AgriCos e-Newsletter
ISSN: 2582-7049
Volume : 02 Issue : 02 February 2021 Article No: 34

Hydroponic, Step towards Smart Agriculture

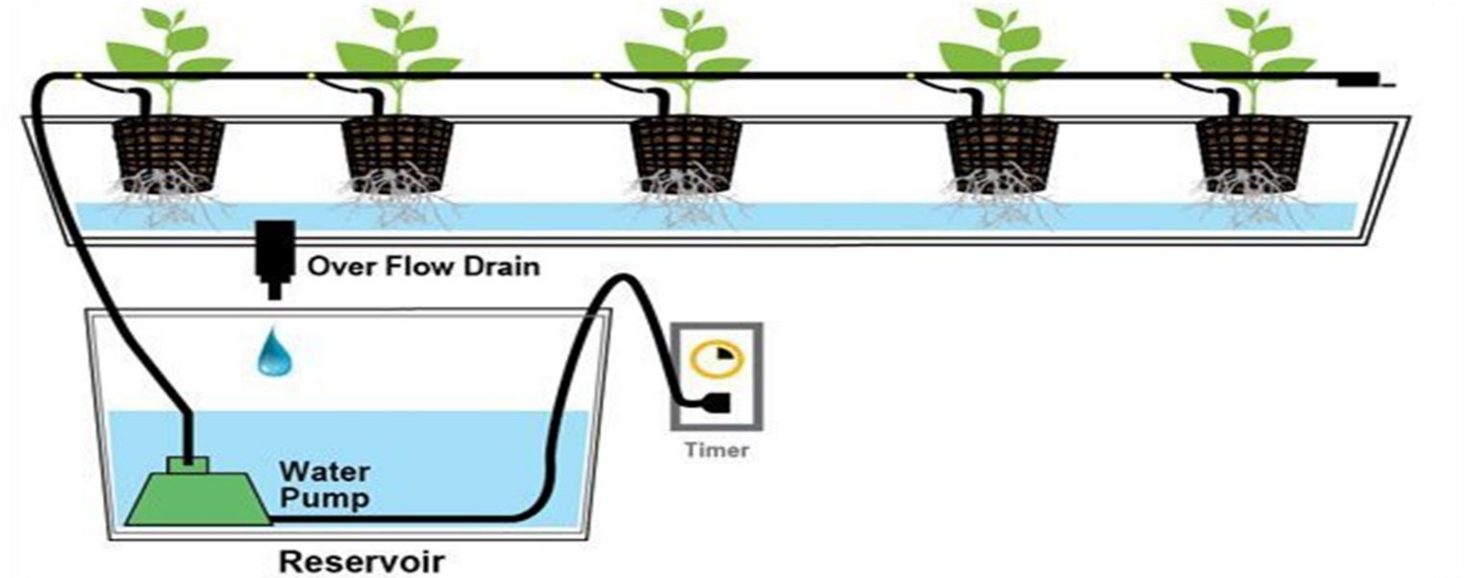
Raheem Khan[1] , Rokade H. N.[2] , Shinde G.U.[3] , and Kakade A.S.[4]
[1]JRF, (SSPN) NAHEP-CAAST-DFSRDA, VNMKV, Parbhani (M.S.)
[2]SRF, (SSPN) NAHEP-CAAST-DFSRDA, VNMKV, Parbhani (M.S.)
[3]Principal Investigator, NAHEP-CAAST-DFSRDA, VNMKV, Parbhani (M.S.)
[4]SRF (FPA), NAHEP-CAAST-DFSRDA, VNMKV, Parbhani (M.S.)

SUMMARY

Soilless cultivation represents a valid opportunity for the agricultural production sector, especially in areas characterized by severe soil degradation and limited water availability. Furthermore, this agronomic practice embodies a favourable response toward an environment-friendly agriculture and a promising tool in the vision of a general challenge in terms of food security.

INTRODUCTION

Considering that human world population will reach about 9 billion by the year 2050, it appears clear that food security is one of the pivotal themes of the new millennium and, reasonably, the most urgent challenge for the agricultural sector. However, it should be considered that the progressive drop of fertile soil surface, due to environmental pollution and urbanization phenomena, greatly complicates the context. Precipitation reactions may occur when cations and anions in aqueous solution combine to form an insoluble ionic solid (the precipitate). Such conditions, called saturation, occur when the concentrations of certain cations and anions in solution reach a maximum limit value (solubility).



Basic Setup of Hydroponic System

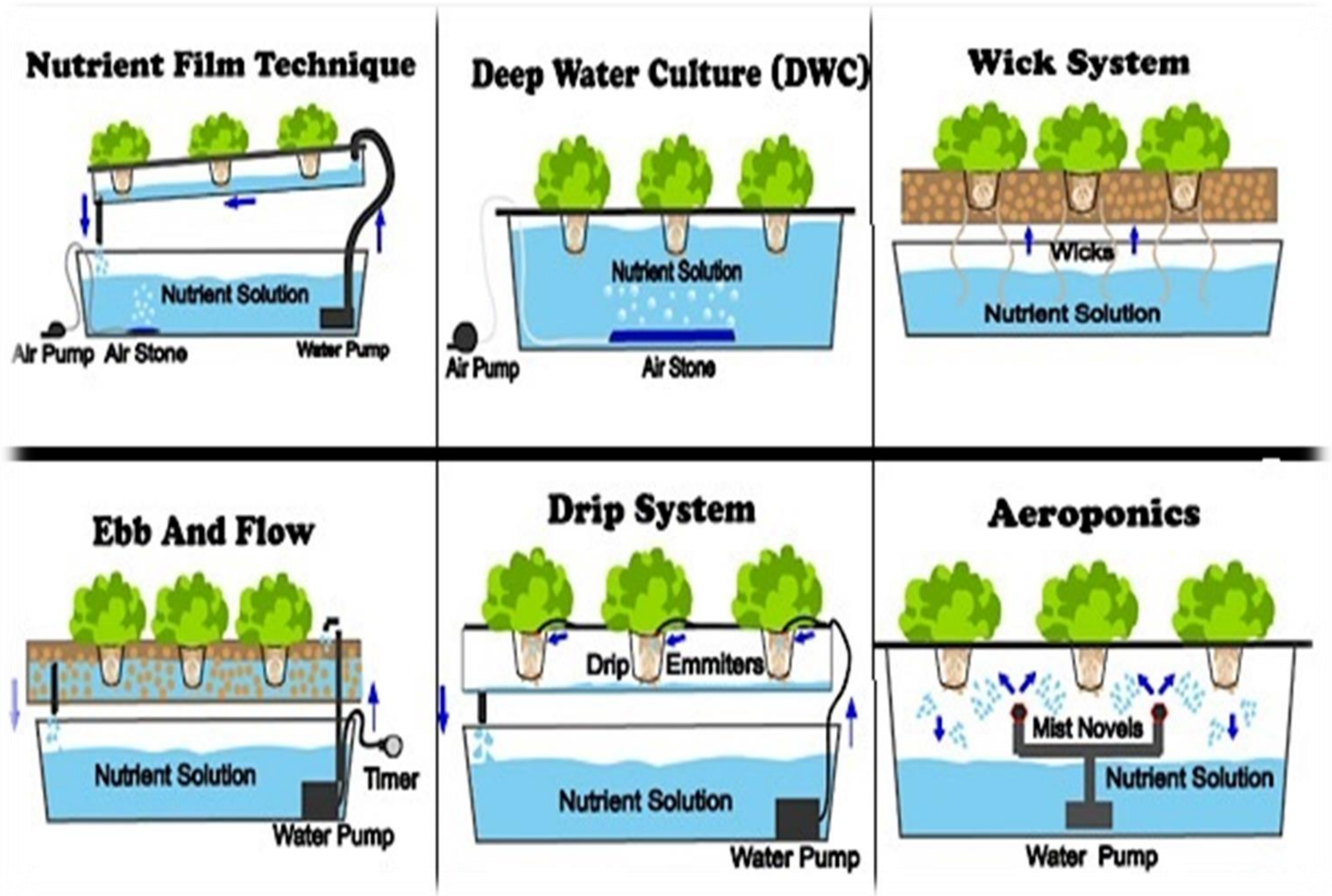
How does hydroponics work?

There are various different ways of growing things hydroponically. In one popular method, you stand your plants in a plastic trough and let a nutrient solution trickle past their roots (with the help of gravity and a pump). That's called the **nutrient-film technique**: the nutrient is like a kind of liquid conveyor belt it's constantly sliding past the roots delivering to them the goodness they need. Alternatively, you can grow plants with their roots supported by a nutrient-enriched medium such as Rockwool, sand, or vermiculite, which acts as a sterile substitute for soil.

Types of Hydroponics

There are six separate types of hydroponic systems which include the following:

- N.F.T. (Nutrient Film Technology)
- Deep Water Culture.
- Wick System.
- Ebb and Flow.
- Drip System.
- Aeroponic systems.



N.F.T. (Nutrient Film Technology)

The N.F.T. system has a simple design but is widely used because of how well it scales to a variety of different applications. When you use one of these systems, the nutrient solution is placed into a large reservoir. From here, the solution is pumped into sloped channels that allow the excess nutrients to flow back into the reservoir. When the nutrient solution is sent into the channel, it flows down the slope and over the roots of each plant to provide the right amount of nutrients. It's highly recommended that you use net pots with this type of hydroponic system. In most cases, the N.F.T. system won't make use of a grow medium. Since the channels that are used with this system are relatively small, it's recommended that you pair it with plants that have smaller roots. Even though this system can't readily accommodate larger plants, it does scale well, which means that you can alter it to allow for the growth of a large number of plants at the same time. Since it scales well, this system is commonly used by commercial growers alongside home growers. It is another highly simplistic type of hydroponic system that places the roots of the plant directly into the nutrient solution. While the wick system places certain materials between the plants and the water, the water culture system bypasses this barrier. The oxygen that the plants need to survive is sent into the water by a diffuser or air stone. When you use this system, keep in mind that the plants should be secured into their proper position with net pots.

Deep Water Culture System

The **best aspect** of the water culture system is that the plant roots are placed directly into the nutrient system, which means that the nutrients can be easily absorbed by the plants. Because of the direct access to nutrients and oxygen, plants that are grown with the water culture method will grow very quickly. The best aspects of the water culture system are that it's very easy to make and works well with any kind of plant. Even large plants with sizable foot systems will grow quickly with this method. the only potential issue with this hydroponic system is the development of root diseases, which is caused by dirty growing conditions.

Wick System

The wick system is easily the simplest type of hydroponic system that you can use to grow plants, which means that it can be used by practically anyone. The wick system is notable for not using aerators, pumps, or electricity. In fact, it's the only hydroponic system that doesn't require the use of electricity. With the majority of wick systems, the plants are placed directly within an absorbent substance like perlite or vermiculite. Nylon wicks are positioned around the plants before being sent straight down into the nutrient solution.If you're thinking about using a wick hydroponic system to grow plants, the simple nature of this system means that the plants are unable to obtain a significant amount of nutrients. As such, the system is ideal for small garden plants and herbs. Any plant that doesn't require a substantial amount of water will grow well in this specific system. While this system is fantastic for smaller plants, you'll want to avoid growing plants like peppers and tomatoes. These plants are considered to be heavy-feeding plants, which mean that they require more nutrients than the wick system will be able to provide. Another negative aspect of this growing system is that water and nutrients aren't absorbed evenly, which could lead to the buildup of toxic mineral salts. When you use this system, make sure that you flush any extra nutrients with fresh water every 1-2 weeks.

Ebb and Flow.

The ebb and flow system is another popular hydroponic system that's mainly used among home gardeners**.** With this type of system, the plants are positioned in a spacious grow bed that's packed with a grow medium like Rockwool or perlite. Once the plants are carefully planted, the grow bed will be flooded with a nutrient-rich solution until the water reaches a couple inches below the top layer of the grow medium, which ensures that the solution doesn't overflow. The water pump that floods the grow bed is outfitted with a timer that will switch the pump off after a certain amount of time. When this occurs, the water will be drained from the grow bed and sent back into the pump. The ebb and flow system has been found to be effective at growing nearly all types of plants, which includes certain root vegetables like carrots and radishes. However, it's recommended that you don't use particularly large plants with this system. Because of how much space these plants will require, you may not be able to fit enough of the grow medium and nutrient solution into the grow bed with larger plants. The *main issue* with the ebb and flow system is that the pump controller can malfunction, which halts operation until the pump is fixed or replaced.

Drip System

A drip system is an easy-to-use hydroponic system that can be quickly altered for different types of plants, which makes this a great system for any grower who plans to make regular changes. The nutrient solution that's used with a drip system is pumped into a tube that sends the solution straight to the plant base. At the end of each tube is a drip emitter that controls how much solution is placed into the plant. You can adjust the flow to meet the needs of each individual plant. These systems can be as small or large as you want them to be. They can also be circulating or non-circulating systems. A circulating system will drip almost constantly. Any extra nutrients will be sent back into the tank that holds the nutrient solution. Since you can readily alter the size and flow rate of this hydroponic system, it can be used to grow practically any plant. If you decide to use a circulating system, the main problem that you'll run into is that you'll need to consistently maintain the fluctuating nutrient and pH levels that occur when the solution is recirculated.

Aeroponic Systems

Aeroponic systems are easy-to-understand but somewhat difficult to build. With this type of system, the plants that you wish to grow will be suspended in air. A couple of mist nozzles are positioned below the plants. These nozzles will spray the nutrient solution onto the roots of each plant, which has proven to be a very effective hydroponic method. The mist nozzles are connected directly to the water pump. When the pressure increases in the pump, the solution is sprayed with any excess falling down into the reservoir below. As long as you use the right dimensions for the reservoir, you can grow nearly all types of plants in an aeroponic system. However, the reservoir will need to be very deep if you plan on growing larger plants. Otherwise, mist nozzles may not be able to reach all of the roots.

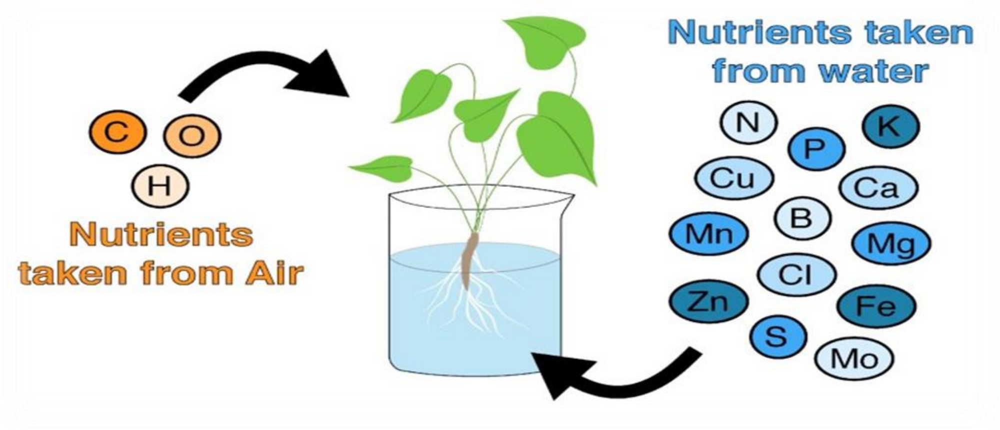
Since the plants with an aeroponic system are suspended in air, they get all the oxygen that they need. This system also uses less water than any other hydroponic system, which is great for efficiency. However, there are a *couple issues* with this system. For one, they can be costly to build. The nozzles that spray the nutrients might also become clogged from time to time, which can be frustrating to clean.

Nutrient management –Heart of Hydroponics.

When dealing with hydroponic cultures, solution chemistry is fundamental to ensure adequate nutrient concentrations for plant uptake. In particular, multiple chemical equilibria must be taken into account when preparing nutrient solutions using salts or concentrated liquid stocks, especially solubilization/precipitation equilibria (De Rijck and Schrevens, 1998b). In fact, a number of physical-chemical phenomena can alter the nutrient availability for plants, the most important of which are (1) precipitation, (2) co-precipitation, and (3) complexation. In this respect, it should be highlighted that the temperature of the nutrient solution, affecting the chemical equilibria in solution, may considerably influence these processes.

Nutrient (chemical symbol)	Approximate content of plant (% dry weight)	Roles in plant	Source of nutrient available to plant
Carbon (C), hydrogen (H), oxygen (O)	90+%	Components of organic compounds	Carbon dioxide (CO_2) and water (H_2O)
Nitrogen (N)	2–4%	Component of amino acids, proteins, coenzymes, nucleic acids	Nitrate (NO_3^-) and ammonium (NH_4^+)
Sulfur (S)	0.50%	Component of sulfur amino acids, proteins, coenzyme A	Sulfate (SO_4^-)
Phosphorus (P)	0.40%	ATP, NADP intermediates of metabolism, membrane phospholipids, nucleic acids	Dihydrogen phosphate ($H_2PO_4^-$), Hydrogen phosphate (HPO_4^{2-})
Potassium (K)	2.00%	Enzyme activation, turgor, osmotic regulation	Potassium (K^+)
Calcium (Ca)	1.50%	Enzyme activation, signal transduction, cell structure	Calcium (Ca^{2+})
Magnesium (Mg)	0.40%	Enzyme activation, component of chlorophyll	Magnesium (Mg^{2+})
Manganese (Mn)	0.02%	Enzyme activation, essential for water splitting	Manganese (Mn^{2+})
Iron (Fe)	0.02%	Redox changes, photosynthesis, respiration	Iron (Fe^{2+})
Molybdenum(Mo)	0.00%	Redox changes, nitrate reduction	Molybdate (MoO_4^{2-})
Copper (Cu)	0.00%	Redox changes, photosynthesis, respiration	Copper (Cu^{2+})
Zinc (Zn)	0.00%	Enzyme cofactor-activator	Zinc (Zn^{2+})
Boron (Bo)	0.01%	Membrane activity, cell division	Borate (BO^{3-})
Chlorine (Cl)	0.1–2.0%	Charge balance, water splitting	Chlorine (Cl^-)
Nickel (Ni)	0.000005–0.0005%	Component of some enzymes, biological nitrogen fixation, nitrogen metabolism	Nickel (Ni^{2+})

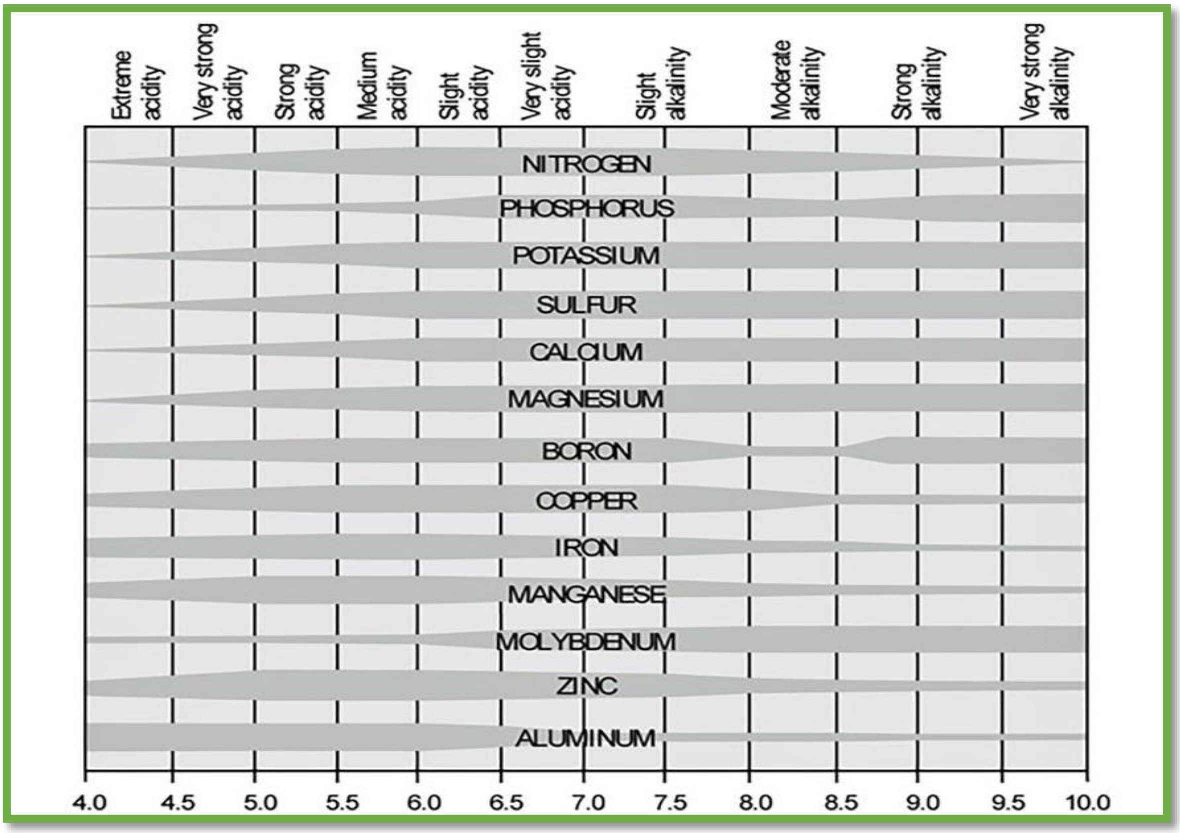
Plants obtain 3 nutrients from the air–carbon, hydrogen, and oxygen–and 13 nutrients from supplemented water: nitrogen, phosphorous, potassium, calcium, magnesium, sulphur, iron, manganese, copper, zinc, boron, chlorine, and molybdate.



Nutrient Solution

pH Adjustment/Management

It is impossible to discuss plant nutrition without considering pH. In hydroponics, we are primarily concerned with the pH of the water used to make up nutrient solutions and irrigate plants. pH is a measure of the relative acidity or hydrogen ion concentration and it plays an important role in plant nutrient availability. It is measured using a 0- to 14-point scale where 0 is the most acidic, 7 is neutral, and 14 is the most alkaline. The scale is logarithmic, and each unit represents a 10-fold change. This means that small changes in values are large changes in pH. For example, a value of 7 is 10 times higher than 6 and 100 times higher than 5. In general, the optimal pH range for growing vegetables hydroponically is 5.0 to 7.0.



This chart shows the pH and availability of nutrients

Advantages of Hydroponics

- Up to 90% more efficient use of water.
- Production increases 3 to 10 times in the same amount of space.
- Many crops can be produced twice as fast in a well-managed hydroponic system.
- Decreasing the time between harvest and consumption increases the nutritional value of the end product.
- Indoor farming in a climate-controlled environment means farms can exist in places where weather and soil conditions are not favorable for traditional food production.
- No chemical weed or pest control products are needed when operating a hydroponic system

REFERENCES

Hydroponics: Indoor Horticulture by Jeffrey Winterborne.
Commercial Hydroponics by John Mason. Simon & Schuster.