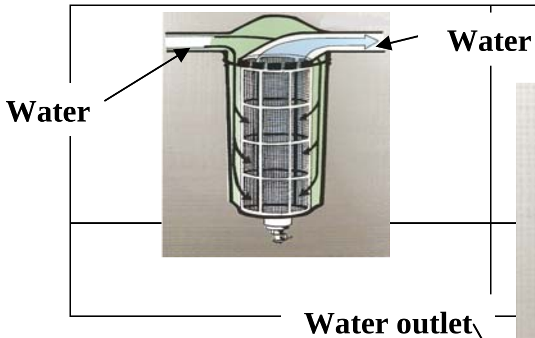
Filtration system

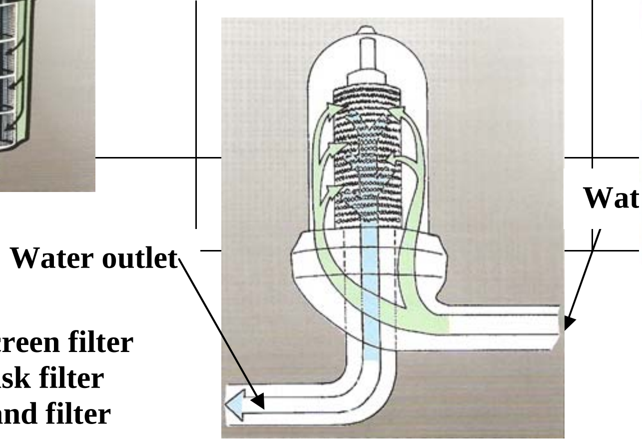
Filters in the irrigation system are necessary in order to reduce the hazard of blockage or clogging in trickles due to solid particles and organic matter suspended in the water. The type, size and number of filters to use depend on the quality of the water and the diskharge in the control head.

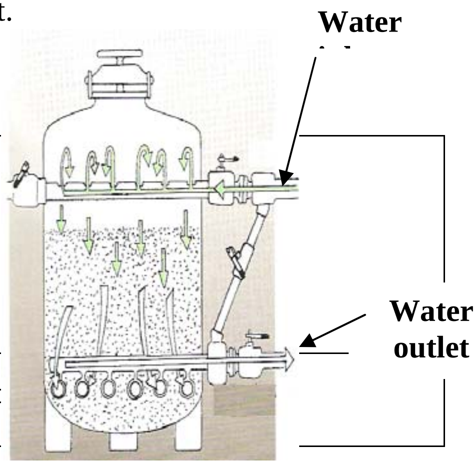
!! The filtration size should not exceed 80 to100 microns. No need to obtain too high quality water. Filtration cost should correspond to the irrigation system sensitivity.

The filtration system, sometimes comprising several filters (both in parallel and in series), is usually centralized in the control head, although it is not uncommon to have filters serving individual plots. Occasionally a system has a central filter (or filters) in the control head and additional ''safety'' filters at the entrance to plot.

3 main types of filters can be found on the market:







1. **The screen filter**
2. **The disk filter**
3. **The sand filter**

The table below shows the filters suggested in relation with the water quality.

Water source		**Frequent clogging agents**	**Filtration type**
Underground water	Drilling	Sand	Disk Filter (or Screen Filter)
	Well	Sand	Disk Filter (or Screen Filter)
Surface water	River	Organic matter and Algae	Floating filter, Sand Media Filter Disk Filter (or Screen Filter)
	Channel	Organic matter and Algae	Sand Media Filter Disk Filter (or Screen Filter)
	Reservoir	Organic matter and Algae	Floating Filter, Sand Media Filter Disk Filter (or Screen Filter)

!! Note Soluble elements and pathogens are not controlled by the filtration system.

It is recommended to analyze water in order to define better the filtration requirements. Three water criteria should be verified:

1- Sediments

To test sedimentation, sample water from the network and pour it in a transparent container of at least 15 cm height. Shake the container, if after one minute of resting period sediments appear, the water contains particles sizing more than 50 µ which correspond to fine sand.

Particles size

	mm	Micron (µ)
Coarse sand	2 to 0.2	2000 to 200
Fine sand	0.2 to 0.05	200 to 50
Coarse silt	0.05 to 0.02	50 to 20
Fine silt	0.02 to 0.002	20 to 2
Clay	less than 0.002	less then 2

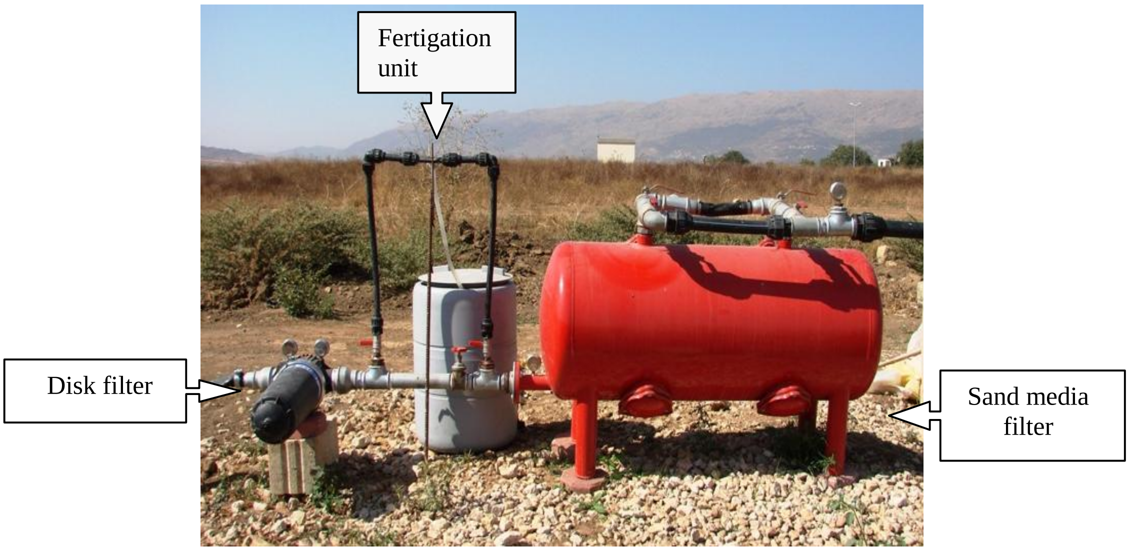
2- Turbidity

Turbidity is a measure of the degree to which the water looses it's transparency due to the presence of suspended particles. The more total suspended solids in the water, the murkier it seems and the higher is the turbidity.

3-Mineral precipitation

Iron and calcium can precipitate or help bacteria development. In a critical zone, only water analysis helps defining their rate.

The figure below shows an example of filtration used in most of the localized irrigation systems (T-tape, GR...).



!! The fertigation unit must be placed **after** the sand media filter and **before** the disk filter, which prevents any pipe clogging due to the injection of non dissolved fertilizer.

Sand media filter

What are sand media filters?

Sand media filters are made of either **vertical** or **horizontal** chambers filled with a media. Sand is almost always used as filtration media but alternative media are being investigated.

P.S: A disc filter must be placed after the sand filter as a security to prevent any pipe clogging due to media leakage.

P.S: The filter body must be stainless steel internally anticorrosive coated to contain the wall abrasion caused by the sand movement of pressurized water.

When to use sand media filters?

To remove coarse material as well as organic matter and very fine colloidal particles from the water. This type of filter, especially when followed by a disk filter, is adapted to poor quality water pumped from reservoirs or ponds as shown in the figure below.

Sizing of the filtering bed particles

The calibration of the needed filtration is based on the following principle: "the size of the smallest particle to be stopped is about 1/10 to 1/7 of the diameter of the smallest paths in the micro-irrigation system".

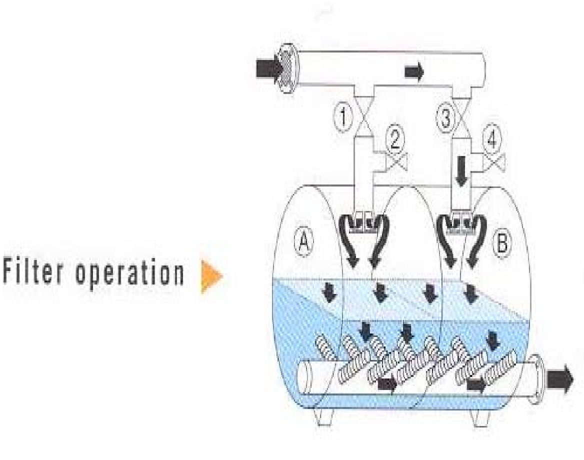
In drip irrigation, the diameter of the narrowest paths of the emitters is around 1 mm; then all particles with a diameter > 0.10 to 0.15 mm must be retained. It is recommended to choose media particles "10 times bigger than the smallest solid to filter"; this means particles with a diameter ranging between 1 and 1.5 mm.

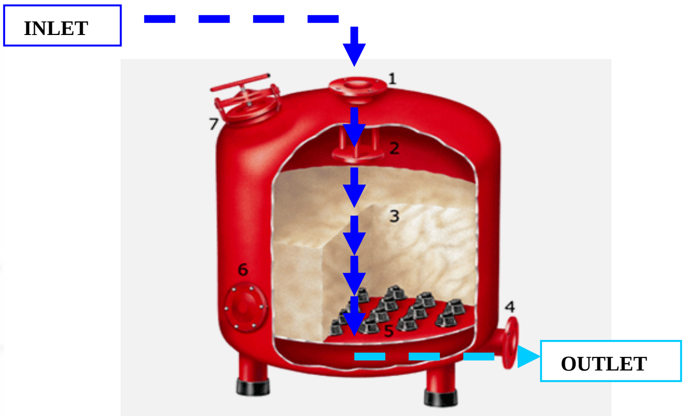
It is always advised to choose one size of media instead of several media size layers to avoid mixing of the media layers during the back-flushing.

Why it is preferable to use a horizontal sand media filter instead of a vertical sand media filter?

When compared to horizontal sand media filter, the vertical one shows:
a) Higher filtration performance due the thicker layer of media and to the larger filtration area provided by the horizontal candles plate,
b) Higher back-flushing efficiency.

Horizontal sand media filter **Vertical sand media filter**



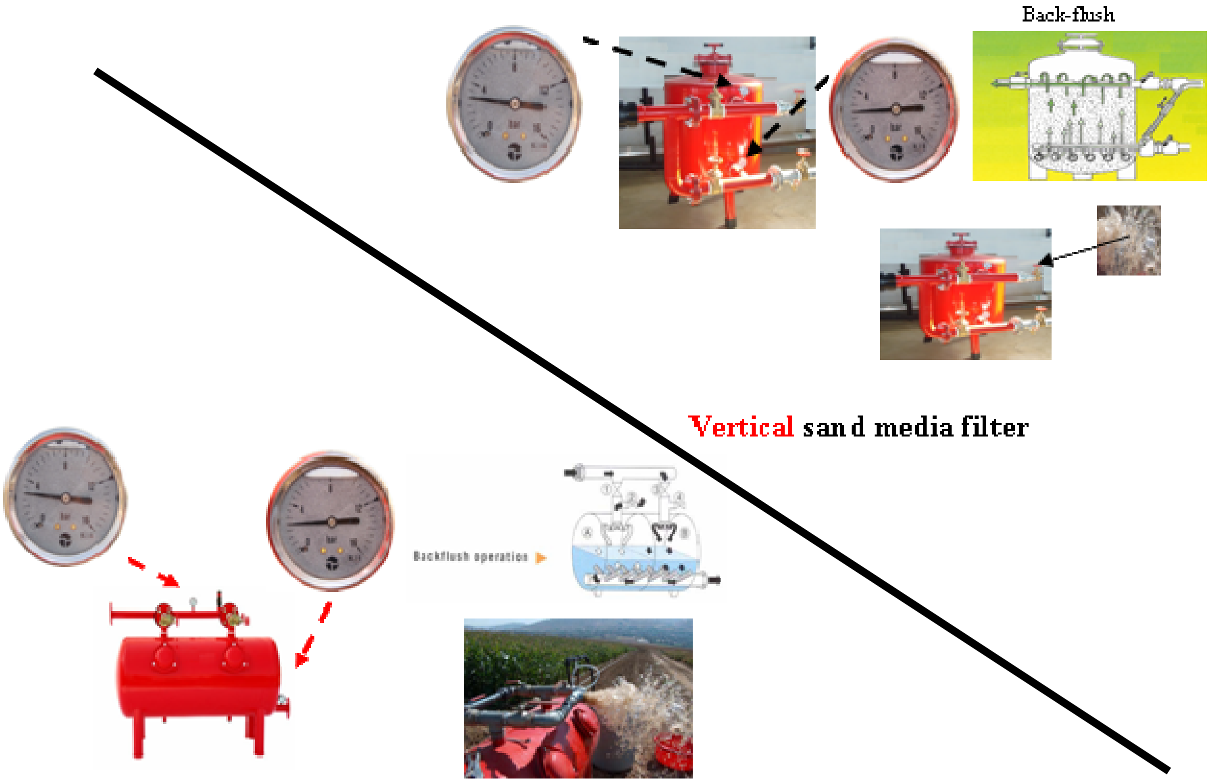


1.Water inlet **2.** Water **3.** Sand bed
4. Water outlet **5.** Filtration **6.** Service port **7.** Media filling

Maintenance

1. Back-flushing

Two pressure gauges are needed, one upstream and the other downstream the filters. When the head losses exceed 0.5 bar, a back-flush is required:



Horizontal sand media filter

To calibrate the back-flush valve, place a fine tissue on the back-flush outlet, and control if any media particle is rejected as shown in the figure below.

2. Cleaning or renewal of the media

Farmers should regularly (more than once a season) check the status of the media (level, regularity of its repartition) by opening the tanks; and maintain the situation by adding more sand and/or leveling the media bed if necessary. To be on the safe side, farmers should clean the media using bleach at the end of the season, and renew it every two years. After removing the media, it is necessary to check the nozzles to be sure that none is broken.

Specifications:

Inlet/Outlet	Tank diameter	Flow rate (m^3/h)	Filtration area (m^2)	Max. pressure (bar)
3” (76mm)	36”(915mm)	50	0.65	8
4”(102mm)	48”(1220mm)	75	1.15	8

Volumetric or disc filter

The volumetric or disc filters (Fig.1) are used to remove suspended material from irrigation water. These filters are made of grooved plastic rings (Fig.2) that are mounted on a longitudinal shaft. When tightened together, the rings form a cylindrical filtering body (fig. 3) where water moves from the outside of the cylinder to its core (fig. 5). The degree of filtration is determined by the number of grooves in the rings (fig. 4); for example, when the number of grooves is 490, the equivalent is a 120 mesh screen.

Fig. 1: Several models of disc filters

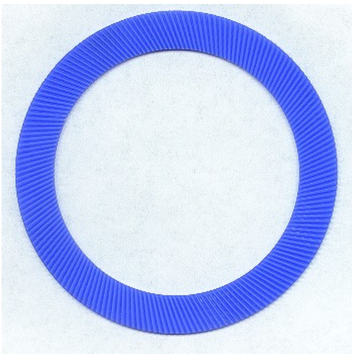


Fig.2:Disc filter grooved ring

Fig.3: Disc filter cartridges

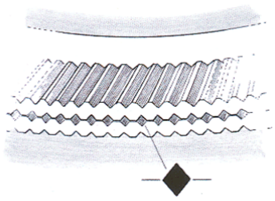


Fig. 4: Piled grooved discs creating the filter effect.

Maintenance

The Filters can be cleaned in two ways:

1. Manual cleaning, after dismantling and removing the disc stack.
2. Back-flushing, without dismantling the filter.

When to do maintenance?

When the head loss reach a maximum value of 0.5 bar, it is necessary to clean the filter (fig.6).

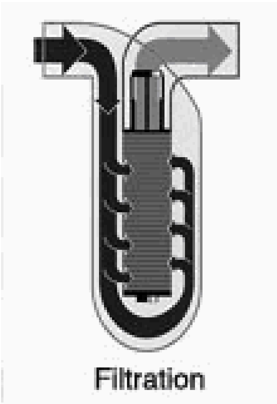


Fig.5: Water filtration movement

Fig.6: Head loss

1. **Manual cleaning:** Withdraw the cylinders of piled-up plastic discs and wash them in water. Bleach can be added to water when needed. The hooking system with “fitting rings” allows easy and quick opening and closing. The discs can be easily separated from each other by unscrewing the central axis (Fig. 7).

Fig. 7: Manual cleaning of the disc filter. The flat, grooved rings stacked together are firstly unscrewed to operate the necessary scrubbing.

2. **Back-flushing:** The disc filters can be back-flushed by reversing the water circulation (from inside to outside the filtering cylinder) (Fig.8).
To be efficient, the back-flushing should be made with a minimum of 3 to 4 bars pressure. The back-flushing must be made using filtered water and this may require the installation of at least two filters placed in parallel (Fig. 9).

Fig. 8: Water movement during the back-flush operation

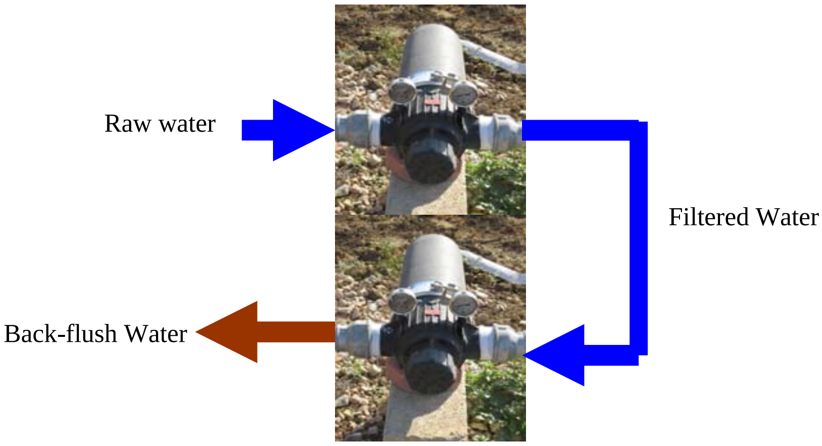


Fig. 9: Back-flushing: The use of two filters in parallel allows the back flushing of one filter while the other is actively filtering the water

Partial flushing
Some filters have a valve to open and flush the filter. While the filter is operating, one can turn on the flushing valve located on the filter. It creates a very fast and turbulent flushing of the water contained inside the filter. This is a superficial washing which can prolong, for a while, the operation time before the next disassembly for an appropriate washing.

Specifications:

Inlet/Outlet	Tank diameter (mm)	Flow rate (m^3/h)	Filter length (mm)	Max. pressure (bar)
3” (60-120 mesh)	165	28-50	530	8
4” (60-160mesh)	165	40-75	780	8

Screen filter

Constituents like suspended solids and sand are often removed using screen filters (Fig.1). These filters are made of stainless steel or nylon screen sheets (Fig.2). When sheets are rolled they form a cylindrical filtering body where water moves from outside of the cylinder to its core (Fig.3). This type of filter commonly has either a single or a double screen. A 200 mesh screen is used often in trickle irrigation. Water filtered with a 200 mesh screen will contain only particles of very fine sand or particles of even smaller sizes (Table 1).

Figure 1: Screen filter

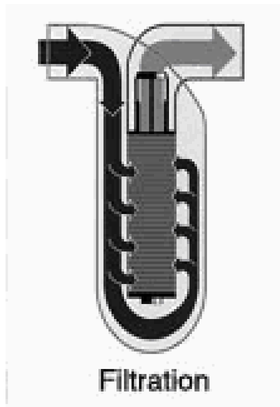


Fig.3: Water filtration movement

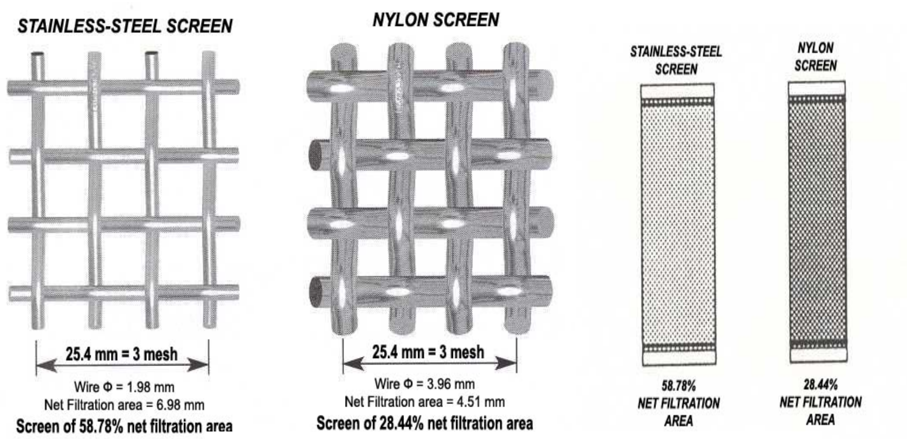


Figure 2: Stainless steel and nylon screen sheets

Table 1. Soil Particle Size Classification and Corresponding Screen Number.				
	Particle Size			
Soil Classification	mm	microns	inches	Screen Mesh Number
Very coarse sand	1.00 - 2.00	1000 - 2000	0.0393 - 0.0786	18 - 10
Coarse sand	0.50 - 1.00	500 - 1000	0.0197 - 0.0393	35 - 18
Medium sand	0.25 - 0.50	250 - 500	0.0098 - 0.0197	60 - 35
Fine sand	0.10 - 0.25	100 - 250	0.0039 - 0.0098	160 - 60
Very fine sand	0.05 - 0.10	50 - 100	0.0020 - 0.0039	270 - 160
Silt	0.002 - 0.05	2 - 50	0.00008 - 0.0020	--*
Clay	0.002	2	0.00008	--*
* Screens are not normally used to remove particles of these sizes.				

Maintenance

Filters can be cleaned in two ways:

1. Manual cleaning, after dismantling and removing the disc stack.
2. Back-flushing, without dismantling the filter.

When to do maintenance?

When the head loss reach a maximum value of 0.5 bar, it is necessary to clean the filter (fig.4).

Fig.4: Head loss

1. Manual cleaning

This operation is done by opening the filter body and withdrawing the cartridge(s) to wash in water (fig.5). Bleach can be added to water when needed.

Fig. 5: Manual cleaning of the screen filter. The screen cartridge is firstly withdrawn from the filter body, to operate the necessary scrubbing.

2. Back-flushing

The screen filters can be back-flushed by reversing the water circulation. To be efficient, the back flushing should be made with a minimum of 3 to 4 bars pressure.

The back flushing must be made using filtered water and this requires the installation of at least two filters placed in parallel (fig.6).

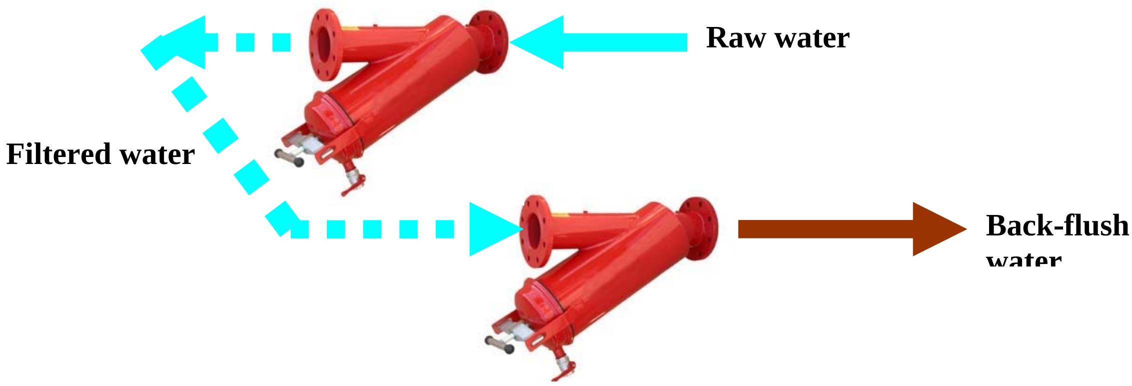


Fig. 6: Back-flushing: The use of two filters in parallel allows the back flushing of one filter while the other is actively filtering the water

Partial flushing

While the filter is operating, one can turn on the flushing valves (fig.7) located on the filter. It creates a very fast and turbulent flushing of the water contained inside the filter. This is a superficial washing which can prolong, for a while, the operation time before the next disassembly for an appropriate washing.

Figure 7: Partial flushing through the flushing valve

When compared to screen filter the disc filter shows:

a) Higher filtration performance and longer cleaning intervals;

b) Higher resistance to maintenance practices (manual washing).

Specifications:

Inlet/Outlet	Flow rate (m^3/h)	Max. pressure (bar)
2” (120mesh)	30	8
3” (150mesh)	45	8

Technical sheet n 1: Soil sampling

What is a soil sample?

A soil sample should represent the field structure and composition of the plot to be analyzed. It is made of 10 to 15 soil extracts (800 to 1000 g in total) carefully selected in the sampled area. The sampling area needs to be **homogeneous** to avoid any loss of accuracy. If the field is made of several non homogeneous areas, one soil sample per area should be collected and analyzed.

Homogeneity criteria mainly depend on:

- Field slope
- Soil texture and color
- Previous fertilizer application
- Cropping patterns
- Plantation system (open field or green house)

How to take soil extract?

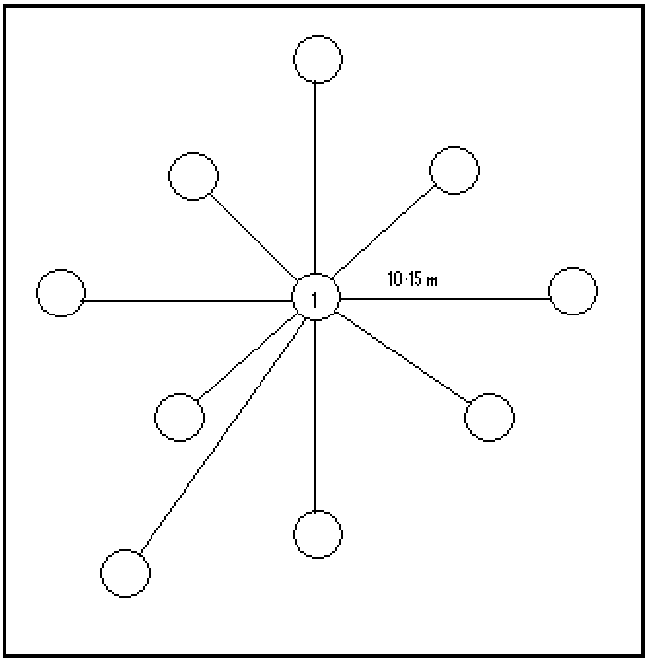
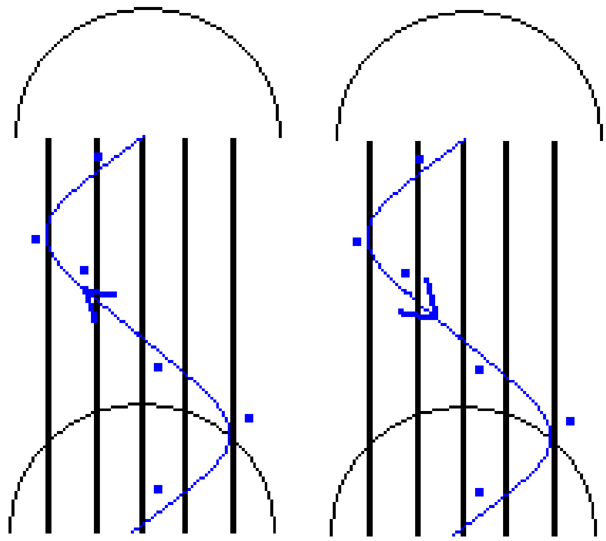
Step 1: Extract the soil from the roots zone (0 to 30 cm), between two plant and at 10 cm from the dripper line

Step 2: Collect the extract in a plastic bag and keep it closed

[1] Sample should be taken between two plants and at 10 cm from the dripper line

The sample should be crushed and kept free of big stones. When the analysis is not done directly on the field, soil sample should be dried before to be sent to the laboratory. Indeed, wet or damp samples stored for only a few days may yield unreliable results. Remove the soil from the plastic bag and spread it in a dry area in thin layers. Do not apply artificial drying by oven, stove or furnace as this may alter the sample result.

How to collect soil samples in the field?

The star method (open field)	The slalom method (green house)
	

Sample identification

The following information should be written on the plastic bag and if possible on a separated paper kept in the bag with the soil sample:

- Sampling date
- Farmers name and telephone
- Location
- Sample depth
- Number the bag if several samples are taken from the same farm

Technical sheet n 2: Soil salinity measurements

What is soil salinity?

Soil salinity corresponds to the amount of salt dissolved in the soil. For the same soil with the same amount of salt, soil salinity will range according to water content and temperature.

Material needed

Auger and plastic paper

Weight machine

Distilled water

EC meter

Cup

How to measure soil EC on the field?

Step 1: Sample your field 	Step 2: Mix well the sampled soil 	3: Weight 100g of soil 
4: Complete with 500g of distilled water 	5: Shake strongly during 4 min 	6: Measure the EC using a portable EC meter (mS/cm) 

To convert it in quantity of salt, this reading should be multiply by 4:

Total dissolved salt (g/kg) = Conductivity (mS/cm) x 4

How to appreciate soil EC toxicity?

The EC measurement in a sample diluted 5 times gives you the total amount of salt dissolved in your sample. Its appreciation must be done according to the soil organic matter content. More organic mater you have in your soil, less soil salinity will affect the crop. As an example, a soil that contain less than 4% of organic matter is considered salty when the reading is above 0,5. Commonly, the appreciation can be done as following:

Conductivity (mS/cm)	Salt content (g/kg)	Appreciation
0 to 0.4	0 to 1.6	Low
0.4 to 0.7	1.6 to 2.8	Medium
0.7 to 2	2.8 to 4	High
2 to 5	4 to 20	Risk of accident

Warning!! When a reading is high it is strongly advise to ask for laboratory analysis to get a measurement without sulfate (less dangerous for the plant) in order to appreciate the risk of chloride and nitrate.

Warning!! When a reading is high it is strongly advice to ask for laboratory analysis to get a measurement of sodium in order to appreciate its risk.

How to deal with high soil EC?

Before planting:
- Leach the soil as following:
  - irrigate during ¼ to ½ hour (15 to 30 mm)
  - 6 h later, irrigate again during ¼ to ½ hour (15 to 30 mm)
  - 24 h later leach the soil totally by applying around 200 mm of water
- Increase the amount of stable organic matter in the soil (dry cow or sheep manure, straw…)

Remarks: Chicken manure can not be used to control soil EC due to its high capacity of mineralization. It is recommended to use chicken manure before solarisation to increase soil temperature while leaching excess of elements produce during mineralization.

After planting:
- Decrease the amount of fertilizers used and concentrate on fertilizers having low salinity index

Technical sheet n 3: NITRATEST, a tool for nitrogen management

Nitrogen in the soil is a soluble and very mobile element. Its evolution depends on many factors (soil texture and temperature, mineralization, irrigation…) and it is usually difficult to evaluate the soil content. NITRATEST is a rapid method of analysis and a useful tool for diagnosis and fertilization decision making.

Material needed

NITRACHEK tester and strip

Auger and plastic paper

Weight machine

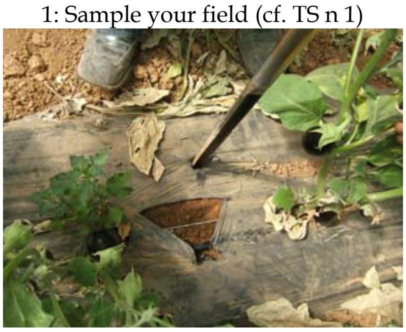
Filter paper

Distilled water

Small Cup

How to conduct the analysis

1: Sample your field (cf. TS n 1)



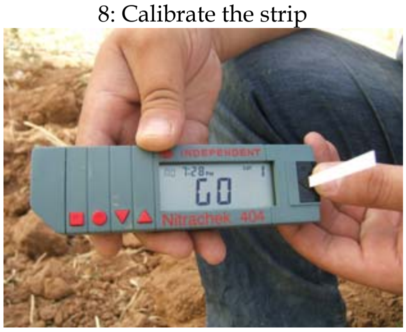
3: Weigh 100g of soil

4: Complete with 100g of distilled water

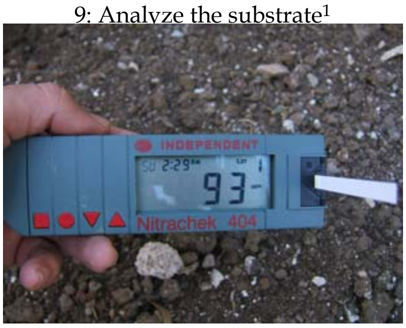
5: Shake strongly during 4 min

6: Position the filter in the soil past

8: Calibrate the strip



9: Analyze the substrate[1]



[1] Dip the strip during 3 sec in the solution, shake it well and wait 50 sec, place the strip in the NITRACHEK during the last 10 seconds. The reading is given in **ppm (mg/l)**. Repeat the procedure 2 to 3 times, do not take into account any result with a difference above 10%.

Result's interpretation

The amount of NO_3 available for the plant (in kg/ha) will be calculated by multiplying the tester result by a correction factor.

	Very humid (sticky soil)	*Humid (plastic soil)*	*Dry (crumbly soil)*
Very fine soil	2	1.8	1.7
Fine soil	1.6	1.4	1.3
Coarse soil	1.2	1.2	1.1

Usually, the common correction factor for most soils is **1.3** (density of 1.4: humidity of 15%, no stones in the sample, 30cm depth).

e.g.: 93 x 1.3 = 120 kg/ha = 12 kg/du

Remark 1: If the soil contains stones, the % of stones should be estimated and deducted from the total amount of nitrogen available.
Remark 2: The time between soil sampling and testing should be as short as possible. If the test cannot be done on the field, the sample should be kept in an icebox or in the fridge.
Remark 3: If the soil is too wet after the sampling, dry it during several hours. Remove the soil from the plastic bag and spread it in a dry area in thin layers. **Do not apply artificial drying by oven, stove or furnace as this may alter the sample result.**

Recommendations and application

$$\text{Fert.} = N^1 - N^2$$

Fert. = Quantity of fertilizer to be applied
N^1 = NO_3 need before planting (kg/du)
N^2 = NO_3 available before planting

Crop	NO_3 need before planting (kg/du)	Crop	NO3 need before planting (kg/du)
Squash	4 to 6	Eggplant	7
Salad	6	Cucumber	8
Melon	6 to 8	Cauliflower	10-15
Pepper	6 to 8	Potatoes	15-17

Example of NO3 soil requirements for different plant species

e.g.: For Salad (at the 18 leaves stage)

		Examples of fertilizer application	
NITRATEST result (kg/du)	Advised	Calcium nitrate	Ammonium Nitrate
> 6	No application	-	-
Between 4 to 6	1 application of 1,5 kg/du of N	10 kg/du	5 kg/du
< 4	2 application of 1,5 kg/du of N	2 x 10 kg/du	2 x 5 kg/du

Technical sheet n 4: Nitrogen monitoring in eggplant sap and interpretation using PILazo method

Main effects of nitrogen on eggplant

Excess	Deficiency
- Excess of vegetative development (risk is increased when using grafted planted) - Reduced fruit quality (non homogeneous color) - Reduced flowering and yield	- Pale green leaves - Reduced plant development - Reduced fruit size - Reduced the yield

PILazo method

<u>Step 1.</u> Build a nitrogen stock available for the plant before planting.

Eggplant needs about 7 kg/du nitrogen available before planting. This amount is needed to fill the gap between planting and the first irrigation (from 2 to 3 weeks). In order to ensure the nitrogen availability a NITRATEST should be done in the first 30cm soil layer (CF. Technical sheet number 3).

<u>Step 2.</u> Analyze sap weekly starting from the 3rd week.

Sampling shall be done on 15 first mature leaves from the main apex. Usually, the first mature leaf corresponds to the 3rd or 4th leaf of **the plant main branch**. Care should be taken to collect the 15 leaves from plants that represent well the current situation of the field. The sampling should be done early in the morning (before 10 a.m.) and must be conserved in icebox (5 degrees) if the analysis is not done directly on the field. Take care not to put the petioles in direct contact with the ice to protect them against frost.

Sap sampling procedure, analysis and interpretation

1. Material needed

NITRACHEK and strips

Crusher

1 and 5 ml string

Small Cup

2. Sampling procedure and sap analysis (dilution 1/20)

<u>Step 1:</u> Pick 15 adult leaves

<u>Step 2</u>: Separate the petioles

<u>Step 3:</u> Crush the petiole to get sap juice

<u>Step 4:</u> Take 0.5 ml of sap (or 1 ml)

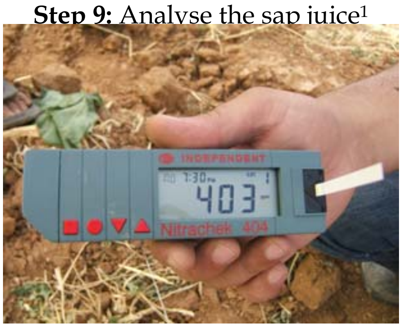
<u>Step 5:</u> Pour the sap in the cup

<u>Step 6:</u> Take 9.5 ml of distilled water (or 19 ml)

<u>Step 7:</u> Mix the water and the sap

<u>Step 8:</u> Calibrate the strip

<u>Step 9:</u> Analyse the sap juice[1]



[1] Dip the strip during 3 sec in the solution, shake it well and wait 50 sec, place the strip in the NITRACHEK during the 10 last seconds. The reading is given in ppm (mg/l). Repeat the procedure 2 to 3 times, do not take into account any result with a difference above 10%.

3. Interpretation

The result obtained on the screen should be multiplied by 20 and interpreted according to the plant stage as presented in the following table.

e.g: week 10; test result 403 x 20 = 8060 mg/l = VERY HIGH

NO3 (mg/l)																
> 6000																
5000 to 6000																
4500 to 5000																
3500 to 4500																
3000 to 3500																
2500 to 3000																
2000 to 2500																
1500 to 2000																
< 1500														Do not fertilize		
Week after planting	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Excess of nitrogen
No application needed
Apply 1 to 2 kg/du
Apply 2 to 3 kg/du
Apply 5 to 10 kg/du

<u>Remark</u>: If, after the application of nitrogen, the sap content does not increase, do a soil analysis to check the availabilities of nitrogen. Plant may not be able to uptake nitrogen due to irrigation deficiency or cold soil temperature. In this case spray fertilizers may be used to fulfill the plant needs.