

A tall waterfall cascading down a rocky cliff in a dense forest. The water is white and frothy as it falls, surrounded by lush green trees and foliage. The scene is captured from a low angle, looking up at the waterfall.

**Improvement of Agricultural Water  
Management – Step Toward Environmentally  
Friendly agriculture in prespa**

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**Faculty for Agricultural Sciences and Food-Skopje**

**Ohrid, June 2009**

**FACT**

**AGRICULTURE IS THE BIGGEST DIFUSE  
SOURCE OF POLUTION OF THE  
ENVIRONMENT**

**FACT**

**HUMAN POPULATION PERMANENTLY  
INCREASE**

# **FACT**

**FOSSIL ENERGY IS DECREASING AND BECOMING MORE EXPENSIVE. GREEN PLANT CELL IS STILL BEST WAY TO TRANSFORM ENERGY OF THE SUN IN CHEMICAL ENERGY**

**FACT**

**AGRICULTURAL LAND AND FRESH WATER ARE  
VERY LIMITED RESOURCES AND  
PERMANENTLY DECREASE**

**FACT**

**AGRICULTURE SHOULD PRODUCE MORE FOOD  
MORE RAW MATERIALS FOR THE INDUSTRY  
EVEN MORE ENERGY FOR NEEDS OF THE  
HUMANITY**

**FACT**

**DESPITE ALL AGRICULTURE IS BUSSINESS  
AND MANY FAMILIES DEPEND ON INCOME  
FROM AGRICULTURAL ACTIVITIES**

# QUESTION

**IS IT POSSIBLE TO PRODUCE MORE WITH LESS  
RESOURCES AND IN SAME TIME TO PROTECT  
ENVIRONMENT?**



**QUESTION**

**CAN AGRICULTURE PROTECT ENVIRONMENT?**

# ANSWER

- **AGRICULTURE IS PROCESS OF CHANGING OF NATURAL ECOSYSTEM BY ENERGY INPUTS IN AGROECOSYSTEM.**
- **AGRICULTURE CAN PRODUCE MORE WITH LIMITED RESOURCES**
- **AGRICULTURIST HAVE TO CHANGE THEIR WAY OF THINKING**

# **NEW APPROACH**

**WE SHOULD STOP TO TREAT LAND AND WATER AS SOMETHING WE GOT FROM OUR PARENTS. IT IS SOMETHING WE BORROW FROM OUR CHILDREN. WE SHOULD GIVE THEM BACK WITH SAME OR BETTER QUALITY.**

# **ENVIRONMENTALLY FRIENDLY AGRICULTURE WHAT IS IT?**

**ALL AGRICULTURAL PRACTICES THAT  
REDUCE “POLLUTION” FROM AGRICULTURAL  
SOURCES AND PROTECT LAND, WATER AND  
OTHER NATURAL RESOURCES**

# ENVIRONMENTALLY FRIENDLY TECHNIQUES - EXAMPLES

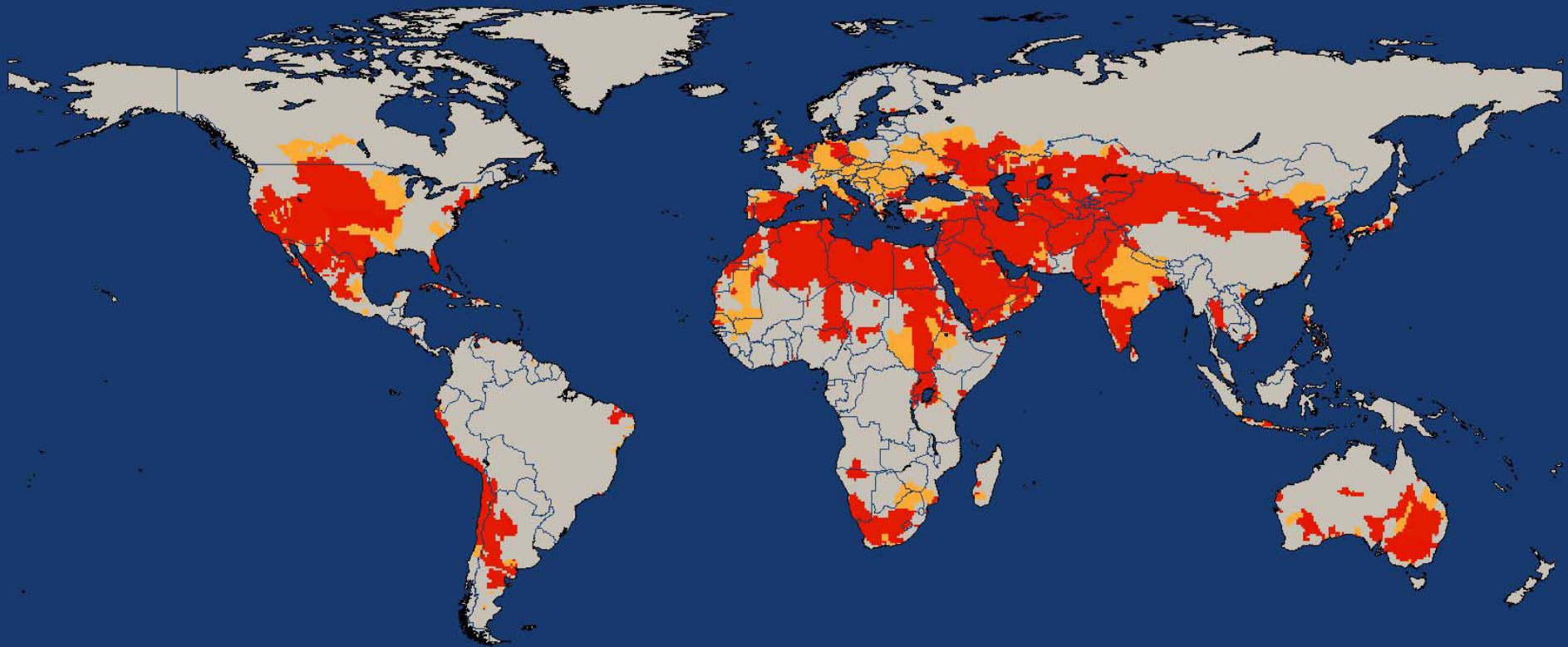
- **ORGANIC FARMING**
- **CONSERVATION AGRICULTURE**
- **INTEGRATED PLANT PROTECTION**
- **WATER SAVING IRRIGATION TECHNIQUES**
- **SLOW RELIESE FERTILIZERS**
- **FERTIGATION**
- **AND MANY OTHERS**

# Water resources on earth



| Resource            | km <sup>3</sup> | %     |
|---------------------|-----------------|-------|
| total               | 1.383.844.700   | 100,0 |
| Salt water          | 1.350.505.000   | 97,6  |
| Fresh water         | 33.339.700      | 2,4   |
| Pola ice & Glaciers | 26.00.000       | 1,879 |
| Ground water        | 7.000.000       | 0,506 |
| Surface water       | 126.700         | 0,009 |
| Soil moisture       | 150.000         | 0,011 |
| Water in bio mass   | 50.000          | 0,003 |
| Water in atmosphere | 13.000          | 0,001 |

# Water stress



Criticality : Withdrawal-to-Availability Ratio

Low Stress

Mid Stress

Severe Stress



0

0.2

0.4

(c) Center for Environmental  
System Research  
University of Kassel  
March 2000 (TH)

# Water use

Human needs

Recreation

Transport

Hydro power

Industry

Agriculture





Water  
use

Human needs

Recreation

Transport

Hydro power

Industry

Agriculture



Water  
use

Human needs

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Transport

Hydro power

Industry

Agriculture



Water  
use

Human needs

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Transport

Hydro power

Industry

Agriculture



Hydropower produces 10% of the nation's electricity.

**Water  
use**

**Human needs**

**Recreation**

**Transport**

**Hydro power**

**Industry**

**Agriculture**



Water  
use

Human needs

Recreation

Transport

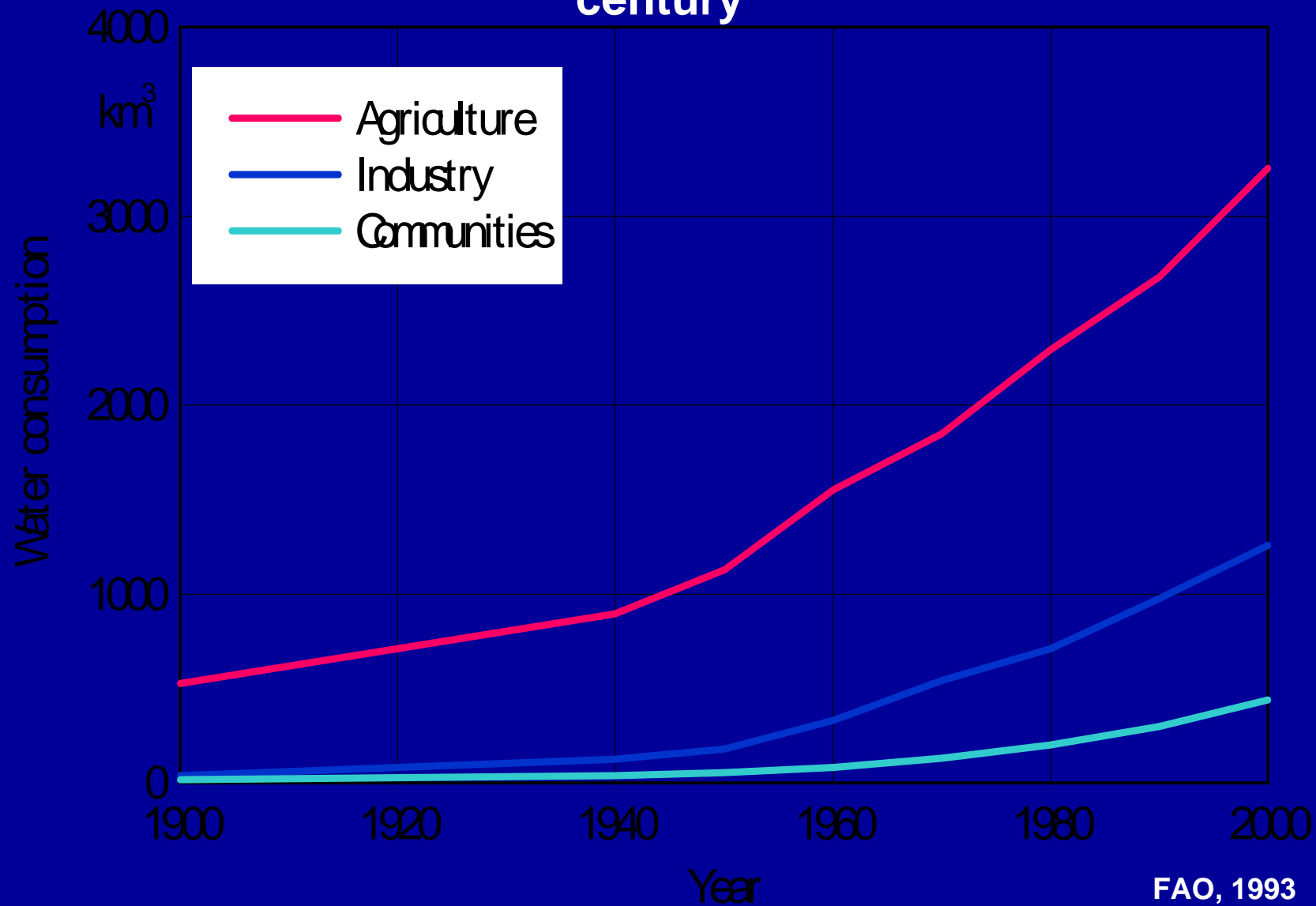
Hydro power

Industry

Agriculture



# Comparasion of water consumption in 3 main sectors in XX century



- The major user of water in the world (from previous figure) is agricultural sector (3300 km<sup>3</sup> water consumption),

but

- Almost 50 % from agricultural water is used inappropriately by the farmers (1650 km<sup>3</sup> water), especially in developing countries.

*(FAO, 2000)*

- It is important to mention the necessity for proper water resources management especially in the forthcoming period when the climate changes are expected to have an influence on water resources in the world.

- The proper irrigation management (good practice of irrigation, proper irrigation technique, etc.) can obtain not only high yields per crops per hectare, but also more efficient use of water in agriculture, so more water will be delivered for other sectors, especially for water supply of households and industry.

# IRRIGATION

## Why ?

- To produce enough food to alleviate the suffering of today and in the future.
- To increase yields - *Irrigated land is more than twice as productive as rainfed cropland. The 17 % of world land that is irrigated is producing 40% of the global food. (FAO, 2000)*
- To multiple yields- *In the developing countries, irrigation increases yields for most crops by 100 to 400 percent. (FAO, 2000)*
- To improve economic income – *more yields per hectare = more economic income.*
- To reduce the drought risk.
- To cultivate a high value crops - *Irrigation allows farmers to reap the economic benefits of growing higher-value cash crops. (FAO, 2000)*



# APPROPRIATE IRRIGATION

## Why ?

- To increase water use efficiency by the crops
- To increase the crop yields
- To produce cheaper agricultural products
- To improve economic income of farmers
- To provide more water for other sectors

or

- To open new additional hectares of land for irrigation - more land for irrigation = more food production

# MAJOR QUESTIONS IN IRRIGATION

1. When to irrigate?
2. How much water to apply?
3. How to apply water on the field?

# What are the main irrigation factors?

- Climate
- Soil
- Crop water requirement
- Water quality
- Economic conditions
- Infrastructure
- Food industry



**When and How to irrigate?**

# DESISSION WHEN TO IRRIGATE CAN BE DONE ACCORDING:

- **Evapotranspiration**
- **Soil Moisture Content**
- **Crop Appearance**
- **Fixed Schedule**

# What is evapotranspiration?

*Evapotranspiration is process by which water is evaporated from soil surface and water is transpired by plants growing on that surface.*

## Direct methods:

Lysimeter

Class A pan

Water balance

Field exam

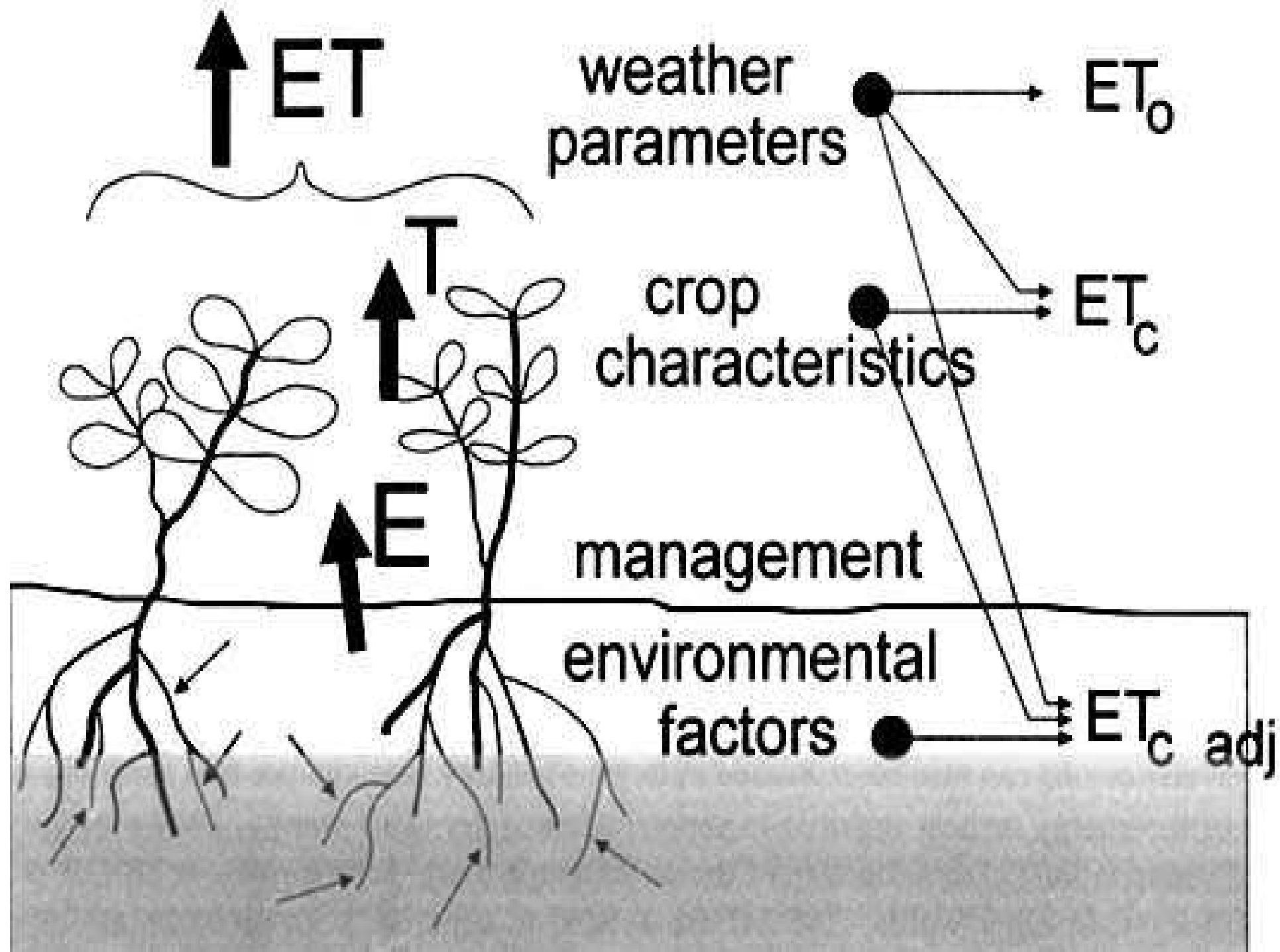
## Indirect methods:

Penman-Monteith

Blaney-Criddle

Thornthwaite

Jensen-Heise



# Lysimeter

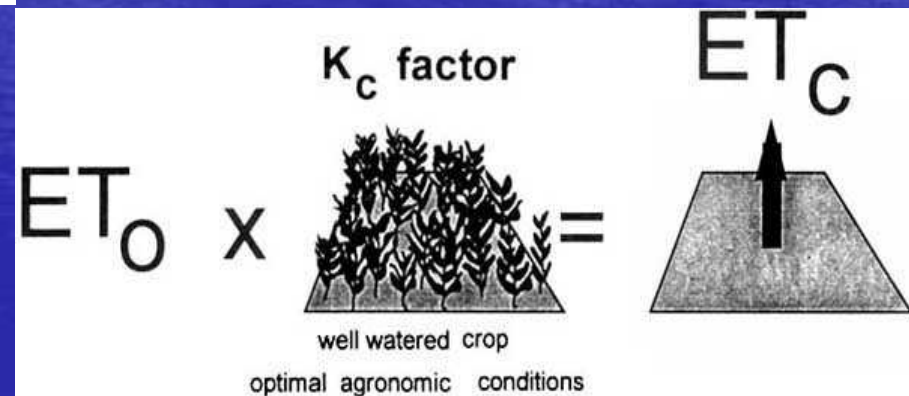
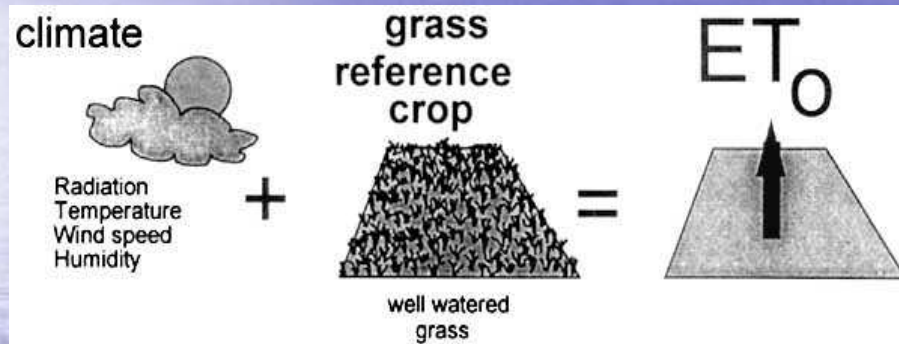




## Class A pan



# Penman-Monteith (CROPWAT)



**Follow climate**



**Weather station**

**Indirect method of  
soil moisture  
mesurment**



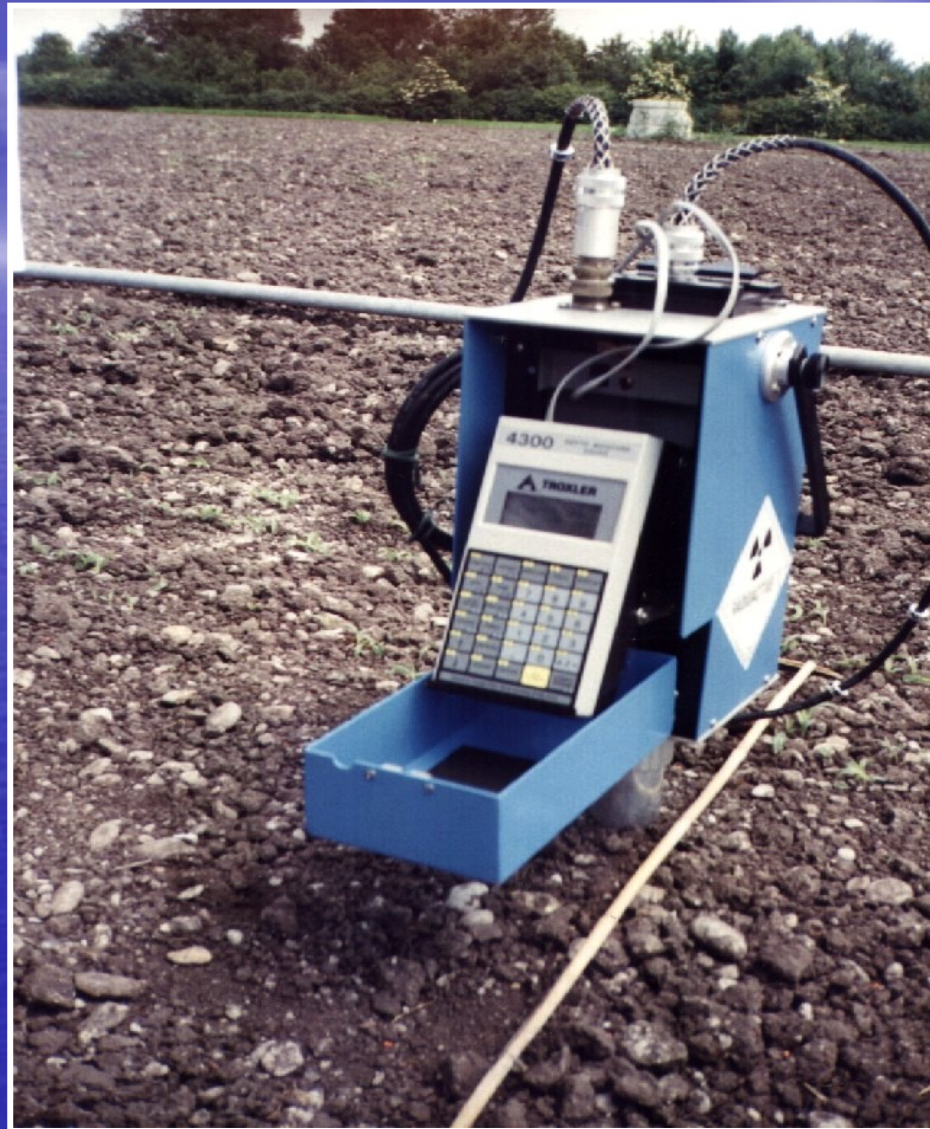
**Equipment for indirect soil moisture mesurment**

Direct method of  
soil moisture  
measurement



Tensiometers

Direct method of  
soil moisture  
measurement



Neutron probe

Direct method of  
soil moisture  
measurement



Data logger

# WHAT FARMERS USE NOW: CROP APPEARANCE

- **Wilting appearance (usually to late)**
- **Changing of color**
- **Changing of plant (leave curving, angle of canopy)**



# How much water to apply

- According soil water balance (incomes, outcomes of water in soil)
- According moisture content in soil
- According fixed schedule

# How much water to apply

- Basic principle is to refill water reservoir in the soil
  - Maximum amount (full reservoir) **FIELD CAPACITY (FC)**
  - Minimum amount (empty reservoir) **WILLTING POINT (WP)**
  - Critical point (decided according needs) **(CP)**
  - Soil water content **(SWC)** should be compared with **CP** and if close or lower of **CP** irrigation should be done
- **APPLICATION AMMOUNT:**  
**AA = FC - SWC**

# Which method of irrigation to apply?

Several factors influence of applying of irrigation method:

- **Biology, morphology and physiology of the crop;**
- **Soil conditions;**
- **Water quality;**
- **Water quantity;**
- **Economic conditions;**
- **The structure of terrain (uniformity, erosion, degradation etc.);**
- **Infrastructure;**



**Basin irrigation**



**Furrow irrigation**



**SURFACE IRRIGATION**



**Border irrigation**



**SURFACE IRRIGATION**

# Land preparation



# Levelling



# Levelling



Laser  
application

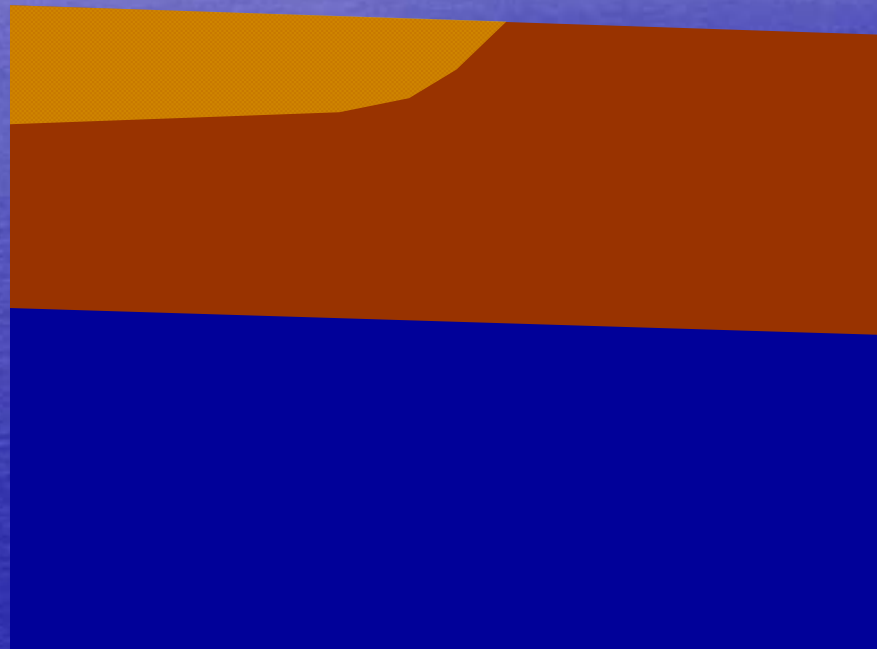


**Furrow irrigation**



# Furrow irrigation

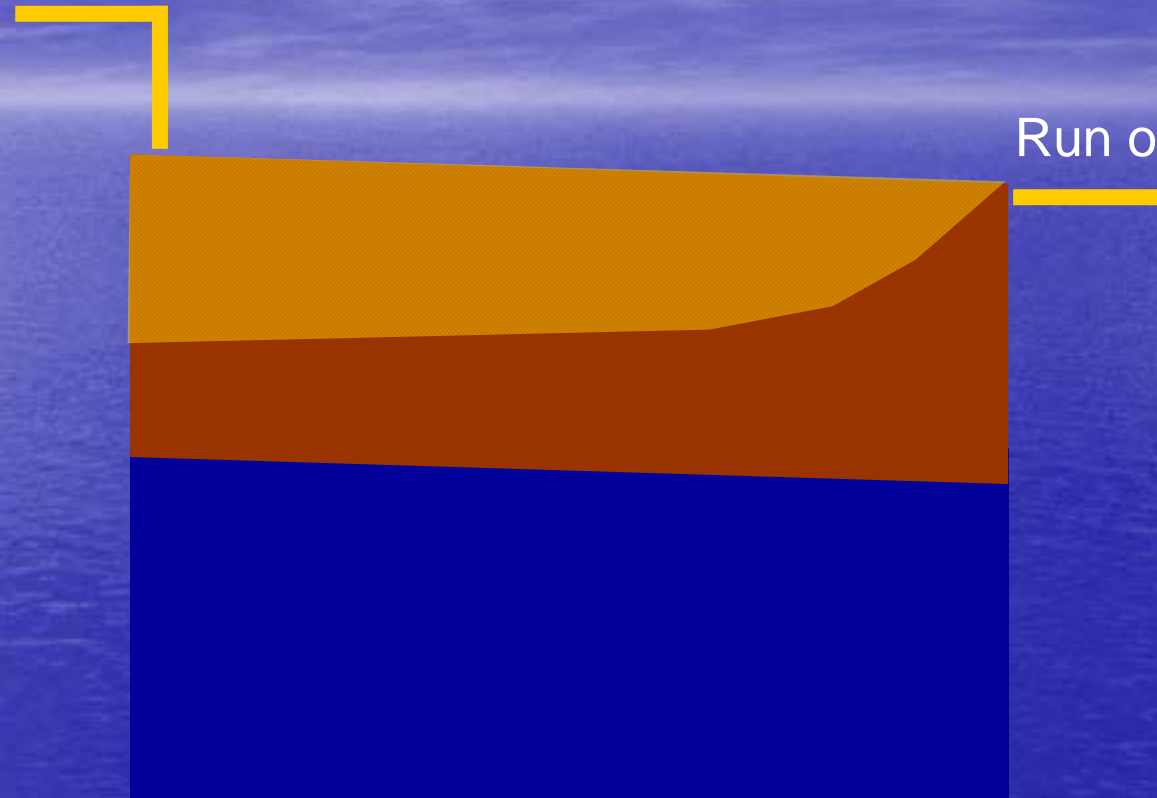
Intake



# Furrow irrigation

Intake

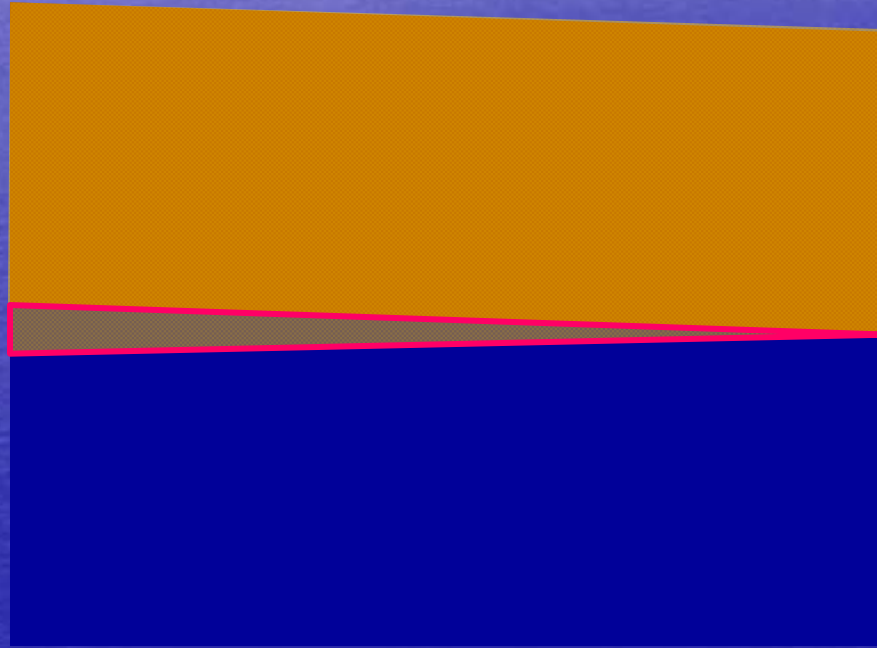
Run off



# Furrow irrigation

Intake

Run off



# Furrow irrigation

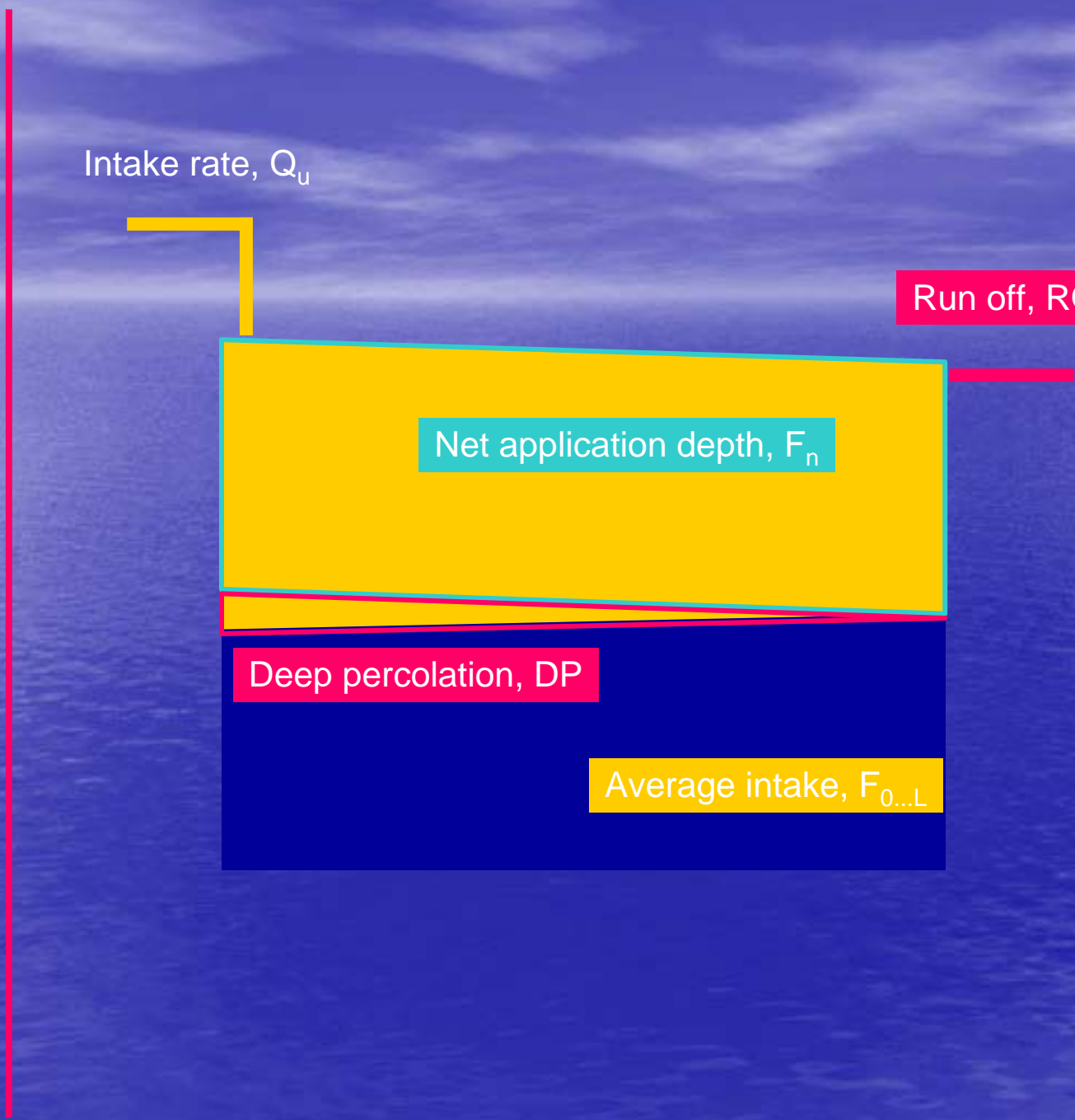
Intake rate,  $Q_u$

Run off, RO

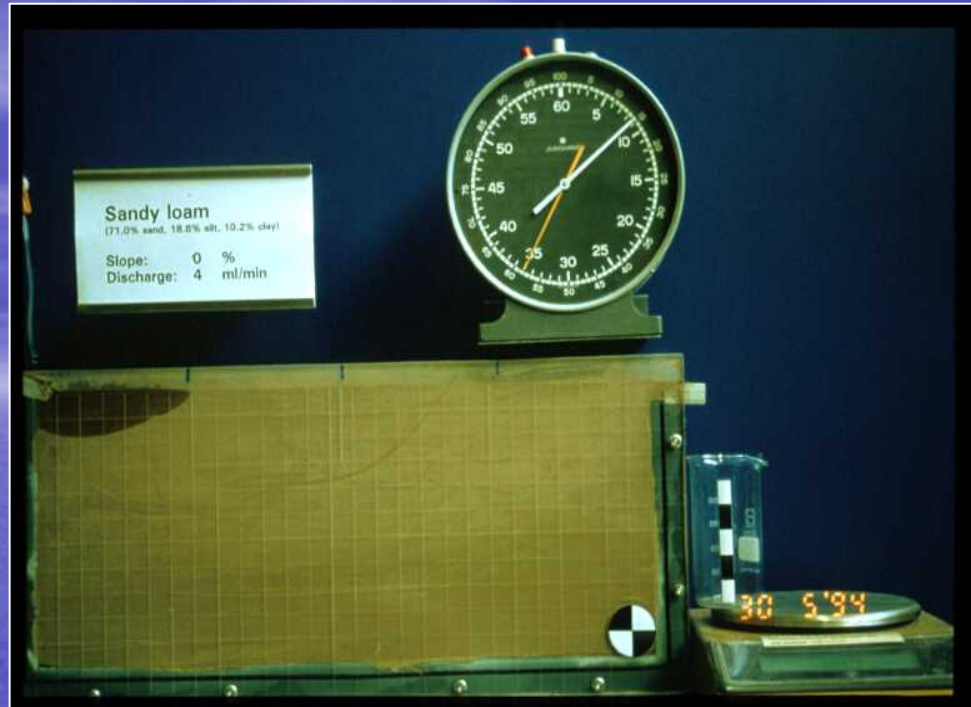
Net application depth,  $F_n$

Deep percolation, DP

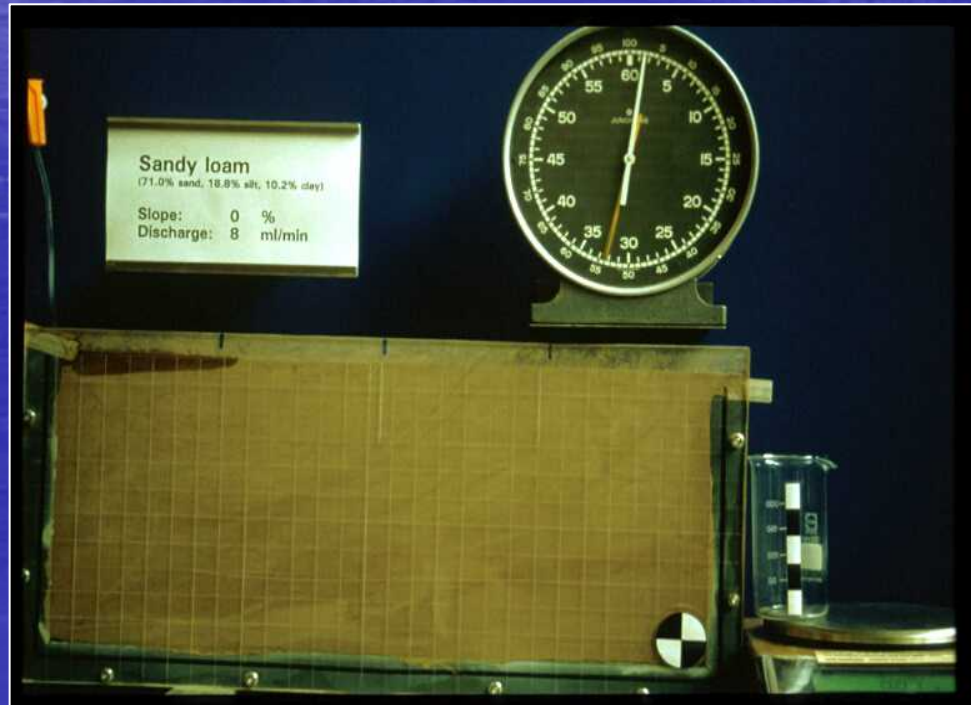
Average intake,  $F_{0..L}$



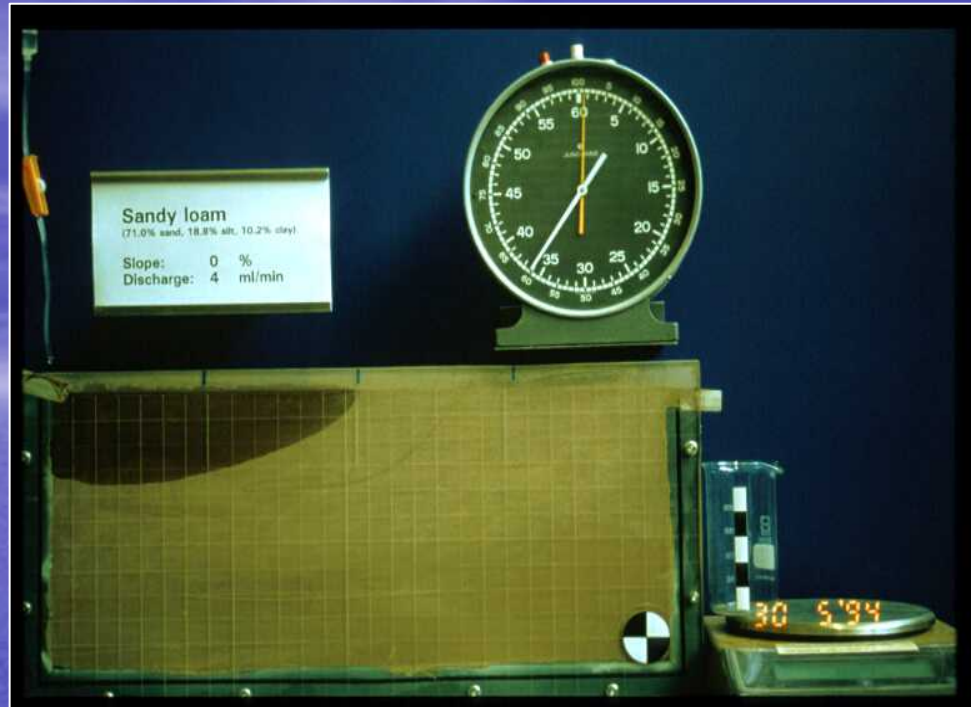
V=4 ml/s



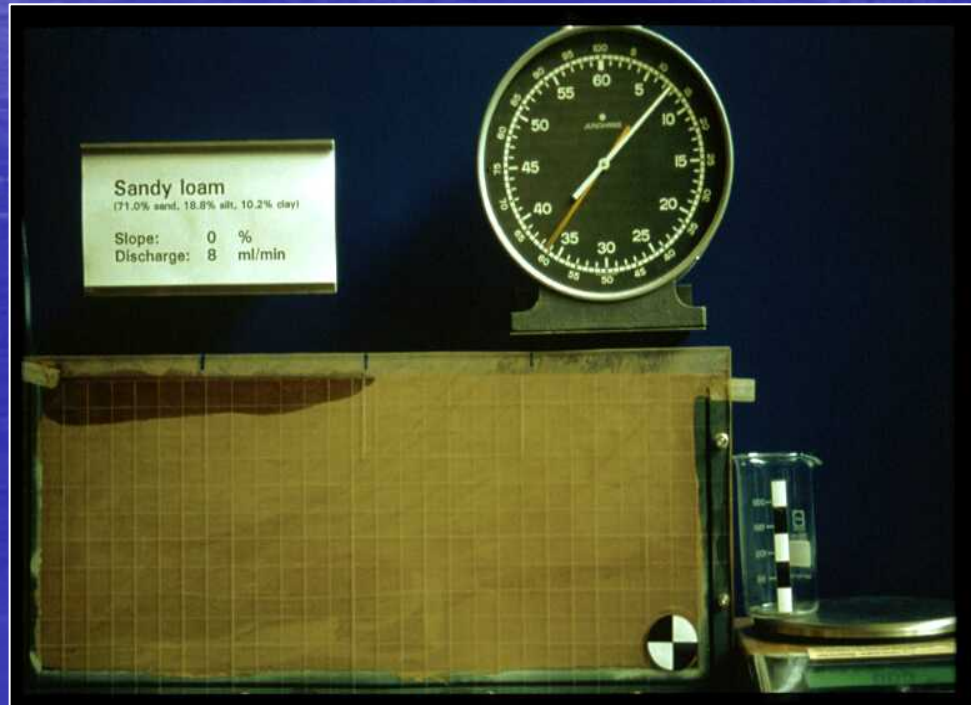
V=8 ml/s



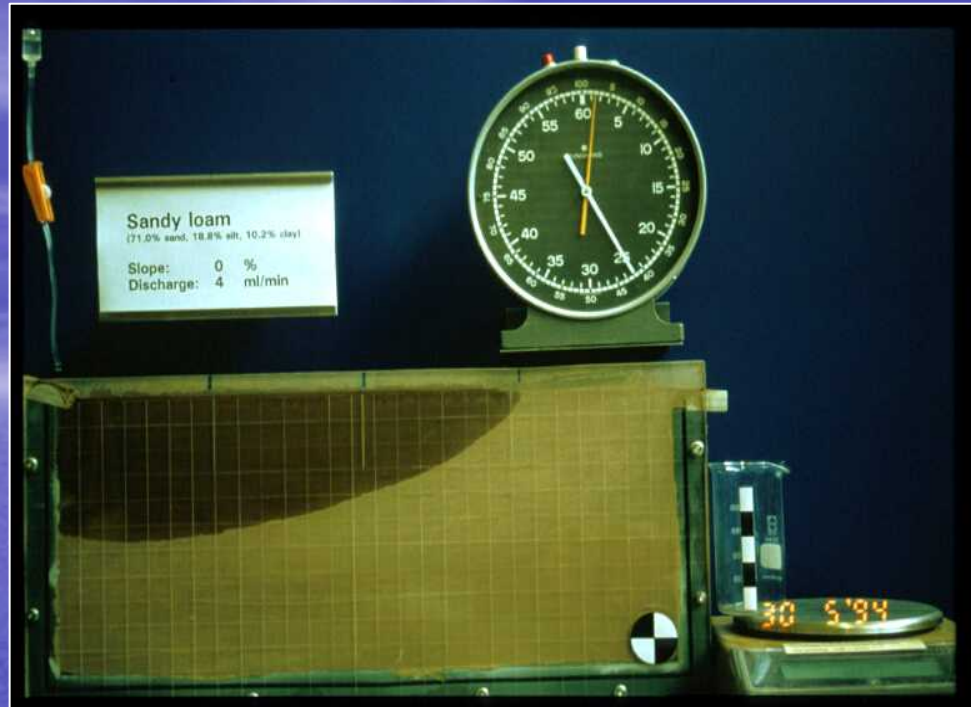
V=4 ml/s



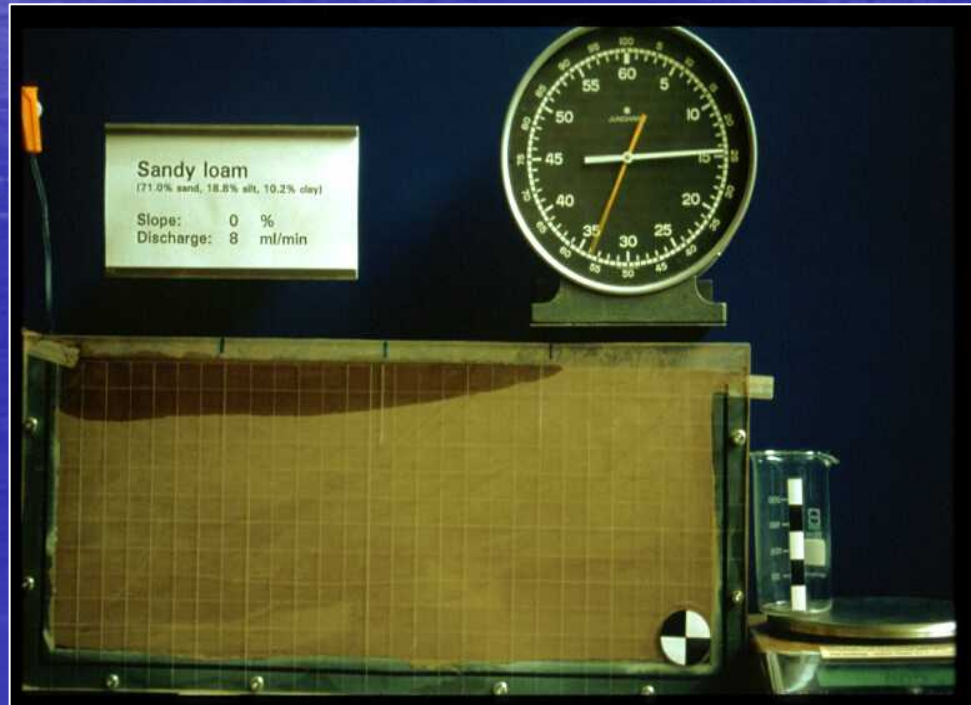
V=8 ml/s



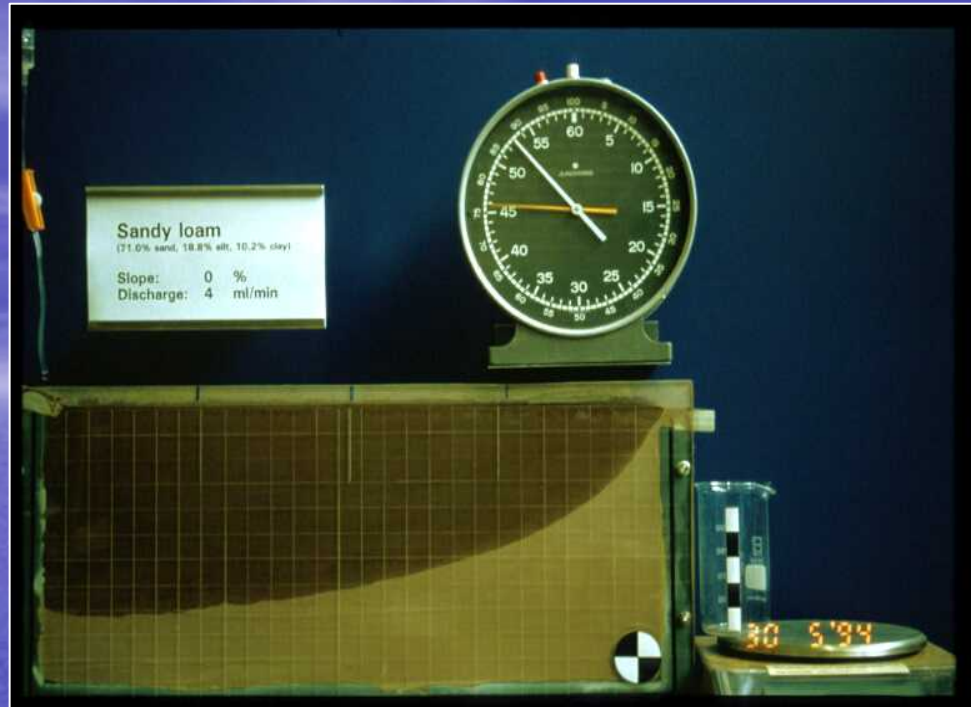
V=4 ml/s



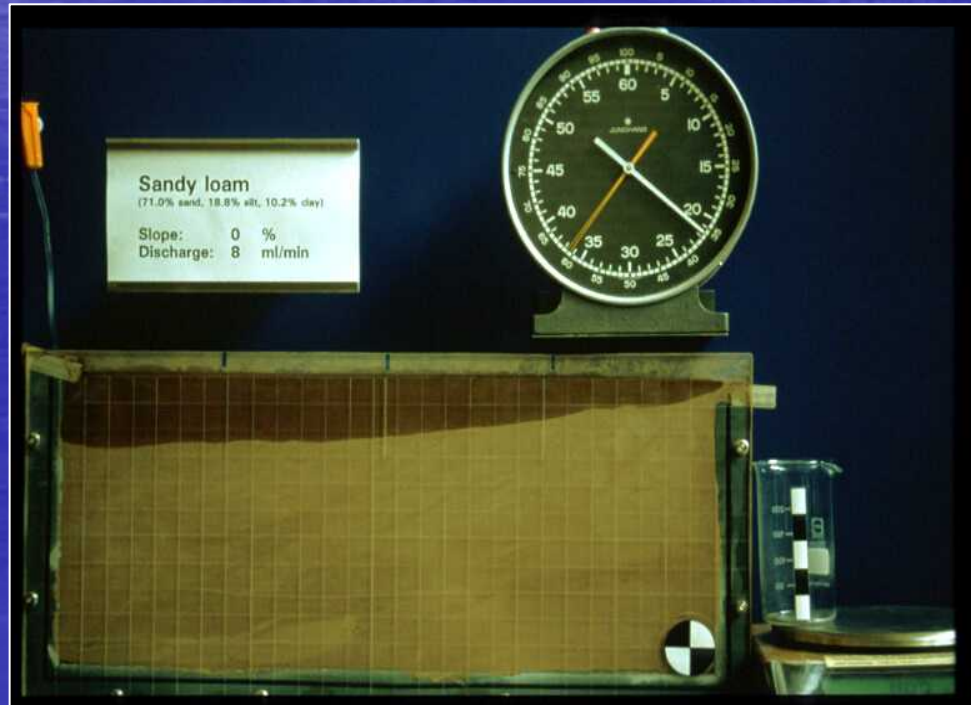
V=8 ml/s



V=4 ml/s

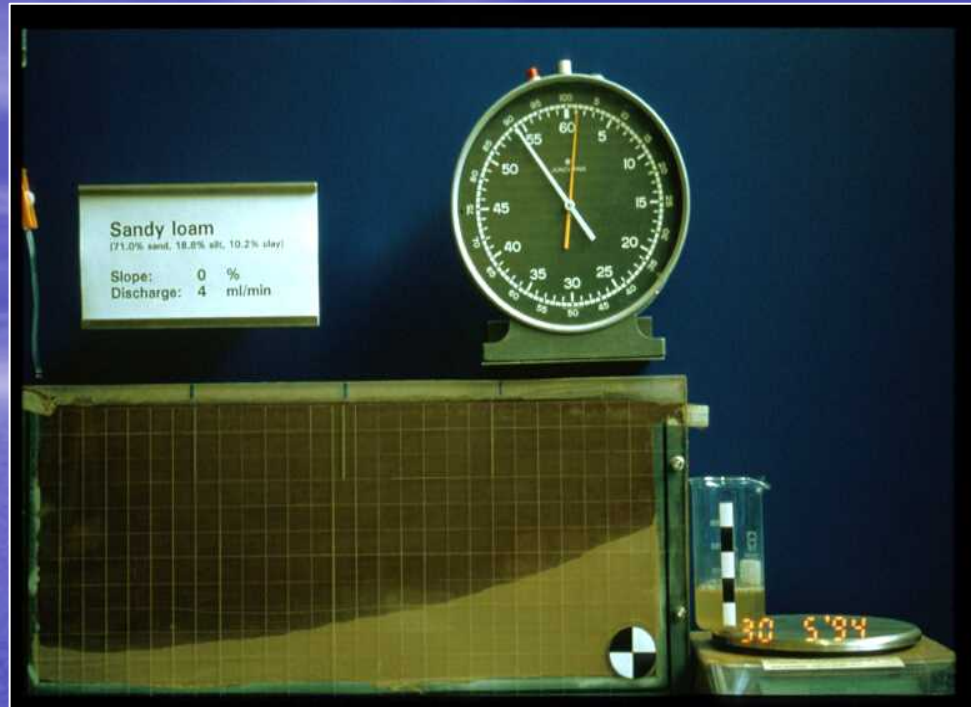


V=8 ml/s





V=4 ml/s



V=8 ml/s



# Siphons



# Siphons



# Gated pipe



# Orchard valve



**Problem  
of  
Surface  
Irrigation**





# **SPRINKLER IRRIGATION**

## Solid set



Alfalfa

- ❖ low labour
- ❖ high investment
- ❖ obstruction of farm traffic



## Hand-move laterals



- ❖ movable
- ❖ high labour
- ❖ temporal obstruction of farm traffic

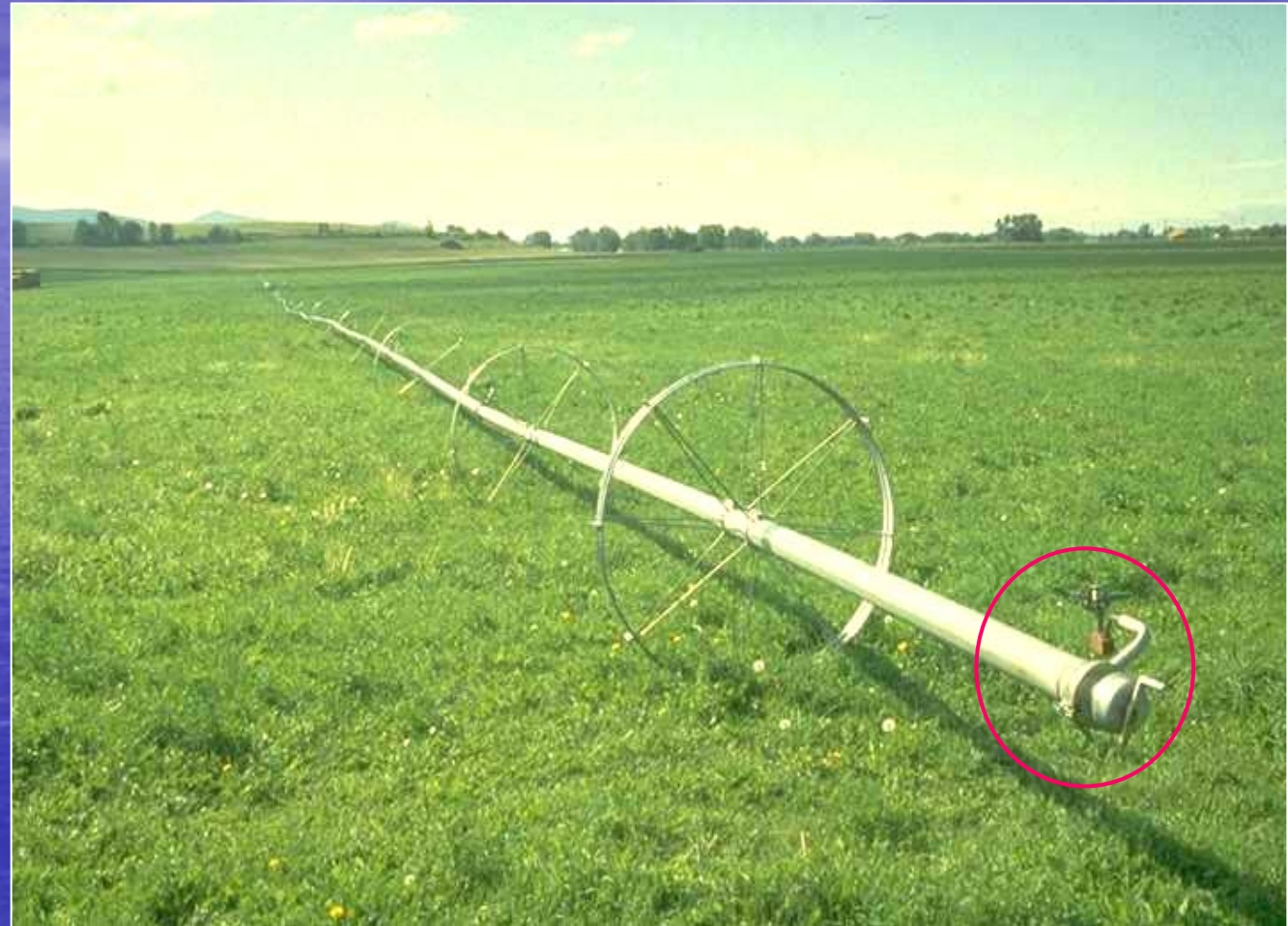
# Hand-move laterals



# Tow-move



# Roll rain wing



# Traveling gun



# Center pivot



Center pivot



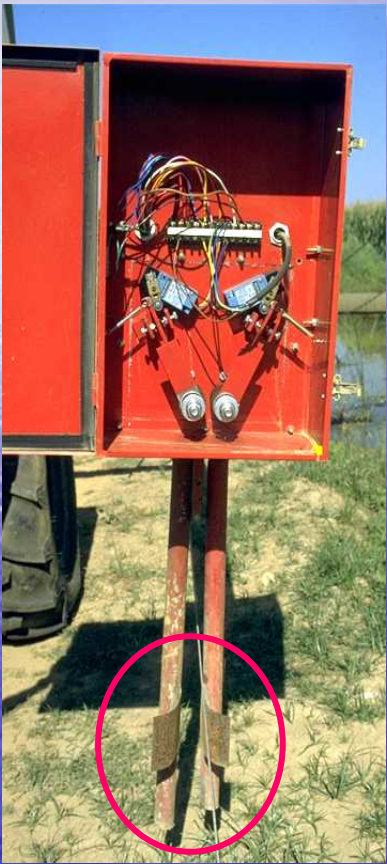
End gun

# Linear move





# Linear move



A photograph showing a tomato plant with several green, unripe tomatoes. A black microirrigation tube is visible in the foreground, running horizontally across the frame. The soil is light brown and appears to be sandy. The word "MICROIRRIGATION" is overlaid in white, bold, capital letters across the center of the image.

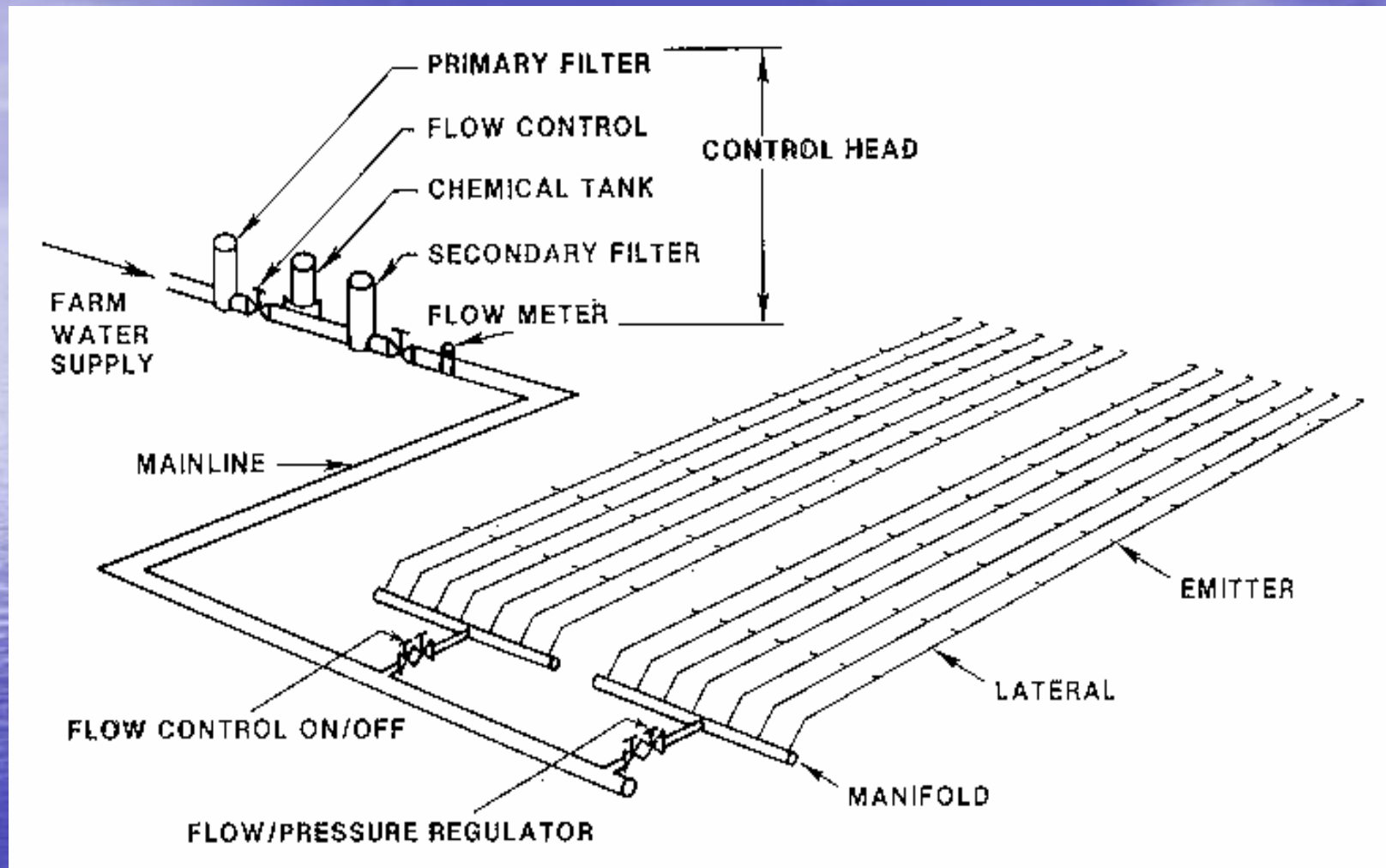
**MICROIRRIGATION**

## Advantages of Micro Irrigation

- 💧 *High water use efficiency (~95%, compared to less than 50% in surface),*
- 💧 *Flexibility of wetted area,*
- 💧 *Versatile selection of emitters: type, discharge rate, position,*
- 💧 *Economy in weed control,*
- 💧 *Low interference with cultivation,*
- 💧 *Day and night irrigation,*
- 💧 *Prevention of leaf wetting,*
- 💧 *Energy saving,*
- 💧 *Salinity control,*

## Limitation of Micro Irrigation

- 💧 *High investment,*
- 💧 *High level of knowledge for optimal and economical operation,*
- 💧 *Susceptibility to mechanical damage,*
- 💧 *Large number of emitters,*
- 💧 *Long application time,*
- 💧 *High level of filtration and other controls,*



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Components of a microirrigation system

# Control head



# Pipes



Surface  
Drip  
Irrigation



**Mechanical installation**





**Laterals with emitters (for row crops)**



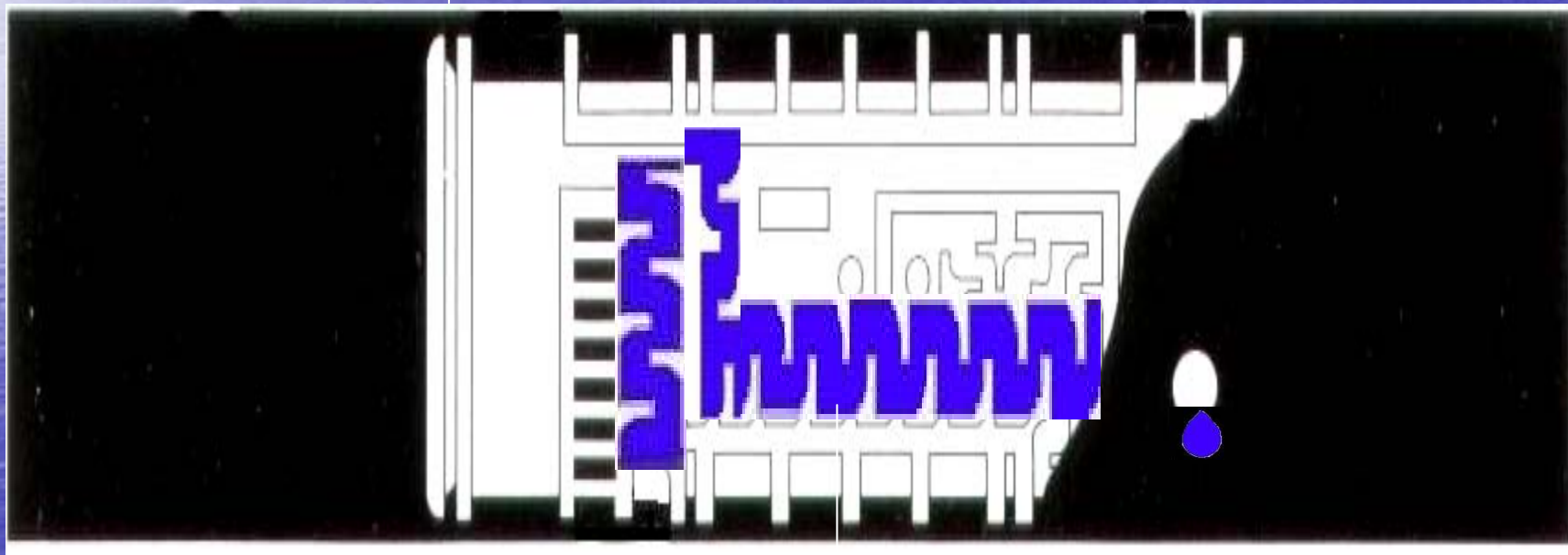
**Laterals with emitters (for row crops)**

# Emitter

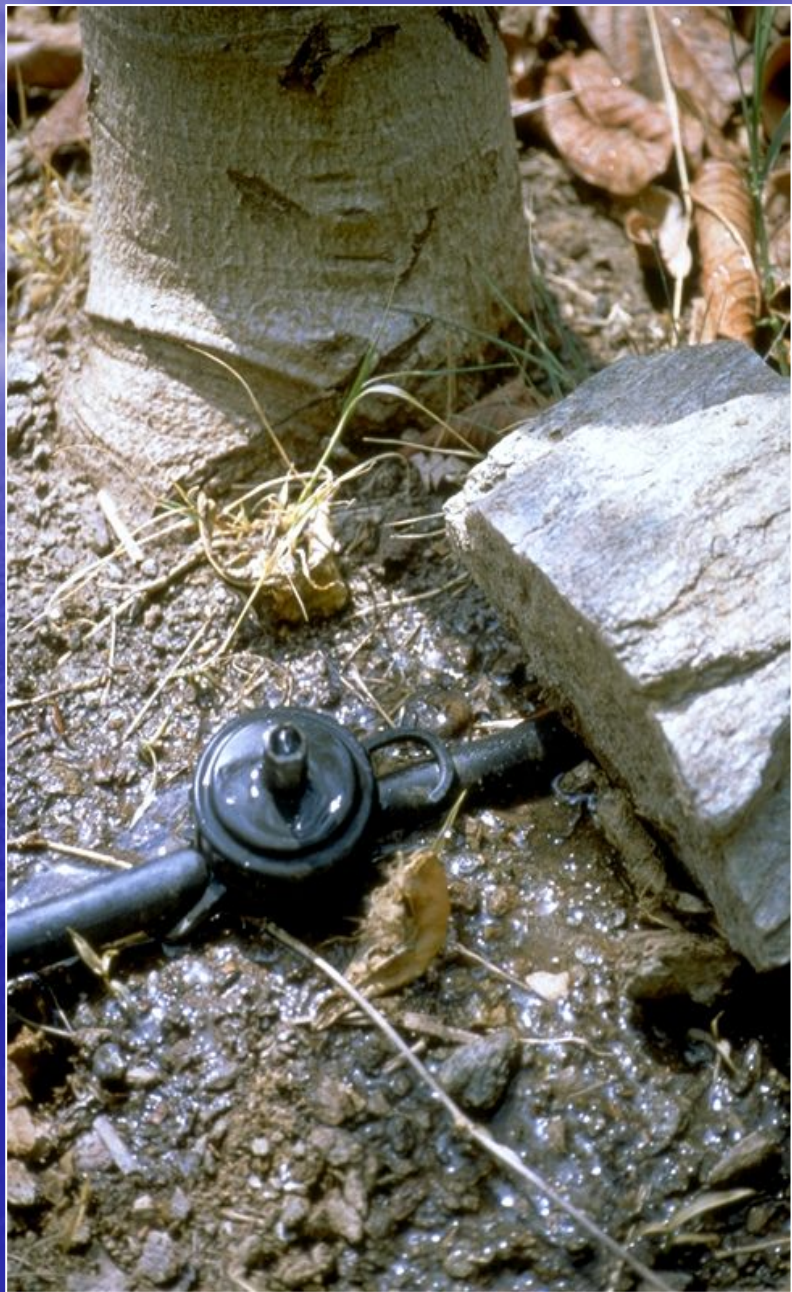
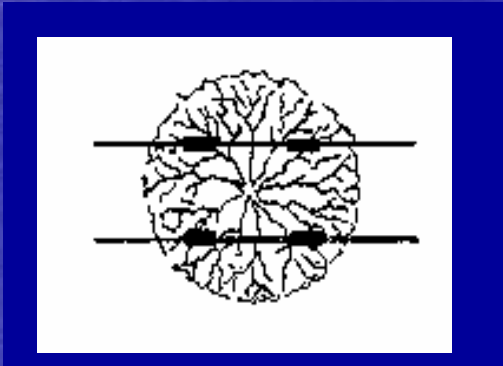
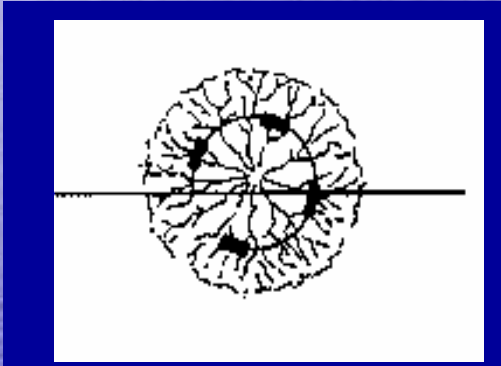
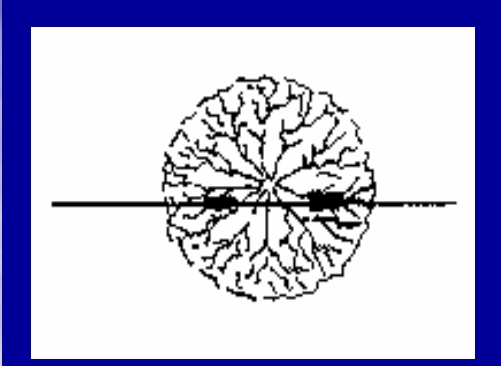


# Work principle of Emitter

POLYETHYLENE  
CYLINDER

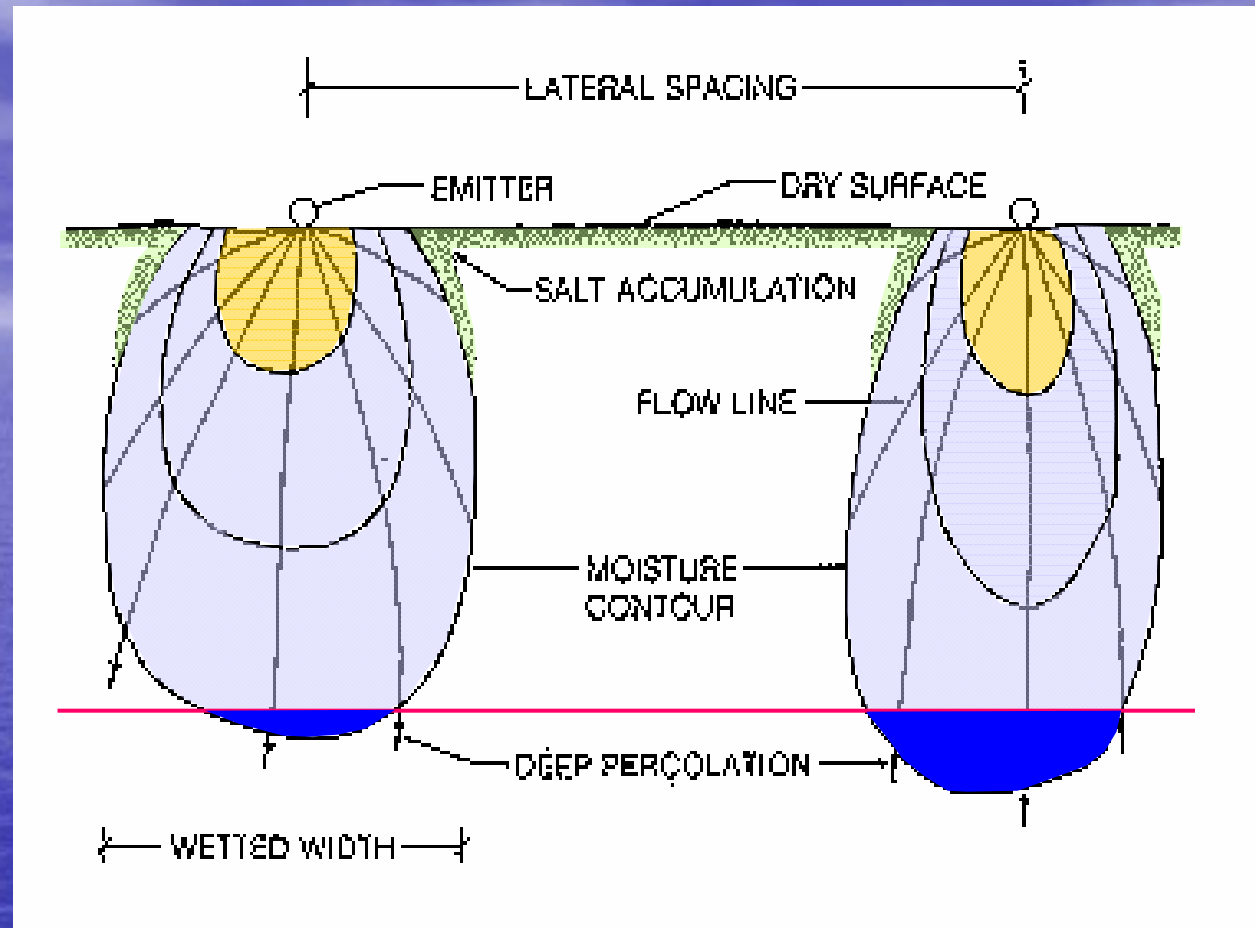


MAZE



Laterals with emitters (for trees)

# Moisture patterns



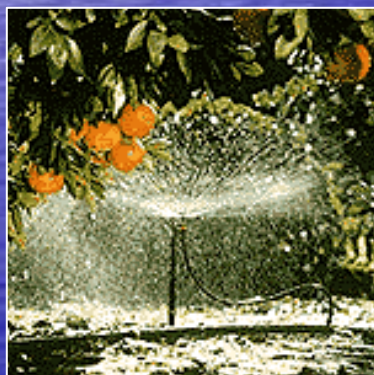
**low flow  
or  
low infiltration rate**

**high flow  
or  
high infiltration rate**

# Chimney effect



# Micro jets – ideal for orchard irrigation





# Spray nozzle



# Filtration

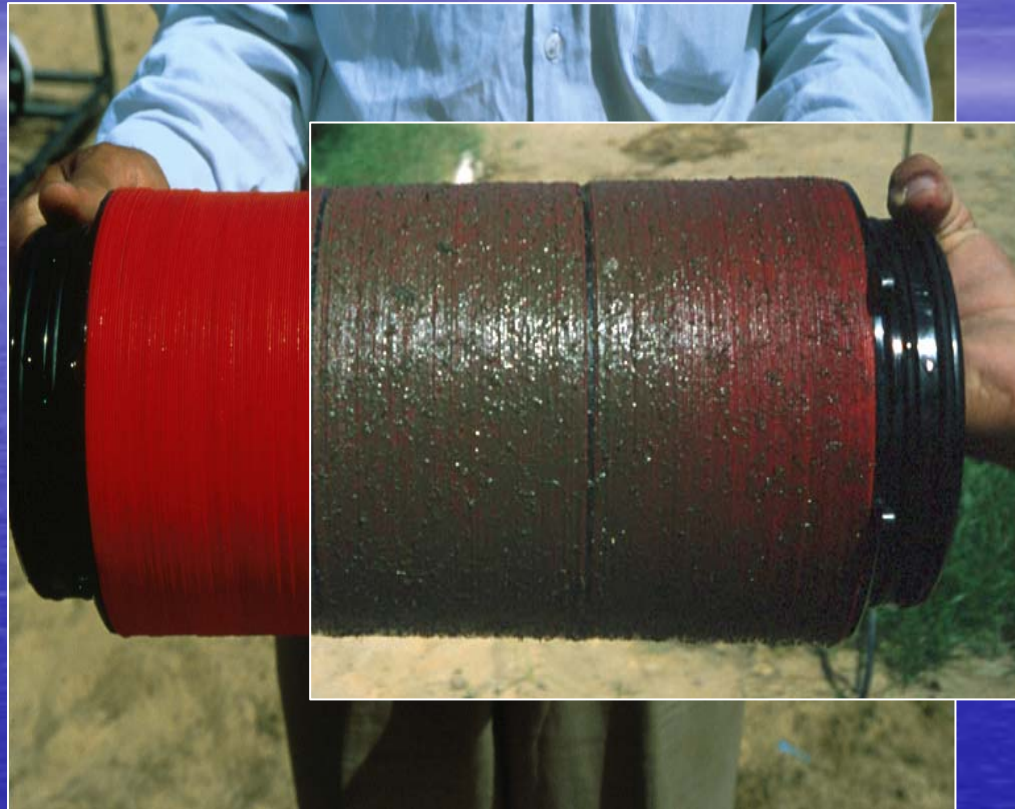
sand separation



# Media filter



# Disc filter



# Fertigation

## Methods of fertigation

Injection  
by pumps



Suction  
by venturi

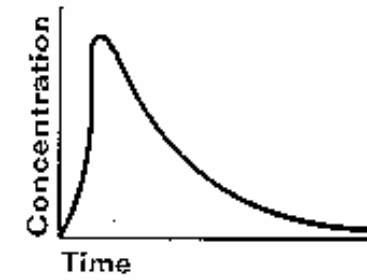
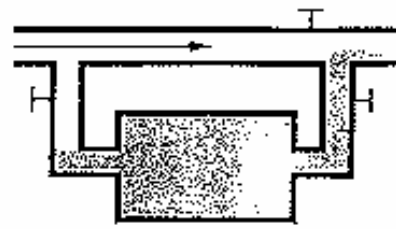


By-pass tank:  
Application  
by pressure  
differential

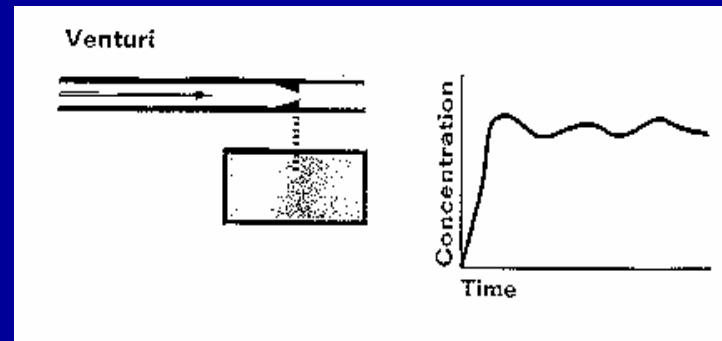


# Fertigation pressure tank

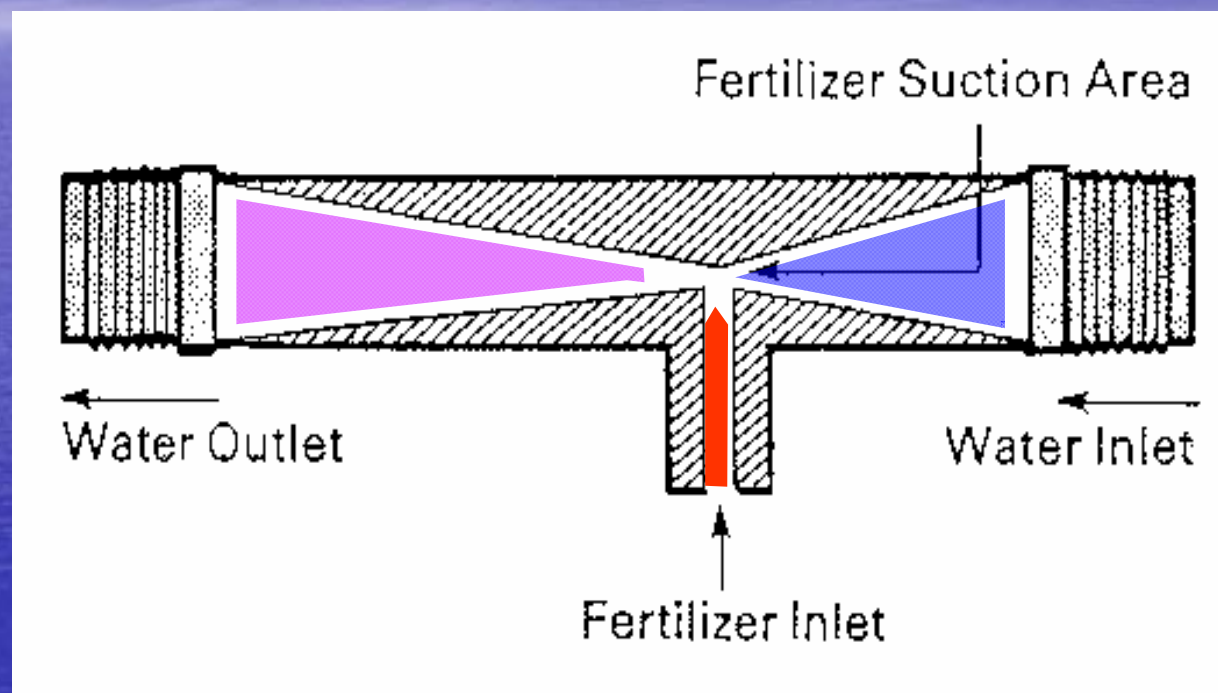
Pressure Differential Tank



# Fertigation Venturi

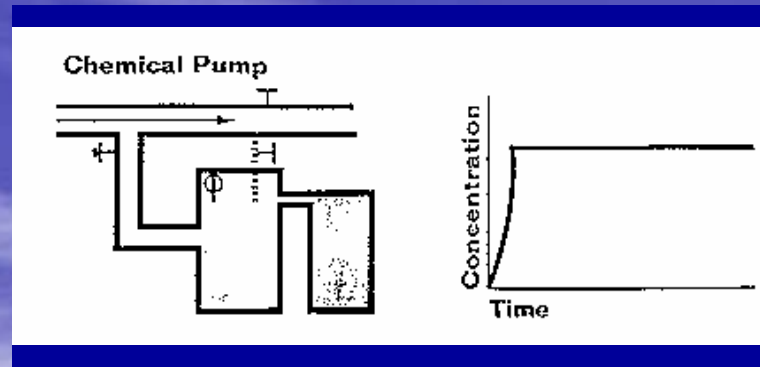


# Fertigation Venturi





# Fertigation chemical pump

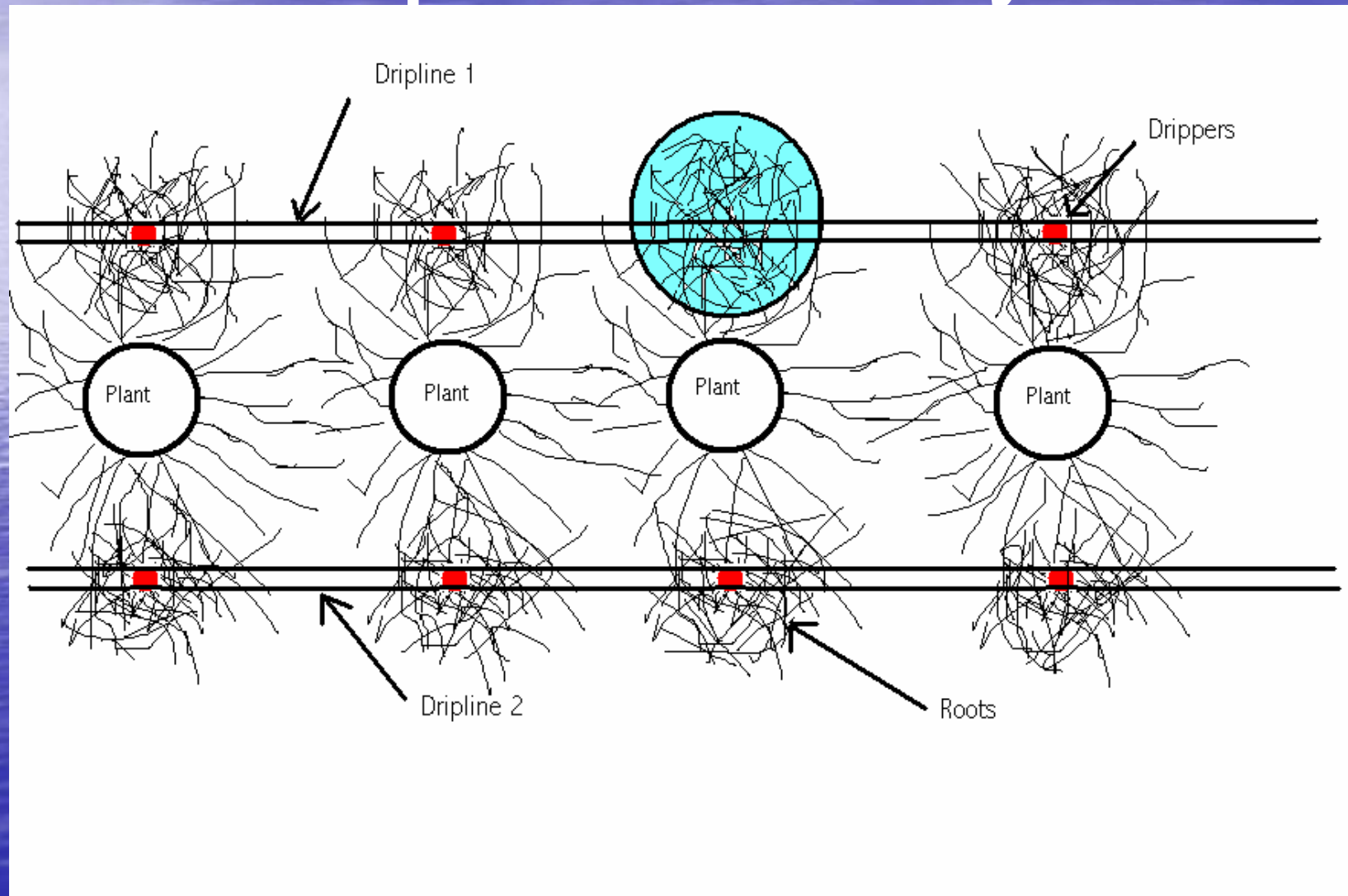


# Key Features for Primary Irrigation Methods

|                     | Surface Irrigation |        | Sprinkler Irrigation |              | Microirrigation |            |
|---------------------|--------------------|--------|----------------------|--------------|-----------------|------------|
|                     | Basin              | Furrow | Hand Lines           | Center Pivot | Drip            | Subsurface |
| <b>Initial Cost</b> | low                | low    | medium               | high         | high            | high       |
| <b>Energy</b>       | low                | low    | high                 | high         | medium          | medium     |
| <b>Labour</b>       | high               | high   | high                 | low          | low             | low        |
| <b>Water</b>        | high               | high   | medium               | medium       | low             | low        |
| <b>Erosion</b>      | low                | medium | high                 | high         | low             | low        |
| <b>Salination</b>   | low                | medium | medium               | medium       | medium          | medium     |

# How we can influence quality of crop

## Example PRD in Vineyards



## Present Situation

Apple is major agricultural crop and other crops are almost neglected (problems in irrigation of only one crop)

The existing irrigation scheme is in very bad condition

Farmers are using furrow and drip irrigation

Over irrigation is very common

## Present Situation

Big number of farmers use ground water for irrigation

Ground water level decrease due to uncontrolled overexploatation

Problem with deep ground water quality (iron compounds and clogging problem)

It is not proven, but such situation cause serious environmental problems (deep percolation, erosion, salinisation...)

## Proposed measures

Rehabilitation of existing irrigation scheme

Use of irrigation water saving techniques

Public awareness concerning the use of water saving irrigation techniques and farmers training.

Proper irrigation scheduling should be part of the training for the farmers and for water users' associations in the region.

## Proposed measures for Prespa

Setting up of experimental fields where water saving techniques can be applied.

Establishment of a meteorological station for the collection of data and further calculation of evapotranspiration in apple growing areas (same mini met station for plant diseases can be used)

Use of Tensiometers for scheduling of irrigation by time and amount applied to avoid deep percolation

# Proposed measures for Prespa

Introducing GAP

Introducing of Fertigation

Establishment of environmental monitoring

EDUCATION....

TRAINING....

AWARENES....



A tall waterfall cascading down a rocky cliff in a lush green forest. The water is white and frothy as it falls, surrounded by dense green trees and foliage. The scene is bright and natural.

# THANK YOU

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