Training course packages targeting food operators on the adoption and management of the technological innovations

SIMPLIFIED HYDROPONIC SYSTEM: HOW TO MANAGE IT?

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1. FoodLAND technical innovation for local food supply chains: concepts and approaches

The FoodLAND project has the ambition to impact on a large number of supply chains and communities, hence the process of food operators' capacity development has to be tailored and as much participative as possible. Accordingly, one of the assumptions of FoodLAND is that sustainable and nutrition-responsive farming systems can be achieved basically by strengthening the capacity development, and specifically by **a)** empowering farmers and processors through the implementation of capacity building processes and concrete opportunities; **b)** creating or consolidating cooperation and shared knowledge to overcome the lack of coordination among food operators; **c)** addressing the inefficient use of resources; **d)** trying to address and build resiliency to the high vulnerability of food systems to climate change; **e)** enhancing the integration of supply chains by creating commercial and stakeholders' networks; **f)** improving the responsiveness of the production sector to the market demand.

To implement these elements of capacity development, FoodLAND proposed the adoption of specific innovations, among which the organizational ones, to create strong and responsive links between producers and encompassing all the intermediate actors along the food value chain, such as researchers, SMEs, NGOs, local and national authorities. In order to ease the creation of those links and guarantee the sustainability over time of the results, 14 Food Hubs will be created in 6 countries as part of the organizational innovations. Food Hubs are conceived as multi-actors centers of innovation where to develop or enhance the organizational and operational conditions enabling local food supply chains (D3.6).

Functional to the implementation of the Food Hubs and of the innovations, the training courses were designed – in form of capacity development activities – as a two-phase process. Firstly, a training session focused on general, preparatory topics was provided to farmers as described and reported in D3.5 ("Group Introductory Training", GIT). According to the project GA, GIT broad set of goals were: to enhance the knowledge of consumers' nutritional needs and market opportunities, and to boost the notions about climate change, sustainability, resilience, and food culture. Secondly, a specific training session were organized to provide food operators with practical information on the adoption and management of the innovations tested at lab / small scale level and to contribute to validating them at appropriate scale.

However, as the whole approach has been designed by FoodLAND to ensure the inclusion of the local actors from the first moment, both the training sessions were set up accordingly. Indeed, yet in the inception phase of the project, an assessment on participatory methods has been run and Participatory Learning and Action (PLA) approach has been eventually assessed as the best one to ensure the inclusion of multiple perspectives. The main purpose of PLA is to support people within communities to analyze their own situation, rather than have it analyzed by outsiders, and to ensure that any learning is then translated into action (Gosling and Edwards 2003). In addition, a gender-sensitive approach has been applied to the trainings that have been designed considering gender roles and power relations; they have provided equal opportunities to participate in the process by caring to times, venues and use of local languages.

The GITs have been conceived as the first step towards the innovation validation and aim at involving the producers, yet from the inception phase. They are just the first step in a sequence of 6, summed up in **Table 1**. After the GITs, where farmers and processors meet and share their vision and goals for the Food Hubs and exchange information about specific topics, the Food Hubs were created and the innovation tested (first in pre-test, then in pilot phase). The constant iteration between researchers and local actors is a key feature of the project: specifically, the practical trainings focused the single innovations (step 5) are aimed at validating the innovations at adequate scale and planned to trigger feedback loops of control and improvement involving developers and adopters.

Table 1. Activities with farmers and food processors (SMEs) and participatory approach

Step	1	2	3	4	5	6
Task	**T3.3**	**T3.3**	**T3.4**	**T4.1¸T4.5**	**T5.1¸T5.5**	**T5.1¸T5.5**
Activity	Group introductory training	Food Hubs creation	Innovation undertaking	Innovation tests	Individual and group practical training	Innovation pilot and validation

2. FoodLAND practical training: aims and scope

According to the project bottom-up and participatory approaches, following the courses on introductory topics GIT organized in the early project phase (T3.3), and as component creating / strengthening the Food Hubs as local innovation centres, FoodLAND has organized a second set of training activities with food operators based on active learning methods and gender equality principle (Task 5.1-5.9). In this regard, specific mechanisms (being aware of the gender roles and power relations; providing equal opportunities to participate in the process by putting attention to the times, venues, use of local languages, etc.) will be lifted to ensure women's participation. These training packages are aimed at providing the local farmers and food processors with operational instructions on the adoption and management of the validated innovations.

This second set of training activities has been organised – triggering PLA approach – as individual and group practical (demonstration/capacity building) activities to be conducted in parallel to the implementation of the technological research (where relevant) and of the innovation pilots and validation. These technology-centred trainings aim at strengthening the participants' understanding of novel production and post-harvest techniques, innovative tools and systems (e.g., climate smart/precision agriculture, hydroponics, and integrated aquaculture), new technologies for primary and secondary processing, and supply chain management. Thus they aim at fostering knowledge and operational capacity to deploy, manage, and maintain the validated technological innovations – documented by the released guidelines D4.1 ÷ D4.11 (e.g., training pamphlets, user manuals, flow diagrams, and operational recommendations) and practice abstracts D6.5 – validated jointly at appropriate scale.

3. Second training packages on the adoption and management of the tested innovations: an overview

The second training course aimed at consolidating the food operators' knowledge and practical skills to adopt, manage and validate the project innovations and complement the related guidelines. Specifically, the realized training materials provide local farmers and food operators with a set of notions and concrete information on a series of innovative tools and systems as per the following **Table 2**. It is clear that both the contents and formats of the learning packages widely differ across technologies as well as Food Hubs (when the same type of innovation must be validated in different contexts). The diversity that emerges from the proposed solutions reflects the different needs highlighted by farmers and stakeholders as well as the conditions and opportunities characterizing the local communities. Nevertheless, in order to take into due account the existing heterogeneity inside the local communities, the developed learning materials have been let available on the project intranet so as to be used for further training initiatives across the network of Food Hubs.

4. Second training packages on practical information on the adoption and management of the tested innovations

Hydroponic systems

Simplified hydroponic system: how to manage it?

Training course on Simplified hydroponic systems: how to manage them?

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The garrafas pet: hints on the system

Composed of:
- a **sloped garden** where plastic bottles are placed in lines
- A supporting **structure** in wood or in iron
- Fed gravity **irrigation system**
- **Shading net** placed on the top of the garden to avoid excessive solar radiation in summer

The dimension of the system can be adapted according to the available space, and needs of the user

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Growing substrate

The plants need a growing media (or substrate) from which to absorb the water and nutrients to satisfy their requirements. The substrate fills the bottles and the plants will be transplanted on it.

The **main functions** of the substrate are:

- Guarantee the **stability** to the plant
- Ensure the **uniform flow of the nutrient solution** through the slope

It can be composed of different materials, of **organic or inorganic origin**. On the left, the perlite (inorganic), and on the right the coconut fiber (organic).

Often, the growing substrate can be **self-produced with recycled materials**

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Growing substrate

The substrate can be produced by recovering local available materials, such as **cereal straw** or **husk**, **coconut fiber**, or other vegetable materials

The organic materials found cannot be used as such, but it need to be made pathogen-free. They can be fermented (put into water for 15 days), or, still better, **carbonized**

The carbonization will ensure the **sterilization** of the substrate, making it suitable for cultivation

Carbonization of wheat straw

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Wheat straw carbonization

Prepare a furnace using tins as in photos (the bigger the better), making some holes on the side: it ensures the fire will not suffocate thanks to the presence of oxygen. Insert dry wood inside, and make it burn on high fire inside a wheelbarrow.

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Wheat straw carbonization

Once the fire is high, cover the furnace with wheat straw. The carbonization has to be done slowly, otherwise, the straw will lose its consistency and will become ash. Thus, press continuously with a shovel as in the photo, avoiding any type of fire.

Apply further straw and press it with the shovel if the fire comes up. Pressing with the shovel is essential since it reduces the oxygen content inside the straw, which is the cause of the fire

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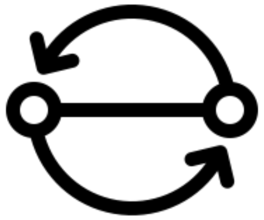
Wheat straw carbonization

Sometimes, if the heat is too high, the straw turns into black too quickly (i.e., after 10 minutes). If this happens apply further straw. The total process should requires 2 hours.

In general, the upper layer receives less heat than the inner one, often resulting in less carbonized. Thus, **inverting the two layer** will homogenize the carbonization among all the straw. The use of anti-heat gloves is high recommended for this procedure.



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Wheat straw carbonization

During the carbonization, be careful to not breaking too much the straw. The size is essential for cultivation because it affects the drainage capacity of the substrate.

Once the carbonization is over, remove the furnace, and use your hand to reduce the size of the straw in **3 cm pieces**.

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Transplant

It is a critical stage for the plants, since they pass from one environment (the well-watered tray, with less solar radiation) to another completely different. The stress transplant syndrome often occurs, but it can be limited by adopting some cautions

1. The day before the transplant, **put the plants, still into the trays, outside** close to the hydroponic system where they will be transplanted: they will adapt easily to the new environment
2. Before the transplant, **apply the nutrient solution to the substrate** inside the bottle **where they will be transplanted** until it is drained out of the system. Do it only using the irrigation system
3. Do the **transplant during the least warm hours**! During the sunshine or sunset

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Irrigation

Technically it is better to call it fertigation, given that it combines the fertilization with irrigation.

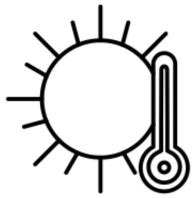
In this system the management of irrigation only consists of defining the amount of water. Given that the capacity of the substrate to retain water is much lower than the soil, **irrigation is needed every day**

The farmer chooses the time (in hours) when he will keep the irrigation system active, which **depends on the season**.

Cold

T < 22 °C

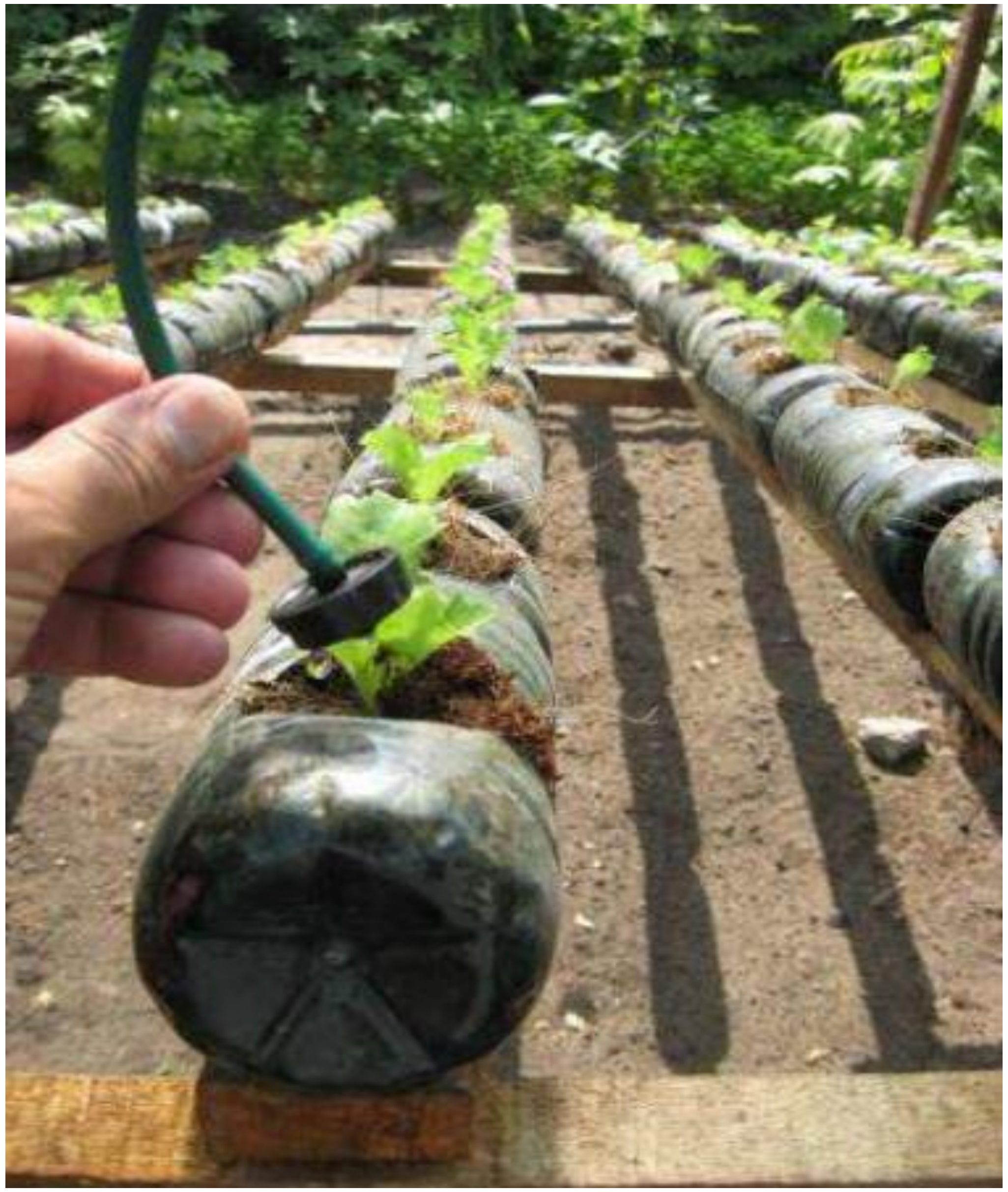
4-5 hours



Warm

T > 26 °C

8-9 hours



Three days a week the drippers (photo) have to be checked: sometimes they can be occluded and need to be cleaned or substituted

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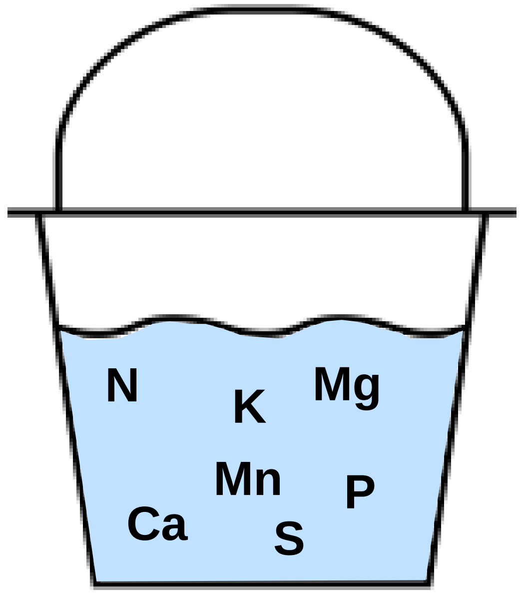
The nutrient solution

Since fertilization is coupled with irrigation by dissolving the fertilizers in the water, we talk about fertigation.

When any compound is dissolved in the water (sugar, salt, fertilizers…), the liquid takes the name of **solution.** Thus, if fertilizers are dissolved in the water, we talk about **nutrient solution**



Nutrient	Macro/Micro nutrient	Abb.
Nitrogen	Macro	N
Phosphorus	Macro	P
Potassium	Macro	K
Calcium	Micro	Ca
Magnesium	Micro	Mg
Manganese	Micro	Mn

Nutrient	Macro/Micro nutrient	Abb.
Molybdenum	Micro	Mo
Copper	Micro	Cu
Boron	Micro	Bo
Iron	Micro	Fe
Zinc	Micro	Zn
Sulphur	Micro	S

The nutrient solution contains several nutrients, which are often indicated with abbreviations. They are classified as macronutrients and micronutrients in relation to the amount absorbed by the plant to live

Both micro- and macronutrients are essential for living plants, and the lacking only one element results in a limitation of plant growth

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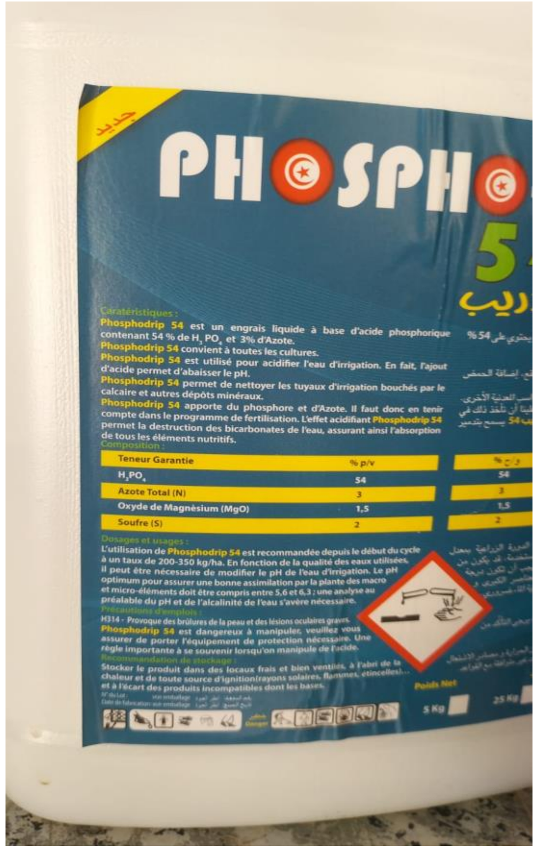
Which fertilizers?

In Jendouba, the most proper way to realize the nutrient solution is to adopt this kind of fertilizers

NPK (20-20-20) + microelements

Nutrion MgS
Magnesium sulphate
(MgO, 16%)

Phosphodrip 54
Phosphoric acid
(H_3PO_4, 54%)



Calcium plus
(CaO, 17%)

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Measuring the concentration

The amount of fertilizers dissolved in the water is indicated by the term **concentration**

The concentration is indicated by the notation **gr / L**, which inform the grams of fertilizers dissolved in 1 liter of water

The concentration of a solution can be measured by using an instrument called conductivimeter

To work properly, the conductivimeter needs to be **calibrated** according to the instruction

The conductivimeter measure the **electrical conductivity** (EC) of the solution providing a value expressed in uS/cm or mS/cm (microsiemens or millisiemens).

The higher the EC, the higher the fertilizers concentration in the nutrient solution

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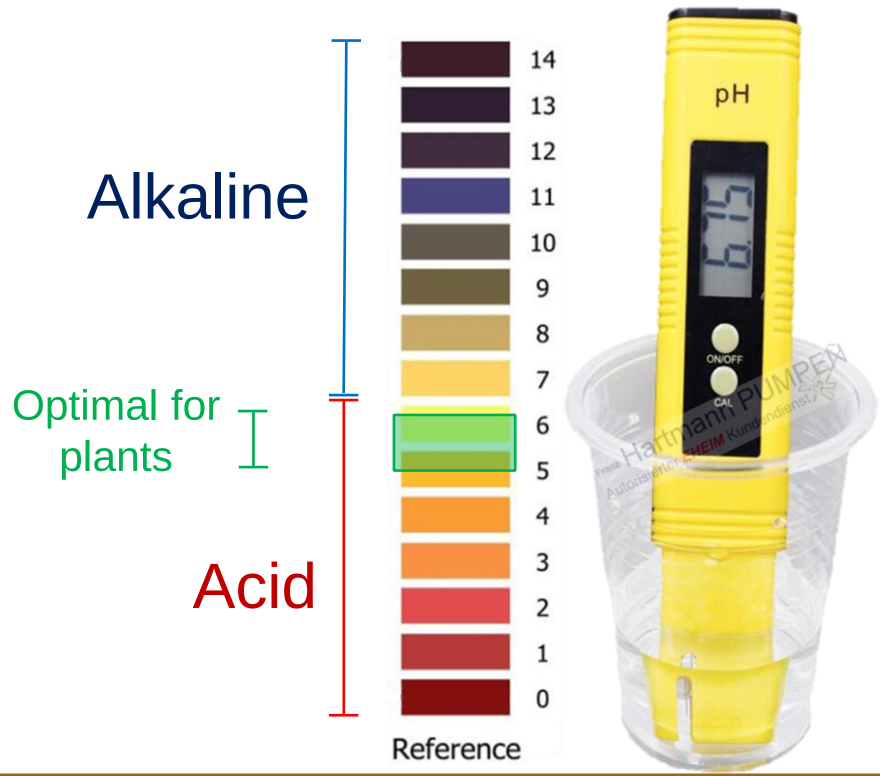
Monitoring the pH

The nutrient solution is characterized also by the **pH**, a parameter that affects consistently the availability and absorption of nutrients by the plants. It informs about the acidity of a given matter, ranging from 0 (acid) to 14 (alkaline)

Optimal range 5.2 – 6.5

Out of the optimal range, the fertilizers don't dissolve in the water, and plants cannot absorb them!



1. The water's pH is often higher than 7, easily reaching 8
2. When plants absorb nutrients, they modify the pH of the circulating nutrient solution (in general it increases).

The pH needs to be monitored and corrected **while preparing the nutrient solution** and also **during the cultivation**.

To monitor the pH, the pH-meter can be used. To modify the pH of the solution, it can be used an acid (nitric, phosphoric, or sulphuric)

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Fertilization management

The management of fertilization in a closed-loop hydroponic system consists of two process

1. Realization of the optimal nutrient solution

2. Monitoring and correction of the EC and pH of the nutrient solution during the cultivation

1. Realization of the optimal nutrient solution

1. Check the water quality
2. Check and adjust the pH
3. Define the optimal EC
4. Dissolve the nutrients in the water
5. Check the EC and pH

2. Monitoring and correction of the EC and pH of the nutrient solution during the cultivation

1. Check the EC and pH of the nutrient solution
2. Correct the pH or EC of the solution

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Realization of nutrient solution

Check the water quality

Assessing the water quality is not possible without a specialized laboratory, but at least it is possible to check the **water salinity**

Water salinity is the amount of salt dissolved in the water. It is mainly determined by high level of Sodium, an element that is not absorbed by plants

High salinity in water **will cause the impossibility to plants to absorb water and nutrients**! High saline water have to be avoided

EC (uS /cm)	Evaluation	Suitability for cultivation
0-750	Not saline	YES
750-2200	Slightly saline	Carefully
>2200	Saline	NO

Up to 1000 uS/cm the water might be used for hydroponic cultivation

Water salinity can be checked by measuring electrical conductivity (EC)

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Realization of nutrient solution

Check and adjust the pH

The pH of the water has to be made optimal before apply the fertilizers, otherwise, they will not dissolve

1. Define the amount liters of nutrient solution to realize (**N in the formula**)
2. Take a sample of 1 liter (exact) of water
3. Check the pH
4. If pH is >7, apply a little dose of phosphoric acid to reduce it within the optimal range. Do some attempts to find the optimal dose of acid to correct one liter of water (**d in the formula**), starting from a lower dose of 0.1 gram. Use a precision scale to do it.
5. Check the pH and repeat the step 4 if its pH >7
6. Once the dose per liter of acid is found (d), multiply it by the amount of nutrient solution to be created (N)

$$Acid\ (grams) = d\ [\frac{grams}{liters}] \times N[liters]$$

Optimal range 5.5 – 6.8

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Realization of nutrient solution

Define the optimal EC

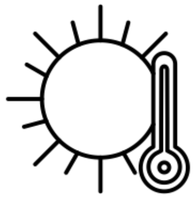
The optimal EC level of the solution depends on external Temperatures.

High temperatures determine high water absorption. Thus, if the nutrient solution contains too many fertilizers (high EC), the plants will absorb a lot of nutrients, which can result in toxic amounts.

Cold

T < 22 °C

1800-2200 uS/cm



Warm

T > 28 °C

1200 uS/cm

Excessive amounts of fertilizers can be toxic for plants!

Chose the EC according the external temperature. For the cultivation of lettuce, an EC of 1700 in the months of november-december in Fernena is ok

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Realization of nutrient solution

Dissolve the fertilizers in the water

Before dissolving, **the amount of fertilizers NPK+microelements has to be defined** as for the pH

Two approaches:
Choose which one you prefer!

Empirical
Gradual application of NPK to the water up to reach the optimal EC value

Mathematical
Evolution of the empirical, which develop formulas to be used to calculate the optimal dose of NPK

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Realization of nutrient solution

Empirical approach

It consists of measuring the EC after applying little doses of NPK. This process is repeated until the optimal value is reached

A precision scale is needed

1. Take a sample of 1 liter of water (with corrected pH) and apply 0.5 gram/liter of **Nutrion MgS** and 0.36 gram/liter of **Calcium plus**.
2. Apply 0.1 gram of **NPK + microelements**
3. Measure the EC. If the optimal EC is not reached, repeat the step 2 until the optimal EC is reached
4. When the optimal EC previously defined is reached, the optimal dose of NPK per liter (**d**) is found summing the total NPK applied to the pre-nutrient solution.
5. As done for pH, multiply **d** by the number of liters of nutrient solution to realize (**N**)

Water + acid + calcium + magnesium is the **pre-nutrient solution**

NPK+microelements are applied after the application of Calcium and Magnesium

$$NPK\ (grams) = d\ [\frac{grams}{liters}] \times N[liters]$$

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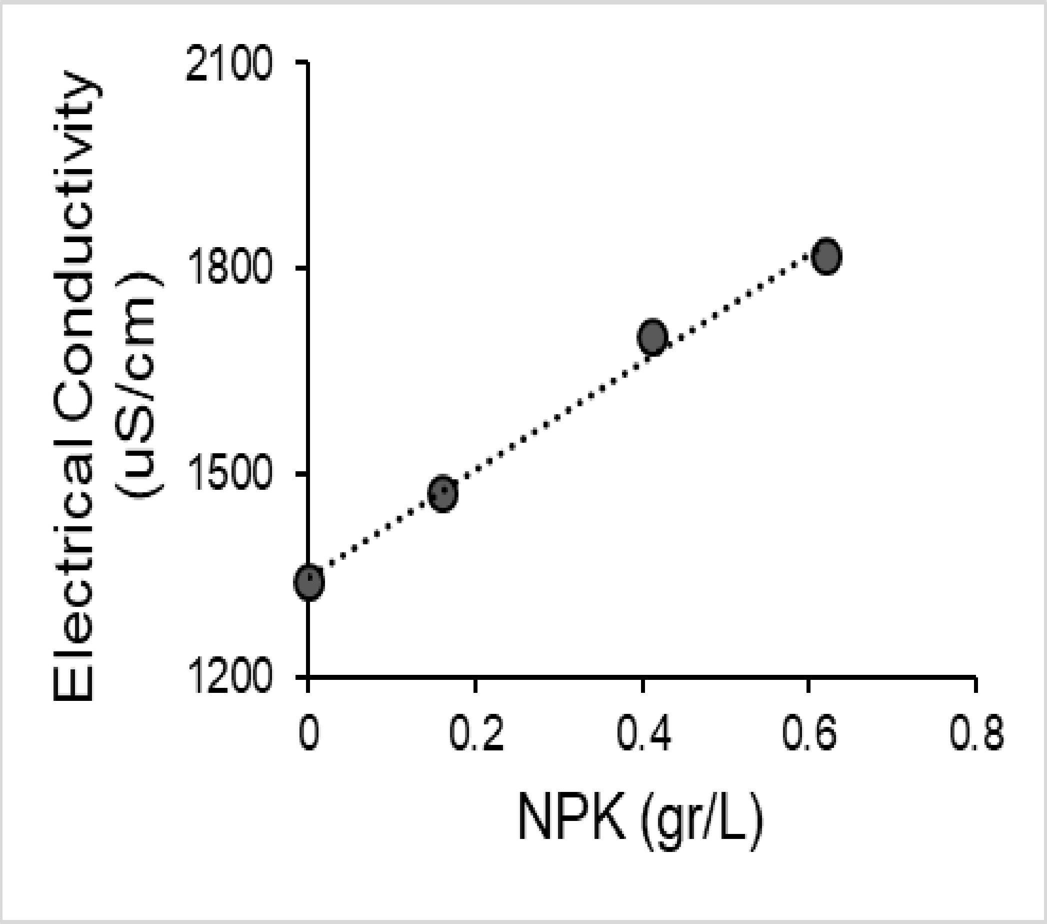
Realization of nutrient solution

Mathematical approach

$$1.\quad EC = 788.93 \times NPK \left[\frac{grams}{liters}\right] + 1347.3$$



The application of growing doses of NPK to the water (containing calcium, magnesium, and pH corrected) is explained by formula 1.

The EC increases proportionally to the increase of NPK dissolved. This proportion is explained by the number **788.93,** which is the slope of the relationship.
The slope informs how much increase the EC if the NPK dissolved in water increases of 1 gram

The number **1347.3** is called intercept and it is the value of the EC of the pre-nutrient solution (water + acid + calcium + magnesium) before applying any amount of NPK.

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Realization of nutrient solution

Mathematical approach

From formula 1 it is possible to derive the NPK dose (using formula 2) and thus calculate the amount of NPK to apply to reach the optimal EC previously defined.

2. $$NPK\left[\frac{grams}{liters}\right] = \frac{EC-1347.3}{788.93}$$

However, this formula can change according to:

1. The fertilizers used: changing fertilizers will modify the number 788.93
2. The water used: changing the water, could change the number 1347.3

Example

In spring, the optimal EC (ECopt) for lettuce cultivation is 1600 uS/cm.

Calculate the optimal concentration of NPK (grams/liter) to reach the ECopt

$$NPK\left[\frac{grams}{liters}\right] = \frac{1600-1347.3}{788.93}$$

$$NPK\left[\frac{grams}{liters}\right] = \frac{252.7}{788.93} = \mathbf{0.32}$$

It is easy to use and time-friendly, given that is consists of applying a formula using a simple calculator

However, this formula has been obtained using the water used by the farmers and the fertilizers reported in slide 23, thus it can be considered fairly generalizable if the same fertilizers are used. Otherwise, it should to be developed for the specific case

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Realization of nutrient solution

Prepare the nutrient solution

1. Dissolve the phosphoric acid in the tank full of water, with the amount previously defined
2. Dissolve 0.5 gram of Nutrion MgS and 0.36 gram of Calcium plus per each liter of water in the tank
3. Calculate the amount of NPK+microelements to dissolve considering the optimal dose per liter, and the number of liters of nutrient solution to be prepared

Let's suppose that:

1. To correct the pH of 1 liter of water, 0.2 grams of phosphoric acid are needed
2. The optimal NPK dose to reach the optimal EC is 0.32 grams/liter

What is the amount of phosphoric acid, calcium, magnesium, and NPK to apply to create 150 liters of nutrient solution?

$$Acid\ (grams) = 0.2\left[\frac{grams}{liter}\right] \times 150[liter] = \mathbf{30\ grams}$$

$$NPK\ (grams) = 0.32\left[\frac{grams}{liter}\right] \times 150[liter] = \mathbf{48\ grams}$$

$$Calcium\ (grams) = 0.36\left[\frac{grams}{liter}\right] \times 150[liter] = \mathbf{54\ grams}$$

$$Magnesium\ (grams) = 0.5\left[\frac{grams}{liter}\right] \times 150[liter] = \mathbf{75\ grams}$$

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Realization of nutrient solution

Check pH and EC

Once the nutrient solution has been created, check the pH and EC if they are ok for cultivation, otherwise, adjust the nutrient solution by applying more NPK, acid, or just water (if EC is too high)

The freshwater of Fernena resulted in an
EC = 900 uS/cm and pH=8.1

The **optimal nutrient solution** with the freshwater of Fernena has been realized by applying

1. Calcium plus (CaO 16%) **0.36 grams/liter**
2. Nutrion MgS (MgO 16%) **0.5 grams/liter**
3. NPK (20-20-20)+microelements **0.4 grams/liter**
4. Phosphodrip 54 (H_3PO_4 54%) **0.2 grams/liter**

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Monitoring the EC and pH during the cultivation

The nutrient solution will flow from the upper tank passing through the substrate where the plants grow. Plants will absorb the nutrient solution, but the exceding one will be drained out of the system

The nutrient solution contains water and nutrients, but plants don't absorb them at the same rate

Sometimes, plants absorb more water than nutrients, and other times they absorb more nutrients. Thus, the nutrient solution that is drained out will change its composition

Plants absorb more water

The nutrient solution will increase the concentration of nutrients, thus also the EC

EC

Plants absorb more nutrients

The nutrient concentration is reduced, and the EC will fall down

EC

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Monitoring the EC and pH during the cultivation

The EC has to be maintained within the optimal level during the cultivation, therefore, it has to be checked continuously during the week (twice a week is sufficient).

If EC is out the optimal level, the nutrient solution in the tank needs to be corrected

Plants absorb more water ↑

EC ↗

Plants absorb more nutrients ↑

EC ↘

Apply just fresh water to reduce the concentration of nutrients and reduce the EC within the optimal level

Apply **just NPK+microelements** to increase the concentration, therefore increasing also the EC up to the optimal level.

Don't apply calcium or magnesium, if symptoms of their lack are not evident

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Monitoring the EC and pH during the cultivation

If the **EC in the tank needs to be increased**, the same approaches of before can be adopted

Empirical

Gradual application of NPK to 1 liter of nutrient solution up to reach the optimal EC

Mathematical

Adoption of formula 2 that is revised as below

⚠

The empirical approach allows individuating the amount of NPK to be applied to restore the EC **in 1 liter of nutrient solution**. Remember to multiply it by the number of liters of nutrient solution present in the tank

Using a graduated tank is the best strategy!

$$NPK\left[\frac{grams}{liters}\right] = \frac{EC_{optimal} - EC_{actual}}{788.93} \times \mathrm{L}$$

Where

- $EC_{optimal}$ is the EC value to be reached by adding NPK
- EC_{actual} is the actual value of EC of the nutrient solution in the upper tank monitored with the EC-meter
- L is the number of liters of nutrient solution to be corrected present in the upper tank

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Monitoring the EC and pH during the cultivation

Instead, pH uses to rise up when the nutrient solution is reused in the cultivation

When plants absorb the nutrients, they release some compounds from the roots, responsible for the pH increase of the nutrient solution that is drained out.

As for EC, monitor the pH of the nutrient solution and apply acid when pH > 6.8 to restore the optimal value.

The empirical method is suggested

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Upgraded hydroponic system

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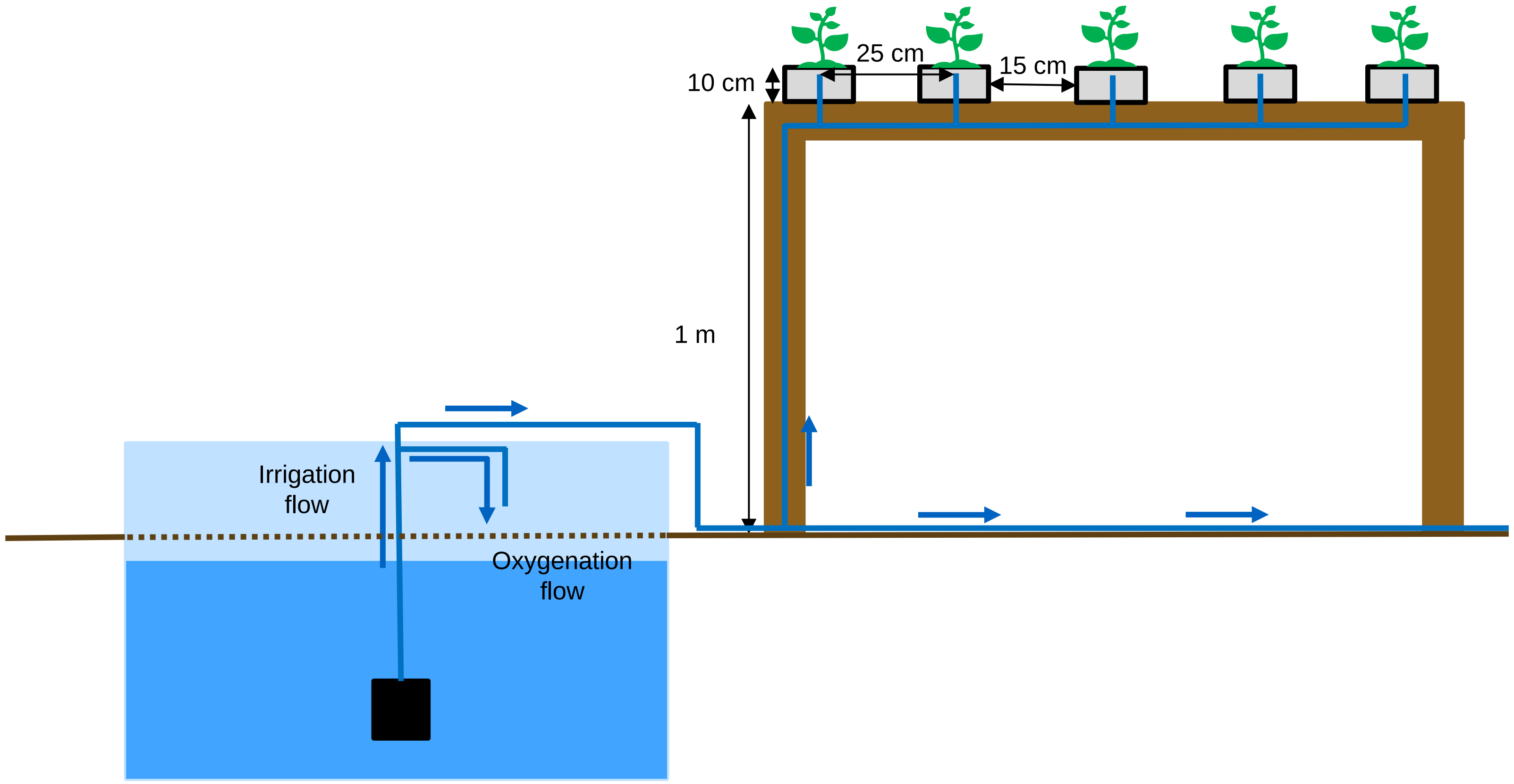
Upgraded hydroponic system

This system is called the Nutrient Film Technique (NFT), as it employs a thin layer of nutrient solution that flows into pipes where plants are placed. Any substrate is used, and a pump ensures a closed-loop irrigation. The nutrient solution come back to the tank after the flow into the pipe.



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Upgraded hydroponic system

The main difference with the previous system is the absence of a growing substrate. It becomes essential to ensure the oxygenation of the nutrient solution

1. Installing a **returning pipe** in the tank will ensure the agitation of the water increasing the oxygen concentration

2. The oxygenation of the roots is ensured with the **intermittent irrigation**

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Upgraded hydroponic system

Intermittent irrigation consists of alternating periods of water supply to drying periods (no water is supplied).

45 minutes of irrigation alternated to 15 minutes of drying period. During the night (from 19.00 to 7.00) the irrigation is not working

As opposite to continuous irrigation, it determine a **positive income** due to reduced energy consumption

			Continuous irrigation		Intermittent irrigation	
	Unit	€ $unit^{-1}$	Use (n unit)	**Cost**	Use (n unit)	**Cost**
Magnesium sulpahte	g	0.001	406	0.36	406	0.36
Calcium	g	0.003	292	0.73	292	0.73
NPK	g	0.0004	325	0.12	325	0.12
Phosphoric acid	mL	0.001	313	0.28	313	0.28
Electricity	kW	0.100	810	81.0	304	30.4
pH meter	daily use	0.236	48	11.3	48	11.3
EC meter	daily use	0.236	48	11.3	48	11.3
Plants	number	-	300	5	300	5
Other	-	-		5	-	5
Total				**115.1**		**64.5**
	Unit	Value		**Revenue**		**Revenue**
Yield	kg m^{-2}	3.03				
Total production	kg	36.4				
Market price	€ kg^{-1}	2.5		**90.9**		**90.9**
Profit per crop cycle				-24.2		26.4
per month				**-15.1**		**16.5**

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Upgraded hydroponic system

Based on the air temperature the shading and the electrical conductivity must be adjusted as in the table below

	Min-max temperature (°C)	**Shading net**	**EC**
January	3 – 14	no	2000-2500 $\mu S\ cm^{-1}$
February	4 – 15	no	2000-2500 $\mu S\ cm^{-1}$
March	5 – 18	no	2000-2500 $\mu S\ cm^{-1}$
April	7 – 21	no	2000-2500 $\mu S\ cm^{-1}$
May	11 – 27	no	1800-2000 $\mu S\ cm^{-1}$
June	15 – 32	yes/no	1500-1700 $\mu S\ cm^{-1}$
July	18 – 36	yes	1200-1500 $\mu S\ cm^{-1}$
August	19 – 35	yes	1200-1500 $\mu S\ cm^{-1}$
September	16 – 31	yes/no	1500-1700 $\mu S\ cm^{-1}$
October	12 – 26	no	1800-2000 $\mu S\ cm^{-1}$
November	8 – 19	no	2000-2500 $\mu S\ cm^{-1}$
December	4 – 16	no	2000-2500 $\mu S\ cm^{-1}$

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Thank you !

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