

OPPORTUNITIES AND CHALLENGES TO SUSTAINABILITY IN HIDROPONIC SYSTEMS– REVIEW

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ABSTRACT

Hydroponics is a viable solution to obtain intensive agriculture, in terms of producing vegetables and fruits as tasty and nutritious as those produced in classical crops. In the current changing climatic conditions, it can be a viable solution for obtaining high quality food. In addition, the system allows establishment of crops, which do not require the use of soil or manure, but only water that contains various dissolved nutrients. This agricultural cropping technology involves the use of various fertilizers instead of soil for the growth and development of plants. The light needed to develop the plates can come from the sun, or can be produced by renewable energy sources.

INTRODUCTION

Providing the necessary food for the population in the conditions of population growth is an increasingly difficult problem to deal with. At this moment, new approaches are being researched, in order to produce clean fuels more efficiently (Nenciu F., 2020), and to develop new technologies to replace the classic energy plants with crops more resistant to drought and stress and more productive, although they are established in different living environments (Nenciu et al., 2021; Vladut et al., 2020).

Hydroponics is a method used for cultivating plants directly in water, without having a soil substrate as a source of plant nutrients. The term hydroponics, consists of the Greek words "hydros", which is translated as water and "ponos", which means work. It is a way of plant cultivation that has been experienced since ancient times. However, in Romania, hydroponic greenhouses have not experienced a special development. In several more developed

countries such as: Denmark, Israel, France, Japan, the Netherlands, Great Britain there are significant number of advanced hydroponic systems, such as the hydroponic greenhouse depicted in Figure 1.



Fig.1 Hydroponic greenhouse

(<https://www.rador.ro/2014/11/12/hidroponia-o-metoda-de-cultivare-a-plantelor-cu-adepti-si-contestatarii/>)

The image shows a technology of modern agricultural cultivation, in which automation is applied at very high standards. The main plants that are grown in this system are: vegetables, flowers, medicinal plants, animal fodder, etc.

(<https://www.rador.ro/2014/11/12/hidroponia-o-metoda-de-cultivare-a-plantelor-cu-adepti-si-contestatarii/>)

Hydroponic agriculture is in a continuous development nowadays. One of the advantages of the hydroponic agriculture is that it does not require fertile land, which is quite limited. In the case of highly automated systems, one of the problems that can occur is the very high energy consumption required for operation. Therefore, it is necessary to consider innovative energy efficiency systems, such as solar trackers (Nenciu et al., 2014). Hydroponic crops can be established in areas where agriculture has never been performed efficiently. Therefore, such systems are suitable for large areas mostly covered by water, figure 2 a), in desert areas, figure 2 b), underground - figure 2 c) or in any location where a greenhouse can be placed, - in addition to people's homes, both in rural and urban areas - figure 2 d. (<https://www.spatulconstruit.ro/articol/ce-este-agricultura-hidroponica-si-unde-se-poate-practica/21469>).



Fig. 2, a, b, c d, - Hydroponic crop establishment areas
(<https://www.spatiuconstruit.ro/articol/ce-este-agricultura-hidroponica-si-unde-se-poate-practica/21469>)

Hydroponic agriculture is an option for cultivating plants in a chemical environment, which instead of soil uses special aqueous solutions or other media (mineral wool, gravel, etc.). Special solutions are composed by certain nutrients with some calculated concentrations, which are being constantly monitored. Among the nutrients used, may be manure from fish farms and various animals (pig farms). In fish farms, the plants behave as a water purification filter, so that through a closed circuit the water returns to the fish ponds (https://mec.tuiasi.ro/diverse/Culturi_agricole_protejate-curs.pdf). The system also allows closer monitoring, no longer requiring the application of antibiotics, which have a negative role on the soil (Petre et al, 2020).

MATERIALS AND METHODS

Hydroponics - is a method of cultivating plants that stimulates their growth by ensuring control of the amount of water, mineral salts and - most importantly - the amount of oxygen dissolved in water.



Fig. 3 Plants grown in hydroponic system
(<https://www.rador.ro/2014/11/12/hidroponia-o-metoda-de-cultivare-a-plantelor-cu-adepti-si-contestatori/>)

This method of cultivating plants can be applied in an ecological system and if it is extended on an industrial scale it can provide the population on all continents with the best quality food. In

our country, at the industrial level this culture system is very poorly represented. Hydroponics can be successfully implemented in people's households, gardens, balconies (figure 4), living rooms, using the same technology as in industrial hydroponic crops.



Fig. 4 Hydroponic system placed in a balcony
(<https://www.rador.ro/2014/11/12/hidroponia-o-metoda-de-cultivare-a-plantelor-cu-adepti-si-contestatari/>)

As people increasingly want to consume fresh products from their gardens, this system meets the requirements, being able to generate tasty and healthy products for their own consumption. (<https://www.rador.ro/2014/11/12/hidroponia-o-metoda-de-cultivare-a-plantelor-cu-adepti-si-contestatari/>)

In general, plants are grown in water in which nutrients have been dissolved (figure 5). This is only one of the many options that are being used.



Fig.5. Hydroponic systems for growing vegetables
(https://www.unitbv.ro/documente/cercetare/doctorat-postdoctorat/sustinere-teza/2016/badiu-eduard-catalin/Rezumat_Teza_Eduard_Badiu.pdf)

An important role in greenhouse maintenance is the automation of nutrient administration to these hydroponic crops. It uses a complex program that monitors the needs of the plant constantly, monitoring the vital factors in their development, such as - temperature, humidity, ventilation, CO₂ content and others. It should be emphasized that an additional source of energy is also required in the event that the main source of energy may be accidentally interrupted. (<https://www.unitbv.ro/>)

documente/cercetare/doctoratpostdoctorat/sustinere-teza/2016/badiu-eduard catalin/Rezumat_Teza_Eduard_Badiu.pdf).

RESULTS AND DISCUSSION

Global temperature changes, soil degradation, natural disasters lead to the increasing use and development of hydroponic crops.

The main systems used in hydroponic crops are:

➤ **Wick system (with absorbent wick)**

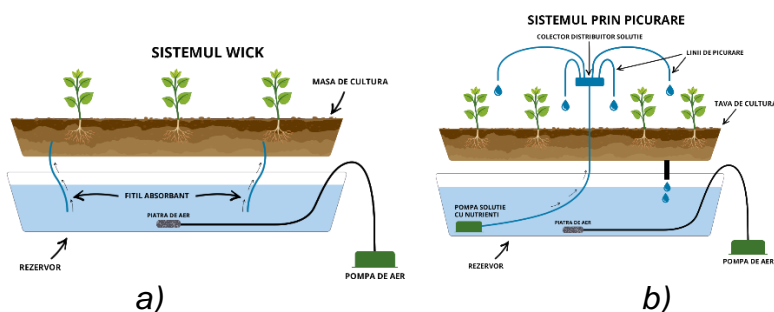


Fig. 6 Wick hydroponic system (a), Drip hydroponic system (b)
(<https://farmbee.ro/blog/ce-este-o-cultura-hidroponica>)

As can be seen in Figure 6 a), it is a simple system consisting of a tank, an air pump and several absorbent wires that connect the culture table and the tank. The air pump has the role of aerating the solution, and is connected to an aeration stone located in the tank. The plants are located in a container based on an absorbed growth medium.

➤ **Drip hydroponic system**

As can be seen in Figure 6 b) this system is similar to the system depicted in Figure 6 a), only the plant feeding system differs, through this drip line which is fed by a submersible pump, in the nutrient solution (Salvatore Gaetano Verdoliva et al., 2021).

➤ Hydroponic system by flooding and drainage (Ebb and flow)

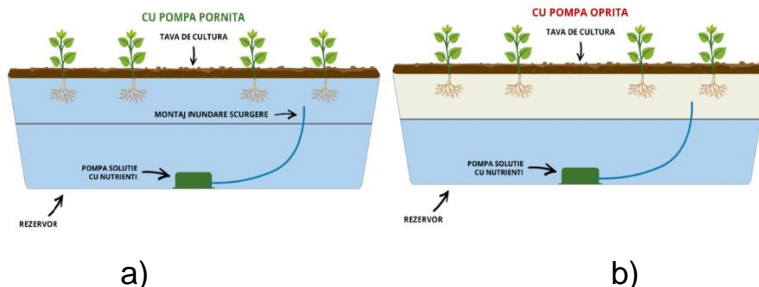


Fig. 7 a) și b) Hydroponic system by flooding and drainage
(<https://farmbee.ro/blog/ce-este-o-cultura-hidroponica>)

The system depicted in figures 7 a) and b) is a flood and drainage system in which when the submersible pump is turned on, figure 7 a), the nutrient solution floods the culture tray and when the pump is stopped, figure 7 b), the nutrient solution drains into the tank. In this way the plants are fed with food without the need for oxygenation with another aeration pump as in the examples shown before.

➤ Water cropping system (with nutrient solution)

In figure 8 a) we have schematically presented the water culture system (nutrient solution), where the plants float above the nutrient solution, their roots being directly in the nutrient. Oxygenation in this system is done with the aeration pump, and for the support and a better stability of the plants can be used light floating materials, like expanded polyester, which are perforated depending on the distance desired between the plants.

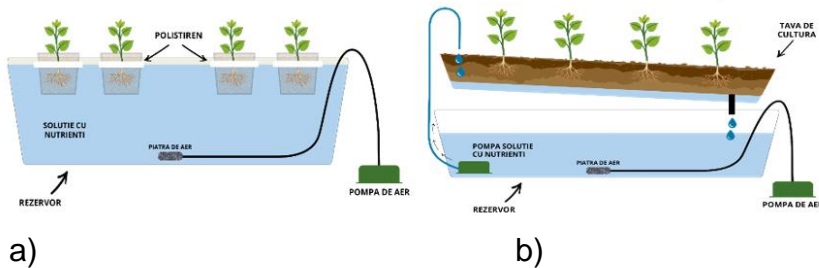


Fig. 8 a) Water culture system, b) The cropping system established on nutritious film (<https://farmbee.ro/blog/ce-este-o-cultura-hidroponica>)

➤ **The cropping system established on nutritious film (NFT)**

This system shown in Figure 8 b) provides at all times the required amount of nutrient solution at the roots of the plants, using a pump. The culture tray is tilted at a certain angle to ensure that the solution drains into the nutrient solution tank.

➤ **The aeroponic system**

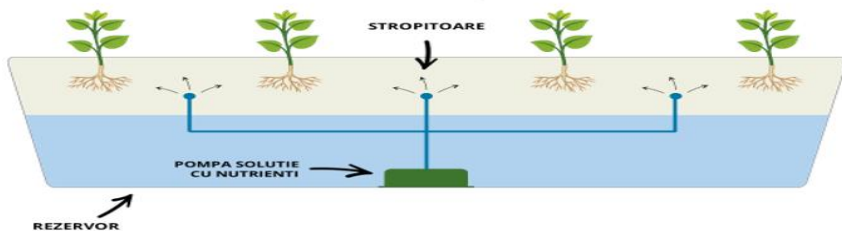


Fig. 9 The aeroponic system (<https://farmbee.ro/blog/ce-este-o-cultura-hidroponica>)

For the aeroponic system shown in Figure 9, the plants are positioned above a nutrient, and a solution spraying system, is used to pump the solution directly on the plant roots.

➤ **The aquaponic system**

The aquaponic system is a relatively new system of agriculture, which has received much research attention due to its sustainability potential (Emmanuel Ayipio et. al, 2019). The aquaponic system

combines aquaculture with hydroponics resulting in a much more complex new system, (Richard V. Tyson et al, 2011). The nutrient solution can be improved with water used to raise fish, plants directly influence the quality of water that leads to fish growth and health (Carmelo Maucieri et al, 2018; Rahmita Wirza and Shah Nazir, 2021). In addition, the wastewater from pig farms can be used to obtain the nutrient solution for growing plants and reusing part of the effluent treated as feed dilution water (Kirill Ispolnov et al, 2021).

As advantages of using hydroponic culture we can highlight the possibility of obtaining large and constant yields throughout the year, weather conditions do not influence the crop, plants reach maturity in a shorter time, compared to classical culture, the phenomenon of disease transmission and pests is reduced due to continuous monitoring, requires reduced labor, etc.

Some of the disadvantages of using these hydroponic systems would be that, if the labor force has to be well qualified, the costs for setting up such a crop are relatively high. Hydroponic culture requires the supply of a very stable energy source, any interruption for a longer period of time leads to the compromise of hydroponic culture in a very high percentage. (<https://farmbee.ro/blog/ce-este-o-cultura-hidroponica>)

CONCLUSIONS

In the near future, hydroponic agriculture can play a very important role in obtaining the much-needed food for the world's population. Fresh and tasty quality products can be obtained in all variants of hydroponic systems. If we take into account the fact that some of the current priorities of mankind are the conservation of soil, environment, water resources, we have an answer to how important it is to use and especially modernize these cropping systems.

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