Horticulture (Soilless) Vegetable Farming:

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Front cover photo: A picture of Horticulture (soilless) vegetable system. (Photo credit: APDC)

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Enquiries: International Institute of Tropical Agriculture (IITA). IITA, PMB 5320, Ibadan, Oyo State, Nigeria. Fax: +234 8039 784477. Email: iita@cgiar.org or Africa Projects Developments Centre, (APDC). APDC, Plots 17/18/27 FRCN Layout, Gwagwalada, Abuja Nigeria. www.apdcgroup.org Contact; 0811815111. Email: admin@apdcgroup.org

INTRODUCTION

In Nigeria, food production is depended on the soil as a growing medium for crops. Sadly, soil degradation (particularly desertification) has been identified as the major challenge facing Nigeria soils and has rendered most soils unsuitable for food production in the country. Nwafor (2006) estimated that the areas already lost to desertification in Nigeria is about 351,000 km sq out of the 923,768 km sq of the country landmass and this is said to be moving from less than 1 km to about 15 km per year. This endemic environmental problem has however adversely affected the country's food production system.

In addition to this, the use of soil for food production in order to feed Nigeria ever-growing population is also been stiffly competed with by the need for shelter, transport, urbanization and industrialization, policy inconsistency, and other socio-economic needs. There is therefore an urgent need to opt for an additional means of food production in order to complement the existing traditional (soil) farming system so as to boost food production in the country. Food and Agriculture Organization (FAO) in 2016 declared the soilless farming system as a sustainable agricultural practice that possesses a more sustainable solution to the challenges of soil farming. This, however, would complement the soil farming in order to improve food crop production in Nigeria especially in the urban areas with little agricultural lands.

URBAN AGRICULTURE

Urban Agriculture in tandem with Urban Horticulture has gained enormous attention in recent years. This is because of the need to meet a part of the food demands of the urban dwellers and it is also a source of income for the urban poor. According to (Olawepo 2012), Urban agricultural activities include: horticulture (vegetables, fruit, and ornamental crops grown on roof tops, in backyards, in vacant lots of industrial estates, along canals, on the grounds of institutions, on roadsides, in small and medium-sized farms, in containers, or in hydroponic solutions; aquaculture (cultivation of fish, shellfish, vegetables, or other natural produce in tanks, ponds, rivers, and coastal bays); livestock production (raising animals in backyards, on verandas, on roadsides, in poultry sheds, and dairy farms); and forestry (managing fuel and timber producing woodlots, vineyards, orchards, berry patches, and street and backyard trees).

However, much of what is known as urban agriculture is basically gardening combined with elements of farming (Halder, Agüero, Dolle, Fernández, Schmidt, & Yang, 2018).Urban agriculture can be located within (intra-urban) or on the fringe (peri-urban) of a town, city or metropolis (**Kuhns, Geoffriau, Vidal-Beaudet, Galopin, Orsini, Sanyè-Mengual,... & Gianquinto, 2017).** According to

Koski and Rangarajan (2013), Urban agriculture takes place in close proximity to neighbors and within communities and the success of such farm is often dependent on the support of those neighbors and communities. In order to gain and maintain that support, urban farmers must be careful to minimize disturbance or annoyance to others, such as by:

I. Acting in accordance to community standards of aesthetics by keeping things tidy, keeping less attractive equipment and structures away from streets and pedestrian rights of way, keeping compost piles contained, and planting flowers or other decorative plants;
ii. Maintaining farm sites by picking refuse up on a regular basis, mowing, controlling weeds in pathways, repairing and maintaining fences and structures, and so on; and
iii. Preventing nuisance conditions such as loud noises or offensive odors by carefully maintaining compost and other organic fertilizers, applying manure, fish emulsion, or other fertilizers in accordance to neighbor activities, and properly keeping urban livestock.

Smit, Ratta, and Bernstein (1996), affirmed that urban farming usually involves technologies such as shallow-bed gardening, that is, with beds made of non-soil organic matter; soil-less farming or hydroponics, aeroponics; container farming; and bio-intensive gardening. The competitive advantage of urban farmers comes from their closeness to the market, which reduces transportation and storage costs, allows fresher products to be marketed, and allows farmers to closely monitor the market and respond quickly to market demand. The spaces urban farmers cultivate differ among cities, but are most likely to be small plots in low-density settlements.

Majorly, urban farming is located where the land is either not suitable for building or is awaiting development, rather than land that is particularly suitable for farming. Among the advantages of urban agriculture include food production in urban areas which has a substantial multiplier effect on the city economy; its role in poverty alleviation can also not be overlooked. Unemployed and partially employed persons, youth, home-bound mothers, and elderly persons can supplement family food and income through small-scale urban farming. Urban agriculture can be planned and managed along with rural agriculture to improve the performance of the food-related sectors of the economy.

SOILLESS (HYDROPONICS) FARMING SYSTEM

Soilless farming is any method of growing plants without the use of soil as a rooting medium, in which the nutrients absorbed by the roots are supplied via the irrigation water. The nutrients to be supplied to the crop are dissolved in an appropriate concentration in the irrigation water and such solution is referred to as nutrient solution.

Hydroponics is a soilless, dirt-free, space saving and most importantly water effective method and approach of growing our numerous fruits and vegetables. This system is not new but not a popular practice in Africa. However, modern Hydroponics has been used widely in commercial greenhouses as well as at homes for over 30 years now.

HYDROPONICS PROCESSES

Hydroponics operates on a simple principle that as long as you are able to provide plants with what they need, those plants will grow very well. In this sense, Hydroponics is invented to help Mother Nature in cases where availability of arable land is limited. Hydroponics replaces the soil with water and the growing media in a controlled growing environment. The growing media can be Water, Sawdust, Rock wool, Coco coir, Peat, Vermiculite, Perlite, Pumice, and Rice hulls among others. Their main role is to transfer the nutrients in the water and keep the roots oxygenated.

Nutrients are added to the water and are moved to the growing media and through the plant roots usually by a pump. The interval of each action is often set by a timer. Hydroponics is usually grown indoors or in a greenhouse. This means growers will take full management of the environment - climate, temperature, lights, ventilation, and so on.

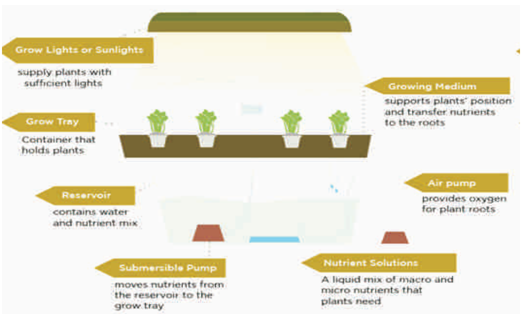

Figure 1: Hydroponics processes

HYDROPONICS MEDIUMS

In hydroponics farming, soil-free growing mediums are used. The less medium a system requires the easier and less expensive it is to operate. This is a major consideration for those intending to make profits from hydroponics farming. The following mediums are commonly used in soilless farming:

i. **Perlite:** Perlite has been around longer than any other soilless growing medium. It granules are very light and originate from a silicone mineral that forms in volcanoes. This medium is available from merchants in small to large bags for addition to growing mediums to increase drainage and aeration in the soil.

Figure 2: Perlite

ii. **Vermiculite:** This compound contains both potassium and magnesium. It holds a lot of water and aids in drainage and aeration of the soil, though it is less durable than some other mediums, such as sand and perlite.

Figure 3: Vermiculite

iii. **Coco coir:** This is a completely organic medium made from shredded coconut husks. It is also known as Ultrapeat, Coconut coir and Coco-tek. It combines the water retention of vermiculite with the air retention of perlite. Finely shredded and steam sterilized, cocopeat offers plants an ideal rooting medium that also offers protection against root diseases and fungus. And unlike peat moss, which is rapidly becoming depleted from overuse, coir is a completely renewable resource.

Figure 4: Coco coir block 5kg

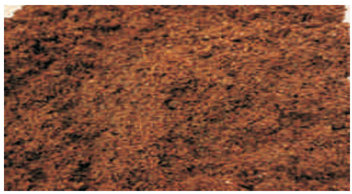

Figure 5: Dissolved Coco coir

iv. **Peat Moss:** Peat moss retains moisture in growing mediums. Many brands of prepackaged potting soil include peat moss for use in container plants that require excess moisture. Tropical plants require extra moisture and warmth to grow and flourish.

Figure 6: Primasta Peat Moss Bag **Figure 7: Primasta Peat Moss**

v. **Rockwool:** This is spun wool from basalt rock, a type of lava rock, and is similar to fiberglass and carbon fiber. Because it is a mineral, it does not degrade. Rockwool is sterile and therefore does not have any contamination issues. Although Rockwool has a pH 8.0 or more, it has a low buffering capacity and will not affect the pH of the nutrient solution or other substrates it comes in contact with. Because the water holding capacity of Rockwool is high, susceptible plants may get stem or root rot.

Figure 8: Hydroponics rockwool

vi. **Rice hulls:** are the outer husk or shell of the rice grain. After the rice grains are dried, the outer hulls are removed in the milling as a by-product. The rice hulls are thin, feather-light,and pointed in shape similar to rice grains. They do not decompose readily, lasting from 3to 5 years. They are neutral in pH and have no nutrients. Their smooth surface does not allow them to retain moisture. They are used in the raw state to free up heavy soils to help oxygenate the soils. They are also used as a hydroponic substrate. They are mixed with peat or coco coir, usually at 20% of rice hulls.

Figure 9: Rice hulls

Properties of a Perfect Medium

1. Holds a uniform ratio of air to water
2. Helps to buffer pH changes over time
3. Is easily flushed and re-wets easily after being completely dehydrated as would be the case during storage
4. Is reusable or biodegradable to ensure safe disposal
5. Is inexpensive and easy to obtain
6. Should be lightweight and easy to work with both indoor and out

HYDROPONICS TECHNOLOGY

A hydroponic system should be designed to fulfill the specific requirements of plant with the most reliable and efficient method of nutrient supply. A hydroponics system must;

i. Provide plant roots with a fresh, well balanced supply of water and nutrient
ii. Maintain a high level of gas exchange between nutrient solution and roots
iii. Protect against root dehydration and immediate crop failure in the event of pump failure or power outage.

Some of the common hydroponic technologies are:

i. Deep Water Culture (DWC): this technique allows the plant to be grown in a bucket containing nutrient solution covered with a lid and the plants, contained in net pots, suspended from the centre of the cover. This system is aerated using an air pump as the covering of the bucket limits air-water exchange.

ii. Float Hydroponics (FH): in this technique, floating materials such as polystyrene or Styrofoam are placed on a trough containing the nutrient solution. These floating materials are used to support each plant in a net pot which is placed in holes made on the material. Most float systems are long, rectangular reservoirs built out of cement or wood and lined with a durable polyliner.

Figure 10: Float Hydroponics (FH) Technique

iii. **Nutrient Film Technique (NFT):** in this technique, a thin layer of nutrient solution is made to flow through an elevated channel (trough) within which the root of the plant lies. A thin layer of the nutrient solution allows the upper part of the plant root to be adequately oxygenated while the elevation of the channel is to allow nutrient solution to reach plants at the lower end. The nutrient solution may be delivered continuously in a 24-hour cycle, or intermittent (alternating watering and dry periods to increase root system oxygenation) or continuous recirculation during daylight hours and automated switching off at night.

Figure 11: Nutrient Film Technique (NFT)

iv. **Aeroponics:** this has to do with growing plants with their roots suspended while a fine mist of nutrient solution is continuously or intermittently applied. This is illustrated in figure 12. Here, a seedling is transplanted to an aeroponic system, the plant is suspended, foliage and roots free of obstructions, nutrient mix is sprayed or misted directly onto the roots through the nozzle, the reservoir holds nutrient mix, a pump supplies nutrient mix to the roots, and the timer controls the nutrient pump.

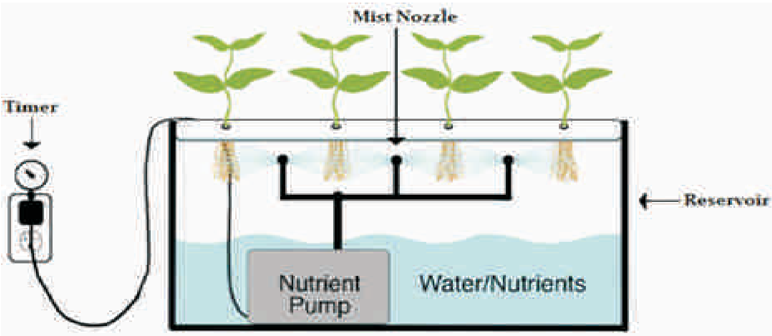

Figure 12: Aeroponics System

v. **Vertical farming:** Vertical farming is a system of soilless farming whereby plants are grown on shelves or storey buildings stake one above the other. This is most relevant in land scarce regions especially developed cities wanting to grow its own crops.

Figure 13: Vertical hydroponics system

vi. **Raft system:** this technique is use to grow lettuce and other short stature crops. In this method, plants are supported by basket fit into Styrofoam sheets that float upon a bath of nutrient solution. The nutrient solution is circulated and aerated from below to maintain a high level of dissolved oxygen and avoid stagnation. The raft system is a very economic means of producing quantities of lettuce and mixed in no time.

NEED FOR HYDROPONICS

Hydroponics comes up with several obvious benefits that the soils cannot compare to. Among which are:

i. **Better growth rate:** It is not uncommon to see that hydroponically grown plants than enjoying a 20-30% better rate than those in the soil, grown in the similar conditions. This is because plant roots directly contact with the nutrients rather than searching for food in the soils. All of these energies will be instead consumed in its growth, and in producing fruits and flowers. Growers are also in charge of the whole growing system - nutrients, temperature, lights, and so on. By this, you can provide with the ideal conditions that plants require.

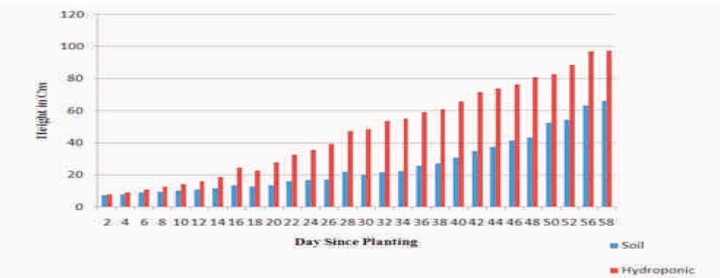

Figure 14: Hydroponic vs. Soil Growth for Tomato Growing

ii. **Higher productivity:** in line with the need for food production to rise faster than population growth to ensure food security and nutrition improvement, crops grown under soilless farming techniques have been studied and observed to better and faster as they expend energy in leave and fruit development rather than in the development of roots systems in search for nutrients in the soil as in the case of geo-ponics.

iii. **Reduced labor requirement:** the labor requirement in soilless farming is lesser as there are no soil to till, plough or ridge, no weeding to be done, no watering and requires less for pest control especially in greenhouses.

iv. **Not season-bound:** plants grown in soilless farming are not affected by the season as they are constantly fed with the required nutrient and water to grow.

v. **Low management cost:** cost of running the systems is usually low especially for the NFT system because these are kept running almost entirely automatic and each input is expected to last for years.

vi. **No weed competing:** since soil is not used, with all seeds carefully selected, soilless farming has no weed or weeding problem. This saves cost on herbicide and spraying.

vii. **No soil-borne pest and disease:** plants under soilless planting system can be attacked by pest and diseases too but not usually as much as that of soil farming as most soil and diseases are known to be soil-borne. Soilless farming has been observed to have little pest and disease issue.

viii. **No big expensive machinery required:** since the system doesn't involve land ploughing, ridging, tilling, clearing, windrowing therefore no big expensive machineries like tractors, bulldozers, combine harvester needed.

ix. **Precision in terms of nutrient supply:** excessive use of fertilizer know with geoponics is not the case in soilless farming as nutrients are either released based on plant requirement or are recycled or reused in most cases.

x. **Pollution:** pollution of the surrounding air and water body close to farmlands has been discovered to be as a result of indiscriminate use of fertilizers and other chemicals which are sent to the environment by the wind or runoff.

xi. **Water and land conservation:** less water and land are used up in soilless farming due to reduced evapotranspiration, no indiscriminate use of water for irrigation, no need for the traditional spacing standards and more is produced with lesser space.

xii. **Support life in space:** research shows that soilless farming has been tested and adopted for use in space jets and other planets since there are no soil for planting.

xiii. **Better for research purpose:** this system is specifically good for research purpose since precision is usually high and can easily be controlled. With this method one can measure the exact amount of nutrient or water or light required for plant to grow or to develop certain characteristics in them.

xiv. **Adaptability to greenhouse and vertical farming:** in develop nations soilless farming is usually practiced in greenhouses and are sometimes grown vertically especially in land scarce countries like Singapore and China.

xv. Increase interest of youths for agriculture as the cloak of dirtiness is removed and the production profession (farming) is dignified.

GREENHOUSE TECHNOLOGY FOR HYDROPONICS

Greenhouse farming: this is also called Controlled Environment Agriculture (CEA) whereby plants are grown in an artificial environment where factors influencing the growth of plant can the controlled. This is currently been integrated into soilless farming systems to boost production among other benefits. It is becoming very common in Nigeria because of its advantages of keeping out pests and diseases and its comparable yield advantage to open filed cultivation of crops. Greenhouse also enables farmers to cultivate crops which they would ordinarily be unable to cultivate because of the climatic or weather condition in their locations. In greenhouse, humidity and temperature can be controlled. It is also possible to control the amount of water passed to crops in greenhouse farming.

Figure 15: **Simple Greenhouse/Screenhouse**

Components of a Greenhouse

Some of the components of a greenhouse are:

i. **Iron rods or pipes:** Most greenhouses are built with galvanized iron or steep pipes. These pipes are used to construct the frame of the greenhouse. Without the pipes, the greenhouses cannot be constructed. However, some people construct their greenhouses with wood or PVC pipe.

ii. **Greenhouse Cover:** The greenhouse cover is the plastic, glass, UV cover or shade net used in covering the greenhouse structure. The greenhouse cover protects the greenhouse from the elements of the weather. The plastic or glass used as a cover for a greenhouse should typically has a light penetration rate of between 80%-96%.

iii. **Drip Irrigation:** Most greenhouses if not all have drip irrigation facilities. Drip irrigation is a type of water efficient irrigation that allows water to drip or trickle to the roots of plants. With drip irrigation, farmers can be able to do fertigation.

iv. **Mister:** Some greenhouses have misting equipment used for misting when humidity is low. Misting is done to provide humidity for crops during times of low humidity. Low humidity can be harmful to some crops.

v. **Carbon IV Oxide Gas Chamber:** All plants need carbon dioxide or carbon IV oxide for photosynthesis. To fast track the growth of plants in greenhouses and to ensure that the crops have a good yield. Some greenhouses have carbon IV oxide gas chamber.

vi. **Plastic Mulch:** Plastic mulch is used to cover the soil in order to prevent weeds and alter the temperature of the soil. Some greenhouses have plastic mulches which are used to guard against weeds.

vii. **Grow Bags:** Grow bags are plastic bags that are used for planting crops. Instead of a farmer to plant directly on the soil, he can decide to plant in grow bags. Soilless medium like coco peat can be stuffed in the grow bags to serve as a planting medium.

viii. **Planting Media:** Soil, coco peat and rock wool etc. can be used as planting media in a greenhouse.

ix. **Pollinators:** Some farmers introduce bees into their greenhouses while some use artificial pollinators to pollinate their crops because the enclosed structure does not allow bees to have access to the crops in their greenhouses.

x. **Climate controlled equipment:** Highly sophisticated greenhouses often have the ability to adjust to the best temperature and humidity suitable for the crops grown in them. This climate-controlled equipment is a key component of some types of greenhouses.

Crops grown in greenhouse hydroponics system

The following are the crops that can be grown:

- Tomato
- Cucumber
- Cauliflower
- Coriander
- Peppers
- Basil
- Kale
- Mint leave
- Celery
- Sweet Pepper
- Broccoli
- Cabbage
- Parsley
- Lettuce
- Strawberry
- Beetroot
- Spinach
- Red Chicory

VEGETABLE SEEDLING PRODUCTION

When planning vegetable production, you need to calculate how many seeds you need. For example, a farmer has an area of 0.1 acre (400m sq)for tomato cultivation. It is important to calculate the number of seeds to buy to cultivate the area. The farmer learns in the planting guide that the correct planting distance for optimal growth for tomato plants is 0.75m x 0.50m and that one gram of tomato seeds contains 300 seeds. Experienced farmers know that not all the seeds will germinate and that some seedlings will die before producing. That is why 30% allowance for replacement seedlings will be added.

Seed computation for cultivating tomatoes
Planting distance for tomato plants: 0.75m x 0.50m
1 gram = 300 seeds
Area for cultivation: 400m^2/ 0.1 acre

To find out how many tomato seeds are needed, use the following calculations:

1. What is the cultivation area for the crop the farmer has decided to grow?
   - Here it is 0.1 acre (400m^2)

2. Amount of seeds needed per hectare (10,000 m^2).
   - For tomato it is 26,600 plants/hectare (details on the crop guide)

3. Calculate the farmer need of seeds based on this
   - 26,600 plants per 1 hectare (10,000m^2)
   - 26,600/10,000= 2.66 plants per m^2
   - 400m2 x 2.66 plants = 1,064 plants

4. Calculate the 30% allowance for extra seedlings for replanting
   - 1,064 seeds/100 x 30 = 320 extra seeds

5. Combine the seed need for the planting area + extra seeds:
   - 1,064 seeds + 320 seeds: 1,384 seeds

6. The number of seeds needed can also be converted to grams
   - 1,384/300 seeds = 5 grams

The farmer would need to buy 5 grams of tomato seeds, or 1,384 seeds for the 0.1 acre (400 m2) area reserved for tomatoes.

Note: Calculating your needs in seeds will allow you to better control cost of production from the start.

Seed computation without a crop guide: tomato
A good field layout will help with the calculation of the quantity of seeds needed. For example, the beds for tomatoes need to be 1 meter wide and 30 cm high. In dry season 20 cm height is enough. The maintenance paths between the beds are 50 cm wide. One (1) meter bed with a path then requires 1.5 meters of space. It can be planted with 4 tomato plants.

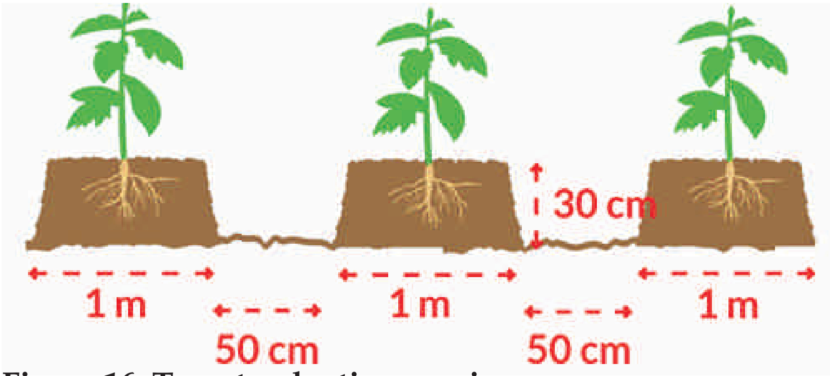

Figure 16: Tomato planting spacing

Note: Plant spacing is important in preparing the field layout

When your total area is 400 m^2 (0.1 acres) you get the number of plants by calculating how many plants you have per square meter and multiplying that with your area.
4/1.5 m2 = 2.66 tomato plants per square meter

You then multiply this by your area of 400 m2 (0.1 acre) reserved for cultivation, you get:
2.66 x 400 = 1067 plants
Then add 30% provision
1067 x 0.3 = 320 seeds
1067 + 320 = **1,387 seeds**

The benefits of using good quality seed: Using good seeds ensures healthy seedlings that will grow into vigorous, high-yielding plants.

How to identify quality seeds: Good quality seeds come from a known source and comply with local regulations or protocols. Knowing who has produced the seeds and how they have been stored will help you determine their quality. The information found on seed packaging can also help you determine seed quality.

How to understand and use the information found on a seed package: A seed package usually states the production date, best before date, germination percentage, crop variety and characteristics, whether seeds are coated or not, the purity of the seeds, and other important information, such as planting distance.

The difference between coated and non-coated seeds: Polymer film-coated seeds are easy to use and provide extra protection against pests and diseases during storage, as well as for the first 30 days after sowing.

Crop production and protection: How to plan quality seedling production using seed requirements and keeping crop environment and seedling protection in mind. This includes planning the layout of the field, knowing about different pests and insects and how to protect the seedlings from them.

Nurseries

It is often productive to use a seed tray for growing seedlings in hydroponics and then move or transplant them to the final field where they will produce. This gives you better control over the growing conditions and results in healthier plants.

Figure 17: Seedlings in the nursery

Seedling hardening

Before moving the plants from the seed tray, you should take a few days to prepare them for transplanting to minimize the transplanting shock. This is called hardening. Seedlings planted without hardening in a sunny field are likely to wilt and die because of heat stress or transplanting shock. It is quite simple to do and will help your seedlings survive better the shock of moving. Start with a few hours of direct sunlight per day and increase the time each day by removing the shade for a longer period of time each day.

A step-by-step guide for hardening:

- Reduce watering.
- Expose the seedlings gradually to more sun for 2-3 days before transplanting.
- Protect the seedlings with shade at midday on the first days.
- Remove shade or move the seedling under full sun gradually.
- When the seedlings are acclimatized for full sun, they are ready to be transplanted. Do this late in the afternoon.

Figure 18: Seedlings exposed to Sunlight (Hardening)

Remember never to allow the seedlings to wilt, the purpose is to keep the seedlings healthy and adapting to field conditions while they are still in seed trays or containers!

Transplanting guide for container or cellular seedlings

When transplanting, take care not to damage the root system. There are 7 easy steps to transplanting your container-grown seedlings.

1. **Water the hardened seedlings 1 hour before transplanting.**
   - Do not soak the seedlings.
   - Water enough to make the media wet, as this will help you unplug the seedling easily from the container or the cell.

2. **Prepare holes in a weed-free medium for the seedlings.**
   - The holes shouldn't be too deep or too shallow. The correct depth depends on the root system of the seedling.

3. **Bring the seedlings to the field in the late afternoon. Carefully remove seedling from a cell for planting.**

- It is easy to transport the seedlings in seed trays and containers.
- Pick and choose uniform seedlings for transplanting.
- An easy way to remove the seedling is to pinch slightly the bottom of the cell to make the seedling move up and out of the cell.
- With plastic bags, you may need to cut open them. Dispose of the plastic properly.
- With leaf pots, just unroll them.

Figure 19: Removed Seedlings from the seed tray

4. **Place the seedling in a prepared hole**
   - Set it at substrate level, or a little higher if you have sandy or loose soil.

5. **Firm the substrate lightly around the plant**
6. **Monitor the transplanted seedlings every day**
   - Remove wilted ones and replace them with extra seedlings from your nursery.

Estimated sowing to transplanting days for different vegetable crops

Eggplant/ pepper 25-30 days
Tomato 18-25 days
Cucurbits 8-12 days
Legumes 8-12 days
Onion/papaya 40-45 days
Brassicas 14-25 days

Taking care of seedling trays

After transplanting, remember to clean all the seed trays for using them again. Remove all soil, wash with detergent and water and let them dry. When dry, stack the seed trays and store them in a shady place.

Assessing seedling quality

Monitoring the growth and health of seedlings is essential throughout their development. If you are not producing seedlings yourself, it is also possible to buy seedlings from a grower.

Checklist for quality seedlings

- Check the vigour and uniformity of growth in the seedlings.
- Monitor that the seedlings are proper height: 3-4 inches.
- Check that the leaf colour is bright green.
- Check the thickness of the stem.
- Check the colour of the roots. They should be white, not brown.
- Ask the vendor about the seeds, the source, the date of sowing.
- You can also ask the vendor about the techniques used.

The benefits of using seed trays and how to select the best ones for your needs

- Ensure that they drain well and that there is enough room for the roots to develop!
- Using trays can increase seedling survival rate, lessening the amount of seeds you need and provides consistency in seedling growth.
- They also allow you to transport seedlings easily.

What a nursery is and why it's useful

- A nursery house speeds up seedling growth and is an efficient way to protect your seedlings.

The importance of good media, sterilization, care, and maintenance

- Growing media are the materials that plants grow in and can be ready-made or hand-made.
- The ideal media has enough porosity and stays moist.
- Without sterilizing, caring for, and maintaining the media your germination rate might be low.

Filing trays or containers and watering regularly to raise high-quality seedlings

- Make sure that seed trays or containers are clean and free of any old residue before sowing.
- In general, the appropriate depth for sowing seeds is about 2 times the size of the seed but not deeper than 1cm.
- Once the seed is planted, water gently and regularly and keep the growing media moist but not too wet.

What pre-germination is and when to use this method?

- Pre-germinating seed is useful when growing crops that are difficult to grow in cold weather.

- It helps the seeds germinate quicker, and allows for uniform germination.
- It is also a good method for when you don't know the quality of the seeds you're sowing and want to check their germination rate.

Caring for and transplanting seedlings, and assessing their quality

- Once your seeds begin to sprout into seedlings, they will need constant care and monitoring.
- Remember to keep the growing media moist but not too wet.
- Water your seedlings when the surface of the soil feels dry.
- The seedlings will also need to be protected from insects and other pests to grow optimally.
- It may also be necessary to give them extra nutrients via fertilization.

PLANT NUTRITION

Basically, plants require 17 essential nutrients for growth and development: carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K^+), sulfur (S), calcium (Ca^{2+}), magnesium (Mg^{2+}), boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn).All these nutrients are made available in hydroponics farming because without these nutrients, plants cannot complete their life cycles and their roles in plant growth cannot be replaced by any other elements.

Organic composition of plants

Four elements form the organic composition of plants and the exclusion or depletion of any of the elements would cause death of the organism

1. Carbon (C): This occur in the cell walls of plants. Carbon constitutes approximately 50% of a plant's dry weight.
2. Hydrogen (H): This is important in nutrient cation exchange (the chemical reaction which causes roots to uptake nutrients) and in plant-soil relations.
3. Oxygen (O): This is essential for the process of respiration which provides the energy plants utilize to grow.
4. Nitrogen (N): Necessary for the formation of amino acids, coenzymes and chlorophyll.

Macro Nutrients

These are nutrients that absorbed in large quantities from the growing media by plants.

S/N	Nutrient	Function	Deficiency	Toxicity
1	Nitrogen (N)	Necessary for the formation of amino acids, coenzymes and chlorophyl	Result in spindly plants with small yellowish leaves. Some parts of the plant may turn purple	Result in overly vigorous growth, dark green leaves and delayed fruit ripening. Plants may also become more susceptible to pests
2	Phosphorus (P)	Production of sugar, phosphate and ATP (energy) – flower and fruit production – root growth	Causes plants to stunt and turn dark green. Lower leaves become yellow and may assume a purplish tinge as phosphorus is drawn from them to feed new growth. Leaves can curl backwards and drop while fruit production and the root system are compromised	Reduce the availability of copper and zinc
3	Potassium (K)	Protein synthesis requires high potassium levels. Hardiness, root growth, and the manufacture of sugar and starch also require potassium	Growth slows while the older leaves develop mottling and plants b ecomes prone to fungus	May cause a secondary Magnesium deficiency

Micro nutrients

These are those nutrients absorbed in small to minute quantities by plants. They are generally less well known than the Macro nutrients since most plants' foods don't contain them.

S/N	Nutrient	Function	Deficiency	Toxicity
1	Calcium (Ca)	Required for cell wall formation	Causes stunting and crinkling leaves. Young shoots die and blooms fall from the plant. Calcium deficient tomatoes will develop brown spots on the bottom of the fruit which will cause decay especially with the onset of high temperature. This is called blossom end	Excessive Calcium is difficult to spot
2	Sulfur (S)	Protein synthesis, water uptake, fruiting and seedling, a natural fungicide	Cause young leaves to turn yellow with purple bases	Slow growth, leaves are smaller
3	Iron (Fe)	Chlorophyll formation, helps in respiration of sugar to provide growth energy	Causes new growth to become pale and blossoms to drop from the plant. Yellowing is initially observed between the veins and leaves may die along their margins	Excessive Iron is difficult to spot and quite rare
4	Magnesium (Mg)	Utilized in chlorophyll production and enzyme manufacture	Cause older leaves to curl and yellow areas to appear between l eaf veins. Only the newest growth will remain green as Magnesium is transport from the older leaves to feed the newer ones	Excessive Magnesium symptoms area rare

5	Boron (B)	Necessary for the formation of cell walls in combination with calcium	Results in brittle stems and poor growth. Stems may twist and split.	Cause leaf tips to become yellow and die off
6	Manganese (Mn)	A catalyst in the growth process, formation of oxygen in photosynthesis	Causes yellowing of leaves between the veins and failed blooms	Can reduce the availability of iron
7	Zinc (Zn)	Utilized in chlorophyll production, respiration and nitrogen metabolism	Results in small leaves with crinkled margins	May also reduce the availability of iron
8	Molybdenum (Mo)	Nitrogen metabolism and fixation	Small, yellow leaves	Cause tomato leaves to turn bright yellow in rare instances
9	Copper (Cu)	Activates enzymes, necessary for photosynthesis and respiration	Causes pale, yellow - spotted leaves	May reduce the availability of iron
10	Cobalt (Co)	While Cobalt is not known to be directly required by plants, Nitrogen fixing organisms that help legumes like beans and alfalfa feed require Cobalt in trace amount. Cobalt also contained vitamin B -12, which is vital to all the forms of life.	N/A	N/A

Note: Hydroponic nutrients come in all flavors; powders and liquids, single part, two-part, three-part and some. Selecting the best one for your application can be tricky but it is important to choose the one that is simple to use, inexpensive to own and effective at growing a wide variety of crops to their fullest potential without requiring additional supplements or stimulants

COMMON PESTS AND DISEASES AND CONTROL

Your number one priority as a hydroponics farmer is to keep your greenhouse healthy since it is very easy to prevent problems than it is to control them. The first rule in keeping your farm healthy is to keep it pest free and the simplest way to achieve this is to keep it clean. Many pests find their way into the greenhouse on the soles of muddy feet. You must be diligent in removing all debris, dust, dead or dying leaves, sickly plant and so on. Look for anything that can be as a breeding ground or as potential food for insect larvae or maturing adults. Naturally, most plants have in-built natural defenses against disease and pests, they are only as strong as their overall health. However, over or under feeding, excessive humidity, or lack of ventilation can all contribute to reducing the vigor of your garden and can open the door to disease and infestation.

Fungi, Algae and Disease

Excessive moisture in the air, on the leaf, and within growing media are the major causes of fungi and mold outbreaks. Fungi are spread by spores that are carried aloft in the air. As a farmer, the first steps against fungi such as gray mold, powdery mildew, and damping off is to pay close attention to the following conditions that will readily allow spores to colonize.

1. Maintain low humidity 60-80%
2. Ensure proper ventilation
3. Remove all dead and dying leaf and stem
4. Never over-water when growing with media

However, in the event of fungi outbreak, even with preventative measures, you essentially have no choice but to employ a fungicide. Botrytis or gray mold is the most common fungi that plagues plants in hydroponics. Other common pests in hydroponics are bugs, whiteflies, spider mite, and aphids among others. These can be controlled by the use of insecticides.

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