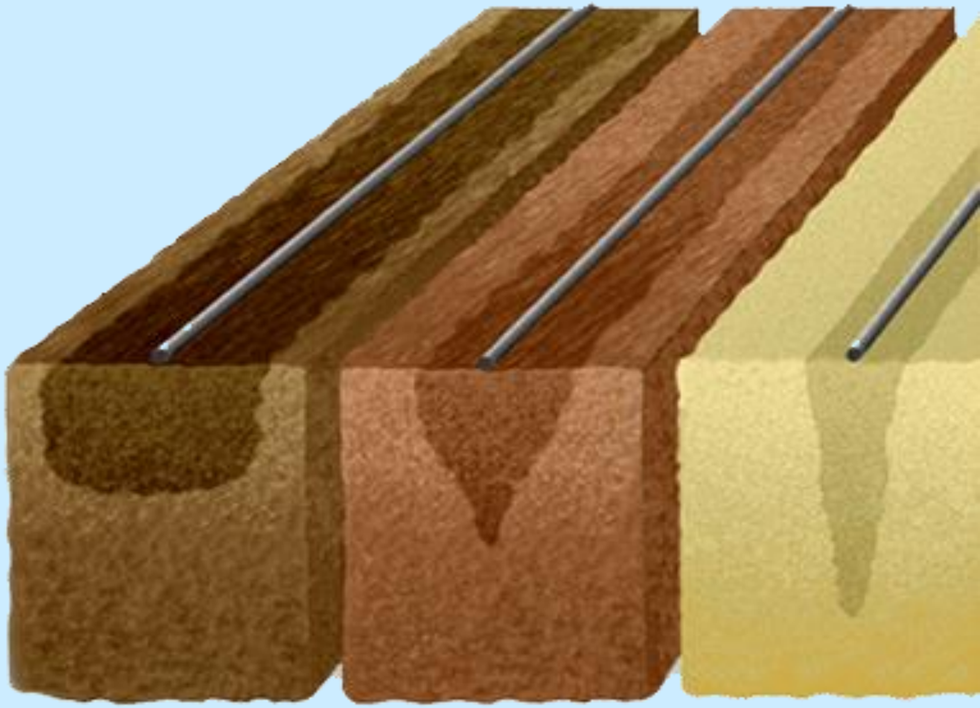


•Wet soil under drip irrigation

■ Shape of the wetted zone depends on the physical soil characteristic.

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

■In heavy soil, water distribution is wider and shallow.



Distance between inline drippers

- Heavy soil recommended distance:
- 0.50m 1.00m

- Medium soil recommended distance:
  0.40m to 0.75m

- Light soil recommended distance:
  0.20m to 0.50m

* GH soilless growing media 0.20m distance between drippers

Calculating emitter irrigation-rate

Emitter: dripper, mist-sprayer, sprinkler, irrigation-hose, big-gun sprinkler etc.,
Emitter flow-rate/Emitter area = Irrigation-rate (lit/hr./m^2) or (mm/hr.)

Data:

- Emitter flow-rate: **lit/hr.**
- Emitter area: **m^2** (W x L)
  - W = distance between emitter-line
  - L = distance between emitters on the emitter-line

An example:

Emitter flow-rate = 256lit/hr.
Emitter area = 64m^2 (8m^2 x 8m^2)

Irrigation-rate = **4mm/hr.** (256lit/hr. divide to 64m^2 = 4lit/hr./m^2)

Calculating Operation (Shift) Duration

Water-requirement divide Irrigation-rate = Operation duration (hr.)

Data:

- ❑ Water requirement: **mm/day** (or **lit/tree/day**)
- ❑ Irrigation-rate: **mm/hr.**

An example:

Water-requirement: (Evaporation/day x Plant-factor) = 8mm/day
Irrigation Rate = 4mm/hr.
Operation duration = **2hr.** (8mm/day divide 4mm/hr.)

Calculating number of operations/shifts per day

Total available hours/day divide one operation-duration =
= Number (amount) of operation/day

An example:

Total available hours/day = 16hr.
1 operation-duration = 2hr.
Number of operations/day = **8 operations/day** (16hr./2hr.)

Base on 7 days Irrigation per week

Thank You