Soilless Agriculture- A progressive Technique in agricultural development

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Abstract: Agriculture out of the soil is to use any means that would cultivate plants without entering the soil as a mediator for agriculture, where cultivated plants are in isolation from the soil as long as the system allows the plants to strengthen, the system here provides water needed for growth and nutrients for plants. This kind of agriculture may sound doubtful regarding the plant quality but 100% results are seen. Agriculture outside of soil is including hydro agriculture (Hydroponics), aqua agriculture (Aquaponics), aerobic agriculture (Aeroponics) as well as agriculture using supportive mediators. Benefits of soilless cultures are as follows- reservation of cultivated lands for main crops, saving of not less than 90% of irrigated water, use of nearly recycled fixed amount of water can be done, most vegetable crops succeed and gives the highest productivity in soilless agriculture than in the typical agriculture. It could be run in several places such as balconies, roofs of buildings, various greenhouses and lands unfit for cultivation. The provision of fertilizer materials are used in an accurate amount based on the requirement of plants, also there is ease in dealing with plants and conducting the required protection operations against various pests despite the increase in the constituent unit cost of soilless culture, but the huge amount of production neutralises this cost in a shorter period. Soilless culture is a method of cultivation of new and advanced plant culture and requires us to search for human cadres who have the ability to qualify for this work as this kind of practise is rare, unfortunately.

Keywords:* *Hydroponics; Aquaponics; Aeroponics; Soilless cultures; Agriculture

Introduction:

Although many members have published the activities of planting crops in the soil, a few continue to focus on planting crops in soilless cultures. The work presented is a vision of agricultural programs that can be done without land. However, landless agriculture provides a way to overcome the deficit of the normal amount of water needed to grow crops. Landless agriculture, historically, dates back a few hundred years to the ancient Egyptian civilization, Chinese, and other cultures. The Aztecs developed a system of established gardens based on the hydroponics of Lake Tenochtitlan during the 10th and 11th centuries. There are a variety of outdoor farming methods that have been used recently. Such strategies include Hydroponics, Aquaponics, Aeroponics and agriculture using supporting mediators. Landless farming can be done in a variety of areas such as balconies, roofs, nursery and uncultivated lands. These types of agriculture operate under regulatory conditions in order to obtain high yields and high incomes. Although there is an increase in the current cost of landless cultures, the quantity of production eliminates this amount in a very short period of time. Landless culture can be a modern and advanced farming method and also needs to go looking for powerful human officers who are qualified for this rare job. In this regard, it will be reviewed. These approaches are briefly intended in the following sections.

Historical steps of soilless agriculture

As it was told in introduction, soilless agriculture was used and practised in several ancient civilizations but not a single information was recorded about it. However, the earliest published work on growing terrestrial plants without soil was in the 1627 book, Sylva Sylvarum by Sir Francis Bacon, father of the scientific method, which he nominated as "water culture".

However, Robert Boyle, the Irish scientist, in 1666 had described the first experiments on growing plants with their roots submerged in water. In 1699, John Woodward published his water culture research with spearmint and discovered that plants in less-pure water sources grew better than plants in distilled water. In the 1860s by the German botanists, Julius von Sachs and Wilhelm Knop through experiments perfected the mineral nutrient solutions for soilless culture of plants in 1842 and 1895 respectively. The first proposal for a commercial water culture system was made in 1929 by Professor William Frederick Gericke of the University of California at Berkeley. The term ''hydroponics'' was termed by Gericke 1937 to depict the growing of crops with their roots in a liquid medium. Moreover, in 1940 Gericke wrote the book, Complete Guide to Soilless Gardening. However, two others of plant nutritionists at the University of California called Dennis R. Hoagland and Daniel I. Arnon developed a nutrition solution named Hoagland solution used for hydroponics until now. Since 1930, on Wake Island, a rocky atoll in the Pacific Ocean used as refueling stop for Pan American Airlines, Hydroponics has been used to grow vegetables for the passengers passing by. Hydroponics was necessary on Wake Island because there was no soil, and it was prohibitively expensive to airlift fresh vegetables. In the 1960s, Allen Cooper of England invented the Nutrient Film Technique. In recent decades, many companies worldwide are appearing and strongly working on soilless agriculture. Moreover, NASA has done several hydroponics research to support their Controlled Ecological Life Support System (CELLS).

Designation and function of soilless culture

Man-made land-based culture that provides plants with support and a place to store nutrients and water. In this regard, Savvas et al, reported that a culture without Soil could be termed "any method of planting plants without using soil as a rootstock, where inorganic nutrients are absorbed by the roots and provided with irrigation water". The only old-fashioned method of soilless culture would be a water tank where inorganic chemicals dissolve (nutrient solution) to produce all the nutrients the plant needs. It is often known as the solution culture or the water culture. Outdoor planting activity is a way to promote plant growth while controlling the amount of water, mineral salts and most importantly, dissolved oxygen. The basic idea is simple. When the roots are immersed in running water, they quickly absorb food and oxygen. If the oxygen content is insufficient, plant growth will be delayed. But when the solution is full of oxygen, plant growth will begin to accelerate. Therefore, the farmer's job is to balance the combination of water, nutrients, and oxygen, with the needs of the plant, in order to increase productivity and quality. For best results, a few key elements are needed; temperature, humidity and CO_2 levels, bright light, low air, pH and plant genetic makeup. Out-of-land agriculture includes aquaculture (Hydroponics), aqua agriculture (Aquaponics), aerobic agriculture (Aeroponics) and agriculture using supporting mediators. , Potassium (K), Phosphorus (P), Calcium (Ca), Magnesium (Mg), Sulfur (S), Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Molybdenum (Mo) , Boron (B), Chlorine (Cl) and vitamins. And they need water, light, carbon dioxide, and oxygen in their root system.

Types of soilless cultures

There are two important types of soilless culture, closed soilless culture and open soilless culture.

Closed soilless culture type:

In closed soilless frameworks the dissolved supplements are recycled and the supplement concentrations are recorded and balanced. Keeping the supplement adjusted in such hydroponic frameworks is a test and the dissolved supplements are examined and dissected in any event once every week. The dissolved supplements should be balanced using the results. If it is not supervised appropriately, then the dissolved supplements may escape from the balance. Closed soilless frameworks incorporate both basic and advanced soilless culture frameworks.

Open soilless culture type:

In open soilless frameworks a new dissolved supplement is involved for every irrigation cycle. The dissolved supplements are generally conveyed to the plants utilizing the dripping framework. In open soilless frameworks a sufficient run-off must be kept up with a specific goal to keep supplement adjusted in the root zone. Every soilless culture requires just the substrates and dribble frameworks. However, there is a drip system used as a closed system in case of use of a reservoir for recirculating the nutrient solution.

Soilless culture systems that are divided from both soilless culture types.

The following systems belong to closed soilless culture in brief

Hydro agriculture (Hydroponics): Hydroponics (i.e., "water performance") is the growth of plants without soil. Plants do not need soil, but they need vitamins and minerals that the soil can provide. Plants also need light, water, carbon dioxide and oxygen in the root zone. In hydroponics, plants are grown in a waterless environment such as rock or coco coir fiber, and are fed with a solution that contains a complete mix of primary, secondary and micronutrients. Almost any type of plant can be grown hydroponically, including veggies, herbs, fruits and flowers. Hydroponics is widely used by farmers and ranchers. Hydroponics offers benefits over growing plants for a number of reasons. Plants can be planted all year round because the weather conditions can be controlled in the nursery. Because their roots do not need access to nutrients, plants can be grown close together. Raised plants are extremely large due to their high nutrient content and do not need to spend time growing with many roots. This increases the yield. The nutrient solution also retains the same amount of nutrients available all the time, while the soil tends to "age" as the nutrients are taken up. The combination of all these factors makes hydroponics plants more productive than plants growing in the soil. Many farmers in various fields are beginning to switch to hydroponics for all these reasons. Concerns about water use are also a major reason why hydroponics is becoming increasingly popular - it saves a lot of water over normal growth methods.The following figures from 1 to 5 show some of the most widely used hydroponics types, but anyone can design their own design according to their needs and the type of plants according to the main purpose and objective of hydroponics. The following are five applications in particular:

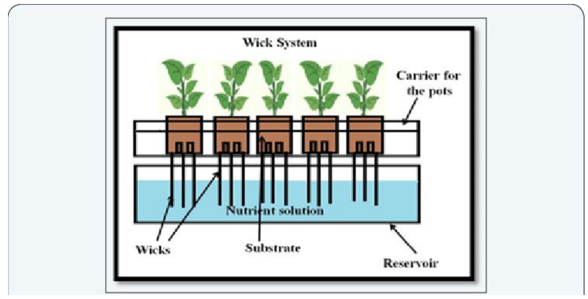

Fig:1:Wick System

Wick system: The wick system (Figure 1) is the simplest of all types of hydroponic systems. That's because traditionally it doesn't have moving parts, so it doesn't use pumps or electricity. However, the rope is part of the connection between the aquatic plant and the food solution in the existing pond. Because you do not need electricity to operate, and it is very useful in areas where electricity cannot be used, or unreliable. The wick program is a simple type of construction program where you start learning about hydroponics, and / or you just want to get your feet wet first. This type of hydroponic system is often used by teachers in classrooms as tests for children. In this system plants are planted in the substrate.

Nutrient (NFT) Film Process: The genetic film process (Figure 2) is redesigned to use highly soluble nutrients of oxygen continuously over plant roots through a series of channels, which are usually planted in baskets hanging from PVC pipe. The solution is drained from the catch tank, using irrigation canals on top of all soft pipes and the discharge from the bottom of the channels is returned to the tank. Therefore, the nutrient solution is reused continuously. You may have to lower the angle of the pipe and insert the overflow pipe similar to that in the closing and flow system. This will work to provide a permanent supply of nutrients in the event of a power outage. Due to the restricted space of the PVC pipe and the need for nutrients to continue flowing over the roots, the nutrient film process is best suited for plants with small root balls such as lettuce, strawberries, and herbs.

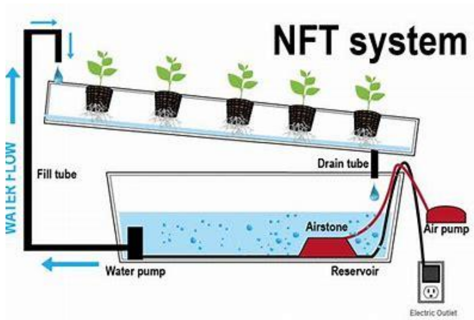

Fig 2: NFT System

Water culture or deep water culture (DWC):

A water culture or a deep water culture is a straightforward approach to hydroponics systems (Figure 3). Plants float on a floating platform in the bath of a hydroponic solution of nutrients. Oxygen is supplied by a continuous air pump. The water culture system can be easily set up in glass pits, (fish ponds), plastic boxes, ice boxes, pointed baskets or engraved holes covered with polypropylene sheets. As plants float and continue to interact with the nutrient solution, there is no risk of damage to the plants in the event of a power outage or when there is a wind pump stoppage. The simplest herbs in the program are Lettuce, strawberries, and herbs that grow well in this program.

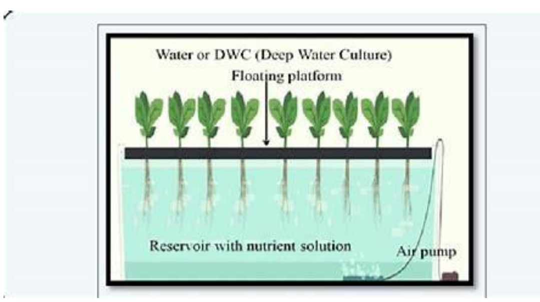

Fig 3: Deep water culture

Drip system: Plants are found in the upper container, and the nutrient solution is in the lower container. The nutrient solution is applied to the drips found on the stem of each plant by a water pump, and the aquatic rock is used to make water oxygen. The nutrients are filtered to the roots of the plants and then transferred back to the lower vessel. Normally water and air pumps run continuously through this type of system. The plants will grow well with this system. Plants with large root balls are especially suitable for leak systems.

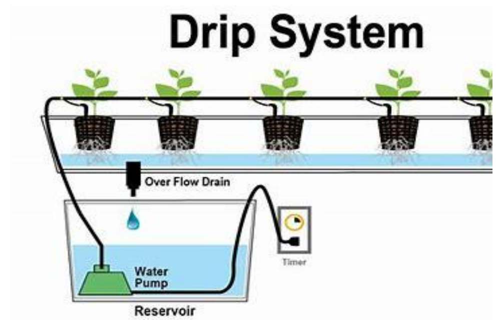

Fig 4: Drip System

Ebb and flow systems: Ebb and flow systems (Figure 5) are another inexpensive form of hydroponic setting. The setting is very similar to the suction system, where there are two containers, one above containing plants in pots with substrate, and the other below containing a nutrient solution. Instead of the nutrient solution being transferred slowly to the stem at each plant stem, the nutrients are sprayed in large quantities in the upper container, filling the container. The overflow pipe determines the height of the nutrients, usually where the roots start at the bottom of the stem, where the excess fluid returns to the overflow pipe back into the lower vessel. With the ebb and flow system, the pump is turned on and off from time to time (maybe 30 minutes on, 15 minutes off), flush the growth tray periodically. When the pump is turned off, all nutrients are extracted from the growing tray by the pump line. This period causes oxygen to reach the roots, and for this reason the airstone is not entirely needed in the descent and flow systems. As with drag systems, almost any plant will grow well with this type of system. Plants with large root balls are also best suited for flow systems.

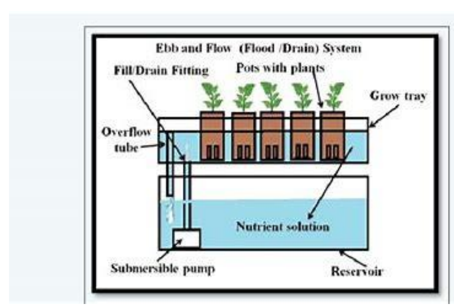

Fig 5: Ebb and Flow systems

Aeroponic Systems : Aeroponics system is a closed system of groundless culture(Figure 6). It is probably the most advanced type of hydroponics system technology. In this system closed root chambers are used as a solution and plants above the pond cover (polystyrene or other material) are hung in holes in the expanded cover, therefore the roots hang in the air under the cover and are misted by a nutrient solution found in the pond. Misting is usually done every few minutes around the hanging roots. Because the roots are exposed to air, the roots will dry out quickly if the misting cycles are interrupted. The timer controls the component pump like other types of hydroponic systems, except that the aeroponics system requires a short time that uses the pump every few seconds and every few minutes. However, the room should be empty from everywhere, so that the roots in the dark work well and prevent algal growth which interferes with the growing plants and pollutes the system.

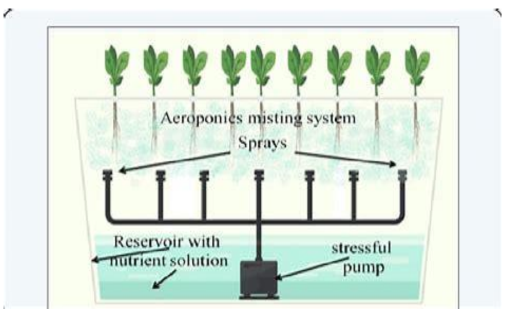

Fig 6: Aeroponics system

In this process, the nutrient solution is sprayed like a fine mist in closed root chambers. Plants are planted in holes for expanded polystyrene panels or other material. The roots of the plants are placed in the center under the panel and placed in a spray box. The box is closed so that the roots are in the dark (to prevent algal growth) and the moisture is filled. The misting system sprays a nutrient solution over the roots from time to time. The system is usually turned on for only a few seconds every 2-3 minutes. This is enough to keep the roots moist and the nutrient solution in the open air. There are three types of aeroponics frameworks. The first frame is a high-pressure aeroponics frame that usually does not use a water pump due to the various time required (on / off). They usually contain a two-sided tank with an expandable separator. Additional arrangements on one side and air on the other. At that time an air compressor is used to compress the tank. A water line from the side races of the extension arrangement to the coiled heads, and the solenoid is used to open and close the valve on the water line at specific times using a cycle clock. The real aeroponics frame uses high pressure (60-90 psi). The second framework is the framework of low-pressure aeroponics (soakaponics) is what most refer to when they say aeroponics. Low pressure structures use normal underwater water pumps, but at the same time require a reasonable amount of water weight or water that will simply come out of the spray heads. If you use spray heads, you will need water pressure. Sadly the lower pumps don't give the psi rate a look. They just give you liters per hour (GPH)
and head length, and GPH is a measure of volume, not pressure. Your best water weight indicator is "head stature". It takes pressure to pump water upwards, so the higher GPH if you are able to pump more, the water pressure will be higher. In any case, most are talking about low-pressure structures in the aeroponics framework. The third frame is Ultrasonic foggers that mist mist on aeroponic frames. While they make a mist with a small amount of water beads, there is nothing close to the actual humidity in the mist / mist. The fog formed by the ultrasonic foggers alike tends to descend to the base of the conductor. Ensuring that the roots are completely protected is always foggy. Another problem with using foggers is that the plates tend to stand out with the mineral form. Large plates have been shown to work with any reliance on Teflon expensive heads. They can be cleaned simultaneously using white vinegar, or purified with pH, and then wiped with a Q-tip. A few manufacturers have joined the use of ultrasonic foggers alongside a low-weight aeroponic plan with the same frame.

Aqua Agriculture (Aquaponics)

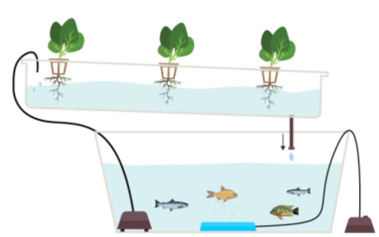

Fig 7:Aqua Agriculture

Aquaponics is an aquaculture system (Figure 7) in which aquatic animals such as snails, fish, crayfish or prawns are raised in tanks by a combination of hydroponics where plants are planted in water in a symbiotic environment. In aquaculture, aquatic extracts rise and accumulate in water, increasing toxins based on ammonia base as toxic products of aquatic animals; which is why aquaculture has to be cleaned from that toxic substance. In the aquaponics system, water from the aquaculture system goes to the hydroponics system where the toxic product is lowered by Nitrifying bacteria that live on the surface of the beds that grow first into nitrites and later nitrates, used by plants as nutrients, and then purified to return to the system. of water. However, the water used goes through the biofilter area where nitrification bacteria can grow and convert ammonia into nitrate, which is used by plants.These are the most widely used types of aquaponics programs:

1- Media-filled beds are an easy alternative to aquaponics, using containers filled with rock medium-expanded clay or similar. Water from a fish tank is pumped over beds filled with media, and plants grow in rock media outlets. This style of system can be carried out in two different ways, by continuous flow of water over rocks, or by filling and discharging a growing bed, in a flood and in or out of a flow cycle.

2- Nutrient Film Technique (NFT) is a widely used hydroponic method, but it is not common in aquaponics systems. In NFT programs, rich nutrient-rich water is packaged as a thin film under small gutters. Plants live in small plastic cups that allow their roots to enter the water and absorb nutrients. NFT is suitable for certain types of plants, green leafy vegetables, however, large plants will have very large and invasive root systems, or are very heavy on slow-growing gutters.

3- Deep Water Culture (DWC), works on the concept of floating plants allowing roots to hang in the water. This can be done in a number of ways. This method is one of the most widely used trading methods. DWC can be made by floating a foam pad on top of a fish tank; however another common method is to grow fish in a fish tank and pump water through a filtration system, and then long channels where floating sea urchins float on the water and release nutrients. However, this process is considered to be a closed groundless process and a process of replication of nutrient solution is possible. Figure 7 erases the traditional steps of Aquaponics culture with deep hydroponics.

Substrate culture (Growth medium)

Figure 8: Clears some of the used substrates in soilless cultures.

Growth rate replaces soils in soilless culture systems. In this program, a strong environment provides crop support. The functions of the root augmentation center provide the roots with oxygen to bring water and dissolved nutrients into the roots through the irrigation system through the media, allowing them to use waste to repeat the solution system and strengthen the plants as supporting mediators so they do not fall. There are various substrates (Fig. 8) used as a growth medium containing unusual (natural; expanded clay, glass, gravel, perlite, pumice, rockwool, sand, sepiolite, vermiculite, volcanic tuff with zeolite or synthetic; foam mats, hydrogel and plastic foam) or organic (bark, coconut coir, coco ground, wool, marc, peat, ruffia bark, rice husk, sawdust and wood chips). Cultural systems of the substrate are subdivided according to the drainage process in the following two systems. As noted earlier, in many soilless cultures using substrates without a replica of nutrient solution is less open soil culture, therefore, greater care in the matter of plant nutrition should be taken because irrigated irrigation water is much lost. The culture of the open substrate appears to be very promising due to its high adaptability to the conditions of farmers . In countries where hydroponics is used commercially, open-source hydroponics systems have created pollution problems that have led to subsequent changes to the closed system. Closed substrate systems increase water efficiency, nutrients and the use of pesticides and reduce their impact on the environment but a specific plan needs to be done for each crop. Features of land-use materials: There are many materials used to build growing groundless cultural systems, such as asbestos, aluminum, concrete, corrugated sheets, polyethylene, polypropylene, polystyrene foam, PVC, steel and other sensors. All of these factors must have stability characteristics. Technical specifications of the materials used to create the systems: However, the details of these materials should reflect the following; 1- There is no exit during installation and implementation of the process and the possibility of testing the potential exit. 2- No harmful volatilization of water or substances. 3- Resistance to vapors used for transport of sewage, UV rays and pesticides. 4- Ensure return items to suppliers for reuse. 5- Low cost. 6- Do not have any feedback from each other or the solutions used (inert). 7- Also, metal objects should be fitted with weatherproof materials compared to contact with any solid, liquid or gaseous materials.

Technical specification of supporting substrates: Normally hydroponics as a soil-free custom system uses water only, without a substrate. This is true of NFT or Aero-hydroponics, which does not use media, or is sufficient to serve as plant support. But farmers working with Drip Irrigation, Deep Channel NFT, or Ebb and Flow, will use a lower or supportive base depending on the growing system of their choice. Supporting substrates should have the following structures 1- Aeration and drainage. 2- It works in a natural way without the need for processing. 3- Can be milled or manufactured by industry. 4- Cation exchange volume (final action). 5- Easy to use with environmental and health risks. 6- Free to grit, heavy metals and radiation and hygiene. 7- It has consistent quality (no decrease in body composition during use). 8- Being healthy for at least three years. 9- Hydrophilic. 10- Inert (no physiological reaction). 11- Low cost. 12- Low quantity. 13- Have a neutral pH. 14- Struggling. 15- Reuse or destruction without risk. 16- Resistance to reproduction many times without change in the quality of the structure. 17- Insects free. 18- Biological stability. 19-Be able to store water and water in the air. Another important factor to keep in mind is the close relationship between the supporting substrate and the irrigation cycles used and some of them will retain much more moisture than others. Many supportive substrates on the market meet the above requirements for label specification.

Advantages and Disadvantages of Soilless Cultures :

There are published papers from a few years ago stating the advantages and disadvantages of soilless cultures in the following brief points.

Advantages of soilless cultures :

Production augmentation: The use of soil-free culture is likely to increase yields as a result of direct control of plant nutrients in nutrients such as nutrients, pH, oxygen, carbon dioxide, light and temperature. However, increasing yields using landless cultures will help to eliminate initial costs and any additional costs of landless cultures. Landless vegetable-producing cultures can be high-quality and require minimal washing.

Water management: In many types of landless culture the use of irrigation water is precisely controlled with a very small amount of water compared to conventional irrigation in the context of indigenous cultures. Save much-needed work and time of inspection, cleaning of watering cans and frequent pedestrian testing that can be easily prevented by calcium carbonate or other chemicals that can be eliminated by acidification of nutrient solution or by re-irrigation of water and require more cost, efficiency and time.

Plant nutrition monitoring: Nutrients are used as solution forms in accurate prices as they require the plant and not in Hugh's prices as in a standard container. According to soilless culture, harmful substances in plants that exceed a certain amount can be stored within safe doses. However, there is a uniform distribution of nutrients only in all plants in water cultures. The PH and E.C of nutrient solution can be controlled depending on the need for the plant and the environmental conditions and that is very difficult and costly in the case of common soil cultures.

Crop diversity: In a soilless culture, the rest period between crops is almost non-existent because of the lack of productive farming practices such as soil cultivation and therefore, more crops are grown per year and that means more income.

Reducing labor needs: According to the landless culture, all traditional farming practices such as soil closure, weed control etc. can be removed from the landless culture and save labor placement and the required working time.

The evils of landless cultures:

Big investment: The initial cost of building a landless cultural system is high, but producing large and large yields removes such costs immediately in the first 3-4 years from the start of the program if all goes well.

Shortage of skilled and skilled workers: Outside agriculture is facing a shortage of skilled workers and professionals.

Risk of disease damage: The degradation of the open system of landless cultures is minimal and in closed systems they become larger and require more intensive care and sanitation.

Thought and conclusion:

Landless cultures regard it as a newly developed agricultural system but it is not an easy process. However, there is a lack of technical infrastructure for new methods among farmers and horticulturalists in many countries and requires well-trained jobs. In addition, many substrates are a global market, so they are expensive. Therefore, it is best to look in the area for good and affordable services. Farmers can be more aware of landless plans based on their needs, the location of the system and according to their potential income. The system anywhere should be closely monitored and considered with the parameters required for good plant growth such as nutrient concentration, light, oxygen content of plant roots, water quality, pH, disinfection, solution temperature and more. In conclusion, one could say that much progress has been made towards the end of the development of improper land systems and there are now widespread business applications from countries to adopt new farming methods.

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