


# Hydroponics

 Low-tech Lab




<https://wiki.lowtechlab.org/wiki/Hydroponie/en>

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 Difficulté Facile

 Durée 1 jour(s)

 Coût 50 EUR (€)

## Description

This tutorial aims to introduce hydroponics and how to build an individual system. This technology was documented during a stopover in Singapore of the "Nomade des Mers" expedition. We met Comcrop, a company that grows aromatic plants (basil, mint...) on an area that is usually unused and worthless: the roofs of buildings!

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# Introduction

Hydroponics is the cultivation of plants and vegetation above ground and in water. The roots are immersed in a neutral and inert substrate (such as clay balls, sand...) which serves as a support. They directly capture the nutrients necessary for their growth in water enriched with a nutrient solution. Unlike conventional hydroponics, bioponics (hydroponics+organic) allows fruits and vegetables to be grown organically without the use of synthetic chemical fertilizers. These are replaced by organic fertilizers such as manure, earthworm, urine or compost juice. In biopony, the nutrient solution is not sterile and bacteria, micro-organisms and fungi can develop. These active micro-organisms will make it possible to transform certain substances such as ammonia into nitrate, one of the nutrients essential for plant growth. In our case we use an organic solution by mixing water with human urine (**1% urine in relation to the volume of water**).

""Hydroponics has many advantages in certain contexts:""

- In arid regions where fertile land and water are scarce. Hydroponics can save 7 to 10 times the volume of water needed for irrigation compared to conventional agriculture. It also helps to avoid water stress.
- In cities and urban areas where there is little space available for earth cultivation. It is particularly suitable for cultivation in restricted spaces (roofs of buildings, apartments, abandoned factories, etc.). As it can be developed vertically, hydroponics also makes it possible to obtain a production per square meter much higher than land agriculture. It can also allow a return to culture among urban residents, who are often disconnected from nature.
- In case of soil pollution.
- Allows better control of invasive insects.

""But hydroponics can also have disadvantages:""

- Can be expensive and uneconomical if installed in greenhouses with artificial lighting and heating.
- In a non-organic hydroponic system, the nutrient solution must be renewed regularly. Water rich in minerals and oligo-elements is then rejected and can affect the ecosystem. In this tutorial, we present a method to avoid chemical inputs.
- The environment being humid and hot, bacteria or diseases can spread very quickly. Hydroponics requires particular and daily attention to the health of plants.

## Matériaux

### 1. Crop gutters

- Cleats (minimum width 10cm)
- Plastic sheeting
- Staples
- Clay beads



Prefer the small clay balls, they are heavier and will allow a better maintenance of the roots

- Brackets
- Wood screws
- Young shoots and cuttings

### 2. Irrigation system

- 1 Submersible pump (aquarium pump)
- 5 m of thin plastic pipe (pump outlet)
- 1 End cap with 4 outlets for fine pipe
- 50 cm of wide plastic tube (Link between the filter and the bio-filter)
- 1 Wide pipe end cap (to be fixed on the filter tank)
- 1 Blower

### 3. Filter and bio-filter

- 2 plastic bins of 60L
- Large gravel
- Sand
- 10L Clay beads
- 40L of water

Modèle: In order to ensure homogeneity of the water in terms of nutrients and temperature, we recommend using about 40L of water per square meter of cultivation.

### 4. Control system

- Socket outlet with programmable timer or Arduino

## Outils

- Drill/driver or screwdriver
- Saw
- Stapler
- Hole saw
- Cutter or scissors

# Étape 1 - Manufacture of culture gutters

The system used measures 2m long by 50cm wide. The skeleton is made up of 4 cleats / bamboos fixed in parallel at a distance of 15 cm thanks to wooden cleats. It is covered with an agricultural cover (width 1m) so as to form 3 gutters about 10cm deep. These gutters are filled with clay balls. An aquarium pump immersed in the biofilter tank propels the nutrient solution from the top side of these gutters (inclination of about 10 degrees) so that it flows through the clay balls until it returns to the storage tank (biofilter). The table is about 1.2m high (ergonomic for taking care of plants). A shade screen is attached like a skirt on the sides to protect the biofilters, nutrient solution storage tank and mushroom farm from the sun.

## 1. Manufacturing of the support

- In this model we explain the process for 3 gutters but it is of course possible to duplicate it at will !
- Cut 4 strips of the same length (190 cm for us)
- Attach them parallel to a support using brackets and screws at regular intervals (15 cm)
- Staple the tarpaulin on the side of the first strip and then extend it to cover the next three (Possibility to double the tarpaulin for more resistance)
- Form gutters with the tarpaulin until it touches the support
- Staple the tarpaulin on each strip and cut it out.
- Water recovery

## 2. Water recovery

The water system operates in a closed circuit. The water is pumped into the biofilter that serves as a reservoir, exits at one end of the gutter and is recollected at the other end before passing through a filter and returning to the initial reservoir.

In order to recover the water, the tarpaulin is pierced very finely (to prevent the clay balls from escaping) at the opposite end of the water inlet. Below this end, another tarpaulin is stapled to form a pocket to collect and channel the water before it flows into the filter.





## Étape 2 - Filter and Biofilter

Once passed through the plants, the water flows into two separate tanks: the filter and the biofilter.

- The purpose of the filter is to block all coarse particles that could block the pumps (root and leaf residues, erosion of clay balls, etc.). The filter has three stages of filtration, from the finest to the coarsest.

- The biofilter constitutes the water reservoir, to which is added about a quarter of the volume in clay beads. These serve as a culture medium for bacteria that will allow the transformation of natural inputs (urine, compost juice, etc.) into nutrients that can be assimilated by plants. In particular, the transformation of ammonia into nitrite and then nitrate, essential for foliar development (leaf development). Bacteria develop naturally after 6 weeks or can be purchased in culture at hydroponics sites.

For their proper development, bacteria need:

- of moisture, provided by water
- shadow
- of oxygen, install a bubbler to regularly stir the water in the biofilter.
- of food, natural inputs

In our case, we only use human urine as an input (The dilution is ~1 part urine to 100 parts water (~1:100))

**i** If you use chemical inputs (not so good...) you won't need a biofilter.

### 1. Filter

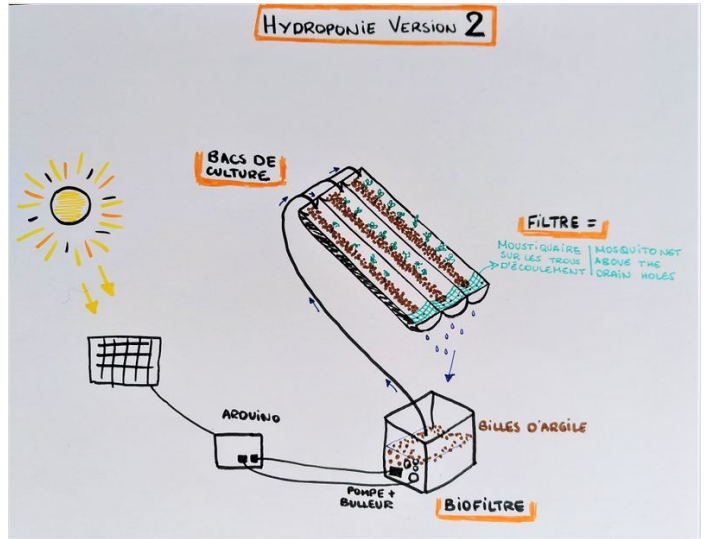
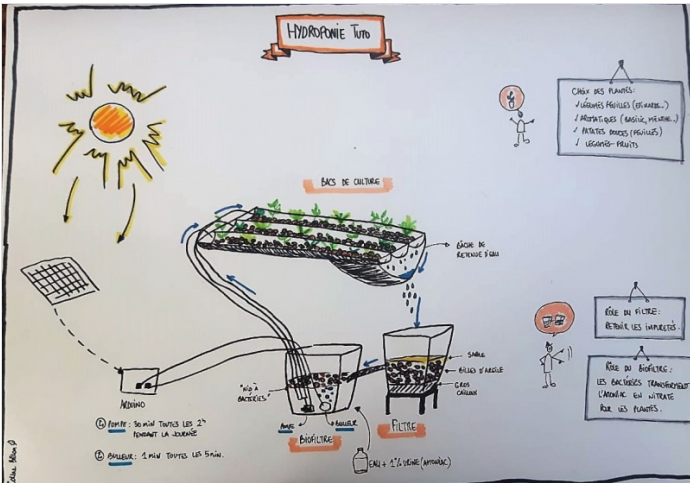
- At the bottom of the first tank, drill a hole with the hole saw of the diameter of your outlet pipe to the second tank.
- Install the nozzle and hose on the tank
- Spread a layer of coarse gravel on the bottom (1/4 of the filter volume)
- Add a layer of clay beads of the same thickness
- Add a slightly thinner layer of sand on top
- Install the filter under the water pocket at the outlet of the gutter, and raise it above the biofilter to allow the water to flow by gravity.

### 2. Biofilter

- Fill the second tank with water (40L) and add about a quarter of the volume of water in clay balls (10L)

**i** In our system, the clay beads in the biofilter are replaced with plastic beads, which also serve as good bacterial nests (but are not natural).

**💡** In the introduction video, only one biofilter bucket is used. The filter is then integrated directly at the end of the gutters by placing a piece of mosquito net over the holes through which the water flows into the biofilter. (See version 2 drawing) This simpler setup is possible if your crop produces little fine matter (roots, leaves, gravel) that could pass through the mosquito net and clog the pump.



## Étape 3 - Irrigation system and bubbler

After being filtered, oxygenated and recharged with nutrients, the water is ready to be re-injected into the system. For this purpose, a small submersible pump is used. The power of the pump depends on the size of your system.

- Measure a length of plastic pipe (of a diameter suitable for your pump) from the biofilter to the end of the gutters.
- Connect one end to the pump and the other to a 4-way nozzle (to be adapted according to the number of gutters), placed at the end of the gutters
- Attach this end cap to the central gutter.
- Connect pipes to the outlets of the nozzle to irrigate all gutters.
- Immerse the pump in the biofilter
- Immerse the bubbler in the biofilter



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## Étape 4 - Control system

In order to gain in autonomy, it is possible to install a timer system thanks to a programmable electrical socket or an arduino allowing to program the starting of the pump and the bubbler.

- Indeed, for a better development of the plants, it is advisable to proceed to a regular watering alternated with dry breaks. This water stress will strengthen the roots.

For this purpose, we recommend that the pump be switched on for 30 minutes every 2 hours during the day. No watering at night.

- The biofilter needs to be aerated regularly for good growth and survival of bacteria.

**We recommend lighting the bubbler for 1 minute every 5 minutes, 24 hours a day.**

**Arduino control system:**

Gestion énergétique d'un système d'hydroponie/fr

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# Étape 5 - Crop selection and harvesting

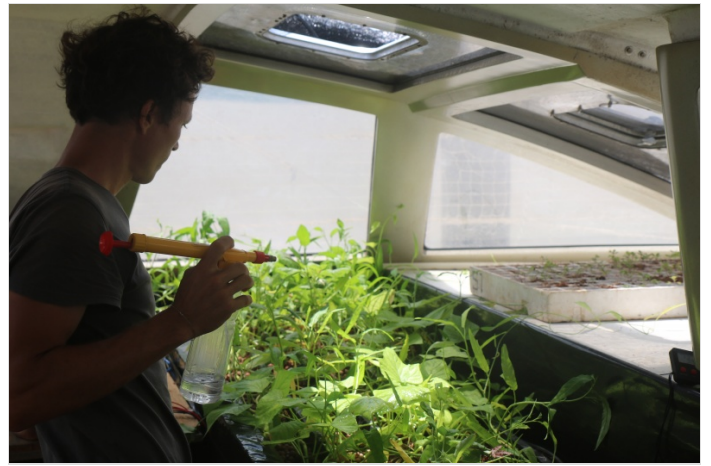
Not all crops are suitable for hydroponics. It is easier, especially without chemical fertilizers, to prefer leafy vegetables (lettuce, cabbage, spinach, sweet potatoes...) and herbs (mint, basil, coriander).

"Plant" them in the clay balls, making sure that the roots are well immersed.

"It is always necessary to integrate the plants after sowing or cutting them so that they have developed a long and strong root system."

Some advice:

- Prefer direct light if possible but do not hesitate to add shade in case of high heat.
- Ventilate the system well and control the temperature. Do not hesitate to add a small fan in case of high heat.
- Regularly check that the roots are under the clay balls.
- Check the colour of the leaves regularly: if they turn yellow, this may be due to excessive watering, lack of nutrients, poor pH or too much sunlight.
- Transplant the shoots at the end of the day.
- Transplant the shoots when they have at least 5 leaves. Then you have to water.
- Cuttings: for mint and sweet potatoes, for example, cut one or more branches. Remove the leaves on about 2/3 of the branch. Bury this cleared area under the clay balls. Then you have to water.
- Harvest in the morning, shortly after sunrise. Choose the oldest, most damaged leaves or leaves that develop in parallel with auxiliary shoots.



# Étape 6 - Educational content to download

You can download an educational sheet created by the Low-tech Lab for the exhibition "In Search of a Sustainable Habitat" in the "Files" part of the tutorial (tab in the "Tools-Materials" section)

**HYDROPONIE ACTIVE**  
PRODUCTION ALIMENTAIRE

L'HYDROPONIE DÉSIGNÉ LA TECHNIQUE DE CULTURE DES PLANTES DANS UN SUBSTRAT NEUTRE. LES NUTRIMENTS SONT FOURNIS AUX PLANTES SOUS FORME DILUÉE DANS L'EAU. LE SUBSTRAT PEUT ÊTRE ORGANIQUE, TELLE LA FIBRE DE COCO, OU MINÉRAL COMME LA PIERRE Ponce.

**Hydroponie, bacelle 7**  
L'hydroponie est une méthode de culture des plantes sans sol. Elle consiste à cultiver les plantes dans un substrat inerte, tel que la pierre ponce, la fibre de coco ou le perlite. Les nutriments sont fournis à la plante sous forme d'une solution aqueuse diluée dans l'eau. Cette technique permet de cultiver les plantes dans un espace réduit, de contrôler l'apport en eau et en nutriments, et de réduire les risques de maladies.

**Avantages de la hydroponie**  
La hydroponie permet de cultiver les plantes dans un espace réduit, de contrôler l'apport en eau et en nutriments, et de réduire les risques de maladies. Elle est également plus écologique que la culture traditionnelle, car elle nécessite moins d'eau et de produits phytosanitaires.

**Précautions**  
Il est important de surveiller régulièrement le pH de la solution nutritive, car une valeur trop élevée ou trop faible peut nuire à la croissance des plantes. Il est également conseillé de renouveler la solution nutritive régulièrement.

**L'Équipe de la Low-tech Lab**  
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**LOW-TECH LAB**  
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# Notes et références

*This section gathers the most frequently asked questions about this tutorial and the progress of the Low-tech Lab's thinking on these topics .*

## Use of urine as fertilizer

1L of urine contains on average 6g of nitrogen, 1g of phosphorus (directly assimilable) and 2g of potassium. Nitrogen is in the form of urea, which will be transformed into ammonia on contact with the air. It is this step that produces the odor associated with urine, but it is eliminated by the action of micro-organisms or by storage without contact with air.

Plants are able to assimilate nitrogen in two forms: ammonium  $\text{NH}_4^+$  and nitrate  $\text{NO}_3^-$ , with a preference given to nitrate in most cases. The biofilter enables this transformation.

It is important to dilute the nitrogen to avoid too high a salt concentration.

## References

- FAO's detailed report on small-scale aquaponics: <http://www.fao.org/3/a-i4021e.pdf>
- Antroponics: specialized website on the experimentation of human urine in hydroponics: <http://antroponics.com/>
- Arduino control system: Gestion énergétique d'un système d'hydroponie/fr
- Tutorial written by Guénolé Conrad, Valentin Coyard and Coline Billon in January 2020
- English translation: Guénolé Conrad
- Spanish translation: Viridiana Arenas