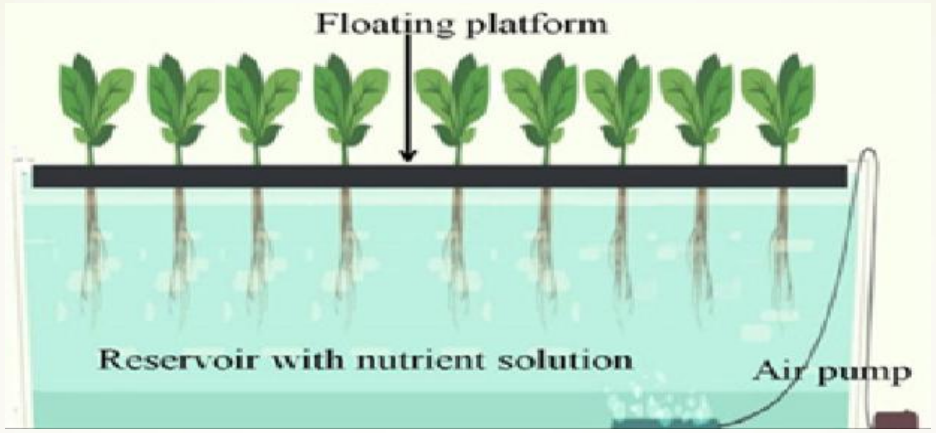
SOILLESS PRODUCTION TECHNOLOGY

'A WAY FORWARD FOR INDOOR HORTICULTURE'



COURSE SEMINAR

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Introduction

Soilless culture is the agriculture out of the soil i.e. to use any means or medium in which the cultivation and development of plant takes place without entering the soil as a rooting medium for agriculture.

The soilless agriculture offers a way to overcome the shortage of the normal amount of water needed to grow plants.

Contd.

Agriculture without soil, in fact, historically dates back to several hundred years BC since the civilization of ancient Egyptian, the Chinese and other cultures [2].

The Aztecs started a method of suspended gardens based on hydroponics at Lake Tenochtitlan during the 10th and 11th centuries [3,4].

Definition of Soilless Culture

Soilless culture is a man-made technique which provides support to the plant as well as a reservoir for nutrients and water. Savvas defined soilless culture as "any method of growing plants without the use of soil as a rooting medium, in which the inorganic nutrients absorbed by the roots are supplied via the irrigation water". It is also known as solution culture or water culture.

Functions of Soilless Culture

The function of soilless cultivating method is stimulating plant growth while controlling the quantities of water, mineral salts and most important, dissolved oxygen.

The basic concept of soilless culture is quite simple: **When roots are suspended in moving water, they absorb food and oxygen rapidly.** The grower's task is to balance the combination of water, nutrients, and oxygen, with the plant needs, in order to maximise yield and quality.

Contd.

For the best results, a few important parameter need to be taken into account; temperature, humidity and CO2 levels, light intensity, ventilation, pH and the plant's genetic make-up.

Requirements for Soilless Culture

- Light
- Temperature
- Water
- pH- maintenance
- Nutrient Solution
- Aeration for the roots
- Electric Conductivity
- Anchorage
- Inorganic Nutrients

Types of Soilless Cultures

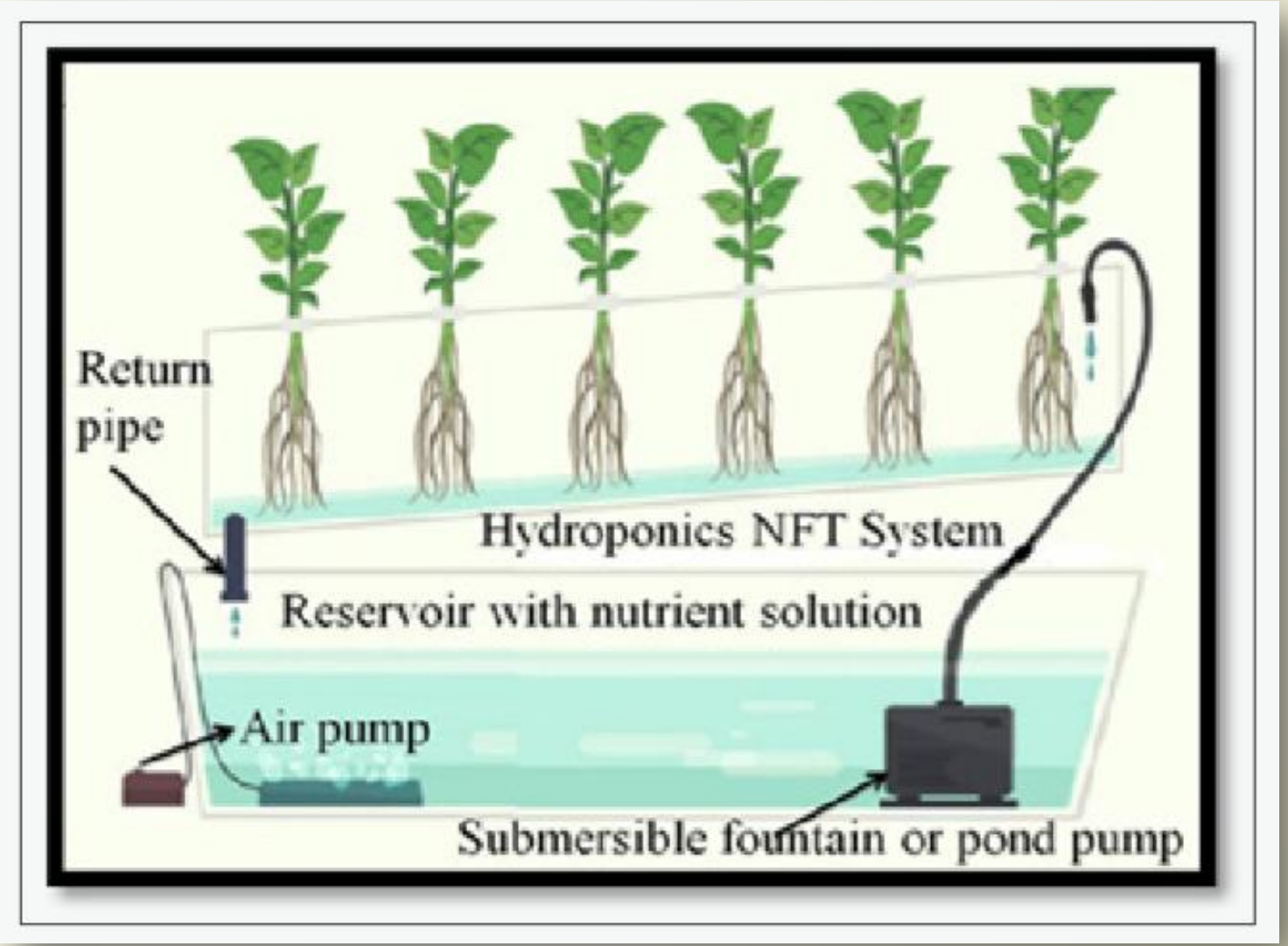
- Hydroponics
- Aeroponics
- Aquaponics
- Substrate Culture

Hydroponics

Hydroponics-Nutrient Film Technique (NFT) is a most common form of culture wherein a thin layer of nutrient solution (about 0.5mm) is circulated in trays and root tips touches the running nutrient solution. It requires regular circulation of nutrients to avoid oxygen deficiency in the solution.

Hydroponics provides an advantage over soil growing for several reasons [5,6]. Plants can be grown year-round since climate conditions can be controlled in a greenhouse.

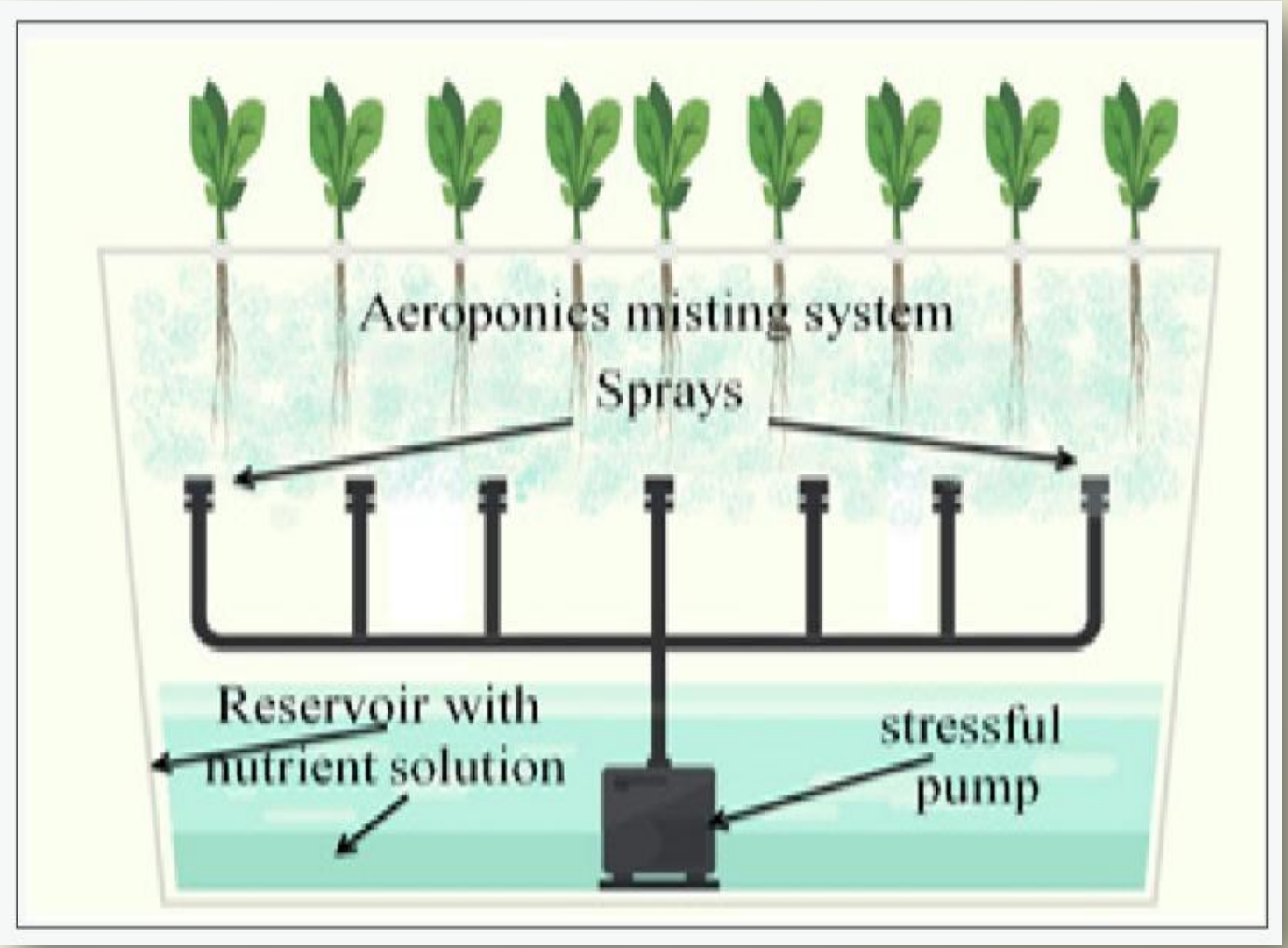
Hydroponics



Aeroponics

Aeroponics is now a days gaining popularity wherein plants are grown without any substrate or water culture. Nutrient solutions are sprayed mostly on the root zone of the plants and proper temperature, humidity, light *etc*. are maintained as per the requirements of the plants.

Aeroponics


Aeroponics misting system
Sprays
Reservoir with
nutrient solution
stressful
pump

Aquaponics

Aquaponics is another advanced method of growing plants in Hydroponics. The aquatic animals like fishes, prawns *etc*. are cultured in the nutrient solution tanks/ plant trays and excreta of these animals enrich (ammonia *etc*.) the nutrient solution which is utilized by the plants. This adds new dimensions to Hydroponics in using the water in most efficient way.

Aquaponics

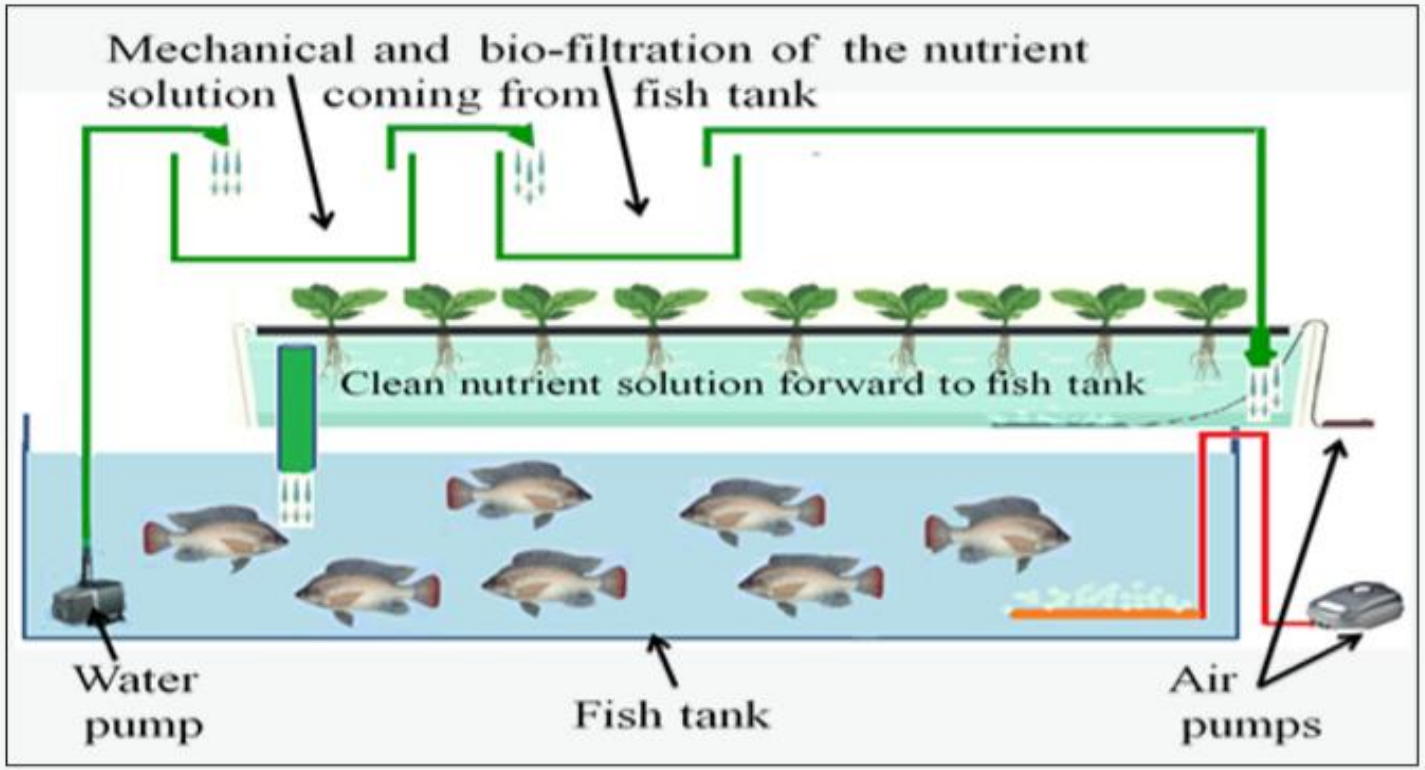


Figure 7: Clears the target steps of Aquaponics culture with hydroponics deep water culture (Can be replaced by NFT system or Media filled beds system or all systems together can be worked).

Substrate Culture (Growth Medium)

Plants are grown in different soilless substrate/ rooting media like sand, gravel, cocopeat, vermiculite *etc*. in different containers, boxes, beds, bags, pots *etc*. and essential nutritional requirements are made available by frequent supply and watering.

Substrate Culture (Growth Medium)

Properties of Substances used in Soilless Culture

1. Low costs.
2. No damaging volatilization of substances.
3. Ensure rewind materials to suppliers for recycling.
4. Have no reactions with each other's or any used solutions (inert).
5. Metallic materials must be coated with weatherproof materials against interact with any solid materials, liquid or gas.
6. No outflow during installing and usage process and possibility of evaluating possible outflows.

Properties of Substrate used in Soilless Culture

1. Aeration and drainage.
2. Applicable in natural form without need for processing.
3. Having a lifespan for at least three years.
4. Cation exchange capacity (buffering action).
5. Free from grit, heavy metals and radioactive pollutants and Cleanliness.
6. Has constant quality (no decrease of physical properties during use).
7. Can be produced by the industry.
8. Inert (no reaction with the nutrients).
9. Low cost.
10. Low density.
11. Have neutral pH.
12. Recyclable or destroyed without hazard.
13. Pest free.
14. Stability of organic matter.
15. Have water retention capacity.

Composition of Nutrient Solution

Macro Nutrients	
$Ca(NO_3)_2$	120g/100 lit. water
KH_2PO_4	20g/100 lit. water
KNO_3	80g/100 lit. water
$MgSO_4$	50g/100 lit. water
Micro Nutrients	
Boron	0.30 ppm
Manganese	0.20 ppm
Zinc	0.203 ppm
Copper	0.022 ppm
Molybdenum	0.015 ppm
Chelated Iron	
Iron	1 ml/lit. water

Plant Necessities

- **Growth Demand:** In soilless culture systems, nutrition and water are permanently available to the plants. The systems must provide available oxygen using good air circulation at the root zones to keep them alive. Healthy roots which are white in colour are responsible for absorption of nutrients and water for plant growth.
- **Nutrient Solutions:** The success or failure of agriculture without soil depends on the existence of balanced nutrient solutions. Growers must choose the right fertilizer for soilless cultures that contain all the macro and micro elements necessary for plant growth.

Water Quality

One of the main elements of the success of farming systems without soil is water availability and quality. There are many sources for water availability from lakes, rainwater, rivers and underground reservoirs or from other treatments. However, water must be of high quality, free of pathogens as determinant factors for the success of agriculture without soil.

Water Disinfection

One of the disadvantages of the closed systems is the risk of a rapid dispersal of soil-borne pathogens by the recirculating nutrient solution. To eliminate these pathogens, several disinfection methods can be used and the followings are some of them:

- Ozone Treatment
- UV Disinfection
- Heat Treatment
- Slow Sand Filteration
- Electrolysed Water
- Hydrogen Peroxide
- Membrane Filteration
- Chlorination

Advantages of Soilless Cultures

- Increase Productivity
- Control of Plant Nutrition
- Water Economy and Control
- Reduction of labour requirement
- Control of root environment
- Multiple crops/year
- Unsuitable soil
- No need of sterilization practices

Constraints of Soilless Cultures

- High capital investment
- Shortage of technicians and skilled labour
- Risk of pathological injuries (Disease Infection)

Conclusion

Progress has been rapid and results obtained in various countries have proved that this technology is thoroughly practical and has very definite advantages over conventional methods of crop production.

The main advantages of soilless culture is the much higher crop yields.

People living in crowded city streets, without gardens, can grow fresh vegetables and barren and sterile areas can be made productive at relatively low cost.

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Thank You