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The “buried diffuser” a new technique:

- for underground-localized irrigation of Vegetables, shrubs, trees, and plants in containers,
- for the anticipated irrigation and the injection of the dams retention water , the natural Spring’s water and the water of rivers

The “gravity draining floater” a new technique:

- for the “pumping” and distribution of the natural Springs water and rivers
- for the “pumping” and distribution of the retention Water of the hill lakes and other similar (small sized) Runoff water retention managements

August 2012

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- **for underground-localized irrigation of Vegetables, shrubs, trees, and plants in containers,**
- **for the anticipated irrigation and the injection of the dams retention water , the natural Spring’s water and the water of rivers**

Considering the problems of water in the Arab countries, and in the arid and semi arid regions in the world, Dr.CHAHBANI Bellachheb (senior teacher researcher in Arid Regions Institute in Tunisia), has invented a new technique for irrigation and for the injection of retention water or natural spring’s water to be conserved in the deep soil horizons. This Technique is called: “buried diffuser”. It has an invention patent in Tunisia and worldwide (PCT). A Tunisian industrial and commercial company (Chahtech SA) is created to manufacture and to distribute worldwide the different types of diffusers. The mean objectives of the invention are:

- *- Enhance the efficiency of the water resources, use of less water to produce food : “more crop per drop”,
- *- Increasing the productivity of rain fed agriculture specially rain fed trees(olive, figs, grape, almonds, apples, and other species in the world),
- *- Make the rainfed agriculture sustainable taking in consideration the irregularity of rain: existence of humid and very humid year and the existence of short drought periods(seasonal) and long drought periods(one till three successive years) ,
- *- Conservation of the oasis and combating desertification,
- *-Combating soil salinization when the irrigation water contains 3 to 5 grams salts per litter.

The diffuser for underground irrigation is a new irrigation technique which could be manufactured using several raw materials (plastic, cement, metals, ceramic etc...), but the adequate and cheapest process is plastic injection using specific moulds and plastic injection machines. The diffuser for underground irrigation has three mean utilizations:

- *-Irrigation of trees (fruit trees, forest trees, ornamental trees) and shrubs,
- *- Irrigation of the vegetables in fields and in green houses,
- *- Plants in containers, pots or boxes,

The diffuser has several shapes and has as principal function the facilitation of irrigation water storage in the soil in the field or in the container. The storage is done in the zone containing the great part of root system of the tree or the plant. For this facilitation the diffuser has specific part composed of a porous material allowing a rapid infiltration of the irrigation water. This porous material does not retain the water in the pores or on the surface of the material. This is to avoid its obstruction by the fine roots.

For the Irrigation of trees (fruit trees, forest trees, ornamental trees), the diffusers are installed in pits or holes, 50 to 70 cm below the soil surface (topographic surface). It is possible install the diffusers in the plantation pits before the installation of the tree. In this case the diffuser should be 50 to 70 cm far from the axis of the tree. When the diffusers are added after the trees plantation, in this case they should be installed in the extremities of the canopies.

For the Irrigation of shrubs and perennial medicinal or ornamental herbs, the diffusers are installed in pits or holes 20 to 40 cm deep below the soil surface (topographic surface) and 20 cm far from the axis of the shrubs and perennial medicinal or ornamental herbs.

For the Irrigation of vegetables in fields and in green houses, the diffusers are installed about 3 cm far from the axis of the plant and 5 to 10 cm deep below the soil surface (topographic surface).

For the irrigation of Plants in containers, pots or boxes, the diffusers include small water reservoirs to be filled during the irrigation. The capacities of the small reservoirs are few litters depending on the volumes of soil (to be completely “wetted”) contained in the containers, boxes or pots. The moisture of the container soil, after the irrigation using the diffusers, is sufficient for several days or weeks. This duration is at least 3 times longer then the existing irrigation methods (capillarity, and surface, and dripping).

The trial of diffuser prototypes has been done in the farmers’ fields’ conditions and in

the Arid Regions Institute experimental fields. The mean results are:

*-Great irrigation water saving. This saving reaches 100% for the irrigation of the trees using buried diffusers. The comparison of diffuser prototypes at laboratory level, outside, with surface and drip irrigation, during 2 months of summer 2003, demonstrates the superiority of the diffuser in saving water. 61 days after the irrigation, the diffuser allowed to save 34 % of the initial irrigation water amount, the surface irrigation allowed only 3,4% and the drip irrigation allowed 8%.

*- An important reduction of number of irrigations .This is a result of water saving which prolongs the duration between two irrigations. This was confirmed by the comparison of irrigation of ornamental plants in containers using surface irrigation and buried diffusers. The results of this trial show:

- After 2 months, the water content in the containers irrigated by buried diffusers is 89 and 91%. For the surface irrigation the values are respectively: 51 and 54%,
- After 4 months, the water content in the containers is : 22,6% and 20,6% for the surface irrigation, and 81% and 84% for the diffuser,
- This means that in a programmed irrigation, when the water content in the containers reaches 50% of the field capacity, the periodicity of irrigation is 2 months for the surface irrigation and 6 months for the buried diffuser.

*-An important crop productivity and irrigation water efficiency. This is demonstrated, in the farmer field in the oasis of Regim Maatoug (Desert of south of Tunisia). For full conventional water volume (500 liters per plant during the cycle), the production of 112 pimentos plants irrigated using buried diffusers, is 716 kilograms. In the drip irrigation, the production of 112 pimentos plants is 141 kilograms. That means that one liter of water produces one kilogram and 432 grams for the buried diffuser irrigation and only 282 grams for the drip irrigation. For the same irrigation water amount the diffuser produces 4 times more than the drip irrigation.

The second use of the buried diffuser is the injection of retention water or natural spring's water to be conserved in the deep soil horizons. This second use is very important because it is an efficient solution to avoid the negative impacts of seasonal and long period(1 to 3 years) droughts. The injection by buried diffusers uses especially the huge volumes of water which are not harvested and retained by the different sizes of retention infrastructures (big dams, hill lakes, "jessours", traditional underground masonry reservoirs, etc.) during the torrential rains. It uses also the water flowing from the natural springs and not use during the autumn, winter and the beginning of spring.

This injection has been done in the village of Djebba (Thibar-governorate of Beja-North of Tunisia). During 3 months each buried diffuser has injected **2500 liters** of water coming from a natural spring. The injection has been done in the deep (50 cm below the soil surface) soils horizons (heavy soil)of a farmer field planted with fig trees.

The 23 328m³ non used water of spring (with a flow of 1 liter/second.), going to the rivers (from September till May) if this volume is injected in the soil horizons, it is sufficient for the water needs of about 518 adult olive trees during 3 years.

The lost water during 1 rainy and 1 very rainy year , 1 550 000 Cubic meters. This volume if it is injected and stored in deep layers of the soil , using the buried diffuser. is sufficient to maintain in good conditions of production for 34 444 adult olive trees, during three dry years (each tree has 15 Cubic meters per year) .

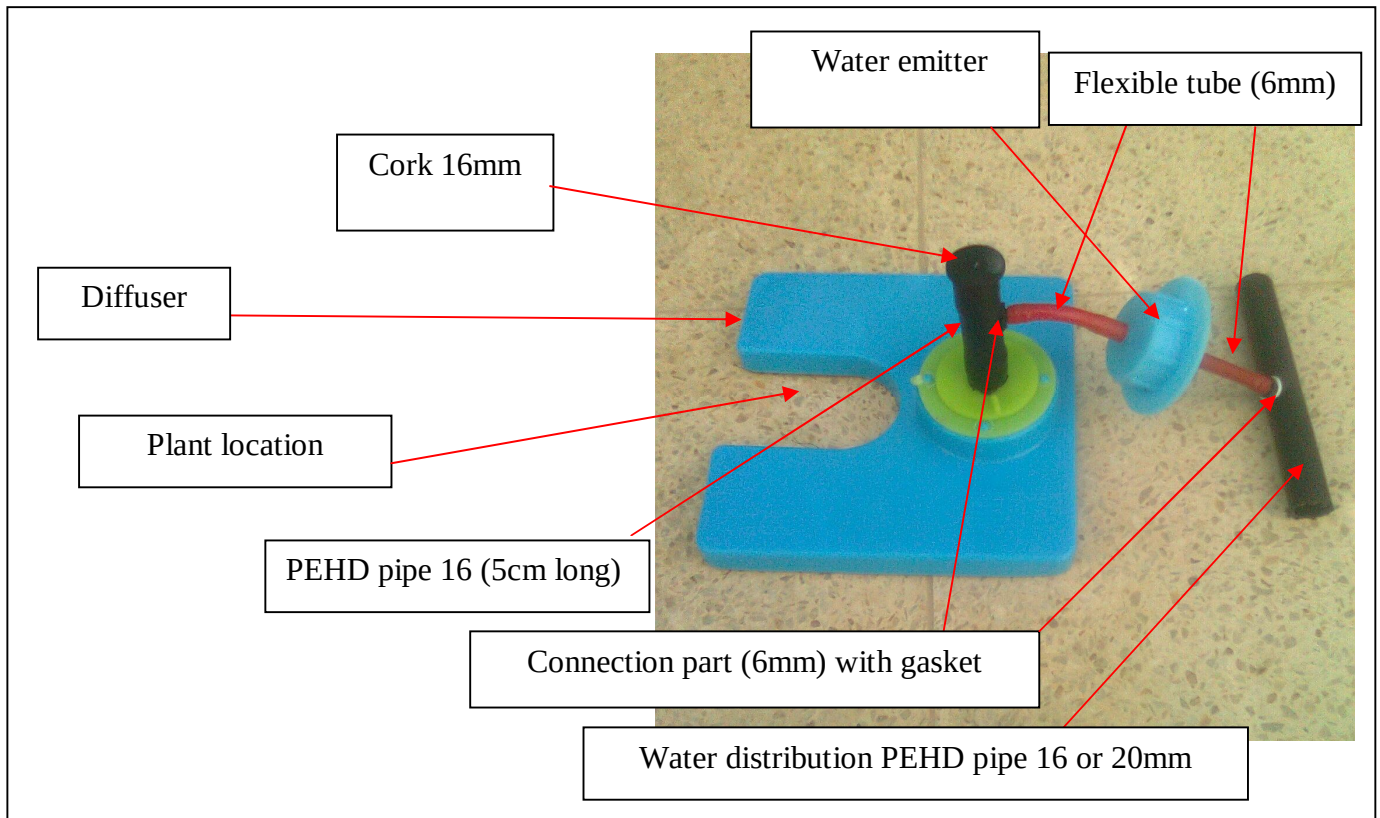
Other advantages of the irrigation using the buried diffuser:

➤ Important Energy saving by reducing the pumping time resulting from the reduction of needed irrigation water,

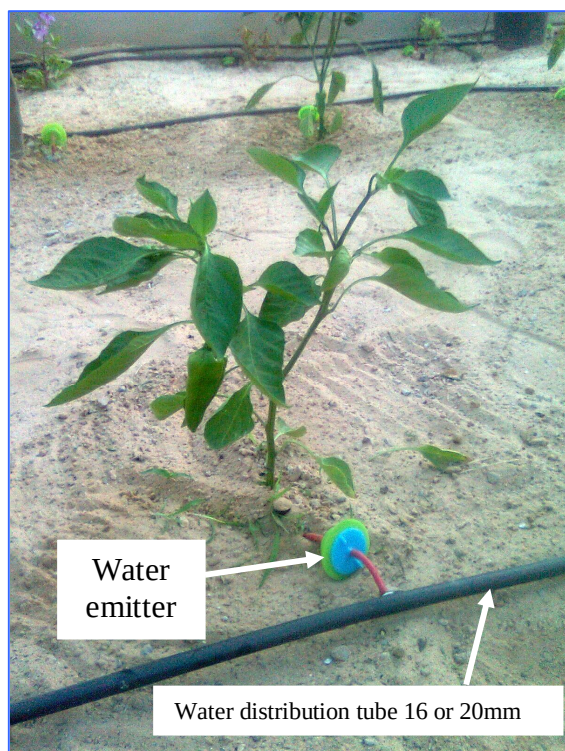
➤ Reduction of water vapor in the atmosphere inside the greenhouses. This has a good

impact by reducing the development of diseases. This low rate of water vapor inside the greenhouses, facilitates the movement of pollen and increase the rate of flowers producing fruits.

- Important reduction of soil salinization when using salty irrigation water (3 to 5 grams salt per liter). This reduction is estimated 9000 kilograms per year and per hectare (with irrigation volume of 10000 cubic meters with 3 grams per liter salts, 3000 cubic meters of the volume are evaporated).
- Better "look" of landscaping areas, because the irrigation water distribution network could be totally buried (20 cm below the topographic surface) when using buried diffusers.
- Important reduction of the air pollution resulting from the use (for irrigation of the recreation and green areas) of treated waste water.
- Important energy saving at least 70% less than drip irrigation. This is a result of the reduction of the irrigation frequency and by the possibility to use the gravity (very low water pressure) during the irrigation. In this case the irrigation water is stored in a simple reservoir on the soil surface.
- Important reduction of :
 - *-Labor for the maintenance of soil: weeds pulling out, irrigation frequency, mulching actions, etc,
 - *-Fertilizers amounts, because there is less degradation of the fertilizers, and less loss by leaching, this reduces the pollution of the ground water by the leaching chemical components,
 - *-Herbicides and pesticides because there are no weeds in the irrigation by buried diffuser (for vegetable fields and trees plantations), this is a great contribution in the protection of the environment.



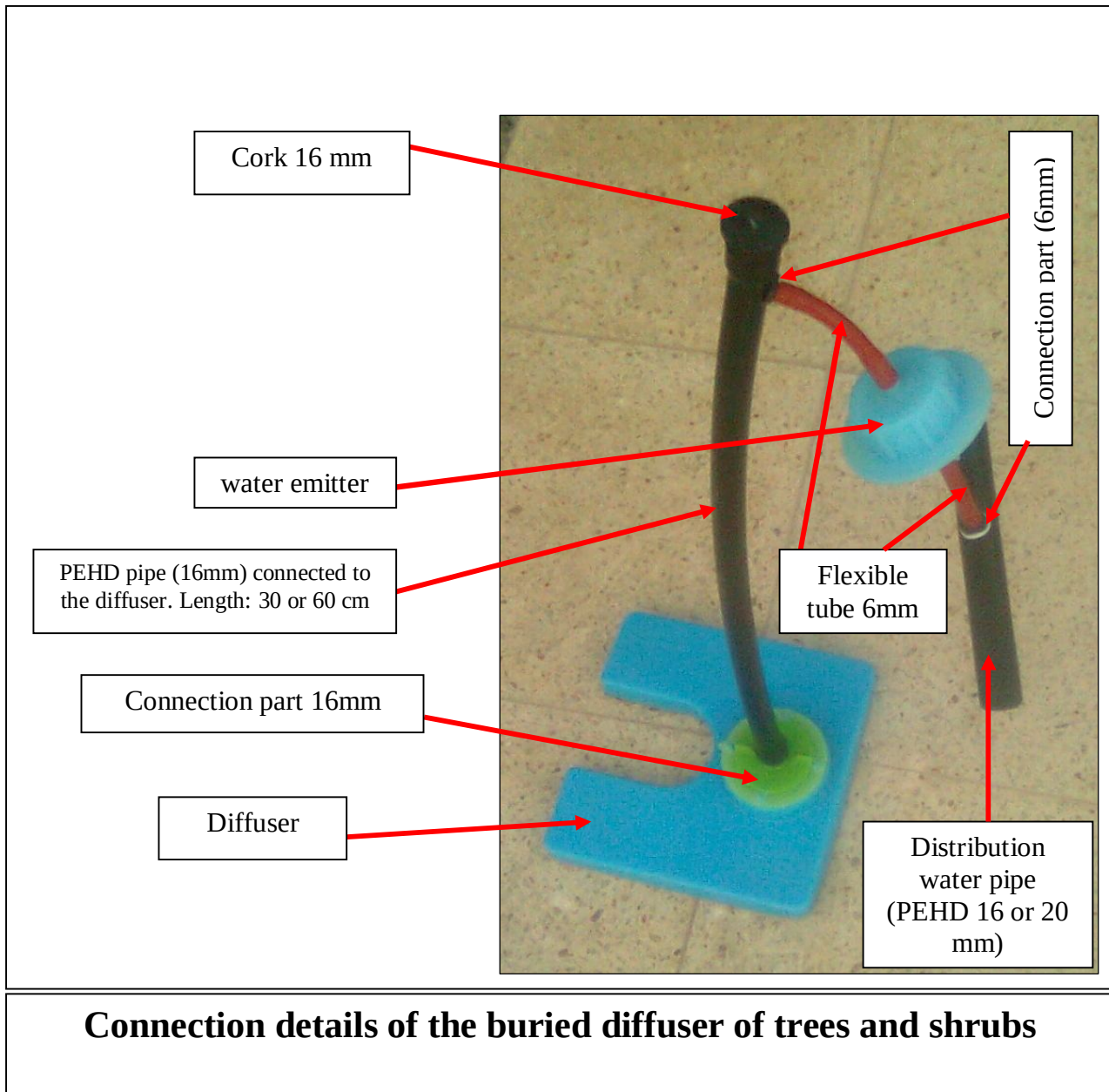
Connection accessories of the integrated water emitter for buried diffuser of vegetables



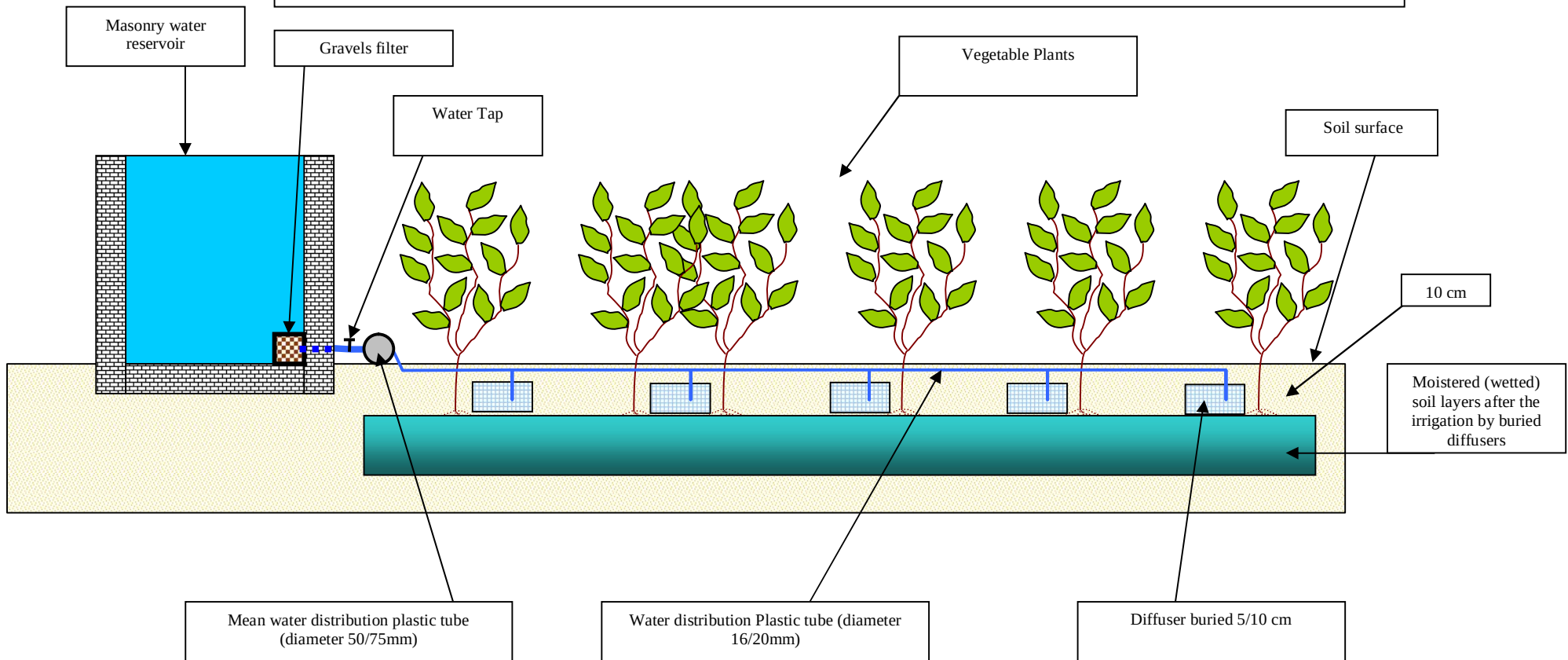
Mimintoe irrigated with buried diffuser



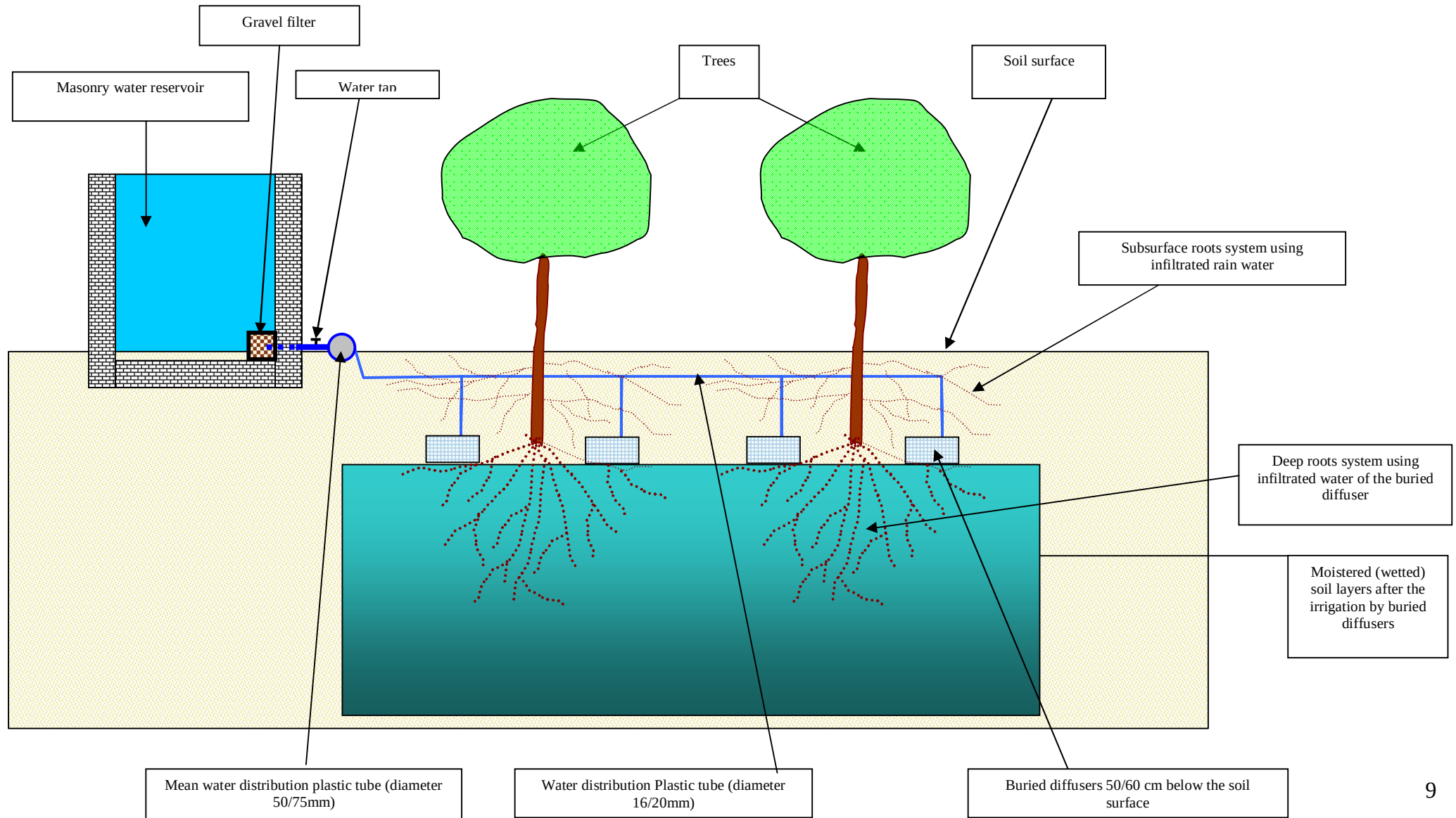
Private garden with pimentoes and orange trees irrigated with buried diffusers



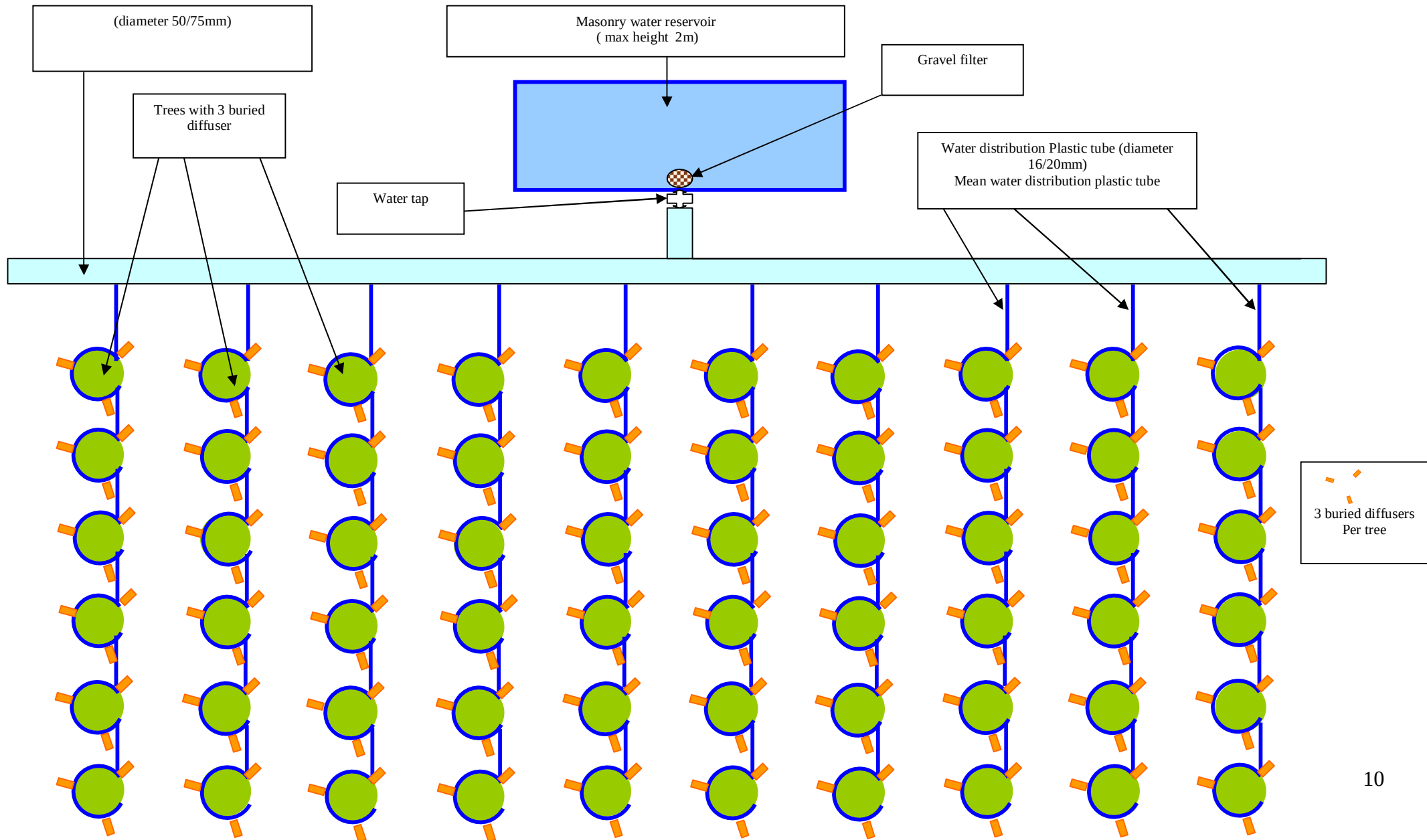
**Cross section of vegetables irrigation with buried diffusers using gravity water flowing
(from a reservoir built on the topographic soil level) and low water pressure (0,1bar)**



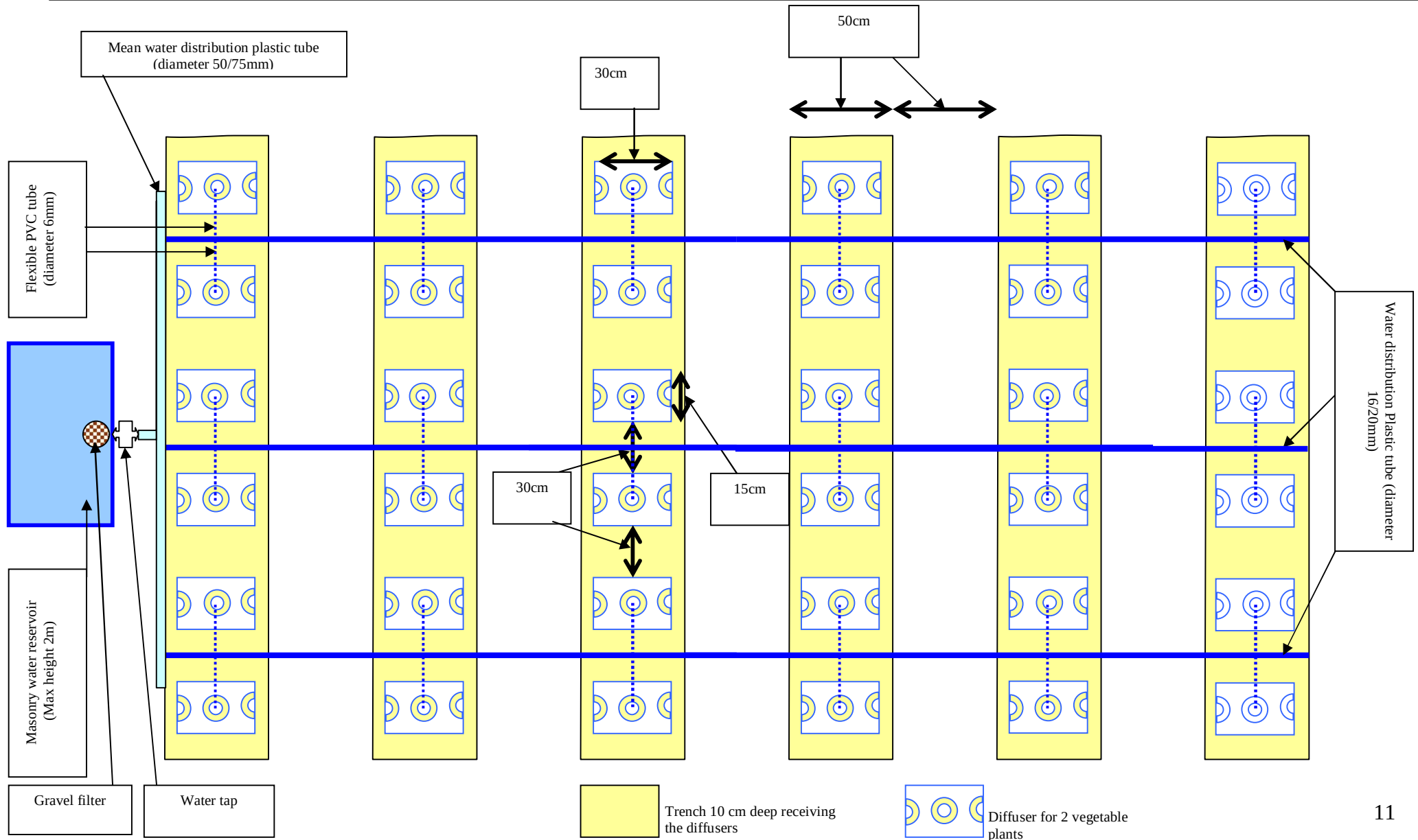
Cross section of trees irrigation with buried diffusers using gravity water flowing (from a reservoir built on the topographic soil level) and low water pressure (0,1bar)



Plan view of trees irrigation with buried diffusers using gravity water flowing (from a reservoir built on the topographic soil level) and low water pressure (0,1bar)



Plan view of vegetables irrigation with buried diffusers using gravity water flowing (from a reservoir built on the topographic soil level) and low water pressure (0,1bar)

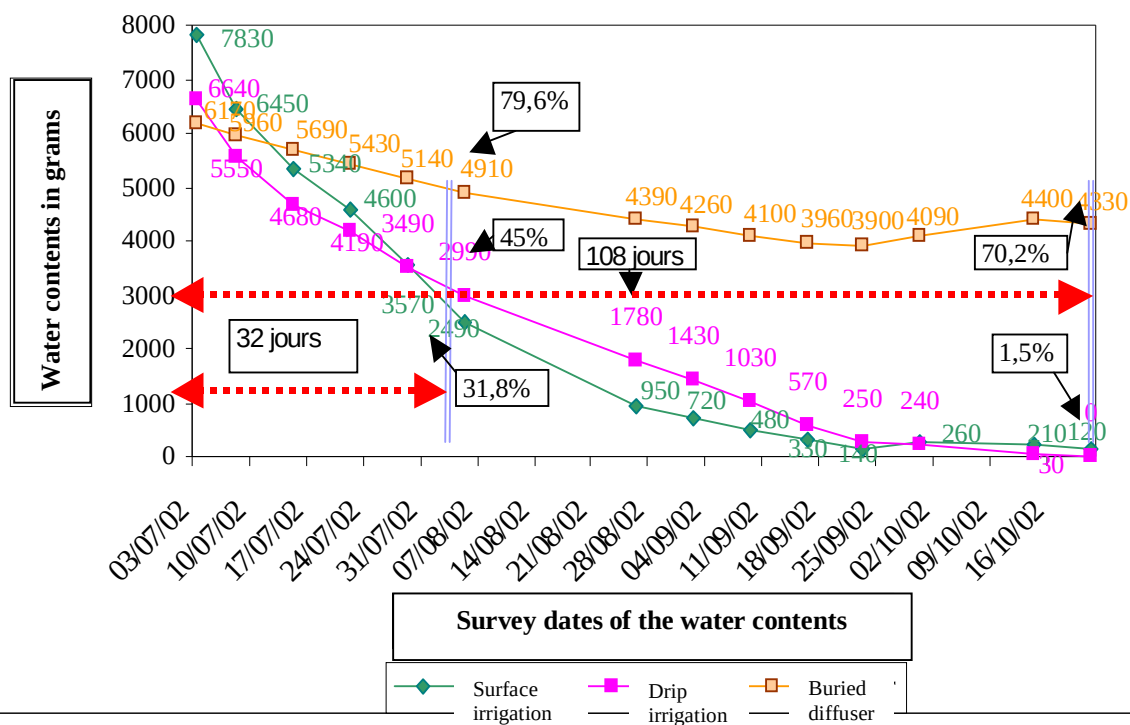


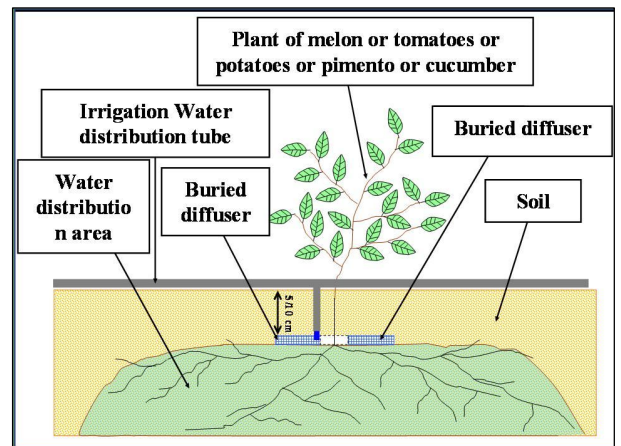
Comparison of irrigation of ornamental plants in containers using surface irrigation and buried diffusers during the period: 15/10/2003 and 18/2/2004

Periodicity of Data survey	Irrigation method							
	Surface irrigation		Buried diffuser		Surface irrigation		Buried diffuser	
15/10/03	8925	100 %	9600	100%	9565	100%	8135	100 %
16/12/03	4890	54%	8770	91%	5240	51%	7290	89%
18/02/04	2025	22,6%	8095	84%	1970	20,6%	6585	81%

4 Months

Evolution of water amounts in ornamental plants containers irrigated with surface irrigation, drip and buried diffuser, outdoor on the roof of a building-Medenine south of Tunisia





Melon and pimentos in greenhouse irrigated with prototypes of buried diffusers

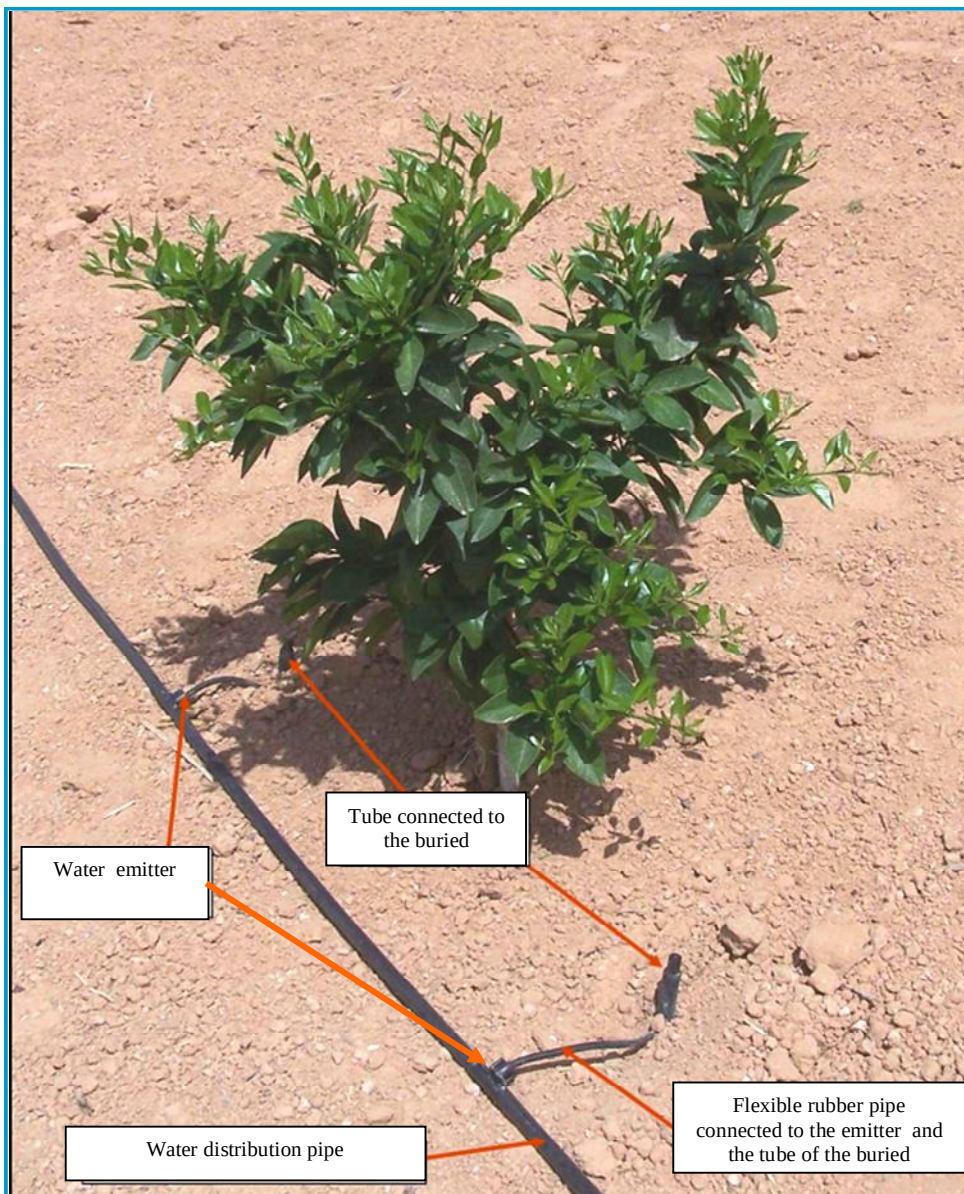
Total Production in kilograms for 112 plants	Volume of irrigation water per plant in litter	Irrigation technique	Number of Plants an ¹ specie
716	500	Buried diffuser	112 Pimentos
141.2	500	drip	112 Pimentos
382,5	250	Buried diffuser	112 Pimentos
103.7	250	drip	112 Pimentos

Trial results of comparison of irrigation by drip and by buried diffusers in the green house of farmer field in Regim Maatoug (desert of south of Tunisia)

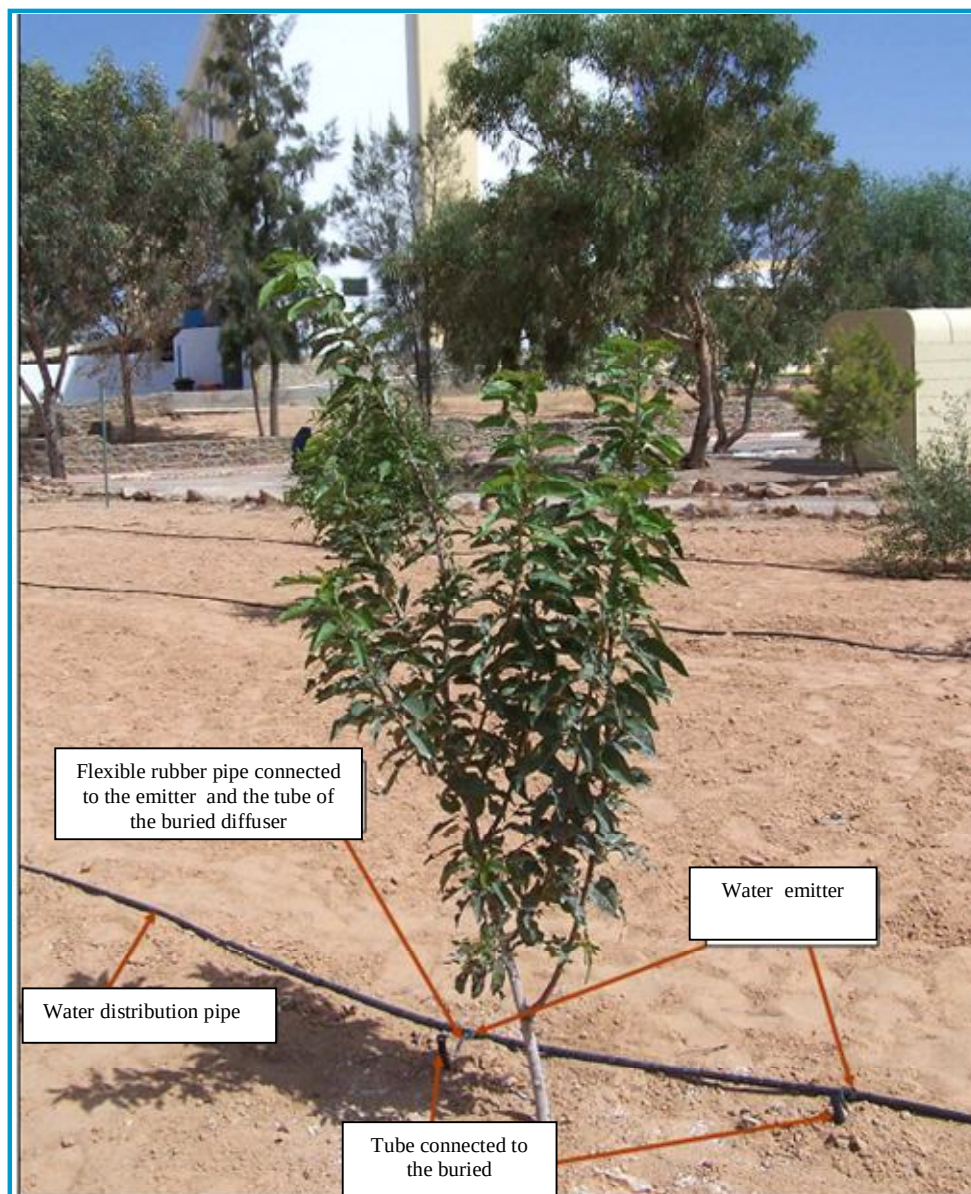
$$\frac{382}{141} = 2,7$$

$$\frac{382}{103} = 3,7$$

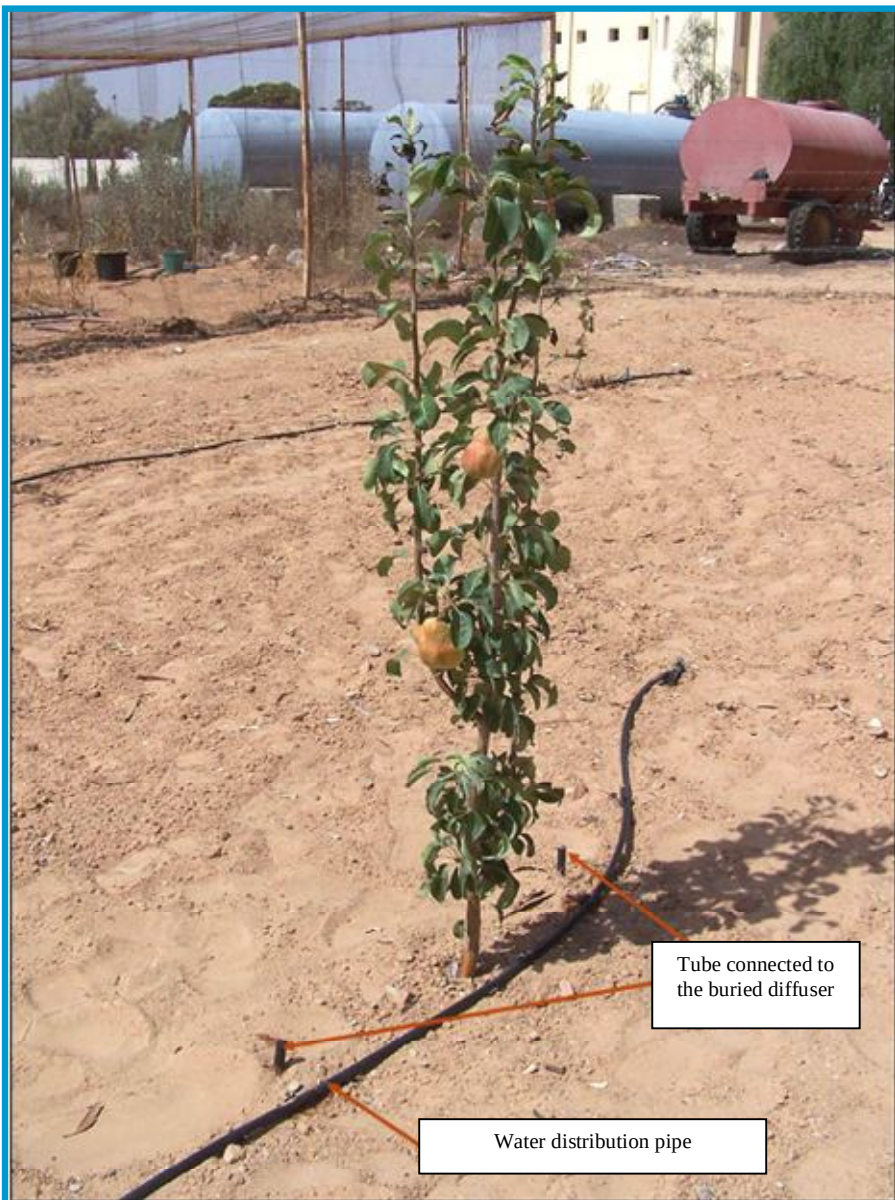
$$\frac{716}{141} = 5$$



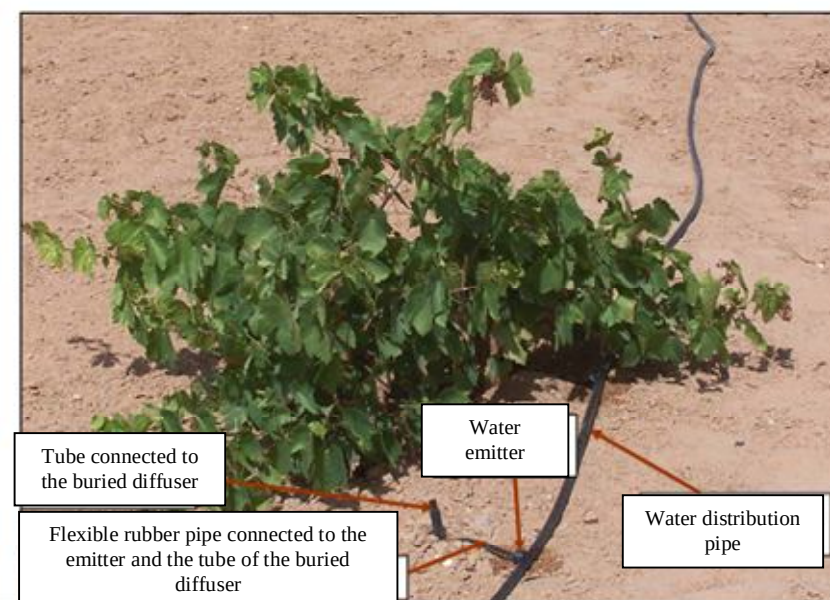
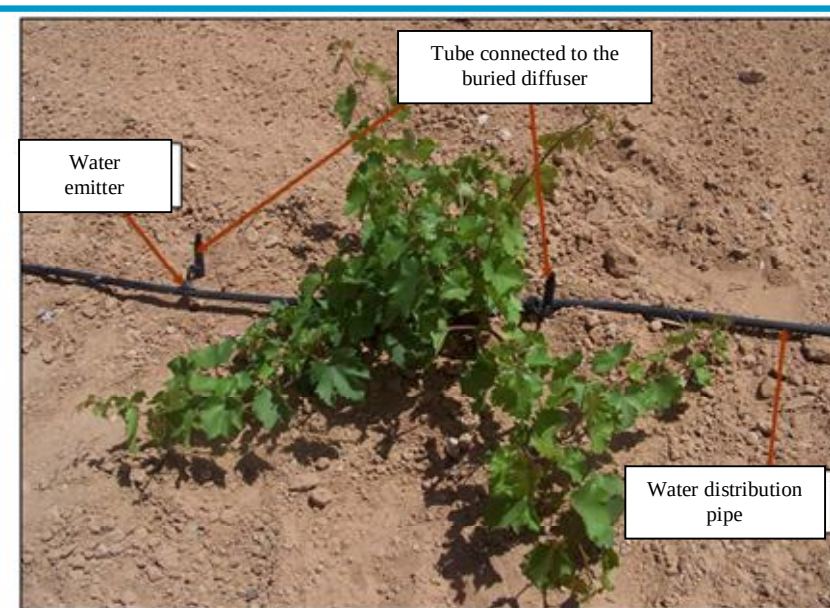
Orange tree irrigated with 2 buried diffusers in fruit trees plantation of Arid regions Institute(Medenine-South of Tunisia)



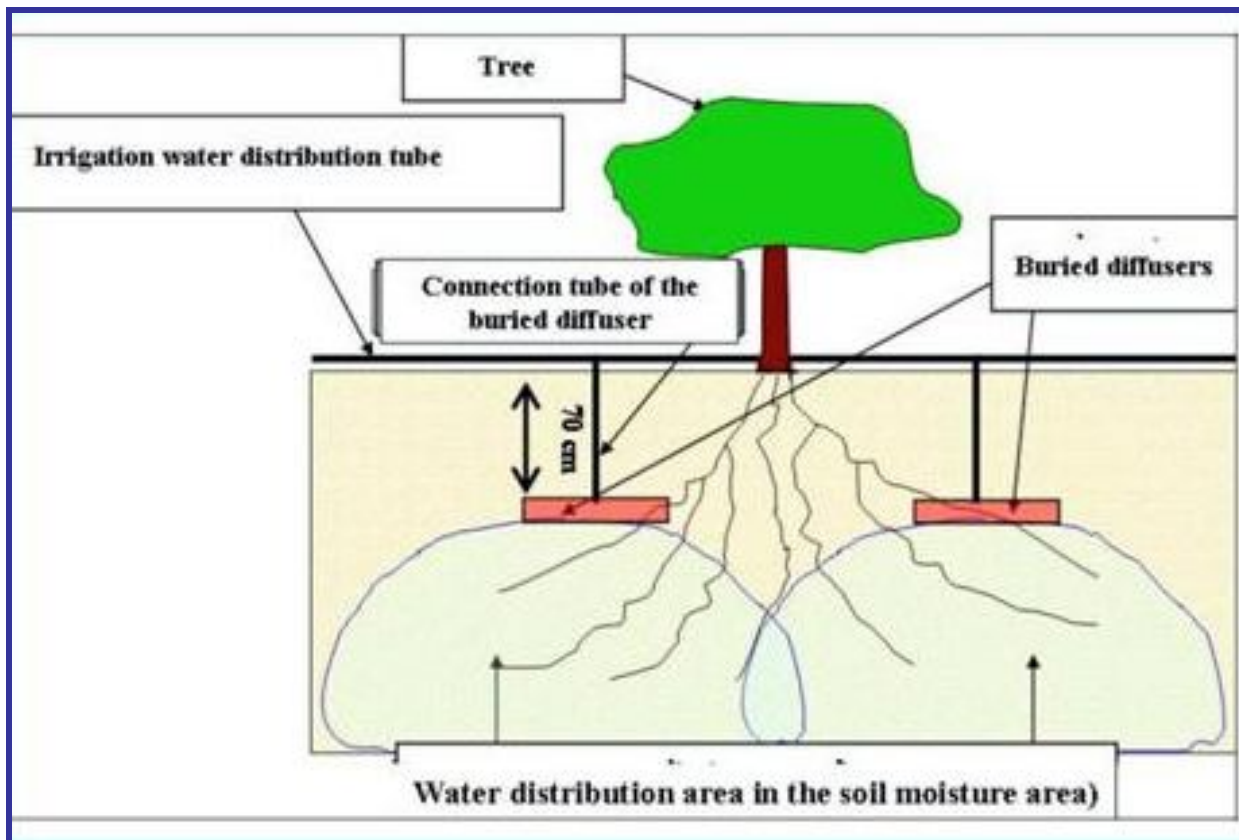
Cherry tree irrigated with 2 buried diffusers in fruit trees plantation of Arid regions Institute(Medenine-South of Tunisia)



Pear tree irrigated with 2 buried diffusers in fruit trees plantation of Arid regions Institute(Medenine-South of Tunisia)



Grape tree irrigated with 2 buried diffusers in fruit trees plantation of Arid regions Institute (Medenine-South of Tunisia)



November 24th 2008

Orange tree, 3 years old, irrigated with buried diffusers
Experimental field of Arid Regions Institute-Medenine (South of Tunisia)



Installation of diffusers for dates palm trees in a private plantation in the oasis of Douz in the Desert (Kebili South of Tunisia)



Buried diffuser in the pit with the 16mm connection tube



Installation of diffusers for olive trees in a private plantation in Sfax, South of Tunisia



Drilling Auger

Use of drilling auger to prepare the pits (holes) for the installation of the buried diffusers for orange trees in Beni Khalled , Cap Bon North of Tunisia

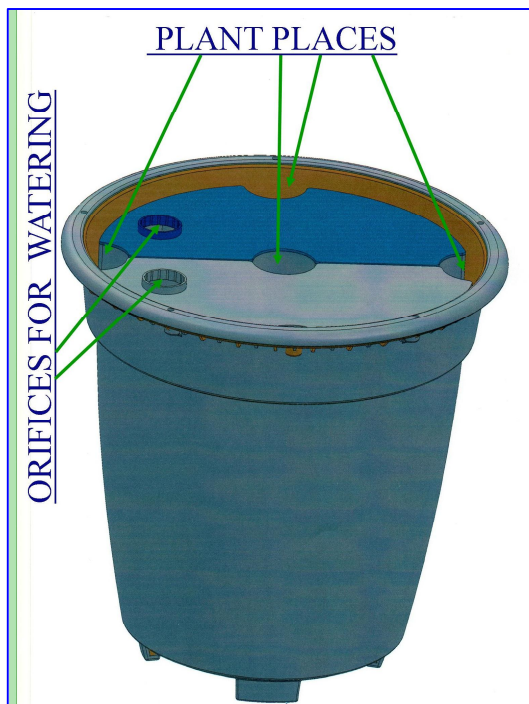


Installation of the buried diffusers for orange trees in Beni Khalled , Cap Bon North of Tunisia

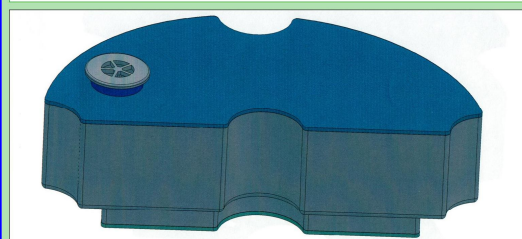
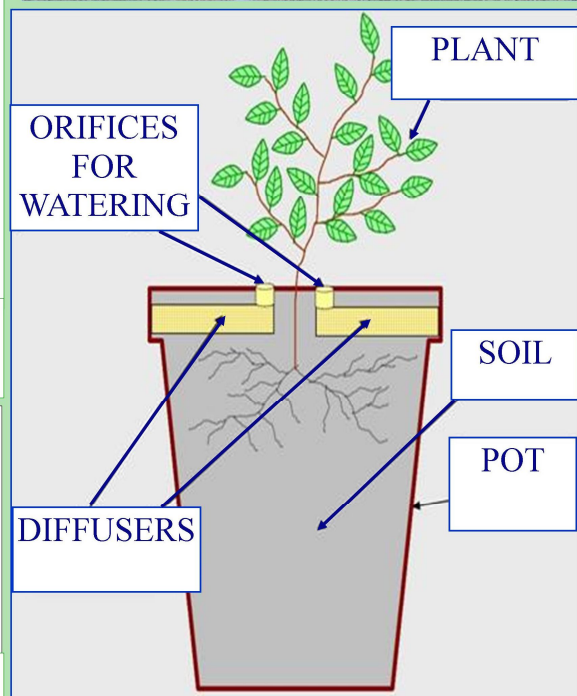


Young orange tree in a private garden irrigated with buried diffusers

Photos Takelsa



Pot with a couple of buried diffusers with reservoirs



diffuser with reservoir



A couple of diffusers with reservoirs for pots



Pot with a couple of diffusers with reservoirs

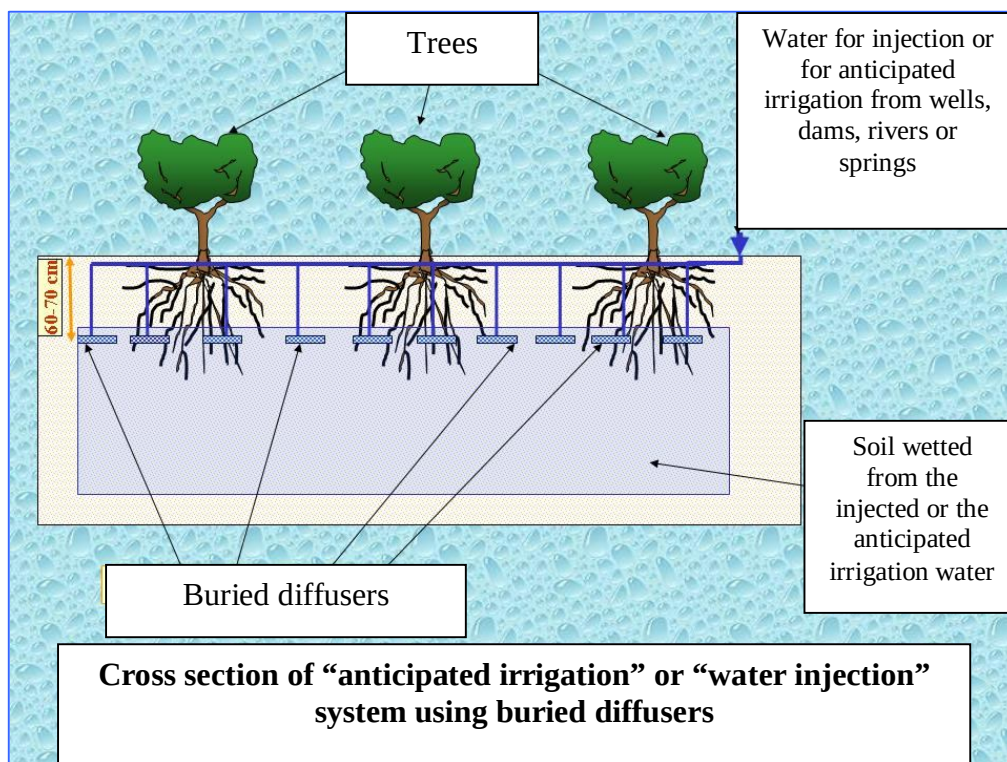
Buried diffuser for anticipated irrigation and water injection and storage in the deep soil layers

Chahtech SA after the use of the buried diffuser in the normal irrigation has created a new method of “anticipated irrigation and water injection in the deep soil layers “. The goal of this new concept is: how to save and conserve the huge of water received during the wet season, for the next dry season. More then that in other regions of the world the challenge is higher: how to save and conserve the huge of water received during the wet or rainy years to be used during the long dry period: one till 3 years?

For the "anticipated irrigation», instead of irrigation during the hot or the dry season, the irrigation using buried diffusers is done during the autumn and winter or during the rainy season. The amount of water of the «anticipated irrigation» should cover the total need of the crop during the hot or dry season (spring and summer). This water amount is stored in the deep soil layers will be used by the deep or sob surface roots systems of the crops.

For the "water injection in the deep soil layers” it is useful especially for trees crops. The injected water comes from: dams, rivers, and springs. The amount of the injected water could cover the need of the trees for several years (3years) when the soil below 60cm is thick (1 meter or more). This injected water is conserved in the deep soil layers (60 cm below the soil surface) and used later by the deep root systems of the trees during a long drought period: six months till 3years. During the Drought the trees produce normally using the injected water.

Both: “anticipated irrigation” and “water injection”, are solutions for drought mitigation and for climate change adaptation.





The lost water during 1 rainy and 1 very rainy year is **1 550 000 Cubic meters**. This volume could be injected, using buried diffusers, and stored in deep layers of the soil . The injection of 1 550 000 Cubic meters is sufficient to maintain in good conditions of production for **34 444** adult olive trees, **during three dry years** (each tree has 15 Cubic meters per year). This water stored in deep soil layers is very important for the trees plantations used to be irrigated yearly, and suffer from long drought(2 till 3 years) like it is illustrated in



The water flowing from the natural springs and not used during the autumn, winter and the beginning of spring is lost in the rivers. This lost water is estimated $23\,328\text{m}^3$ (from September till May) for a spring with a flow of 1 litter/second. If this volume is injected in the soil horizons, using buried diffusers, it is sufficient for the water needs of about 518 adult olive trees during 3 years (without any rain).



This injection of spring's water has been done in the village of Djebba (Thibar-governorate of Beja-North of Tunisia). During 3 months each buried diffuser (connected to a reservoir filled with water coming from springs as shown in the photo above) has injected **2500 liters** of water coming from a natural spring. The injection has been done in the deep (50 cm below the soil surface) soil horizons (heavy soil) of a farmer field planted with fig trees.

BURIED DIFFUSERS FOR THE INJECTION OF RAIN WATER (RETAINED IN DIFFERENT SIZED RESERVOIRS) AND THE WATER OF THE NATURAL SPRINGS , IN THE DEEP SOIL LAYERS



Installation of buried diffusers for the injection springs water(stored in a concrete reservoir, in the deep soil layers of figs' trees plantation in Djebba Beja Governorate North West of Tunisia

Photos anticipated irrigation in Takelsa

THE BURIED DIFFUSER

is a recommended solution for :



Sustainable Agriculture



Climate change Adaptation



Combating desertification



Drought mitigation



**Food Security and Hunger Eradication
and Poverty alleviation**

Chahtech SA-Tunisia



Innovation and Efficiency

THE BURIED DIFFUSER

**A PRODUCT OF « CHAHTECH SA »
DJERBA-TUNISIA**

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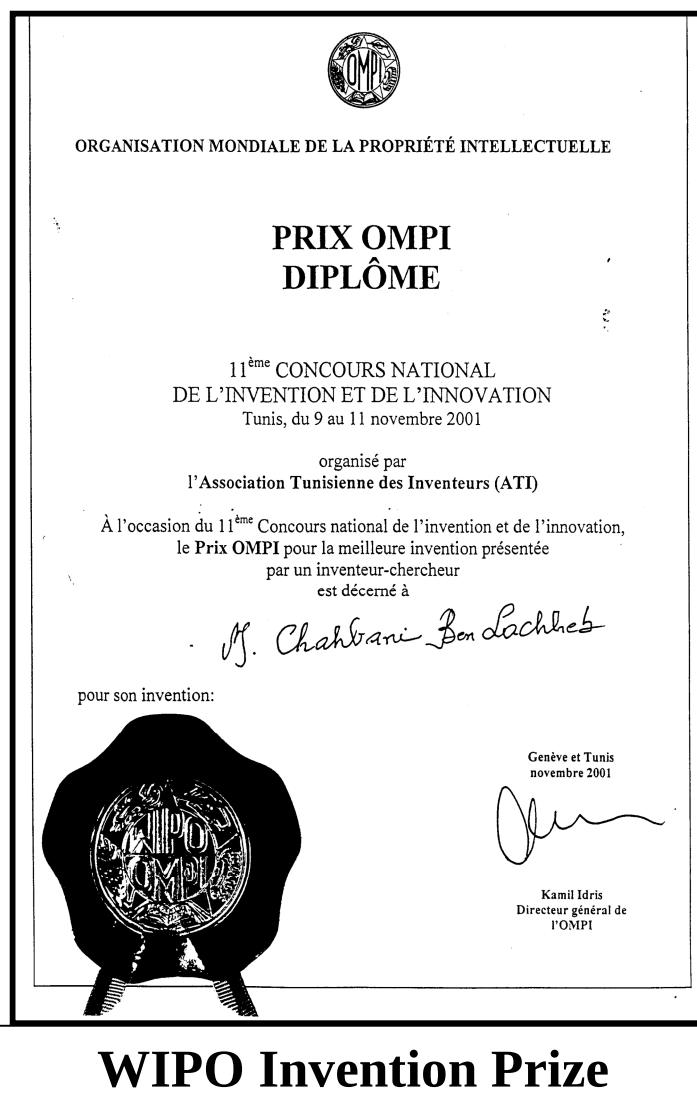
Tel/fax : +21675654391 **Mobile Phone :** +21698254383

THE BURIED DIFFUSER IS A WORLDWIDE PATENTED INVENTION INTERNATIONALLY AWARDED :

- 1-Hydrotop Water Prize (2001),
- 2-WIPO Invention Prize (2001),
- 3-ALECSO Water Prize (2002),
- 4-Maghreb Union Combating Desertification
Technologies Prize (2007),
- 5-UNESCO International Water Prize(2009),
- 6-Top 50 SME Infodev-World Bank(2011).
- 7-Top 20 SME(*Access to Market and Finance Award*)
Infodev-World Bank(2011).



Hydrotop Mediterranean Water Prize



WIPO Invention Prize



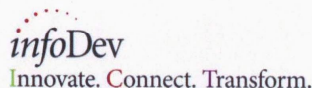


infoDev Global Top 50 Competition

This Certificate is Hereby Granted to
Chahtech (Chahbani Technologies) S.A
who has been selected as the winner of the
Top 50 SME Award

held at the 4th Global Forum on Innovation & Technology Entrepreneurship
in Helsinki, Finland
April 15, 2011

Valerie D'Costa
Program Manager, infoDev



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June 1, 2011

Valerie D'Costa
Program Manager, infoDev



The “gravity draining floater” a new technique:

- for the “pumping” and distribution of the natural Springs water and rivers**
- for the “pumping” and distribution of the retention Water of the hill lakes, dams and other similar (small Sized) Runoff water retention managements**



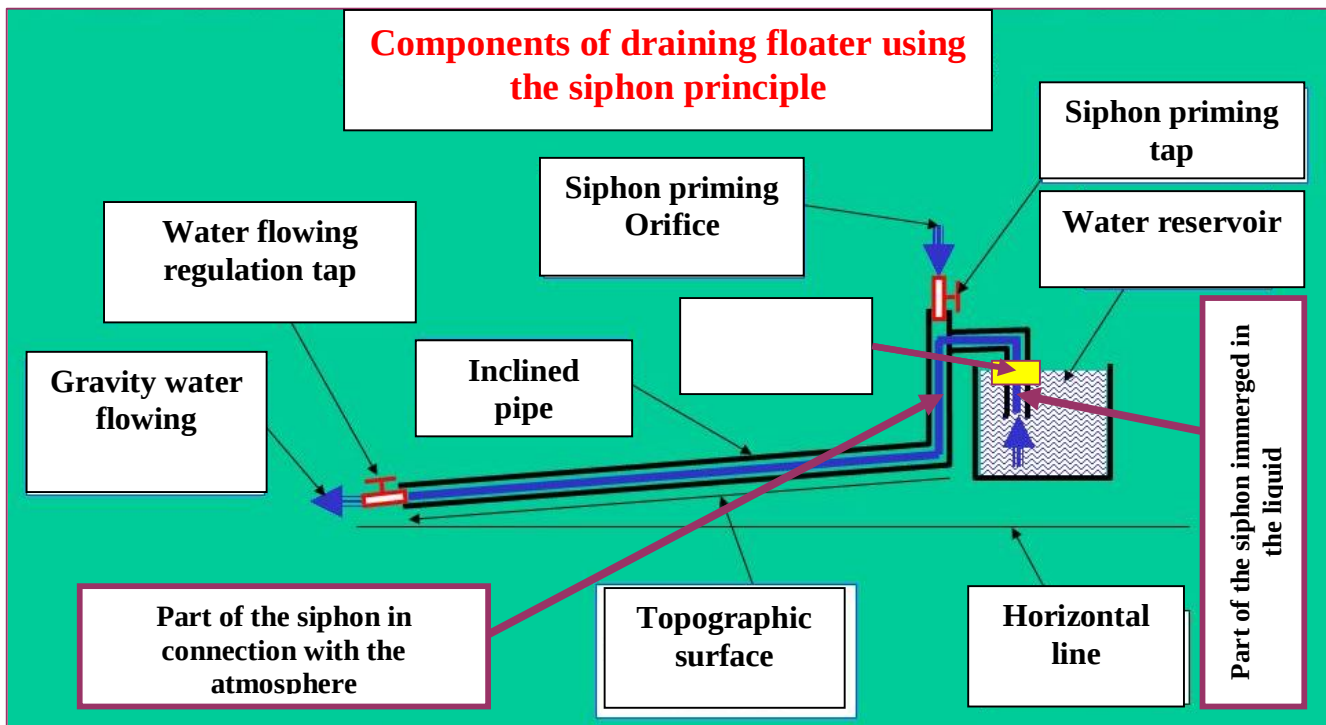
Big sized draining floater for big dams and rivers



**Small sized draining floater for small water
rain water storage concrete reservoirs**



**Middle sized draining floater for middle
dams(1000 till 10000 cubic meters)**

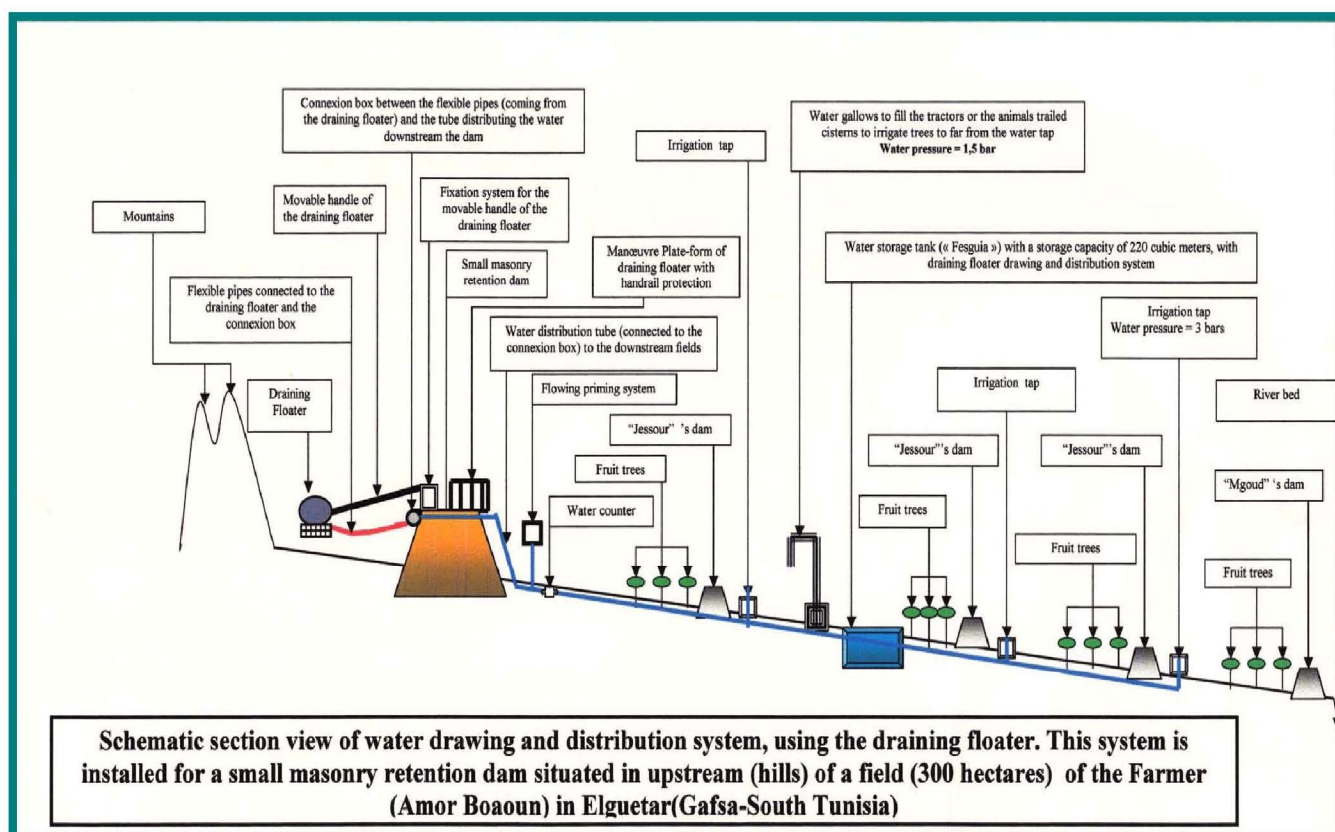
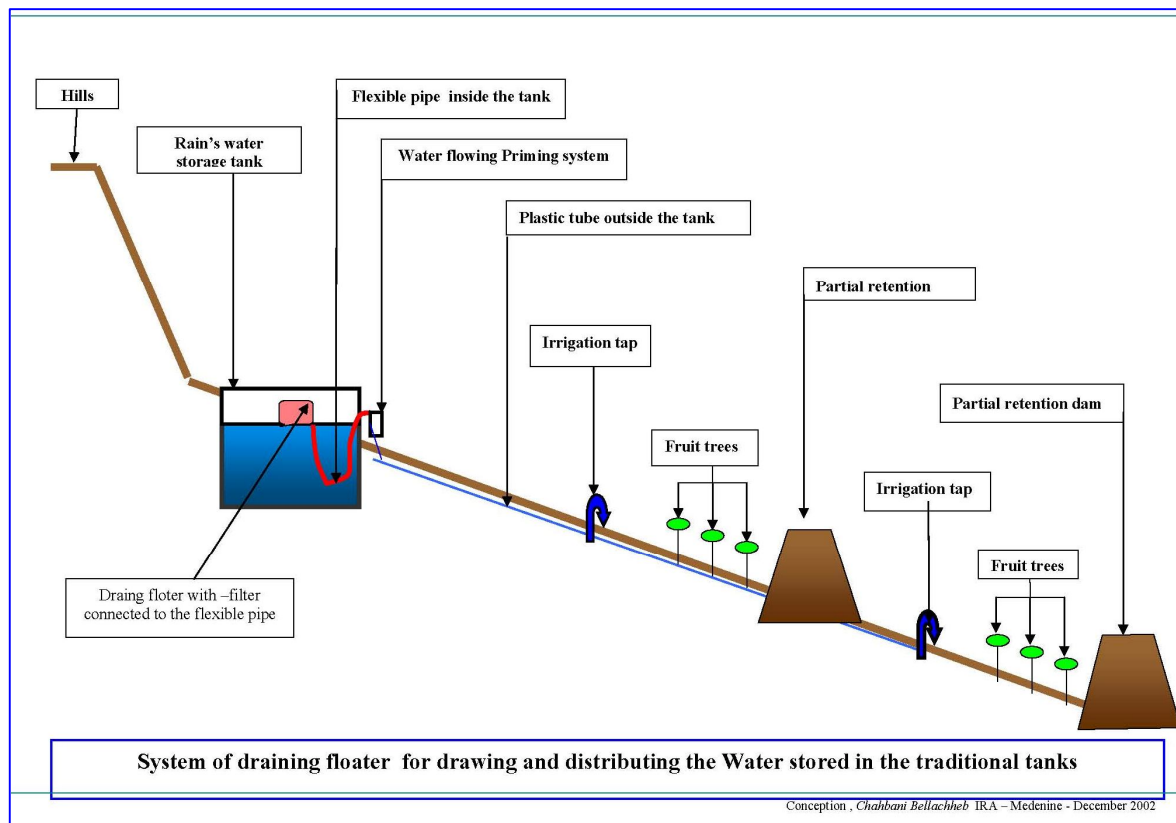


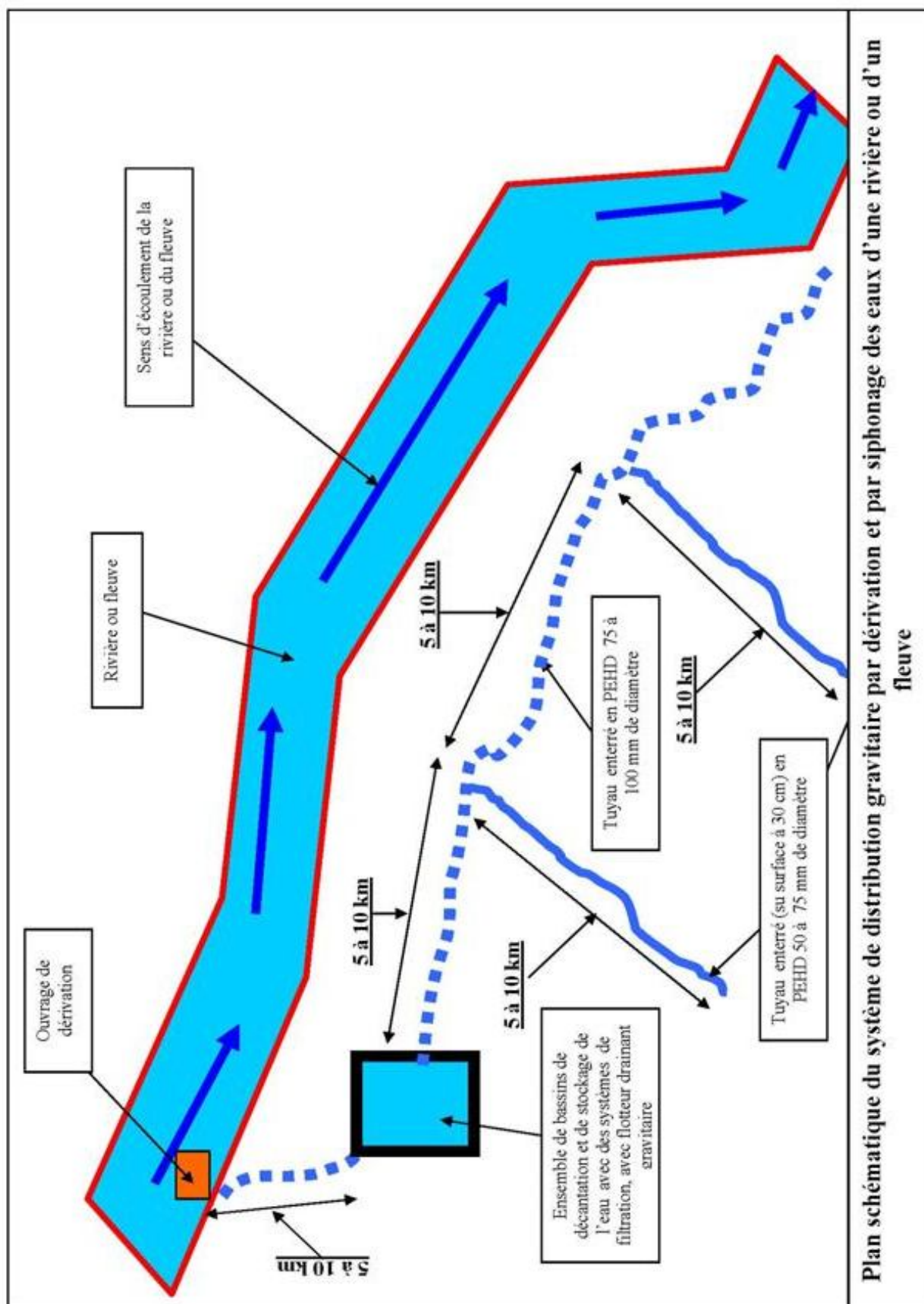
The draining floater allows to «pump» » and to distribute the water using the gravity. It uses the siphon principle. This principle works with a inversed « U » shaped pipe. This siphon pipe has a section with orifice immersed in the water of the reservoir to be emptied. The second section connected with the atmosphere. This second section should be 2 times longer then the first section. This second section is connected to water flowing regulation tap.

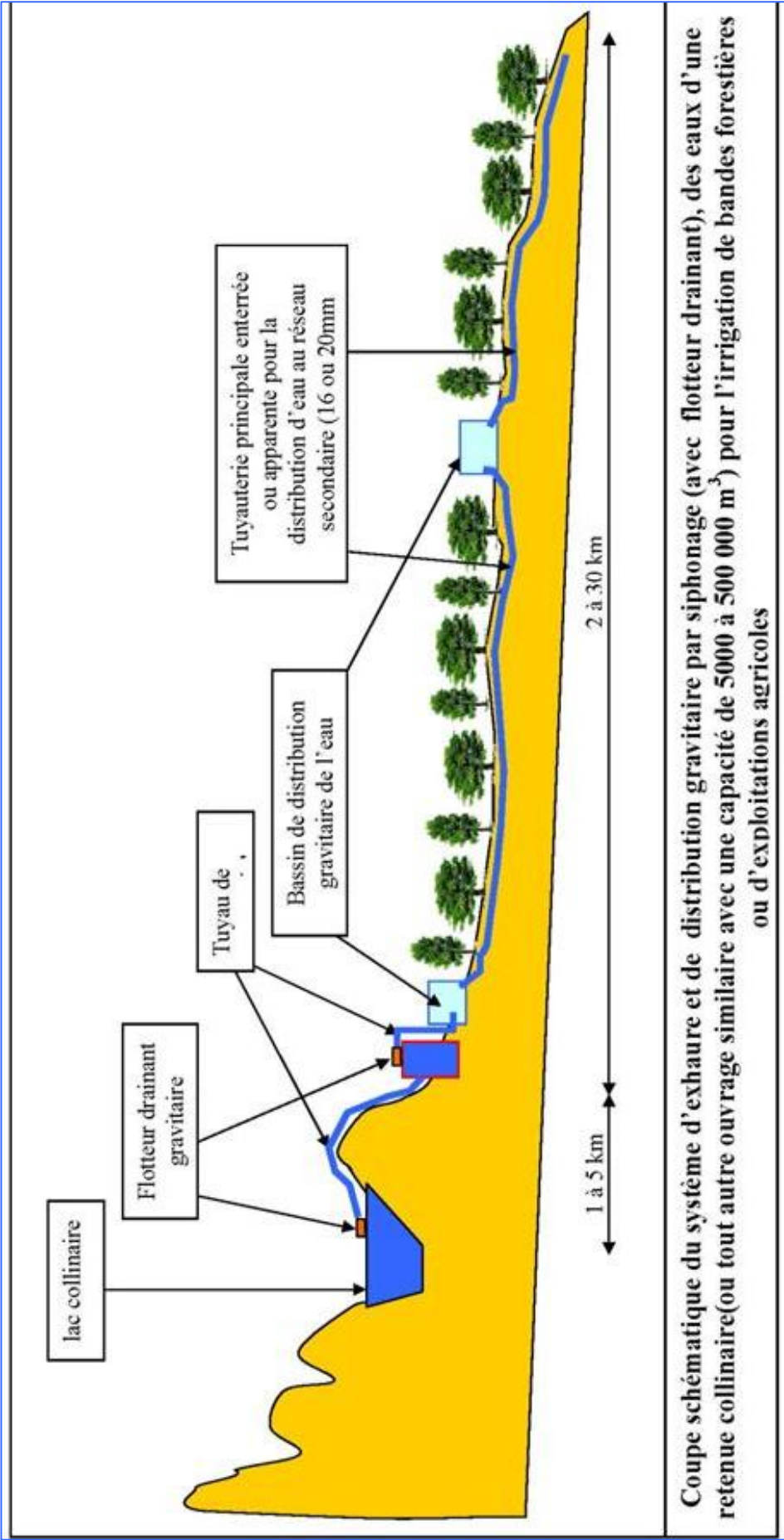
The first section is connected to a draining floater allowing the filtration of the “pumped” water. This draining floater is always floating even when the water level decrease. A second tap is connected to the siphon pipe in continuity with the vertical part of the second section. This tap is used to prime the “pumping” by filling the second section of the siphon through the orifice of the second tap (Siphon priming tap). When this section is filled the Siphon priming tap is closed.

To begin the pumping and the distribution of the water using the gravity, the Water flowing regulation tap is opened and the water is pumped and distributed continuously without any intervention. The “Water flowing regulation tap” could be closed and opened at any time without priming the siphon.

How works the draining floater using the siphon Principle









Connection of tubes to the floater and the tubes collector



Draining floater

Fixing the handrail to footbridge



Draining floater

Attachment of the draining floater to a fixing system fixed to a footbridge



Water is flowing from a tap after priming the draining floater system

Installation and starting up the draining floater for a hill lake in Sidi Bouzid(center of Tunisia) with the collaboration of the technicians of the agriculture regional services



Tubing Gravity water distribution system for natural springs, installed in 2 villages(Tiniri and Tazla) in the region of Ighil Ali (Bejaia- Algeria).