1. INTRODUCTION

1.1 What is Hydroponics?
Plants are Nature’s greatest food factories which utilizes the most basic chemical elements with water and gases in the air to create food and energy for growth with the help of light energy through photosynthesis. Every living plant depends on water as the basis of life to thrive. In nature, water acts to recharge the soil with nutrients. In Hydroponics, the basic nutrient salts in the form of a balanced solution supplied directly to the plant roots. In other words, hydroponics is about enriching water with the very same nutrient salts as found in nature, creating and maintaining a “nutrient solution” that is perfectly balanced for our plants. This results in reduced strain on distant agriculture farms, transportation costs and fewer carbon emissions. Optimization of land area and the preservation of biodiversity has become the need of the hour in both developing as well as developed countries Hydroponics helps to limit terrestrial biodiversity loss through the reversion of large tracts of current farmland into sustainable and fundamentally natural environments.

1.2 Why Hydroponics?
There are many advantages of growing plants hydroponically;

1. Hydroponic gardens produce the healthiest organic, pesticide free crops with high yields and are consistently reliable
2. Due to nutrients fed directly to the roots, plants grow faster and with small roots plants may be grown closer.
3. In general hydroponically grown garden needs 1/5 of the overall space when compared with soil gardens
4. Hydroponically grown plants do not come in contact with soil borne pests and diseases thus saves costs of soil preparation, insecticides, fungicides
5. Since the amount of nutrient solution is fed directly to the plant roots, there is no wastage of water due to run off or evaporation
6. It is clean and extremely easy, requiring very little manpower and effort compared to gardening using soil.

Overall, the main advantages of hydroponics over soil culture are - more efficient nutrition regulation, availability in regions of the world having non arable land, efficient use of water and fertilizers, ease and low cost of sterilization of the medium, and higher density planting, leading to increased yields per acre etc.

2. TYPES OF HYDROPONICS SYSTEMS

• Passive systems
• Active systems

PASSIVE SYSTEM
In a passive system, the plants’ roots are in touch with the nutrient solution and the plants are supported using a suspension method. The principal disadvantage of this system is that it is difficult to support your plants as they grow and get heavier. However, a passive system is a very basic system and is, therefore, easy for a beginner to set up. A passive system tends to be very portable and quite inexpensive. One example of a passive system is the Wick System.

Wick System
A wick system uses a lamp wick or wick made of nylon, polyester or rayon to supply nutrient solution to the roots. Some of the more commonly used growth material are Vermiculite, Perlite or LECA. A pot is supported above the nutrient tray solution and a wick soaked in this solution is passed through the drainage hole into the nutrient tray. You must leave 10cm of the wick inside the pot and ruffle the ends for better circulation of nutrient solution.
ACTIVE SYSTEM
Active systems are more efficient and productive because they use pumps to supply nutrient solutions to the plants and a gravity system to drain off any excess solution, which is then recycled and reused. Various types of materials can be used to act as a quick drain system such as Perlite, Rockwool, expanded clay pebbles, or Coconut Coir. If you are using Coconut Coir, a higher air holding ratio can be achieved by mixing it with an equal volume of Perlite. The principal difference between an active and passive system is that an active system uses pumps to supply nutrient solution whereas a passive system uses a wick to draw in the nutrient solution.

TYPES OF ACTIVE SYSTEM
The following are the various types of active system:
• Ebb and Flow System
• Nutrient Film Technique
• Drip (or Top Feed) System
• Aeroponics
• Dutch Bucket Method
• Raft Method

Ebb and Flow System
An Ebb and Flow System is also called a flood and drain system. Maintenance and set-up is not expensive and, as a result, has proved to be a popular system. Using this system provides uniform distribution of nutrient solution to all the plants in. Both long-term and short-term produce grow well in this type of system. Here, the nutrient solution can flood the material for 15 minutes every hour or two. The most popular growth material used is expanded clay pebbles, Perlite or Rockwool. The Ebb and Flow system has the additional benefit in that it can be automated using a computer.

Nutrient Film Technique
The Nutrient Film technique uses an automated pump and reservoir system to supply and recycle nutrients. Plants are placed in an enclosed inverted ‘V’ shape channel which gives you the benefit of being able to grow more produce using this system, however plants can suffocate and die because of a lack of oxygen using this system. This system lends itself well to growing lettuce and, as such, is used primarily by lettuce growers. And, if you are a herb lover, use the Nutrient Film Technique to grow them; you will love the results!

Drip (or Top Feed) System
One of the principal advantages of the Drip (or Top Feed) system is that it is able to withstand short-term power / equipment failure. Rockwool is the preferable material for this system. Nutrient solution is dripped onto the plants with the remaining solution being drained back to the reservoir. The supply of this solution is timed, and as a result, this system can be very expensive and difficult to set up. However, it is popular among tomato and pepper growers resulting in a very high quality yield.

Aeroponics
A recent development in which plants are suspended in midair and then supplied with nutrients has resulted in a system known as Aeroponics. Nutrients are sprayed to the roots and their exposure to air provides them with maximum oxygen. In this system, the supply of nutrients and oxygen is maximized, however, care needs to be taken in order to maintain 100% relative humidity. The principal drawback to this system is the functioning of the pump and reservoir in the event of power failure. As it is a reasonably new system, it is currently quite expensive to set up and (for the moment) is more often used in laboratory studies.

Dutch Bucket Method
This system was first used in the Netherlands to grow tomatoes, cucumbers and roses. This uses a bucket (2.5 gallon) that holds nutrient solution at the bottom of the bucket. A pump is then used to recycle the nutrient solution.

Raft Method
In this method, styrofoam sheets are used to float plants (which are fixed in baskets) on top of the nutrient solution. Usually, short term crops are cultivated using this system and any problems in relation to stagnation of the solution is solved by circulating air from the bottom. This system is used for lettuce production and to cultivate other greens. In business aquaponics, the most frequent expand bed is the raft method. There are two much more expand mattress designs, the NFT or Nutrient Film Approach and the media-filled grow bed. Even though media-filled beds are not so frequent in huge creation scales, it is the preferred of most aquaponics hobbyists. NFT on the other hand is the least desired of the a few patterns simply because it needs a lot more upkeep.

The raft system is very advisable in business aquaponics simply because of the large manufacturing it yields. Media-crammed beds do not get to create as much. Raft method permits for higher stocking densities and in organizations, the much more product sales the far better. Originally, the
raft program requires much more h2o to total but the drinking water flow rewards the well being of the fish. The raft program allows for a larger stocking density of fish because of the h2o that is continually flowing by means of the channels. This demands five to 8 times more h2o than the typical. Since of the higher quantity of drinking water, this makes the number of fish for each gallon of h2o reduce and as a result tends to make controlling of the drinking water easier.

Raft Method

Hydroponics, with its various forms of drip and flow style irrigation (Figures 1 and 2), limits the threat of water waste via over- or poorly-timed irrigation (water loss due to evaporation), and therefore limits freshwater habitat abuses. Crops can be grown in controlled environments with optimal "weather" conditions. The limitation of transpiration stresses means enhanced productivity (Sahara Forest Project, 2009). Productivity within a hydroponic facility is productivity that does not detract from the fertility of the soils of terrestrial habitats. Manipulated, expansive monocultures can be raised (in order to feed our immense population) without depleting soil or hindering the developments of less-biologically-engineered specimens of the base species. Crops can be grown in "stories" in order to maximize vertical space and minimize land occupation (Growing Power, 2011).
3. GROWTH MATERIAL

3.1 Soil free substrates for Hydroponic Media
Soil-free substrates are used for starting seeds and providing support to the plant in hydroponics media. A perfect medium should be able to hold nearly equal concentration of air and water. The water/air holding capacity of a medium is the small spaces between each granule or fiber, which is the determining factor. Many types of sterile substances with varying water/air holding capacities can be used as substrates in the medium. Most common types are – Coir pith, Coco peat, Perlite, Vermiculite, Expanded clay pellets (LECA), Rockwool, etc. Sand, gravel, sawdust, sponge can also be used as growth media substrates.

4. SUBSTRATE/GROWTH MATERIAL

The necessity of using soil is eliminated in Hydroponic gardening. Soil – apart from supplying nutrients also provides support as plants grow. In a Hydroponic system, this support is provided using various materials like Perlite, Rockwool, expanded clay pellets, coconut coir, vermiculite, grow cubes, sawdust, lava rock, and so on. One of the most obvious decisions hydroponic farmers have to make is which medium they should use. Different media are appropriate for different growing techniques.

4.1 Expanded clay aggregate (LECA)
LECA (Lightweight Expanded Clay Aggregate) Baked clay pellets, are suitable for hydroponic systems in which all nutrients are carefully controlled in water solution. The clay pellets are inert, pH neutral and do not contain any nutrient value.

4.2 Growstones
Growstones, made from glass waste, have both more air and water retention space than perlite and peat. This aggregate holds more water than parboiled rice hulls. Growstones by volume consists of .5 to 5% Calcium carbonate. For a standard 5.1 kg bag of Growstones that’s 25.8 to 258 grams of calcium carbonate. The remainder is Soda-lime glass.

4.3 Coir peat
Coco peat, also known as coir or coco, is the leftover material after the fibres have been removed from the outermost shell (bolster) of the coconut. Coir is a 100% natural grow and flowering medium. Coconut coir is colonized with Trichoderma fungi, which protects roots and stimulates root growth. It is extremely difficult to over-water coco due to its perfect air-to-water ratio; plant roots thrive in this environment. Coir has a high cation exchange, meaning it can store unused minerals to be released to the plant as and when it requires it. Coir is available in many forms; most common is coco peat, which has the appearance and texture of soil but contains no mineral content.

4.4 Rice husks
Parboiled rice husks (PBH) are an agricultural byproduct that would otherwise have little use. They decay over time, and allow drainage, and even retain less water than grow stones. A study showed that rice husks did not affect the effects of plant growth regulators.

4.5 Perlite
Perlite is a volcanic rock that has been superheated into very lightweight expanded glass pebbles. It is used loose or in plastic sleeves immersed in the water. It is also used in potting soil mixes to decrease soil density. Perlite has similar properties and uses to vermiculite but, in general, holds more air and less water. It is a fusion of granite, obsidian, pumice and basalt.

4.6 Vermiculite
Like perlite, vermiculite is a mineral that has been superheated until it has expanded into light pebbles. Vermiculite holds more water than perlite and has a natural "wicking" property that can draw water and nutrients in a passive hydroponic system. If too much water and not enough air surrounds the plants roots, it is possible to gradually lower the medium's water-retention capability by mixing in increasing quantities of perlite.

4.7 Pumice
Like perlite, pumice is a lightweight, mined volcanic rock that finds application in hydroponics.

4.8 Sand
Sand is cheap and easily available. However, it is heavy, does not hold water very well, and it must be sterilized between uses.

4.9 Gravel
The same type that is used in aquariums, though any small gravel can be used, provided it is washed first. Indeed, plants growing in a typical traditional gravel filter bed, with water circulated using electric powerhead pumps, are in effect being grown using gravel hydroponics. Gravel is inexpensive, easy to keep clean, drains well and will not become waterlogged. However, it is also heavy, and if the system does not provide continuous water, the plant roots may dry out.

4.10 Wood fibre
Wood fibre, produced from steam friction of wood, is a very efficient organic substrate for hydroponics. It has the
advantage that it keeps its structure for a very long time. Wood fibre has been shown to reduce the effects of "plant growth regulators.

4.11 Rock wool
Rock wool (mineral wool) is the most widely used medium in hydroponics. Rock wool is an inert substrate suitable for both run-to-waste and recirculating systems. Rock wool is made from molten rock, basalt or ‘slag’ that is spun into bundles of single filament fibres, and bonded into a medium capable of capillary action, and is, in effect, protected from most common microbiological degradation. Rock wool has many advantages and some disadvantages. The latter being the possible skin irritancy (mechanical) whilst handling (1:1000). Flushing with cold water usually brings relief. Advantages include its proven efficiency and effectiveness as a commercial hydroponic substrate. Most of the rock wool sold to date is a non-hazardous, non-carcinogenic material, falling under Note Q of the European Union Classification Packaging and Labeling Regulation (CLP)

4.12 Sheep wool
Wool from shearing sheep is a little-used yet promising renewable growing medium. In a study comparing wool with peat slabs, coconut fibre slabs, perlite and rock wool slabs to grow cucumber plants, sheep wool had a greater air capacity of 70%, which decreased with use to a comparable 43%, and water capacity that increased from 23% to 44% with use. Using sheep wool resulted in the greatest yield out of the tested substrates, while application of a bio stimulator consisting of humic acid, lactic acid and Bacillus subtilis improved yields in all substrates

4.13 Brick shards
Brick shards have similar properties to gravel. They have the added disadvantages of possibly altering the pH and requiring extra cleaning before reuse.

4.14 Polystyrene packing peanuts
Polystyrene packing peanuts are inexpensive, readily available, and have excellent drainage. However, they can be too lightweight for some uses. They are used mainly in closed-tube systems. Note that polystyrene peanuts must be used; biodegradable packing peanuts will decompose into a sludge. Plants may absorb styrene and pass it to their consumers; this is a possible health risk.

3.2. Coco Peat: The most common and one of the cheapest growing medium is Coconut Fiber or Coco peat- a completely organic medium made from coconut husks, a renewable resource, unlike peat moss which is rapidly becoming depleted from overuse. It represents a major step forward in organic soil free potting media. It has the water retention of vermiculite and the air retention of perlite. Powdered and sterilized coco peat offers plants the perfect rooting medium. It also provides protection against root diseases and fungus infestation.

4. Nutrients
In hydroponics, we must know the organic composition of plants and elements available in the atmosphere and soil to understand nutrient formulations. On Earth 90% of all organic matter comprises of Carbon, Hydrogen and Oxygen. 78% Nitrogen, 20% Oxygen and 2% Carbon dioxide, in addition to a small percentage of inert gases are present in our planet

4.1 Essential elements
16 elements are considered to be essential for growth of higher plants. Out of these 3 elements -Carbon, Hydrogen and Oxygen are absorbed from the atmosphere. The remaining 13 elements are grouped under macronutrients and micronutrients. Plants possess the ability to extract Carbon, Hydrogen, and Oxygen from the atmosphere in the presence of macro and micronutrients to create food by photosynthesis utilizing Light energy. Commonly available fertilizer saltsCa(NO3)2. Calcium should be provided by calcium nitrate. Calcium nitrate will also provide nitrate nitrogen. Any additional nitrogen required should be provided by potassium nitrate, which also provides some potassium. All the phosphorus may be obtained from monopotassium phosphate, which also provides some potassium. The remaining potassium requirement can be obtained from potassium sulphate, which also provides some sulphur. Additional sulphur comes from other sulphates such as magnesium sulphate, which is used to supply magnesium needs.

Commonly available Fertilizer Salts
In hydroponics all the essential elements are supplied to the plants by dissolving fertilizer salts in water to make the nutrient solution. The choice of salts to be used depends on a number of factors such as solubility in water, cost, availability and most importantly to satisfy the ppm requirement of all elements without excessive supply.

Table 1: Commonly available Fertilizer Salts

<table>
<thead>
<tr>
<th>Chemical Formula</th>
<th>Chemical Name</th>
<th>Molecular Weight</th>
<th>Elements Supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>KNO3</td>
<td>Potassium Nitrate</td>
<td>101.1</td>
<td>K, NO3</td>
</tr>
<tr>
<td>Ca(NO3)2</td>
<td>Calcium Nitrate</td>
<td>164.1</td>
<td>Ca++, NO3-</td>
</tr>
<tr>
<td>NH4NO3</td>
<td>Ammonium Nitrate</td>
<td>80.1</td>
<td>NH4+, NO3-</td>
</tr>
<tr>
<td>K2HPO4</td>
<td>Mono Potassium Phosphate</td>
<td>136.1</td>
<td>K+, HPO4-</td>
</tr>
<tr>
<td>K2SO4</td>
<td>Potassium Sulphate</td>
<td>174.3</td>
<td>2K+, SO4-</td>
</tr>
<tr>
<td>MgSO4·7H2O</td>
<td>Magnesium Sulphate</td>
<td>146.5</td>
<td>Mg++, SO4-</td>
</tr>
<tr>
<td>Fe EDTA</td>
<td>Iron Chelate</td>
<td>302.1</td>
<td>Fe++</td>
</tr>
<tr>
<td>H2BO3</td>
<td>Boric Acid</td>
<td>61.8</td>
<td>B+</td>
</tr>
<tr>
<td>CuSO4·5H2O</td>
<td>Copper Sulphate</td>
<td>249.7</td>
<td>Cu++, SO4-</td>
</tr>
<tr>
<td>MnSO4·4H2O</td>
<td>Manganese Sulphate</td>
<td>239.1</td>
<td>Mn++, SO4-</td>
</tr>
<tr>
<td>ZnSO4·7H2O</td>
<td>Zinc Sulphate</td>
<td>287.6</td>
<td>Zn++, SO4-</td>
</tr>
<tr>
<td>(NH4)2HPO4·7H2O</td>
<td>Ammonium Molydele</td>
<td>1163.9</td>
<td>NH4+, Mo+</td>
</tr>
<tr>
<td>Zn EDTA</td>
<td>Zinc Chelate</td>
<td>451.6</td>
<td>Zn++</td>
</tr>
<tr>
<td>Mn EDTA</td>
<td>Manganese Chelate</td>
<td>581.2</td>
<td>Mn++</td>
</tr>
</tbody>
</table>

Source: Hydroponic Food Production by Howard M Resh.)
Table. IIEssential Elements for most higher plants and their function  
(Source: Hydroponic Food Production by Howard M Resh.)

<table>
<thead>
<tr>
<th>Elements Required</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>Occurs in the cell walls, sugars manufactured by chlorophyll, as well as chlorophyll itself</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>Important in nutrient uptake from roots. Hydrogen is also essential for the formation of sugars and starches and is easily obtained from water</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Required to form sugars, starches and cellulose. Oxygen is essential for the process of respiration</td>
</tr>
</tbody>
</table>

Macronutrients

| Nitrogen          | Necessary for the formation of amino acids, co enzymes and chlorophyll |
| Phosphorus        | Sugar, phosphate and ATP (energy) production, flower and fruit production, root growth |
| Potassium         | Hardness, root growth, and the manufacture of sugar and starch. Protein synthesis also requires high potassium levels |
| Calcium           | Required for cell wall formation |
| Magnesium         | Chlorophyll production, enzyme manufacture |
| Sulfur            | Protein synthesis, water uptake, fruiting and seeding, natural fungicide |

Micronutrients

| Boron            | Necessary for the formation of cell walls when combined with Calcium |
| Chlorite          | Required for photosynthesis, essential part of photocromes |
| Copper            | Activate enzymes, necessary for photosynthesis and respiration |
| Iron              | Chlorophyll formation, respiration of sugars to provide growth energy |
| Manganese        | A catalyst in the growth process, formation of oxygen in photosynthesis |
| Molybdenum        | Nitrogen metabolism and fixation |
| Zinc              | Chlorophyll formation, respiration and nitrogen metabolism |

What Plants Can You Grow Hydroponically?

Given the right setup and nutrient balance, any plant can be grown hydroponically. To choose what plants would be best suited for your system, you should consider the following factors: what kind of system you have or wish to build, how much space you have, how much experience you have, and your personal reasons for choosing hydroponics.

How many types of hydroponic systems available practiced

The two basic categories of hydroponic systems are Solution, or Liquid Culture and Medium, or Aggregate Culture. In a Solution system, such as Aeroponics or Nutrient Film Technique (NFT) the plants grow directly in the nutrient-filled solution. This type of set up works best with fast growing, shallow-rooted plants such as lettuce, spinach, radishes, and herbs. Medium systems, such as Wick Systems or Ebb & Flow systems, utilize a growing medium such as gravel, LECA, Coir pith/ Cocopeat sand or Hydroton.

What is Aquaponics?

It is a system for farming fish and plants together in a mutually beneficial cycle. Fish produce wastes that turn into nitrates and ammonia. These aren't good for the fish if they build up too much, but they're great fertilizer for plants. As the plants suck up these nutrients, they purify the water, which is good for the fish. Many cultures have made use of this cycle to grow better crops and nurture the fish as an additional food source. Rice paddies in the China and Thailand have used aquaponic techniques for years.

Summary and conclusions

The human population is increasing, and is predicted to expand from 7.0 billion to 9.5 billion people within the next 40 years (Sahara Forest Project, 2009). A parallel increase in the demand for food species is implied, and estimates claim that food production will need to be doubled in order to compensate (Sahara Forest Project, 2009). The trouble with this becomes evident upon the consideration of the productivity of current systems of agriculture and fresh water harvesting: despite our efforts, 1.0 billion people suffer from hunger modernly, and 1.2 billion live in areas with water scarcity (Sahara Forest Project, 2009).

There has already been a great deal of buzz throughout the scientific community for the potential to use hydroponics in third world areas, where water supplies are limited. While the upfront capital costs of setting up hydroponics systems is currently a barrier, in the long-run, as with all technology, costs will decline, making this option much more feasible. Hydroponics has the ability to feed millions in areas of Africa and Asia, where both water and crops are scarce. The hydroponics techniques produce a yield 1,000 times greater than the same sized area of land could produce annually. [source: Organitech]

Hydroponics also will be important to the future of the space program. NASA has extensive hydroponics research plans in place, which will benefit current space exploration, as well as future, long-term colonization of Mars or the moon. Hydroponics could be key to the future of space exploration. The benefits of hydroponics in space are two-fold: It offers the potential for a larger variety of food, and it provides a biological aspect, called a bio regenerative life support system. This simply means that as the plants grow, they will absorb carbon dioxide and stale air and provide renewed oxygen through the plant's natural growing process. This is important for long-range habitation of both the space stations and other planets [source: Heiney]
Rooftop gardening through hydroponic technique is a veritable way of life and enables you to take pleasure in new, green spaces that meet the needs for relaxation and leisure. Hydroponics is the fastest growing sector of agriculture, and it could very well dominate food production in the future. As population increases and arable land declines due to poor land management, people will turn to new technologies like hydroponics and vertical farming to create additional channels of crop production. Currently, arable land comprises only around 3 percent of the Earth's surface, and the world population is around 6 billion people, resulting in around 1/5 hectare (2,000 square meters) of arable land per capita. By 2050, scientists estimate that the Earth's population will increase to 9.2 billion, while land available for crop and food production will decline. To feed the increasing population, hydroponics will begin replacing traditional agriculture [source: Chamberlain].

Hydroponics Growing and the Future of Agriculture

To get a glimpse of the future of hydroponics a few examples cited in Tokyo, Japan, due to the surging population land is extremely valuable. The country has turned to hydroponic rice production to feed the citizens while preserving valuable land mass. The rice is harvested in underground vaults without the use of soil. Because the environment is perfectly controlled, four cycles of harvest can be performed annually, instead of the traditional single harvest. Similarly, hydroponics also has been used successfully in Israel, which has a dry, arid climate. A company called Organitech has been growing crops in 40-foot long shipping containers, using hydroponic systems. They grow large quantities of berries, citrus fruits and bananas, all of which couldn't normally be grown in Israel's climate. Typically, aeroponic and hydroponic systems have high energy costs because they incorporate lighting, pumping, and air moderation systems. Primary costs (aside from energy costs) include the purchase and purification of fertilizers and water. Between 20,000 and 25,000 hectares of land are currently under hydroponic development globally, supplying 6 to 8 billion dollars' worth of produce (HydroGarden, n.d.).

To sum up hydroponics is a promising area with vast potentials to improve the quality and quantity of agriculture as well as horticulture crops. With increasing population and decreasing fertile agriculture land and water available for cultivation hydroponics is the solution to produce more crops in limited land. Under urban areas rooftop gardening or green house cultivation can be practiced to obtain organic products which can be pesticide free due to closed and controlled environmental conditions. The basic techniques can be practiced even by school children to create awareness about biodiversity conservation and value addition of plants. This method can also be used to control Indoor pollution as many potential plants such as Dracaena reflexa, Cordyline sps. etc. are known to absorb air pollutants. It will help us to expand our capacity to supply fresh water, foods, and economic stability to arid communities; and optimize space in current agricultural settings.

Acknowledgements:
The authors are grateful to the Chancellor Dr. Paul Dhinakaran, the Vice Chancellor Dr. Sundar Manoharan and the Pro Vice Chancellor Prof. M J Xavier , Registrar Dr. Joseph Kennady , Director/c Dr. Janmets Vennila SBTS&HS of Karunya University, Coimbatore, India for their encouragement and support.

Conflict of Interest: There is no conflict of interest between the authors

REFERENCES
[2] Bridgewood, 2003Hydroponics: Soilless Gardening Explained by Les ...
a. www.amazon.com/Hydroponics...B019L5MWQ4
a. web.mit.edu/12.000/www/m2015/2015/hydro_agriculture.html
[5] Habitat loss is the leading cause of biodiversity loss, and today, about 38 percent of global land is devoted to agriculture (Brudvig et al., 2009, FAO, 2011).
a. web.mit.edu/12.000/www/m2015/2015/hydro_agriculture.html
... meaning that more of the future's consumers will demand higher—quality resources (Charles and Godfray, 2011)
[11] Growing Power, 2011; Passive grinder-irrigation, also understood as suffering hydroponics or ... (zenith agriculture)
[14] Hydroponic Supplies - Grow Lights, Nutrients, Grow Media ...
[16] Howard Resh Hydroponic Services | Hydroponics ...[17] howardresh.com/ Hydroponic Food Production : A Definitive Guidebook - CRC ...
[18] https://www.crepress.com/Hydroponic-Food-Production...Resh/9781439..


[26] web.mit.edu/12.000/www/m2015/2015/hydro_agriculture.html

[27] Organitech Vertical Farming is Already Here OrganitechTreeHugger


[29] www.hoovers.com/.../company-profile.ORGANITECH_LTD.130ca2307...
