ITM 181 X

PROJECT PLAN

A Proposal for a Mobile Farm

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Scope and Purpose

This project aims to find an efficient substitute for conventional farming systems, that will create similar or greater yields, given a similar or smaller space. This substitute will cater and fit to certain ongoing trends. Specifically the trend toward the majority going mobile, and the trend toward transforming agricultural land into industrial / commercial infrastructures. The proposed system will also aid in the time-consuming processes that conventional farming systems entail, through the use of technological advancements. We are currently in that point in time wherein the rate at which technology is increasing rapidly. This project aims to utilize these disruptive technologies to alleviate certain inconveniences, in this case, in the agricultural sector. The proposed system to be used will dismiss the need to constantly be hands on in a farm to ensure a healthy, and abundant crop yield. Additionally, the proposed system also aims to decrease the time needed to grow a batch of crops.

This project will tackle the specifics of how the system will operate. Including the process of how it is done, and what materials are needed. Additionally, the external and environmental factors that will affect the system's operations will also be tackled, to assure its feasibility. This project will also tackle the approximate cost of producing one whole system, and how it will be priced, marketed, and delivered to the company's consumers. Lastly, this project will also tackle certain features to be exhibited by the company's mobile application, which will act as an aiding instrument in the farming system to be proposed.

Objectives and Tasks

Objective	Task	Date	Person-In-Charge
To gain knowledge on alternative agricultural systems that can be done locally	To conduct an extensive research on plant growth and practices being done in different countries	February 18, 2019	JP Garcia
To check for product feasibility in the Philippines	Search for available raw materials, technology, and parts in the country	February 20, 2019	Gino Tantuico
To know whether or not there's a market for this type of innovation	Conduct a consumer survey on diverse citizens	February 20, 2019	Kyra Co
To know if the product is sustainable (if it will harm the environment in the long-run, and if it can withstand external conditions	Analyze the value chain of the product thoroughly and be able to perform experiments on the product (preferably under extreme conditions)	March 1, 2019	Vito Cagang

for a long period of time)			

Brief Company Background
Verde, derived from the word *Berde*, the tagalog word for Green will be the name to be used to symbolize the company, which aims to transform the agricultural sector. It seeks to transform the sector from a conventional, to a contemporary one, revolving around hydroponics.

Mission
We endeavor to bring Verde to the technological forefront of eco-farming in the Philippines. Associates working alongside us are assured to support ethical, profitable, and sustainable approaches to food production. As such, our customers can expect healthier yields at little cost to scarce time and resources when using our hydroponic technologies.

Vision
Our vision is to be the country's first and popular choice for eco-farming solutions while offering technological innovations for the food industry.

Long-term Goals & Objectives
1. In its first year, Verde's hydroponic technology must successfully penetrate the market by positioning its mobile app feature as a unique selling point, thereby garnering publicity and financial support for further development.
2. In three years, Verde must further develop the technology and master its manufactory, to allow production to meet the demands of major farm-related companies, and thus consolidate enough market share to establish the company as a major player in the industry.
3. In five years, Verde must have achieved assembly-line levels of manufactory while directing product development towards a cost-leadership strategy, making hydroponic technology affordable for the average Filipino household, and establishing Verde as the market leader.

The product to be distributed by Verde, will be called the **Farmobile** - a mobile farm located inside a shipping container, which incorporates a specific hydroponics system (explained later), and is controllable through a mobile application.

Figure 1. *The Farmobile*

The company will make use of business-to-consumer (b2c) marketing because aspiring farmers and individuals will be the main target market. The secondary target market will be grocery stores, healthy shops, and restaurants, which will be complemented by the company's business-to-business (b2b) marketing.

The overall branding of the farmobile will be simple yet aesthetically pleasing, minimalistic, and would involve a lot of greens to properly convey the image of farming and of crops. Given this, the color scheme used will be various shades of greens (refer to Figure 2). The logo plays with the image of a leaf and stem, which recreates the letter F to represent "Farmobile" (refer to Figure 3).

Figure 2. *Color Palette*

Figure 3. *Logo*

Optimal conditions for growing produce

The specific factors for optimal conditions are temperature, light, water, humidity, oxygen, and pH levels. In addition, the nutrient solution used is a vital factor as well affecting several other conditions. Given the range of crops that could be grown within the hydroponic farms, optimizing for each respective species will have a different set of conditions. There are, however, average ranges that can suffice in creating a default setting. Also, additional sets of information for each specific crop can be integrated into the app and as suggestions to the user to optimize for the crop he wishes to cultivate.

Temperature

Temperature of the grow room is crop-specific, but, the general optimum temperature for photosynthesis is around 25℃ to 28℃. The default setting should be around that range. Another important thing to note is that rates of photosynthesis drop sharply at high temperatures, and gradually if temperatures are lower. Air-conditioning matched with proper ventilation and insulation and reasonable grow lights should be optimized for this.

Another thing is the water temperature and nutrient solution temperature. These can be regulated by the same devices used to regulate aquarium water temperatures which are conventionally hang-on and fully submerged heaters. Ideally, the range for this is 18℃ to 26℃. But again, this is crop specific with lettuce and baby leaf crops preferring lower temperatures, and onions and cucumbers preferring higher temperatures in the 25℃ to 30℃.

Lighting
In calculating the intensity of the light needed for the crops, a good way to measure is wattage per square foot**.** The goal is to achieve a desired wattage per foot across the grow room. The desired wattage per foot does vary per crop, so adjustability is required. Also, grow rooms will have utility areas and walkways that are irrelevant in this measurement; only the designated areas for growing are considered. Target numbers will again vary per crop, but 50 to 75 watts per square foot is the range that will be considered. The intensity of the light can also be adjusted via the distance between plant and source of light.

In terms of duration of lighting, majority of vegetables need somewhere between 14 to 18 hours of lighting with a continues rest period to stay healthy. An adjustable automatic timer will suffice in maintaining these requirements.

The color of the lighting is another factor. The closest to imitating natural lighting-like conditions is ideal. Full-spectrum LEDs which are basically a combination of red and blue lights can imitate the solar spectrum.

As stated earlier, grow lights do affect the temperature of the room thus necessitating calibrating the entire system to work together in concert to maintain optimal conditions.

Humidity
High humidity makes plants unable to transpire properly, and it sets the conditions for fungi and pests to take hold of the area. The optimal humidity range for most vegetable crops is 50-80% RH (relative humidity), with 50% being the best. A hygrometer should be used to measure this. An exhaust fan to vent out hot and humid air ought to be included in the product, and fans blowing over the grow area will prevent hot and humid patches. Another thing to note is that humidity is ideally gradually decreased over maturity so being able to adjust this will allow for optimization.

Nutrient Solution
One of the most crucial components of the hydroponics farm is the nutrient solution. This affects the pH levels and determines the water intake of the plants in ratio to the concentration of nutrients the plants are receiving. It is also oxygenated with not dissimilar to aquarium setups. Nutrient solutions are available in the market but adjusting them can be done.

Oxygen
Oxygenating the nutrient solution is conventionally done through air stones and air pumps as is done in aquarium setups. The ideal seems to be around 7-12 ppm of dissolved oxygen.

pH levels
Hydroponically-grown plants prefer slightly more acid conditions. The aim for a default pH should be between 5.5 and 6.5. Within this range, availability of nutrients is at optimum. Extremes of this range will reduce availability of certain nutrients; a high pH reduces the availability of iron, manganese, boron, zinc, copper, and phosphorous while low pH reduces the availability of potassium, calcium, magnesium, and again phosphorus.

To adjust the pH levels, lowering it can be done by adding phosphoric or nitric acid to the solution, and raising it by adding potassium hydroxide. This should be probed constantly by a pH meter to calibrate.

Electrical Conductivity
This is a measure of the overall strength of the nutrient solution as a whole. The balance of nutrients in the solution itself is outside the scope of EC. The advisable thing to do given that is to change nutrient solutions at regular intervals such as every week. Basically, high EC means that plants take up water faster than nutrients, and low EC the reverse. To maintain EC, adding water when more water is taken i.e. high EC and adding nutrients when more nutrients are taken i.e. low EC is taken. Measuring this requires an EC meter that should be calibrated regularly.

Optimal EC levels vary wildly so a default is out of the question. For example, feeding lettuce high EC intended for tomatoes will result in bitter lettuce, and in reverse, low EC for tomatoes results in tasteless tomatoes. A guide on the optimal EC levels per crop with a conversion chart of EC to PPM depending on the manufacturer of the EC meter ("Plant PH/EC/PPM") can be found on appendix 1.

With all those features in mind, the product is intended to fit all the necessary equipment in a 40ft. container van in a convenient and aesthetically pleasing manner. This includes the necessary ventilation and insulation surrounding the space and the actual hydroponics system with the reservoir and pumps complemented with all the necessary monitors and adjustment systems in place for each condition. All these will then have to be linked and integrated to a remote control app. In land area, this is just over 300 square feet internally, and 320 square feet externally.

Crops
Theoretically, a hydroponics farm with an independently controlled-environment system would be able to grow any crop all year round. However, factors such as the hydroponics system utilized with the spatial limitations of the Dutch bucket, as well as the profitability and market availability of crops in the region should dictate what should ideally be produced. The controlled-environment system eliminates the need to choose crops based on season and geographical constraints.

The product uses an Ebb and Flow system utilizing a growing medium. This system gives heavier plants good support, enough space for vegetables and herbs with deep roots, and is good for crops that are top heavy such as beans, tomatoes, squash, and cucumbers.

While an in-depth market analysis would be ideal to determine which crops to grow, the next best thing is to investigate the many crops in the Philippines that deal with certain restrictions that do not apply to the hydroponics farm. Cool weather crops such as strawberries that generally only grow in places like Benguet or Baguio are good options for the product; it is also notable to mention that strawberries are said to work best in an Ebb and Flow system.

Generally profitable options are flowers and herbs, and certain vegetables like cauliflower, broccoli, asparagus, and bell peppers are also known to be relatively expensive in the Philippines due to being mostly imported.

The Setup

A Dutch Bucket type of hydroponic system will be used. This system is a variant of the EBB flow system, or commonly known as the flood and drain system. This system ensures that the plants receive the needed amount of nutrients through a cycle of flooding the pots with a nutrient solution, then draining the excess. The Dutch Bucket system involves a specialized component, called the Dutch Bucket which will be thoroughly explained later on.

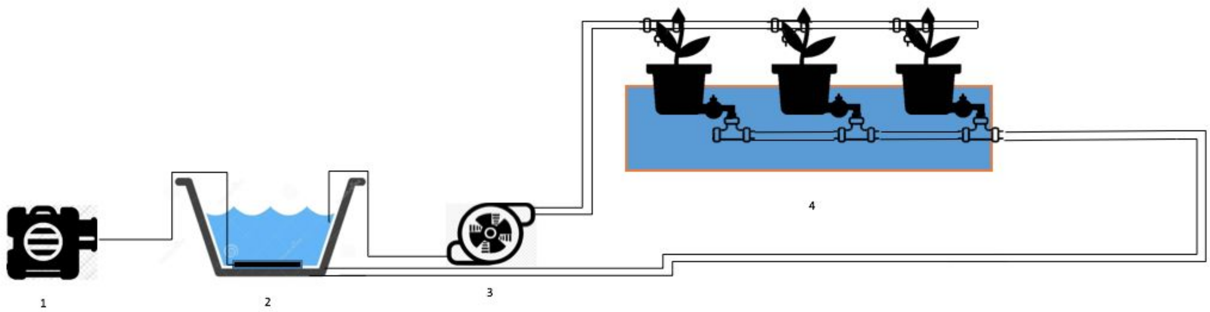

Figure 4. *Layout*

As shown in the figure above, the system requires four individual segments to complete the whole process. An air pump (1) oxygenates the nutrient solution (2), through an air stone placed at the bottom of the reservoir. This oxygenated nutrient solution is then pumped, by a water pump (3), to the shelved dutch buckets (4). Dutch buckets (explained below) are a specialized type of flower pot, specified specifically for hydroponics. Excess nutrient solution will then be transported back to the reservoir (2), which can be reused for a specified amount of times (based on PH level).

Specificifications of the setup

1.) Air pump

The air pump will be used to oxygenate the nutrient solution in the reservoir. Given that a one hundred gallon reservoir will be used, a four-outlet, 13W air pump will be made use of. On average, hydroponic farmers aim for a rate of one to two liters of oxygen per minute. The said air pump is capable of producing two and a half liters of oxygen per outlet. Thus, meeting the amount needed. In addition, to ensure proper air flow from the pump to the reservoir, the pump must be coupled with proper air lines.

2.) Reservoir

Half a gallon, one and a half gallons, and two and a half gallons of nutrient solution are needed per day for small-sized, medium sized, and large-sized plants respectively. Given these figures, each customer will be provided with two, one hundred gallon sized reservoirs (for used, and unused nutrient solution). A reservoir of this size will be able to accomodate 200 small-sized plants, or 65 medium sized plants, or 50 large-sized plants. All of which are above the expected capacity of one whole system. The nutrient solution will be composed of different types of solutions, depending on the likes of the customer. They may range from fish amino acids, fertilizers, yield boosters, etc.

3.) Water pump
A 25 Watt water pump will be used, since it is capable of pumping 4000 liters of water per hour. This figure exceeds the amount of water needed to be pumped in all the dutch buckets provided in the system, since a total of 550 Liters will be needed to be pumped 3 times daily (50 11-liter dutch buckets). The pump will be coupled with appropriately-sized pipes to ensure the efficiency of the process, and drip emitters that allow the water to flow from the tubing to the dutch buckets.

4.) Dutch buckets
Dutch buckets are specified specifically for hydroponics. They have a spout located at the bottom of the bucket and has a specialized mechanism, which releases all the excess nutrient solution that is not needed for the plants. Leaving only around three to four liters in each dutch bucket, which is the average amount of nutrient solution needed for plants. In the system 50 11-liter dutch buckets will be provided. This size will be able to accommodate four small-sized plants, two medium-sized plants, or one large-sized plant per bucket, following the layouts shown below.

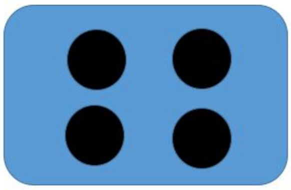

Figure 5. *Dutch Bucket Layout for small-sized plants*

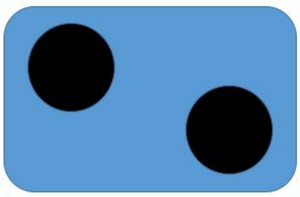

Figure 6. *Dutch Bucket Layout for medium-sized plants*

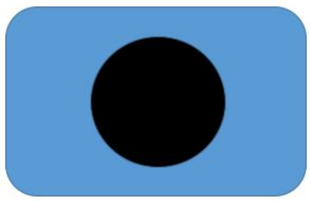

Figure 7. *Dutch Bucket Layout for large-sized plants*

Each dutch bucket will also contain a growing medium, which works as the replacement of soil. Growing media may range from rockwool cubes, expanded clay, coconut chips, river rocks, perlite, growlite, and many more. The type of growing media to be used, highly depends on the type of hydroponic system being used. The group's system will require the use of either coconut chips, perlite, hydroton, or vermiculite. However, coconut chips will be used over the others, due to the fact that the Philippines is abundant in this resource, is cost efficient, and is absorbent. Its absorbency will decrease the needed amount of times water has to be pumped into the dutch buckets, since it will retain the nutrient solution longer. There is no specified amount of pump cycles, since it will depend heavily on the environmental factors (temperature, humidity, light, etc).

Also placed in the dutch buckets are net pots as shown in the picture below . Simply put, they are a type of flowering pot that is composed of a meshed material to ensure that the plants' roots grow in all directions, thus allowing the plant to receive the nutrients from the nutrient solution absorbed by the growing media.

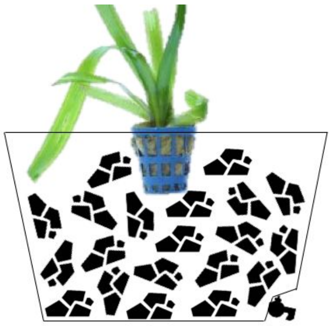

Figure 8. *Dutch Bucket Setup*

Materials Needed

Material	Store	QTY	Price (PHP)	Photo
AIR + WATER PUMPS				
Air Pump	FEV Marine Aquatic Supplies (Cubao)	1 unit	2000.00	
10cm Air Stone	Shopee	5	348.00	
Reservoir (50L)	OLX	2 units	1500.00	
Water Pump	FEV Marine Aquatic Supplies (Cubao)	1 unit	1000.00	
Air hose (opaque)	RS services	1 meter	75.00	

DUTCH BUCKET				
Dutch Bucket System With Lid and Net Pot	Greengold Farms (Lazada)	50 units	495.00	
Dutch Bucket	Greengold Farms via Lazada		420.00	
Net Pot (2”)	Greengold Farms via Lazada		20.75	
Net Pot (4”)	Greengold Farms via Lazada		23.25	
Hydroton (Growing Media)	Greengold Farms via Lazada	1 unit	2000.00 (for 12 kg / 1 sack)	
Wooden Shelving[1]		8 units	400.00	
IRRIGATION LINE				
22mm x 3m PVC pipe	RS Services	25 units	183.08	

[1] These wooden shelves will be produced by in-house staff. Its cost will come from materials (plywood and wood glue)

Drip Emitters	Greengold Farms via Lazada	50 units	7.50	
RETURN LINE				
22mm x 3m PVC pipe	RS Services	2.5 units	183.08	
OTHERS				
2nd hand Shipping Container	OLX	1 unit	80,000	
Electronic PH meter	RS services	1 unit	4009.36	
Digital Submersible Oxygen Level Meter	Yieryi Store (Lazada)	1 unit	4298.00	
Digital Thermometer	RS services	1 unit	3514.25	

Smart LED light bulbs via	Stay Store (Lazada)	8 units	4,800.00	
TOTAL			**139,796.31**	

The Farmobile Mobile Application

The Farmobile will be connected to a mobile application. Having an application enables the farmers to remotely control their farmobile, this way they can be worry-free and be able to monitor the various factors. The specific factors are water temperature, light, oxygen, and PH levels. The application will not only provide awareness, but it will also provide control for the farmers to manipulate the levels of the different factors. There are a variety of crops that can be grown in the farmobile and hence, a variety of “optimal” temperature, water, and oxygen levels, different crops would entail different factors to grow properly (for example, the optimal temperature for the nutrient solution is 65-75 degrees Fahrenheit and the optimal PH level is with 6.0-7.0). With this variety, the application will provide a drop-down menu of the possible crops so that the farmer may select the crop/s they’re currently growing. The application is already programmed to know the optimal level of all factors for all crops, and in addition, will be the new “default” environmental conditions in the mobile farm. The default condition also extends to automatic water and nutrient replacement at given times of the day. In the event that the various levels drops or exceeds the optimal, the farmer will be notified on his mobile device (should they choose to open the notification setting). The application will contain a button “automatic restoration,” which will automatically bring all factors to the optimal level and will automatically replace the nutrient solution.

Figure 9. *Mobile Application*

Delivery to the customer’s doorstep will initially be handled by a third-party logistics company, QuadX, to lower the initial investment. Prioritizing a low initial investment, is a key factor to this business, because of the fact that it is a start-up company. Waters must be tested before investing more money into the business, to lessen the risk of a net loss. However, once the company has established itself and has a positive net cash flow, investing in its own delivery automobiles will be taken into consideration. Once the product is delivered, Verde will immediately install and prepare the system for operation. A tutorial regarding the farmobile app will also be conducted to ensure proper utilization of the whole system. In case of any defects, instead of shipping back the entire farmobile to the warehouse, mechanics will make their way to the customer's location through public transport instead.

Initial Investment Needed

	Amount	**Notes**
Warehouse	PHP 1,050,000 (175,000 x 6 months)	• Located in Sucat • 700 sq. meters • accessible to trucks • easy access to highways
Construction of headquarters	PHP 200,000	• the headquarters will be used for business operations • a 100 sq. meter room within the vicinity of the warehouse
Furniture	PHP 50,000	Tables, chairs, desks, couch, tool rack, shelves
2 Dell Inspiron 7th Gen Intel Core i3 7100 desktop computers	PHP 80,000	Will be used for heavily for business administration purposes
Tools: • Makita Circular Saw • Mail tank Jigsaw and Power Drill • Makita Welding Machine • Opmall Tool Set (screwdrivers, pliers, Allen keys, handsaws, hammer, etc.)	 PHP 2,000 PHP 1,800 PHP 3,000 PHP 200	To be used in the production line
Application Development	PHP 250,000	Development of the application will be outsourced by Monstar Lab
Cost of two farmobiles	PHP 280,000	
TOTAL INVESTMENT	**PHP 1,917,000**	

As shown above, the initial investment includes significant actions that are needed initially to begin business operations. The cost of two farmobiles was also included in the initial investment, since this amount will be needed to initially begin producing and selling the product. Given the total initial investment of PHP 1,907,000.00, this will be split equally among the four business owners, thus each one contributing PHP 479,250.00

Product Costing

Material	Amount
Cost of materials	139,796.31
Labor	(700 daily x 5 days of labor) x 2 people = 7000
Utilities	(Assume a 10k bill monthly for warehouse / 22 working days) x (5 working days) = 2272
Logistics	14,000
Container Refurbishing	10,000
TOTAL	**173,068.31**

Product Pricing

Given the costing table shown above, the finished product will be priced at PHP 300,000.00, which is at around a 100% markup. On the one hand, from the customer point of view, this markup percentage is justified by the practicality, efficiency, and convenience that the whole system provides. Thus, comparing this price to the conventional approach to farming, it deems competitive. The conventional approach entails high involvement in all processes, as compared to farmobile, which allows you to control the processes through your mobile application. In addition, hydroponics decreases the amount of time a seed needs to grow by half, thus increasing productivity rate. Lastly, hydroponics also uses 40% less water, thus further cutting down on costs. On the other hand, from the business point of view; given this price, 14 units of farmobile will have to be sold for the company to breakeven.

Timeline & Task Allocation for 2019

2019 Activities	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Prepare Government & Legal Forms										
Purchase Warehouse										
Headquarters Construction										
Secure Utilities (Water, Electricity, Internet, etc.)										
Purchase Facilities Supply										
Set-up Facilities										
Market & Product Research										
Purchase Machinery										
Hire & Train Employees										
Set-up Machinery										
Purchase Raw Materials & Packaging Materials										
App Development										
Product Development										
Trial Run										
Acquire Outsourced Logistics										
Marketing & Selling of Farmobile										

APPENDIX

Appendix 1. Optimal EC Levels per Crop

Plant	pH	EC	PPM
African Violets	6.0-7.0	1.2-1.5	840-1050
Anthurium	5.0-6.0	1.6-2.0	1120-1400
Antirrhinim	6.5	1.6-2.0	1120-1400
Aphelandra	5.0-6.0	1.8-2.4	1260-1680
Artichoke	6.5-7.5	0.8-1.8	560-1260
Asparagus	6.0-6.8	1.4-1.8	980-1260
Aster	6.0-6.5	1.8-2.4	1260-1680
Basil	5.5-6.5	1.0-1.6	700-1120
Bean (Common)	6.0-6.5	1.8-2.4	1400-2800
Beans (Italian bush)	6.0-6.5	1.8-2.4	1400-2800
Beans (Lima)	6.0-6.5	1.8-2.4	1400-2800
Beans (Pole)	6.0-6.5	1.8-2.4	1400-2800
Beetroot	6.0-6.5	0.8-5.0	1260-3500
Begonia	6.5	1.4-2.4	980-1260
Bell peppers	6.0-6.5	1.8-2.8	1400-2000
Black Currant	6.0	1.4-1.8	980-1260
Blueberry	4.0 -5.0	1.8-2.0	1260-1400
Broad Bean	6.0-6.5	1.8-2.2	1260-1540
Broccoli	6.0-6.5	2.8-3.5	1960-2450
Bromeliads	5.0-7.5	0.8-1.2	560-840
Brussell Sprout	6.5-7.5	2.5-3.0	1750-2100

Cabbage	6.5-7.0	2.5-3.0	1750-2100
Caladium	6.0-7.5	1.6-2.0	1120-1400
Canna	6.0	1.8-2.4	1260-1680
Capsicum	6.0-6.5	1.8-2.2	1260-1540
Carnation	6.0	2.0-3.5	1260-2450
Carrots	6.3	1.6-2.0	1120-1400
Cauliflower	6.0-7.0	0.5-2.0	1050-1400
Celery	6.5	1.8- 2.4	1260-1680
Chicory	5.5-60	2.0-2.4	1400-1600
Chives	6.0-6.5	1.8-2.4	1260-1540
Chrysanthemum	6.0-6.2	1.8-2.5	1400-1750
Cucumber	5.8-6.0	1.7-2.5	1190-1750
Cymbidiums	5.5	0.6-1.0	420-560
Dahlia	6.0-7.0	1.5-2.0	1050-1400
Dieffenbachia	5.0	1.8-2.0	1400-1680
Dracaena	5.0-6.0	1.8-2.4	1400-1680
Eggplant	5.5-6.5	2.5-3.5	1750-2450
Endive	5.5	2.0-2.4	1400-1680
Fennel	6.4-6.8	1.0-1.4	700-980
Ferns	6.0	1.6-2.0	1120-1400
Ficus	5.5-6.0	1.6-2.4	1120-1680
Fodder	6.0	1.8-2.0	1260-1400
Freesia	6.5	1.0-2.0	700-1400
Garlic	6.0	1.4-1.8	980-1260

Gerbera	5.0-6.5	2.0-2.5	1400-1750
Gladiolus	5.5-6.5	2.0-2.4	1400-1680
Hot Peppers	6.0-6.5	1.8-2.8	1400-2000
Impatiens	5.5-6.5	1.8-2.0	1260-1400
Lavender	6.4-6.8	1.0-1.4	700-980
Leek	6.5-7.0	1.4-1.8	980-1260
Lemon Balm	5.5-6.5	1.0-1.6	700-1120
Lettuce	5.5-6.5	0.8-1.2	560-840
Marjoram	6.0	1.6-2.0	1120-1400
Marrow	6.0	1.8-2.4	1260-1680
Mint	5.5-6.0	2.0-2.4	1400-1680
Monstera	5.0-6.0	1.8-2.4	1400-1680
Mustard Cress	6.0-6.5	1.2-2.4	840-1680
Okra	6.5	2.0-2.4	1400-1680
Onions	6.0-6.7	1.4-1.8	980-1260
Pak-choi	7.0	1.5-2.0	1050-1400
Palms	6.0-7.5	1.6-2.0	1120-1400
Parsley	5.5-6.0	0.8-1.8	560-1260
Parsnip	6.0	1.4-1.8	980-1260
Granadilla	6.5	1.6-2.4	840-1680
Paw-Paw	6.5	2.0-2.4	1400-1680
Pea	6.0-7.0	0.8-1.8	980-1260
Peas (Sugar)	6.0-6.8	0.8-1.8	980-1260
Pepino	6.0-6.5	2.0-5.0	1400-3500

Peppers	5.8-6.3	1.8-2.8	1400-2000
Potato	5.0-6.0	2.0-2.5	1400-1750
Pumpkin	5.5-7.5	1.8-2.4	1260-1680
Radish	6.0-7.0	1.6-2.2	840-1540
Red Currant	6.0	1.4-1.8	980-1260
Rhubarb	5.0- 6.0	1.6-2.0	840-1400
Rosemary	5.5-6.0	1.0-1.6	700-1120
Roses	5.5-6.0	1.5-2.5	1050-1750
Sage	5.5-6.5	1.0-1.6	700-1120
Silverbeet	6.0-7.0	1.8-2.3	1260-1610
Spinach	5.5-6.6	1.8-2.3	1260-1610
Squash	5.0-6.5	1.8-2.4	1260-1680
Strawberries	5.5-6.5	1.8-2.2	1260-1540
Sweet Corn	6.0	1.6-2.4	840-1680
Sweet Potato	5.5-6.0	2.0-2.5	1400-1750
Swiss Chard	6.0 6.5	1.8-2.3	1260-1610
Taro	5.0-5.5	2.5-3.0	1750-2100
Thyme	5.5-7.0	0.8-1.6	560-1120
Tomato	5.5-6.5	2.0-5.0	1400-3500
Turnip	6.0-6.5	1.8-2.4	1260-1680
Watercress	6.5-6.8	0.4-1.8	280-1260
Watermelon	5.8	1.5-2.4	1260-1680
Zucchini	6.0	1.8-2.4	1260-1680

EC	Hanna	Eutech	Truncheon	CF
ms/cm	0.5 ppm	0.64 ppm	0.70 ppm	0
0.1	50 ppm	64 ppm	70 ppm	1
0.2	100 ppm	128 ppm	140 ppm	2
0.3	150 ppm	192 ppm	210 ppm	3
0.4	200 ppm	256 ppm	280 ppm	4
0.5	250 ppm	320 ppm	350 ppm	5
0.6	300 ppm	384 ppm	420 ppm	6
0.7	350 ppm	448 ppm	490 ppm	7
0.8	400 ppm	512 ppm	560 ppm	8
0.9	450 ppm	576 ppm	630 ppm	9
1.0	500 ppm	640 ppm	700 ppm	10
1.1	550 ppm	704 ppm	770 ppm	11
1.2	600 ppm	768 ppm	840 ppm	12
1.3	650 ppm	832 ppm	910 ppm	13
1.4	700 ppm	896 ppm	980 ppm	14
1.5	750 ppm	960 ppm	1050 ppm	15
1.6	800 ppm	1024 ppm	1120 ppm	16
1.7	850 ppm	1088 ppm	1190 ppm	17
1.8	900 ppm	1152 ppm	1260 ppm	18
1.9	950 ppm	1216 ppm	1330 ppm	19
2.0	1000 ppm	1280 ppm	1400 ppm	20
2.1	1050 ppm	1334 ppm	1470 ppm	21
2.2	1100 ppm	1408 ppm	1540 ppm	22
2.3	1150 ppm	1472 ppm	1610 ppm	23
2.4	1200 ppm	1536 ppm	1680 ppm	24
2.5	1250 ppm	1600 ppm	1750 ppm	25
2.6	1300 ppm	1664 ppm	1820 ppm	26
2.7	1350 ppm	1728 ppm	1890 ppm	27
2.8	1400 ppm	1792 ppm	1960 ppm	28
2.9	1450 ppm	1856 ppm	2030 ppm	29
3.0	1500 ppm	1920 ppm	2100 ppm	30
3.1	1550 ppm	1984 ppm	2170 ppm	31
3.2	1600 ppm	2048 ppm	2240 ppm	32

BIBLIOGRAPHY

“10 Most Expensive Vegetables in the Philippines.” *Pinoy Top Tens*, Pinoy Top Tens, 25 May 2017, www.topten.ph/2016/08/27/10-most-expensive-vegetables-in-the-philippines/.

“Are You Maintaining the Proper Oxygen Levels in Your Hydroponic Production System?” *Hort Americas*, 30 May 2017, hortamericas.com/blog/news/are-you-maintaining-the-proper-oxygen-levels-in-your-hydroponic-production-system.

Calderone, Len. “More Agricultural Technology Resources.” *What Is Vertical Farming? | AgriTechTomorrow*, 26 Dec. 2018, www.agritechtomorrow.com/article/2018/05/1-article-for-2018-growing-with-hydroponics-aeroponics-and-aquaponics/10733.

Farmer, *ReviewerHydro*. “Hydroponic Lighting Guide.” *Hydroponics Gardening Equipment & Supplies*, 9 Aug. 2018, www.farmhydroponics.com/hydroponics/hydroponic-lighting-guide.

“Frequently Asked Questions.” *Greentrees Hydroponics*, www.hydroponics.net/learn/faq.php.

Gardening, Epic. *YouTube*, YouTube, 27 Feb. 2013, www.youtube.com/watch?v=i3-9u-HtFG8.

“How To Build Your Own Hydroponics Grow Room – Calculating Lighting & Insulation Needs (Part 2).” *How To Start Indoor Growing - Hydroponics For Beginners*, 30 Mar. 2017, www.advancednutrients.com/articles/grow-room-calculating-lighting-insulation-needs/.

“How To Build Your Own Hydroponics Grow Room – Dialing In Your Temperature and Humidity (Part 3).” *How To Start Indoor Growing - Hydroponics For Beginners*, 30 Mar. 2017, www.advancednutrients.com/articles/grow-room-temperature-humidity/.

“HOW TO GROW HYDROPONICS: TEMPERATURE & HUMIDITY.” *Hydroponics Simplified*, www.hydroponics-simplified.com/how-to-grow-hydroponics.html.

“Hydroponic Water Temperature: What Is The Ideal Water Temp For Hydroponics.” *Gardening Know How*, www.gardeningknowhow.com/special/containers/hydroponic-water-temperature.htm.

“Just 4 Growers: Global Garden Community.” *Just For Growers*, www.just4growers.com/stream/temperature-humidity-and-c02/understanding-the-optimum-temperature-for-plants.aspx.

“Maintaining Proper Oxygen Levels in a Hydroponic Production System.” *Hortidaily: Global*

Greenhouse News, 5 June 2017, www.hortidaily.com/article/6035197/maintaining-proper-oxygen-levels-in-a-hydroponic-production-system/.

Max. “Dutch Bucket / Bato Bucket Hydroponic System.” *Green and Vibrant*, 10 Feb. 2017, www.greenandvibrant.com/dutch-bucket.

“Plant PH/EC/PPM.” *Online Hydroponics Shop*, hydroponic.co.za/hydroponics-quickstart/plant-phecppm/.

“What Is the Ideal Nutrient Solution Temperature in Hydroponics?” *Learning about the Art and Science behind Growing Plants without Soil*, scienceinhydroponics.com/2017/06/what-is-the-ideal-nutrient-solution-temperature-in-hydroponics.html.