STANDARD OPERATING PROCEDURE OF HYDROPONICS TECHNIQUE

HYDROPONICS

Hydroponics contributes to a greener and more sustainable future for agriculture and the planet. It is an innovative method of growing plants without using soil, where plants receive all necessary nutrients through a nutrient-rich water solution. In this system, the roots of the plants are submerged, suspended, or misted with nutrient solution, providing them with essential elements for growth. The absence of soil eliminates concerns related to soil-borne diseases and pests, making hydroponics a cleaner and more controlled environment for plant cultivation. The efficient use of resources, reduced need for pesticides, and increased crop yields demonstrate the valuable role of hydroponics in ensuring food security and sustainable practices. Hydroponics has proven to be a game-changer in modern farming, overcoming soil limitations and enabling year-round cultivation regardless of weather conditions. These farming techniques must be embraced to meet the growing demand for food in an environmentally responsible manner.

BENEFITS OF HYDROPONICS:

- **Water Efficiency:** Hydroponics uses significantly less water compared to traditional soil-based farming, as the nutrient solution is recirculated and reused, reducing water wastage.
- **Faster Growth:** With direct access to nutrients, plants in hydroponics grow faster than those in soil, as they don't need to expend energy searching for nutrients.
- **Higher Yields:** The controlled environment allows plants to reach their full potential, resulting in increased crop yields.
- **Space Efficiency:** Hydroponic systems can be set up vertically or in compact spaces, maximizing land use and making it suitable for urban agriculture.
- **Reduced Environmental Impact:** The efficient use of water and elimination of chemical runoff into the soil make hydroponics more environmentally friendly.
- **Year-Round Cultivation:** Hydroponics allows for year-round cultivation regardless of weather conditions, making it suitable for regions with harsh climates.
- **Controlled Environment**: Indoor hydroponic setups allow for precise control over factors like temperature, humidity, and nutrient levels, leading to better plant growth and reduced pest and disease issues.

OVERVIEW OF DIFFERENT HYDROPONIC SYSTEMS

1. Deep Water Culture (DWC): Plants' roots are suspended in nutrient-rich water, with oxygen delivered through air pumps to support root health.

2. Nutrient Film Technique (NFT): A thin film of nutrient solution continuously flows over the roots, ensuring a constant supply of nutrients.

3. Kratky Method: A passive hydroponic system where plants grow in non-circulating nutrient solutions, making it simple and cost-effective.

4. Dutch Bucket System: It's a combination of hydroponics and drip irrigation, where plants grow in buckets filled with a growing medium and receives nutrient solution via drip lines.

5. Aeroponics: Roots are suspended in the air and misted with nutrient solution, providing optimal oxygen and nutrient levels.

These various hydroponic systems offer unique advantages and cater to different plant types and growing conditions, making hydroponics a versatile and promising approach to modern agriculture.

1. DEEP WATER CULTURE (DWC)

Deep Water Culture (DWC) is a hydroponic method in which plant roots are suspended in a nutrient-rich solution. This method allows plants to grow in a highly oxygenated and nutrient-dense environment, promoting rapid growth and high yields.

Here's a standard operating procedure for setting up and maintaining a Deep-Water Culture system:

a. System Setup:

- **Reservoir:** Select a container or reservoir to hold the nutrient solution. It should be light-proof to prevent algae growth and appropriately sized for the number of plants.
- **Air Pump and Air Stones:** Choose an air pump that matches the size of the reservoir. Attach air stones to the pump's outlets to provide a constant supply of oxygen to the nutrient solution.
- **Net Pots or Grow Cups:** Use net pots or grow cups to hold the plants' root systems. These containers will sit in the nutrient solution and allow the roots to access both water and oxygen.
- **Growing Medium:** Common growing mediums include clay pebbles, expanded clay pellets, or Rockwool cubes. Fill the net pots or grow cups with the growing medium to stabilize the plants and hold them in place.
- **Nutrient Solution:** Prepare a nutrient solution according to the specifications of the plants. Follow the manufacturer's recommendations for mixing nutrients and adjusting pH levels.
- **pH and EC Monitoring:** Use a pH meter and an electrical conductivity (EC) meter to monitor the pH and nutrient concentration of the solution. Maintain the pH within the optimal range for plants (usually around 5.5 to 6.5) and adjust the nutrient levels as needed.

b. Planting:

- **Seedlings:** Gently place healthy seedlings in the net pots or grow cups filled with the chosen growing medium. Ensure that the roots are well-covered by the medium.
- **Placing Containers:** Set the net pots or grow cups in the designated locations within the reservoir. The plants should be suspended in the nutrient solution, with the bottom of the containers touching the solution.

c. Maintenance:

- **Nutrient Solution Management:** Regularly check and maintain the nutrient solution's pH and EC levels. Adjust as necessary to keep the solution within the optimal range for plants.
- **Water Temperature:** Maintain an appropriate water temperature for optimal plant growth. Generally, the water temperature should be kept between 65°F to 75°F (18°C to 24°C).
- **Air Pump Maintenance:** Keep the air pump and air stones clean to ensure proper oxygenation of the nutrient solution. Clean or replace air stones if they become clogged or worn out.
- **Lighting:** Provide appropriate lighting for the plants. Position grow lights at the appropriate distance and duration according to the specific light requirements of the plants.
- **Plant Health:** Monitor plants for signs of nutrient deficiencies, diseases, or pests. Address any issues promptly to prevent them from affecting the entire crop.
- **Water Level:** Maintain a consistent water level in the reservoir. As plants consume water, add more nutrient solution to keep the roots submerged.

d. Harvesting:

- **Harvest Timing:** Harvest the plants when they reach the desired maturity. Follow the recommendations for each plant type regarding when to harvest for optimal yield and quality.
- **Clean System:** After harvesting, empty the reservoir and clean all components thoroughly. This prevents the buildup of algae, pathogens, and nutrient residues.

Remember that specific plants might have unique requirements, so it's important to research the optimal conditions for the crops that intend to grow using the Deep Water Culture method. Adjustments may also be needed based on local climate and other factors.

2. NUTRIENT FILM TECHNIQUE (NFT)

The Nutrient Film Technique (NFT) is a hydroponic method in which a thin film of nutrient-rich water continuously flows over the roots of plants. This provides them with nutrients and oxygen, promoting growth in a controlled environment.

Here's a standard operating procedure for setting up and maintaining a Nutrient Film Technique system:

a. System Setup:

- **Channel Design:** Set up channels that will hold the plants. These channels should be slightly inclined to allow the nutrient solution to flow from one end to the other. The channels can be made of materials like PVC, plastic, or other suitable materials.
- **Pump and Reservoir:** Place a reservoir beneath the channels to hold the nutrient solution. Connect a pump to the reservoir to circulate the solution through the channels.
- **Growing Medium:** Use a growing medium to support the plants and hold them in place. Common options include Rockwool, coco coir, or other inert mediums that don't affect the nutrient solution's composition.
- **Plant Holders:** Place net pots or containers within the channels, allowing the plants' roots to reach the flowing nutrient solution.
- **Nutrient Solution:** Prepare a nutrient solution based on the specific requirements of the plants. Follow the manufacturer's guidelines for mixing nutrients and adjusting pH levels.

b. Planting:

- **Seedlings:** Plant healthy seedlings in the growing medium within the net pots or containers.
- **Positioning:** Place the net pots or containers in the channels so that the roots are in direct contact with the flowing nutrient film. The solution should gently flow over the roots without submerging them completely.

c. Maintenance:

- **Nutrient Solution Management:** Monitor the pH and electrical conductivity (EC) of the nutrient solution regularly. Adjust the solution's pH to maintain it within the optimal range for the plants (typically around 5.5 to 6.5). Adjust nutrient levels as needed based on plant growth stages.
- **Flow Rate:** Adjust the pump's flow rate to ensure a thin, continuous film of nutrient solution over the roots. The film should be sufficient to provide nutrients and oxygen without drowning the roots.

- **Temperature Control:** Maintain an appropriate water temperature for optimal plant growth. Typically, the water temperature should be between 65°F to 75°F (18°C to 24°C).
- **Lighting:** Provide proper lighting for the plants according to their specific light requirements. Position grow lights at the appropriate distance and duration.
- **Plant Health:** Regularly inspect plants for signs of nutrient deficiencies, diseases, or pests. Address any issues promptly to prevent them from affecting the entire crop.

d. Harvesting:

- **Harvest Timing:** Harvest the plants when they reach the desired maturity. Follow the recommendations for each plant type regarding when to harvest for optimal yield and quality.
- **Clean System:** After harvesting, clean the channels, pumps, and reservoir thoroughly. This prevents the buildup of algae, pathogens, and nutrient residues.

NFT systems require careful monitoring and adjustments to ensure optimal nutrient delivery and plant growth. Keep in mind that the specific requirements may vary depending on the type of plants used for cultivating, so it's important to research the needs of the chosen crops and tailor the approach accordingly.

3. KRATKY METHOD

The Kratky Method is a passive hydroponic system that requires no electricity, pumps, or complicated equipment. It's a simple way to grow plants using a static nutrient solution.

Here's a standard operating procedure for setting up and maintaining a Kratky Method system:

a. System Setup:

- **Container Selection:** Choose a container that will hold the nutrient solution and support the plants' growing medium. This could be a bucket, container, or any watertight vessel.
- **Growing Medium:** Use a growing medium that provides support for the plants and allows the roots to access oxygen. Common choices include perlite, vermiculite, or coconut coir.
- **Net Pots or Plant Holders:** Place net pots or plant holders in the container. These will hold the plants above the nutrient solution, allowing the roots to grow down into the solution.
- **Nutrient Solution:** Prepare a nutrient solution according to the requirements of the plants. Follow the manufacturer's guidelines for mixing nutrients and adjusting pH levels.

b. Planting:

- **Seedlings:** Plant healthy seedlings in the growing medium within the net pots or plant holders.
- **Container Filling:** Fill the container with the nutrient solution until the bottom of the net pots or plant holders is just above the solution's surface.

c. Maintenance:

- **Nutrient Solution Level:** As the plants grow, they will consume the nutrient solution. Monitor the solution level regularly, ensuring that the roots are always in contact with it. Refill the container with fresh nutrient solution as needed.
- **Plant Support:** As the plants grow, they might become top-heavy. Provide additional support to prevent them from falling over.
- **Lighting:** Position grow lights at an appropriate distance and duration to provide the necessary light for plant growth.
- **pH and EC Monitoring:** Periodically check the pH and electrical conductivity (EC) of the nutrient solution. Adjust as necessary to maintain the desired pH and nutrient levels.
- **Temperature Control:** Maintain an appropriate ambient temperature for optimal plant growth. This is especially important for the nutrient solution, as extreme temperatures can affect oxygen levels in the water.
- **Plant Health:** Inspect the plants for any signs of nutrient deficiencies, diseases, or pests. Address any issues promptly.

d. Harvesting:

- **Harvest Timing:** Harvest the plants when they reach the desired maturity. Follow the recommendations for each plant type regarding when to harvest for optimal yield and quality.

e. Clean-Up:

- **End of Cycle:** After harvesting, empty the container and clean it thoroughly. Remove any remaining growing medium and plant debris.
- **Sanitization:** Disinfect all components, including the container, net pots, and growing medium, to prevent the buildup of pathogens and disease.

The Kratky Method requires a low-maintenance approach and it is important to remember that certain crops might have specific requirements, so researching the needs of the chosen plants will help to achieve the best results.

4. DUTCH BUCKET SYSTEM:

The Dutch Bucket system, also known as the Bato Bucket system, is a popular hydroponic method for growing plants in individual containers (buckets) with a continuous flow of nutrient solution via drip lines.

Here's a standard operating procedure for setting up and maintaining a Dutch Bucket system:

a. System Setup:

- **Buckets or Containers:** Obtain individual buckets or containers for each plant. These buckets usually have a lid with holes to support the plants and allow access to the nutrient solution.
- **Growing Medium:** Choose a suitable growing medium that provides support and good drainage. Common options include perlite, coconut coir, or a perlite-coco coir mix.
- **Hose and Pump:** Connect a hose to a water pump and position the pump in a nutrient solution reservoir. The pump will deliver the nutrient solution to the buckets.
- **Distribution System:** Attach drip lines or irrigation tubing to the hose. This system will distribute the nutrient solution from the pump to each bucket.
- **Nutrient Solution:** Prepare a nutrient solution according to the requirements of the plants. Follow the manufacturer's guidelines for mixing nutrients and adjusting pH levels.

b. Planting:

- **Seedlings:** Plant the healthy seedlings in the growing medium within each bucket, ensuring that the roots are well-covered and supported.

c. Maintenance:

- **Nutrient Solution Flow:** Turn on the water pump to initiate the flow of nutrient solution. The solution will flow from the reservoir to each bucket through the distribution system.
- **Flow Rate:** Adjust the flow rate to ensure a consistent and even distribution of the nutrient solution to each bucket. The goal is to keep the growing medium moist without causing waterlogged conditions.
- **pH and EC Monitoring:** Regularly monitor the pH and electrical conductivity (EC) of the nutrient solution. Adjust as necessary to maintain optimal pH and nutrient levels for plant growth.
- **Temperature Control:** Maintain an appropriate water temperature for optimal plant growth. Generally, the water temperature should be between 65°F to 75°F (18°C to 24°C).
- **Lighting:** Position grow lights at an appropriate distance and duration to provide sufficient light for plant growth.

- **Plant Training:** As plants grow, use pruning and training techniques to manage their growth and ensure proper light distribution.
- **Plant Health:** Regularly inspect plants for any signs of nutrient deficiencies, diseases, or pests. Address issues promptly to prevent them from spreading.

d. Harvesting:

- **Harvest Timing:** Harvest the plants when they reach the desired maturity. Follow the recommendations for each plant type regarding when to harvest for optimal yield and quality.

e. Clean-Up:

- **End of Cycle:** After harvesting, empty the buckets and clean them thoroughly. Remove any remaining growing medium and plant debris.
- **Sanitization:** Disinfect all components, including buckets, growing medium, and tubing, to prevent the buildup of pathogens and disease.

The Dutch Bucket system offers excellent control over nutrient delivery and is well-suited for larger plants that require a substantial root space. Tailor the nutrient solution and system management to the specific requirements of the crops for the best results.

5. AEROPONIC TOWER:

An aeroponic tower, also known as an aeroponic vertical tower or aeroponic tower garden, is a type of hydroponic system that grows plants vertically in a tower structure using a nutrient-rich mist.

Here's a standard operating procedure for setting up and maintaining an aeroponic tower:

a. System Setup:

- **Tower Structure:** Assemble the aeroponic tower according to the manufacturer's instructions. The tower is typically designed with multiple planting pockets or holes where plants will be placed.
- **Reservoir and Pump:** Set up a reservoir to hold the nutrient solution. Connect a water pump to the reservoir to deliver the nutrient solution to the top of the tower.
- **Mist Nozzles:** Attach misting nozzles to the top of the tower. These nozzles will spray a fine mist of nutrient solution over the roots of the plants inside the tower.
- **Growing Medium:** Insert plants into the planting pockets or holes in the tower. Use a growing medium that provides support for the plants and helps hold their roots in place. Some common options include rock wool, foam cubes, or even bare roots.

- **Nutrient Solution:** Prepare a nutrient solution following the recommendations for the specific plants. Make sure the solution is well-mixed and properly balanced with essential nutrients.

b. Planting:

- **Seedlings:** Insert healthy seedlings into the planting pockets or holes in the tower's structure. Ensure the roots are positioned to receive the mist from the nozzles.

c. Maintenance:

- **Nutrient Solution Pump:** Start the water pump to initiate the misting process. The pump will circulate the nutrient solution to the misting nozzles at the top of the tower.
- **Mist Frequency:** Set the misting schedule according to the requirements of the plants. A typical cycle involves misting for a few seconds every few minutes, but this can vary based on plant type and environmental conditions.
- **Nutrient Solution Monitoring:** Regularly check the nutrient solution's pH and electrical conductivity (EC). Adjust the solution as needed to maintain optimal pH and nutrient levels.
- **Temperature and Humidity:** Maintain suitable temperature and humidity levels in the growing area. Proper environmental conditions help support healthy plant growth.
- **Lighting:** Position grow lights at the appropriate distance and duration to provide adequate light for plant growth.
- **Plant Health:** Regularly inspect plants for signs of nutrient deficiencies, diseases, or pests. Address issues promptly to prevent them from spreading.

d. Harvesting:

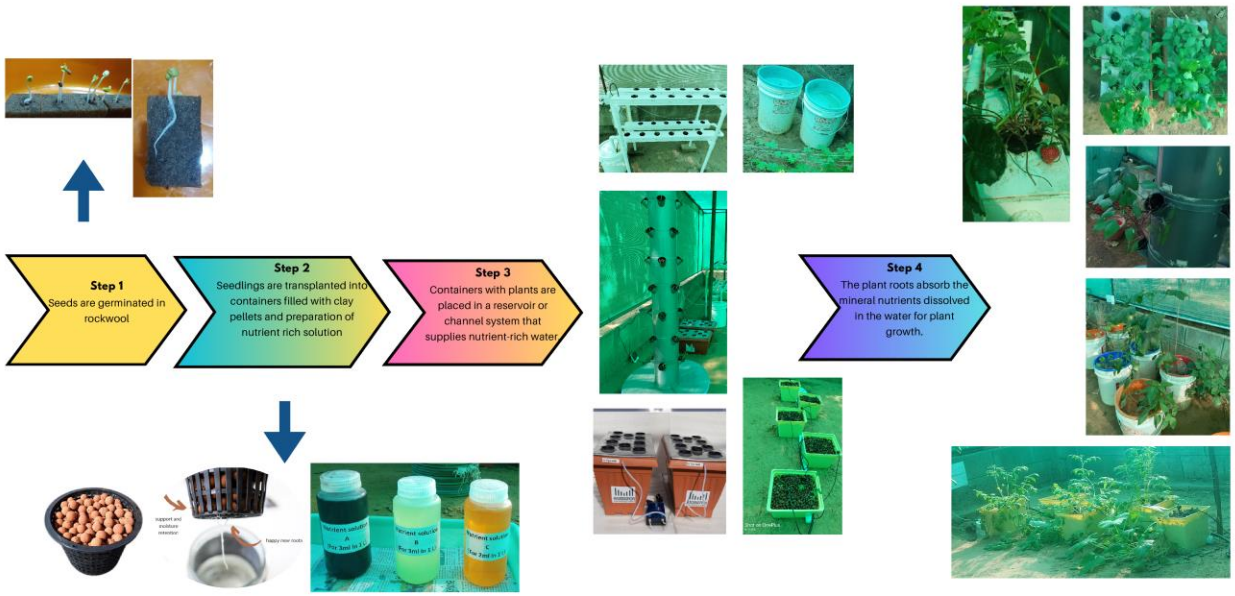
- **Harvest Timing:** Harvest the plants when they reach the desired maturity. Follow the recommendations for each plant type regarding when to harvest for optimal yield and quality.

e. Clean-Up:

- **End of Cycle:** After harvesting, clean the tower and reservoir thoroughly. Remove any plant debris and growing medium residues.
- **Sanitization:** Disinfect all components, including the tower structure, nozzles, and reservoir, to prevent the buildup of pathogens and disease.

Aeroponic towers offer efficient space utilization and can support a variety of plant types. Customizing nutrient solution and misting schedule to the specific needs of plants lead to achieve successful growth in this system.

HYDROPONICS PROJECT MODEL



Marketing strategies that help trainees doing hydroponic cultivation to link with the market

- Advise trainees to identify and target specific buyer segments like grocery stores, restaurants, farmers' markets, etc. that value hydroponic produce.
- Suggest emphasizing the sustainable, pesticide-free, locally grown attributes of their hydroponics plants. These are strong selling points for many buyers.
- Encourage by developing a consistent brand and quality assurance to build customer loyalty and trust in the hydroponic products.
- Helping the trainees to aggregate supply and meet the larger volume and diversity needs of wholesale buyers.
- Promote trainee's products through social media and marketing materials tailored to each target segment. Help share their unique stories.
- Recommend offering promotional discounts and samples to new retail and food service partners to get them hooked on the hydroponic produce.

- Assist trainees in obtaining organic, fair trade, or other certifications that can increase value for certain markets and buyers.
- Advise focusing production on quicker turnover leafy greens, herbs, tomatoes, micro greens, etc. that are well-suited for hydroponics.
- Facilitate trainee's attendance at farmer's markets and trade shows to interact with customers and promote products.
- Aligning the trainees by hydroponic production with specific buyer needs and developing lasting marketing relationships built on trust in the production practices.

FAQ for Hydroponics

1. What is hydroponics?

Hydroponics is the technique of growing plants using a water-based nutrient solution rather than soil, and can include an aggregate substrate, or growing media, such as Rockwool/Stone wool, Hydroton expanded clay pellets, and perlite; however, other popular media consist of bark chips, fibers, sand, rock, vermiculite and coconut coir. Hydroponic production systems are used by small farmers, terrace gardeners, hobbyists, and commercial enterprises.

2. Is hydroponic healthy?

The bottom line is it depends on the nutrient solution the vegetables are grown in, but hydroponically grown vegetables can be just as nutritious as those grown in soil

3. Is hydroponics better than soil?

Yes, 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.

4. Why hydroponics is not successful in India?

Hydroponics is still not a widely practiced technique in India, owing to the traditional nature of farming, lack of technical expertise, and lack of awareness.

5. Do plants grow faster in hydroponics?

Many greens can grow twice as fast in a quality hydroponic system. Hydroponic plants can grow 40-50 percent faster and can produce 30 percent more than the plants growing in soil. A

combination of a fast growth rate and a controlled environment creates predictable harvests consistently.

6. Do hydroponic plants need sunlight?

Light is essential for plant growth in hydroponic cultivation. Hydroponics is used to grow plants in a nutrient-rich, water-based solution as opposed to traditional soil cultivation.

7. What types of hydroponic growing systems exist?

There are several different growing systems, but there are six consistent types used throughout the hydroponic industry – Aeroponics, Kratky, Deep Water Culture, DWC raft system, Ebb & Flow, Wick System, Wick-Raft, Drip Irrigation/Dutch bucket, and Nutrient Film Technique.

8. Is hydroponic difficult?

Hydroponics is one of the easiest ways to garden. There is no tilling, or diggings required - just add water and nutrients to the system and let your plants grow.

9. Why is it called hydroponics?

Simply put, hydroponics is the practice of growing plants using only water, nutrients, and a growing medium. The word hydroponics comes from the roots “hydro”, meaning water, and “ponos”, meaning labor; this method of gardening does not use soil.

10. What is the history of hydroponics?

Hydroponics can be traced back as far back as 2,000 years, with the Egyptians believed to be the first to employ hydroponics. Additionally, hydroponics can also be traced to Asia and the Roman Empire. One of The Seven Wonders of the World, The Hanging Gardens of Babylon, was a hydroponically-grown garden.

11. Is hydroponic chemical-free?

On the other hand, Hydroponics plants are grown in nutrient solutions and are completely free from chemicals and pesticides making them much safer.

12. What are the 6 requirements for hydroponics?

The six things needed are light, air, water, nutrients, and space. Hydroponic growing can be done indoors or outdoors. In either setting, plants will need five to six hours of light per day, access to electricity, and an area that is level and without excessive wind.

13. How long does hydroponic water last?

The best time to change your hydroponic water entirely is after you've topped it off enough times to fill it fully. For an average-size hydroponic system, you'll likely need to change your water every two to three weeks.

14. Is hydroponic profitable?

Hydroponic farming is highly profitable. It is an example of high yield just in a small place in any season or weather condition. The hydroponic vegetables are highly accurate and balanced in fiber, minerals, and vitamins. It is the first method of doing soil-less farming/cultivation.

15. What is the market for hydroponics in India?

The hydroponic market in India is still in its nascent stage but is expected to grow at a significant rate in the coming years. According to a report by Markets and Markets, the Indian hydroponics market was projected to reach 2,525.96 Crores Rupees by 2025.

16. What plants can I grow with hydroponics?

Nearly all types of plant life will grow hydroponically although there are a few that don’t like damp and continuous watering. Most home growers plant vegetables or fruit such as tomatoes, cucumbers, lettuce, peas herbs, etc. These flourish in a hydroponic system.

17. Do I need a greenhouse?

A greenhouse protects from environmental factors such as heat, cold, wind, rain, and insect intrusion. In most climates, a greenhouse is recommended. The type of greenhouse and the environmental control equipment varies widely depending on climate. Many hobbyist growers use shelves indoors, or an attic, etc. This type of growing requires the use of some lighting system.

18. How can I tell if my seeds are viable to use?

Fill a glass with distilled water and place your seeds in it. After 24 hours the viable seeds should have sank to the bottom. Seeds that are still floating will probably not germinate.

19. What does PPM mean?

PPM stands for Parts Per Million and can be used as the measurement of many different things. In hydroponics, it is most commonly used to measure the amount of TDS – Total Dissolved Solids in a nutrient solution or how much CO_2 is in the atmosphere.

20. What are the most commonly grown plants in hydroponics?

The most commonly grown hydroponic crops in India include leafy greens (such as lettuce, spinach, and kale), herbs (basil, mint, and coriander), and vegetables (tomatoes, cucumbers, and bell peppers).

21. What are the government initiatives done in India to support Hydroponics?

The Indian government has launched several initiatives to promote hydroponic farming, such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and the Mission for Integrated Development of Horticulture (MIDH), which provide financial assistance and subsidies for setting up hydroponic systems.

22. What if I have more questions that were not covered here?

Shoot us an e-mail via our contact page and I will get back to you with the answer, and if I don’t have one I will research it and let you know what I come up with.