**Vertical Gardens**

**Reducing Food Importation to Wrigley Institute**

The USC Wrigley Institute for Environmental Studies is an off-campus research facility of the University of Southern California located in Avalon, Catalina Island, California. This research facility focuses its work in the fields of marine and environmental science. In addition to academic research, the Wrigley Institute has the objective of developing sustainable methodologies, defined as a process that is self-sufficient. The ultimate goal of this alternative purpose is to eventually implement these newly developed procedures in USC’s main campus located in South Central Los Angeles. The Wrigley Institute has made this commitment because, as a world-class educational institution, USC is seeking to impact the world with the technologies engineered within its laboratories.

During our team’s visit to the institute, we concluded that the food logistics at the research center were impressive. Despite of this success, there still exist areas for continued development. After a meticulous analysis of the different areas of improvement, our team decided to provide a solution to food transportation to the island from the mainland: vertical gardens. A vertical garden is a regular garden; however, it is stacked vertically. The garden can hang from a bridge, tangle in a fence, or placed in pocket meshes on a wall.

Our team decided to give a holistic view of vertical gardens, so that the reader can completely informed of this concept. Therefore, this paper will provide a general understand of the history of our proposed solution, the different types of gardens, its implementations, the optional irrigation systems, the proposed nutrition value that can be generated, crop selection, soil conditions, space requirements, and harvesting periods. All of our academic research was done to meet the needs of the Wrigley Institute.

**Concerns at USC Wrigley Institute and our Solution**

The food consumed in the Wrigley Institute has to be brought to Catalina Island through a boat once a week, typically on Thursdays. The boat comes with 2 to 4 pallets, depending on the projected food for the week, filled with food bought from supermarkets in Long Beach or San Pedro. A rough approximation of a pallet weight is 1 pallet = 1,000 pounds. Furthermore, the size of each pallet is 4 x 4 x 5 feet. Unfortunately, the process of bringing food to the island is dependent on unsustainable practices. The main unsustainable aspect that our team took into consideration is the gas used by the boat to transport the food from the mainland to the island. Besides gas consumption, food packaging that comes to the island every week represents waste, if disposed as trash, or energy consumption, if recycled. Even though the institute personnel is highly motivated and committed to recycling, a significant amount of energy is used in recycling plants to be able to give a useful end to food packaging material.

In addition to the environmental concerns, food transportation involves a high-cost. As mentioned earlier, our proposed solution is the implementation of vertical gardens in USC’s Catalina Island campus for farming purposes. Our team opted that vertical gardens are the best solution after getting informed on Avalon’s soil. In the area were the Wrigley Institute is located, most of the soil lacks nutrients, which allows plants to grow. Moreover, there is a significant amount of volcanic rocks in the institute’s vicinity. Thus, the use of vertical garden will allow farming to be successful in the region.

**Brief History of Vertical Gardens**

In 1938, Stanley Hart, a professor at the University of Illinois Urbana-Champaign, obtained a patent on “Vegetation-Bearing Architectonic Structure and System.” These structures are now known as vertical gardens. Later, Patrick Blanc, a French botanist modernized and popularized Hart’s idea. The first vertical garden was installed in 1988 at the Museum of Science and Industry in Paris, France. The second one was placed a decade later by the contemporary art museum *Fondation Cartier* located in the same city [1].

**Different types of vertical gardens**

One of the main benefits of vertical gardens is that they can be implemented in multiple sizes and shapes. In general, there are 14 types of vertical gardens, which can be grouped in 6 different categories (see Table 1) [2].

|  |  |
| --- | --- |
| Categories | Types |
| Fence Planters | * Pocket Planters * Hanging Fence Planters * Lattice Garden |
| Self-Watering | * Worth Vertical Planter * Bloomwall |
| Decorative | * Succulent Living Wreath |
| Stand-Alone Planters | * Earth Tower Mobile Garden * Stacked Planter Boxes * Flower Tower |
| Small Indoor Gardens | * Plastic Bottle Herb Garden * Hanging Pot Window Garden |
| Re-Use Materials | * Pallet-Style Planter * Gutter Garden * Mailbox Planters |

In the Fence Planters category, Pocket Planters, Hanging Fence Planters (See Fig. 1), and Lattice Gardens serve the function of creating farming green spaces. In terms of design, the only aspect that varies among these types of gardens is the arrangement of the plants. Additionally, the sizes of the plant containers can be modified according to the needs of the plant that is going to be harvested.



Figure 1: Hanging fence planters used for flowers

Source: Amazon

The Self-Watering gardens are designed to conserve water and, consequently, save money (See Fig. 2). One of the positive aspects of the Worth Vertical Planter is that this system does not need any expensive electronic devices. However, it needs a pump to push the water, so it can reach the entrance pipes. After the water is pumped, the water flows into the pots located at the lower levels of the garden. In contrast, the Bloomwalls are similar to the aforementioned design. Some of the differences are that the pots are arranged in racks that create rows. Additionally, it has water indicators. One of the benefits of this type of garden is that it can be used for indoor gardening because it does not drip water out of the containers. Furthermore, the water indicator helps to water the plants only when necessary.

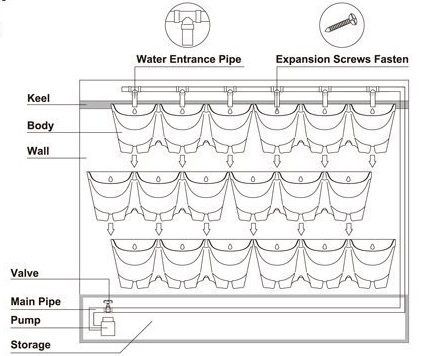


Figure 2: Self-Watering pots

Source: Easy Vertical Gardening

Another useful type of garden that will serve the purpose of farming is the EarthTower Mobile Garden (See Fig. 3), from the Stand-Alone Planters Category. The main benefit of this structure is that it has casters used to relocate the garden as desired. This is a benefit that allows the garden to be moved within the Wrigley Institute without worrying on the installation costs. Additionally, the irrigation system is designed to water the plants from the top resulting in making maintenance easier.

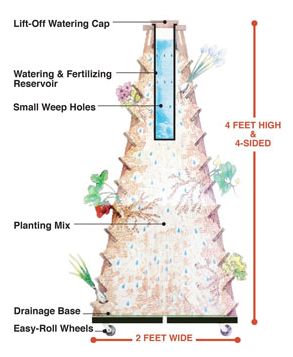


Figure 3: Dimensions of the EarthTower Mobile Garden

Source: Easy Vertical Gardening

Finally, the different types of vertical gardens that can be built from the Re-Use Materials category might be appealing because objects can have an extended useful life. The materials that can be used are plastic bottles and mailboxes; unfortunately, these planters might not prevent water and soil from dripping out of the container.

**Benefits of Vertical Gardening**

Taking into consideration the Wrigley Institute’s mission of developing technologies that will eventually have an impact in the world, our team decided to give attention to the overall benefits of vertical gardens in urban areas. These benefits, mostly mental, are going to directly enhance Angeleno’s and USC’s population quality of life. In general, nature encourages imagination, creativity, cognitive development, social relationships, encourages learning, inquisitiveness, and alertness. Furthermore, researchers have found that residents of urban areas who live close to nature have higher satisfaction with life [3].

In the case of mental health, green spaces reduce mental fatigue. The plants encourage social interaction; therefore, a person who lives in an area surrounded by plants can relieve stress by having conversations with other individuals. Furthermore, farming and maintaining vertical gardens require the owner to be physically active. Physical activity improves learning and memory. As a consequence, this lifestyle decreases the symptoms of Alzheimer’s, dementia, stress, and depression. For people diagnosed with breast cancer, green spaces improve cognitive function. Cognitive function is defined as the action of acquiring knowledge, understanding thought, experience the senses, and having analytical thinking skills.

All of the aforementioned factors contribute to improve the work environment, academic activities, and daily life. Likewise, living in a large metropolitan area, such as Los Angeles, requires a significant amount of mental awareness. Residents have to be aware to monitor traffic and pedestrian flow in order to avoid accidents. This high and constant level of awareness required to drive in Southern California can affect the brain in the long term by reducing self-control and, resulting, in memory loss. In this chaotic urban setting, nature, in this case vertical gardens, ameliorates brain performance by providing a cognitive break from these demands.

In the work environment, green spaces improve employee confidence, decrease absenteeism, and increase efficiency. Moreover, workstations with view of plants have a decrease illness incidence and self-reported sick leave. Furthermore, workers are more satisfied at work and have more patience, less frustration, and increase enthusiasm for work related activities. In contrast, not having a view of nature or indoor plants lead to higher levels of tension and anxiety in office workers. In the case of USC, having vertical gardens on campus can lower stress levels of students and professors during hectic weeks of the semester [4].

Besides the mental benefits, there are economic and environmental incentives, making this option a viable sustainable solution. On the economic perspective, vertical gardens provide a low-cost alternative to alleviate the food shortages in low-income area. Vertical gardens require a minimal area for its implementation, so inner cities, which tend to have high rates of population density, small housing units, and low average household income, can take advantage of these minimum requirements.

Similarly, there are multiple environmental benefits that result from this type of gardens. One of them is the reuse of compost as a fertilizer and soil amendment. Additionally, household wastewater can be reused for watering the plants. In a larger scale, plants serve as temperature insulators, improve air quality of an urban area, and reduce the heat island effect, which is going to be explained thoroughly in the next section. This effect is currently having a negative impact in the Los Angeles area. Evapotranspiration is the reason a significant amount of vertical gardens in the city will reduce the heat island effect. This process cools down the environment when water evaporates resulting in removing energy [5].

**Heat Island Effect affecting Southern California**

The heat island effect occurs when cities get warmer than the rural areas surrounding them. This is caused by the fact that asphalt streets, dark roofs, and concrete get warmer during the day, and these impervious surfaces do not have enough time for the temperature to drop during the night. In the case of traditional asphalt, it absorbs up to 90% of the sun’s radiation. Moreover, as the asphalt’s temperature increases, the surrounding air gets heated as well. This unnatural warm temperature in urban areas is a common cause of heatstroke. In the following map of Los Angeles (See Fig. 4), it is clearly shown that the highest temperatures are registered in areas with more building and located from a greater distance from the coast.

The distance from the coast also affects the temperature of the city. The ocean works as a natural air conditioner that drops the temperature of the closer regions to the coast due to the wind. In contrast to the positive effects of the winds, the current of air brings heat from the coastal areas into inland. As a consequence, it results in an increase of temperature in already warm areas.

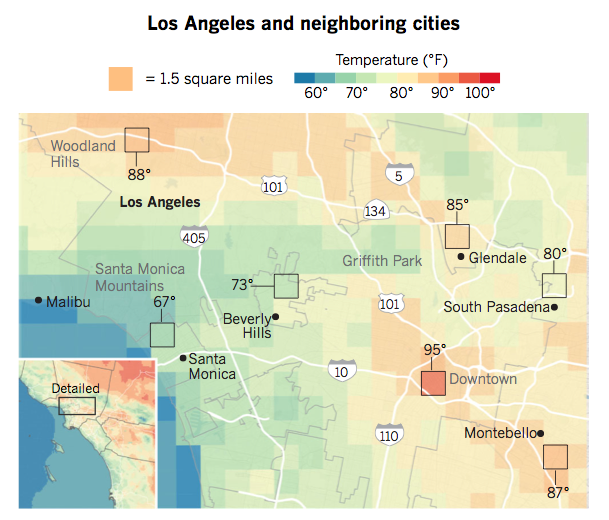


Figure 4: Temperature map of Los Angeles

Source: Los Angeles Times

During the summer of 2016, Los Angeles set new temperature records. The city had a heat wave that had highs of 100 degrees Fahrenheit for 5 days straight. Due to last summer’s temperatures, Los Angeles Mayor Eric Garcetti is striving to reduce the average temperature in the metropolitan area by 3 degrees over the next 20 years by creating more green spaces and changing the city’s surface. Professor George Ban-Weiss from the University of Southern California is working with Garcetti to achieve this goal. Professor Ban-Weiss developed computer simulations to model the temperature variations in the region. His simulations suggest that by 2050, the temperature in downtown Los Angeles will exceed 95 degrees 22 days per year. In contrast, only 6 days reached 95 degrees in 1990. Thus, vertical gardening is an option to decrease the impacts of climate change in the city of Los Angeles [5].

**Modern Implementations**

In present-day, there are multiple places where vertical gardens can be implemented, such as in houses, apartments, or museums. Some local governments in the United States are promoting the use this type of gardens. An example of this is the Civic Center Edible Garden Project in Long Beach, located south from Los Angeles. Even though Long Beach does not experience high temperatures compared to downtown Los Angeles because is located at the coast, this project has the purpose of teaching its residents a sustainable application of their residences. This edible garden uses rainwater, recycles kitchen scraps to make compost, and harvest seeds to reuse them for future crop plantings. When the plants are harvested, they are donated to Food Finders, which is a nonprofit organization that distributes food to community shelters. As mentioned in the previous sections, vertical gardens implemented in urban areas for harvesting, in this case Long Beach’s edible garden (See Fig. 5), alleviate food scarcity in low-income areas [6].



Figure 5: Vertical Gardens at the Civic Center Edible Garden Project

Source: Sustainable Long Beach

Another city that is taking advantage of the benefits from vertical gardens is Mexico City. This city has a deficiency of green spaces and does not have enough horizontal space to solve this issue. This city possesses 3.7 square meters of green space for each resident on average. This green space – resident ratio does not meet the United Nations recommendation, which is 14 square meters per resident. Therefore, Mexico City’s government is implementing a vertical gardens project, named *Via Verde*. These garden structures are composed largely of natural vegetation to avoid excessive cost on maintenance and water.

Nevertheless, they serve another purpose compared to the garden in Long Beach: reduce air and noise pollution. According to VerdMx, a company based in Mexico City focused in reducing climate change through environmental solutions, a vertical garden covering a four-story building filters 40 tons of harmful gases per year. Similarly, it traps 15 kilograms of heavy metals per year [7].

*Via Verde*’s goal is to install and maintain more than 40,000 square meters of vertical gardens in more than 700 columns along 30 kilometers in a highway that surrounds the city’s periphery. In order to avoid damages during the installation phase of this project, the plants were placed in cloth within a metal structure. This metal structure hangs from the highway’s pillars. Besides reducing noise pollution as much as 10 decibels and decreasing temperature by 8 degrees Fahrenheit, the vertical gardens are producing enough oxygen for more than 25,000 residents in the city resulting in the increase of the air quality. As a consequence, the probability that people develop respiratory diseases decreases [8].

**Drip Irrigation System**

One thing that is really important for our vertical gardening proposal is the Drip Irrigation System. As you all know, vertical gardening takes few steps in the procedure. You build the frame, put some plastic sheets on the wall, and then put the plant containers on the sheet so you can stack them vertically. This is the basic and fundamental way of growing plants in a vertical garden. In order for the gardening to flourish, the role of irrigation is always the most important because without the proper watering, the plants can never survive. Drip Irrigation System is a type of Micro-Irrigation System that can potentially save water and nutrients by allowing water to drip down slowly to the roots of plants. Placing water source directly into the root zone is the important point of drip irrigation, and it minimizes water evaporation at a large scale in total [9]. As for its water distribution, drip irrigation system works through a network of valves, pipes, tubes, and emitters in general. Depending how well it is designed, installed, maintained, and operated, drip irrigation system can be more efficient than other types of conventional irrigation systems such as surface irrigation system or sprinkler irrigation system [9].

**Items Needed for Drip Irrigation**

In order to implement the drip irrigation system for the vertical garden, there are required items as well as several steps one needs to go through. The materials one needs for the drip irrigation are as follows. Briefly mentioning, one needs pump in order to pressurize the water source from underground reservoir. Water filters are also required in order to purify the pressurized water in the tank. Next one is backwash controller, which is also known as irrigational timer. This timer allows automated system of irrigation. In other words, through the process of the timer, one can set the time for water and even the amount of water dripping into the soil. Pressure control valve is also very important to keep track of how much water to use. The water pumped from the underground or any other water source is distributed and connected through distribution lines such as pipes or polyethylene tubes. In order to make the connections through these distribution lines, poly fittings and accessories are used. Lastly, emitting devices such as dripper or micro spray head are required to actually drip water into the soil of the plants [9].

**Implementation of Drip Irrigation**

As for the general implementation process for the drip irrigation system, there are several required steps. First, one needs to pump the water from the underground using water pump. Normally, this will go directly into the water tank, which is specifically used for storing the water needed for cultivation. Water filters installed in each filter will clean the water source and make it ready for the instant usage. Now, all we need to do is setting up the time for water drip by using the device. Then, when the time is right, valves attached to the filter will open up and let the water to flow through the distribution pipes or tubes, which connects the filter to each of the plants. This is how the water flows from the underground to the tank and to each of the plants. Using emitting devices such as dripper, the water can drip into the soil of each plant [9]. In this way, one can achieve the water efficiency and the cost efficiency in the gardening process.

**Reasons for Recommendation**

There are several reasons as to why we are recommending applying the drip irrigation system with vertical gardening. The biggest reason is the fact that, by using the method, it lessens fertilizer and nutrient loss. It is possible because drip irrigation uses drippers to pour water directly into the root zone of each plant. This reduces the water waste generated when one uses one of the conventional irrigations such as using sprinklers to spray water on the plants. In this sense, dripping irrigation system enables high water application efficiency if managed correctly. Normally, this water efficiency promotes higher productivity making the plants grow better in both quantity and quality. Dripping method can also be applied well in the vertical garden for the fact that it directly waters the root zone. Since most of the vertical gardening uses wall in order to plant the seeds vertically upward, it is hard to use the automated system with the conventional irrigation system such as sprinkler irrigation unless someone constantly pour water into each of the pots. However, with the drip irrigation system, the timer sets the time and amount for watering, and the dripper actually drips water down into the root zone of each plant [10].

**Evaluation of Our Proposal**

Our proposal about vertical gardening is very comprehensive in total. We are proposing for Wrigley Institute to actually promote the environmental sustainability in the island by practicing vertical gardening as a manufacturing process using the drip irrigation system and the organic fertilizers. We have explained this highly fragmented and specified proposal so far in our report so I won’t be mentioning more about it here. Based on the current situation in the Catalina Island, we think that Wrigley Institute can really take its advantage if they choose to pursue our proposal in the real cultivation. First of all, vertical gardening is by far such a promising technology, which allows us to be able to cultivate fairly large amount of crops in a limited square feet land because we don’t need to grow crops on the ground. Instead, we’re staking them up vertically on the wall or any other forms of supporting devices. In this sense, this technology is highly recommended for individuals who own their own farm as a sustainable life. In this era of sustainability and environmental friendliness, vertical gardening has its own competitive advantage in many sectors of the world. Not only for its sustainability, but also for its compatibility with the other agricultural technologies such as drip irrigation system, vertical gardening is very well applicable. Drip irrigation system is the one we use to irrigate the plants with dripping system. It is also a very unique irrigation technique compared to other conventional ones such as spraying or sprinkler types of irrigation. This system greatly enhances the flaws of the conventional one. With the help of its direct dripping system, we can now save the water amount that used to be wasted due to its spraying or sprinkler system. Once you get to the root zone directly, there’s no reason to waste the water on the outer part. Likewise, our proposal is geared toward people who seek something slightly different from the conventional techniques. Vertical gardening method can support people who are willing to make their own garden in the limited space of land. This technique, along with the drip irrigation system can truly change the way people are farming their own crops. Especially in Wrigley Institute of Catalina Island, it is applicable system because of its limited farming spaces and for its pursuit of sustainable food sources. The use of vertical gardening system will surely provide the institute with sustainability not only for the food source, but also for its environment nearby.

**Manufacturing process**

Neither the vertical garden nor the drip irrigation system are revolutionary technologies. Both have been available for decades and have been applied in many settings beyond just urban and industrial scale. Individuals can implement these methods on a small scale with a relatively low learning curve. However, the success of these technologies varies depending on execution and maintenance.

In order for Wrigley Institute to maximize their ability to use these technologies, they need to approach farming as a manufacturing and scientific process. Taking a technical and analytical approach will allow them to maximize their useful output and minimize time, labor, and material waste. To do so, Wrigley Institute must view vertical farming as a manufacturing process.

There are four basic components to any gardening cycle: planting, trimming, pest control and maintenance, and harvesting. Vertical gardening uses the same principles as traditional gardening; it is only different in its utilization of vertical space and structure. Therefore, it the same problems facing traditional gardens will also affect vertical gardens. For most farmers, the biggest problems that arise come from a lack of planning. Without a plan, the vertical gardens will most likely be inefficient and fail to maximize its main advantage of space efficiency.

The first recommendation for Wrigley Institute is to develop a plan with a purpose for their garden. Ultimately, Wrigley Institute is using this vertical garden to create a sustainable source of food. In order for the system to be sustainable, it needs to be efficient, and its overall comparative advantage must outweigh any costs. The best way to maximize these advantages while minimizing the costs is to approach the vertical garden as a production line.

**Henry Ford and the Assembly Line**

Henry Ford is considered the father of scientific management because of the revolutionary developments he made in the industrial manufacturing process through assembly lines. Initially, the manufacturing of automobiles was extremely costly and time consuming. Each car was individually assembled by a group of skilled workers one at a time. Ford needed to minimize costs and maximize efficiency if he wanted to mass produce automobiles. To do so, he brought in Frederick Winslow Taylor for management and had Taylor observe the workers and factory conditions to determine any changes that could be made to make the process more efficient and time-saving. Taylor understood that workers were most productive when they were given tasks that matched their individuals strengths and capabilities [11].

Another revolutionary implementation designed under Ford was the assembly line. Realizing the growing competition and industrial capitalization, Ford understood that he needed to make his processes more efficient and less costly if he wanted his company to succeed. To do so, he decided to decentralize his company and create 6 designated factories, each designed to produce a specific assembly part. These factories were located in areas that would allow them to maximize their natural resources. For example, Ford made sure that each factory would make maximum use of all nearby rivers in an effort to drive his plants using hydropower. Ford understood his available resources and looked to maximize their usefulness [12]. This production approach allowed Ford to produce for the masses and is still being implemented today. Wrigley Institute can reap the same productive advantages if they design their vertical gardens with the same production mentality as Ford.

**Production Overview**

When creating a plan for the production process, Wrigley first needs to outline the potential problems it may encounter. As the garden grows in size and diversity, the number of potential problems only compound because the number of processes occurring in the gardens is increasing. Therefore, the best way to implement a production-type garden is to start small. Wrigley needs to prioritize efficiency and relative output over size.

If Wrigley Institute designs its vertical gardens as a production line, everything from planting to maintenance to harvesting needs to be calculated and mathematically organized. The requirements for each crop in terms of space, cost, maintenance time, and value need to be determined and compared amongst each other to determine which crops they need most.

**Nutritional Value**

Wrigley Institute hosts 80 to 100 individuals at any given time. These individuals those residing at the institute as well as guests. The average daily caloric consumption for each person is 2,500 calories. In terms of macronutrients, an individual consumes, on average, approximately 76.5 grams of fat, 344 grams of carbohydrates, 172.5 grams of protein, and 35 grams of fiber. These numbers will fluctuate depending on an individual’s physique and physical activity as well as personal eating habits; however, these numbers reflect an average understanding of what an average person requires. Research has shown that the quality and ratio of macronutrients are much more important in determining the health and longevity of any individual. It is important to not only consume the proper amounts of fats, proteins, and carbohydrates, but also to ensure that these macronutrients are from high quality sources. Likewise, meeting caloric needs is important, but the quality of the consumed calories is even more important. For example, fatty acids are the most energy dense macronutrient. However, depending on the type of fat, the way it is metabolized and its resulting health effects will ultimately differ [13]**.**  An individual may consume the appropriate number of calories for his or her physique and physical activity level; however, these calories may be from food sources that do not provide adequate macronutrients levels or proper ratios between macronutrients [14]**.** If Wrigley Institute wishes to truly promote sustainability, then it must understand the nutritional needs behind sustainable meals, and, more fundamentally, the necessary crops to grow.

**Crop Selection**

One of the considerations for Wrigley Institute in their crop selection should be nutritional value. Planting crops with high protein, vitamin, and mineral content should be prioritized. Most crops will have a significant amount of carbohydrates and fiber, therefore protein, vitamin, and mineral content become distinguishing factors.

The June 2017 data for food shipment displayed a total cost of $16,364.97 and a net weight of 6,889.33 lbs (these totals have been adjusted to remove any costs associated with non-food items like utensils and kitchen appliances). Furthermore, the weight and cost of meat from the June total amounted to 691.30 pounds and $2,507.33 [15]. This means that meat accounted for 10.03% of the total weight and 36.39% of the total cost. Planting crops with high protein content can help offset the cost and weight of shipments by reducing the need for meat items.

Another consideration for crop efficiency is determining which crops have the most flexibility as an ingredient. Certain ingredients have limited flexibility in meals and can therefore be regarded as inefficient. Staple ingredients like sweet onions and potatoes should be prioritized because they can be used in a wide variety of dishes across multiple cuisines in addition to their nutritional value.

**Soil Conditions and Space Requirement**

In addition to nutritional value, Wrigley Institute needs to consider the soil conditions required for their selected crops. Crops have varying soil needs that change in regards to pH, soil type, fertilizer type, and water levels in order to maximize their growth potential. One of the benefits of vertical gardenings is that it allows the user to create multiple soil conditions. However, as mentioned earlier, the initial key for a vertical garden’s success is to start small and to keep the gardening process as simple and effective as possible. Maintaining different soil conditions complicates the process, and therefore it is better to choose crops that overlap in regards to necessary soil conditions. Once the initial types of soil condition are optimized, Wrigley institute can then proceed to diversify the types of soil conditions in its vertical gardens.

**Scientific Method**

Planning is necessary to implement a successful vertical garden. However, the production mentality needs to extend much further beyond the initial planning. As mentioned earlier, Henry Ford hired managerial expertise in Frederick Winslow Taylor in order to detect inefficiencies and make strategically efficient adjustments in his production process. In pursuing this, it is recommended that Wrigley Institute take the scientific method approach to gardening. The scientific method has six steps: make an observation, form a question, form a hypothesis, conduct an experiment to test the formulated hypothesis, analyze the data and draw a conclusion, and revise the hypothesis for any corrections. Gardening is an experimental process. Wrigley Institute needs to actively observe its crops and record factors like growth rates depending on watering frequencies or amounts. Other factors include amount of sun exposure, actual output compared to expected amounts, plant responses to different fertilizers, plants susceptibility to pests, seed treatment, and germination period [16]. Those maintaining the gardens at the Wrigley Institute need to approach the garden scientifically and conduct multiple tests to determine which processes are most efficient.

**Importance of Starting Small**

These multiple factors to observe and test highlight the importance of starting small. Trying to test and observe multiple crop species across a large space will prove to be challenging and overwhelming. Wrigley Institute first needs to be able to maximize the efficiency of its initially selected crops by putting them through multiple trials of the scientific method. Only after doing so can it choose to expand its garden and diversify its content.

**Harvesting Periods**

Another important consideration for the Wrigley Institute in its manufacturing approach is the harvesting period. Each crop will have different germination periods and expected harvesting days. Wrigley Institute needs to establish a timetable to determine how long it takes for its selected crops to go from being planted to being ready for harvesting. This way, Wrigley Institute will know how much time is needed to space out its planting to ensure that there will be vegetables available for daily use. If they do not manage this schedule properly, they will have a surplus of harvested crops for certain days and lack of ingredients on other days. This inconsistency will create waste from unused ingredients as well as a lack of available ingredients for meals on certain days. USC Wrigley Institute should track the cycles for each crop and learn how to develop a planting and harvesting time table that will allow for enough ingredients to be available on a daily basis.

**Changing “Meatless Mondays”**

It is not likely that planting crops with high protein content will be sufficient in significantly reducing the amount of meat products shipped to the Wrigley Institute. In the presentation by Wrigley Institute, the idea of “Meatless Mondays” was introduced [17]. The basic notion was that Wrigley Institute could forego meat for a certain day of the week in order to reduce meat and its associated cost, weight, and carbon footprint. However, while the idea of reducing meat from meals is positive, its execution under the label of “Meatless Mondays” may undermine its value.

The consumption of meat raises ethical concerns regarding sustainability because of the massive carbon footprint it leaves. It is becoming environmentally necessary to reduce meat consumption, which will help counter biodiversity loss and climate change in developed and transitioning countries. This issue gradually becomes more and more relevant as the world’s global population continues to rise, which means that there will be more consumers, a greater demand for meat, and ultimately a greater production of meat.

The production of meat has a significant negative impact on the global environment. 70% of the world’s deforestation is due to land being stripped in order to grow animal feed. This deforestation results in a huge degradation of biodiversity. Furthermore, approximately 14.5% of global anthropogenic greenhouse gas emissions are calculated to be the result of livestock farming, specifically industrial. Empirical research has provided substantial evidence that the consumption and production of meat is not a sustainable practice, especially on the industrial scale it is being implemented on today. Despite these scientific findings, there is a difficulty to translate these concerns to mainstream society, and this is because of the existing social norm surrounding meat [18].

The biggest issue with Wrigley Institute’s plan of “Meatless Mondays” is the fact that it invokes the negative stigma towards vegetarians or vegans, the former referring to those who do not consume meat and the latter referring to those who do not consume any animal product. A vegetarian would not eat meat, but would still eat eggs and dairy products; however, a vegan would not eat anything that requires an animal to produce. In the United States, there is a meat-centric culture that has historical roots in the agricultural history as early as the “American West.” Due to historical prominence and industrial influence, consumers have a positive association between the production and consumption of meat. Consuming meat carries symbolic significance. In American society, consuming meat has come to represent “rugged masculinity, virility, and mastery of nature.” On the contrary, vegetarianism and veganism, which fundamentally reject meat consumption, are thereby un-patriotic, effeminate, and even un-Christian to some. Consequently, there is a clear negative stigma associated with the idea of not consuming meat [19]. Ultimately, not consuming meat is against cultural and social norms. Therefore, imposing the label “Meatless Mondays” puts consumers in a position to consciously reject meat consumption.

One of the suggestions to combat this stigma is education. Educating the public about the problems surrounding meat consumption and creating transparency regarding the environmental concerns it is raising is an important step to reduce this stigma. One approach has combined education with celebrity awareness using Arnold Schwarzenegger to reduce meat consumption in China. China accounts for half of the global consumption of pork and marks an important area of environmental concern. Li Junfeng, director general of the climate change center, believes that climate change fundamentally requires the involvement of the general public to make meaningful change. For this to happen, Junfeng states that every individual needs to believe in the low-carbon concept and adapt to it [20]. Using a celebrity figure helps communicate this message. Furthermore, a figure like Arnold Schwarzenegger, who is considered the greatest bodybuilder, can simultaneously tackle the stigmas attached to meat consumption. Ultimately, education is an important step for the Wrigley Institute to implement rather than simply imposing a “Meatless Monday.”

Even in psychology, positive punishment has shown to be much more effective. Instead of taking something away from an individual, positive punishment advocates that an unfavorable outcome should be presented in order to decrease an undesirable behavior [21]. In this case, rather than taking away meat as an option, the Wrigley Institute should communicate the unfavorable environmental conditions that result from meat consumption to decrease its behavior.

Furthermore, instead of implementing a specific day without meat, the Wrigley Institute should simply add more meals that do not include meat. Many cuisines throughout the world do not use meat in their dishes simply because of the lack of availability. Adding equally tasty meals that do not include meat can be a more natural way to reduce meat consumption. Many cuisines have meatless dishes without the added intention of not consuming meat; for these cultures. Currently, there is a trend of replicating meals with meat substitutes; consumers are trying to recreate dishes that are not fundamentally vegan or vegetarian by nature, and therefore create a negative association with the taste of vegan or vegetarian food. For example, trying to reproduce a hamburger without its key component of the beef patty is an overwhelming task. Instead of doing something counterintuitive, it would be much more effective to offer an entirely different dish that is not normally made with meat. Looking towards other cultures like foods from Asian cuisine will provide much more variety. Furthermore, these cuisines will diversify the way Wrigley Institute understands food and how to minimize waste. For example, many cuisines use the roots of vegetables and the bones of animals to create a more flavorful stock rather than throwing them away. The roots and bones hold high nutritional value and are put to edible use rather than being immediately discarded.

**Future Prospect of Vertical Gardening**

The main reason for our proposal is to help the institute manage their food sustainability in the island given their limited land space and the budget. Vertical gardening is not some revolutionary technology and it is expected that the Wrigley Institute will already possess some knowledge of this system. However, our recommendation is for the Wrigley Institute to take a manufacturing approach when implementing its vertical gardens. The level of success for any vertical garden depends on the amount of planning and maintenance invested into it. Furthermore, there needs to be a demand for efficiency. Everything needs to be observed, analyzed, and revised to optimize its production capabilities. Creating an efficient garden is only possible if the Wrigley Institute understands and identifies the individual components of garden and works on maximizing its benefits while minimizing costs.

Throughout the world, major urban cities like Mexico City, Mexico have already implemented vertical gardens. As the vertical garden is scaled across a larger area, the importance of efficiency only compounds. Inefficiencies that may be overlooked in smaller gardens can become financial disasters if they exist on large vertical gardens. Establishing a purpose for a vertical garden and properly planning ahead are essential for successful implementation. Minimizing costs and maximizing the benefits of vertical gardens are important if they are to be realistically implemented in urban planning and landscaping.

**Work Cited**

[1] “A Brief History of Vertical Gardening.” Internet: <http://www.vertigro.co.uk/wp-content/uploads/GrowingUp.pdf> [Nov 3, 2017].

[2] “Types of Vertical Gardens – 14 You Can Make or Buy.” Internet: http://easyverticalgardening.com/types-of-vertical-gardens/ <http://easyverticalgardening.com/types-of-vertical-gardens/>[Nov 1, 2017].

[3] C.L. Wassenburg, M.A. Goldenberg, & et al. (2005, Jul.). “Benefits of botanical garden visitation: A means-end study.” Urban Forestry & Urban Greening [Online]. 14(1), pp. 148-155. Available: <https://www.sciencedirect.com/science/article/pii/S1618866715000035> [Nov, 10, 2017].

[4] “Mental Health & Function.” Internet: <https://depts.washington.edu/hhwb/Thm_Mental.html> [Nov 16, 2017].

[5] Netburn, D. “L.A.’s mayor wants to lower the city’s temperature. These scientists are figuring out how to do it,” Los Angeles Times: Projects, p. 7, Feb. 9, 2017.

[6] “Civic Center Edible Garden Project.” Internet: <http://www.longbeach.gov/sustainability/programs/edible-garden/> [Nov 3, 2017].

[7] Ross, O. “The vertical gardens of Mexico City,” Toronto Star: World, p. 10, Apr. 13, 2012.

[8] Lo, D. “Mexico City’s Vertical Gardens Clear the Air,” Food & Wine: Travel, p. 15, Sept. 1, 2016.

[9] “Effectively Integrating Drip Irrigation & Fertigation into Growing Operations” Internet: http://www.gardenandgreenhouse.net/articles/july-2017/effectively-integrating-drip-irrigation-fertigation-growing-operations/

[10] “Drip Irrigation Design Guidelines.” Internet: https://www.irrigationtutorials.com/drip-irrigation-design-guidelines-basics-of-measurements-parts-and-more/

[11] “Scientific Management Theory and the Ford Motor Company.” Internet: <https://www.saylor.org/site>/wp-content/uploads/2013/08/Saylor.orgs-Scientific-Management-Theory-and-the-Ford-Motor-Company.pdf, Aug. 2013 [Nov. 1, 2017].

[12] J. R. Mullin. (1982). “Henry Ford and Field and Factory: An Analysis of the Ford Sponsored Village Industries - Experiment in Michigan, 1918-1941.” Journal of the American Planning Association [Online]. 41. Available: <http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1040&context=larp_faculty_pubs> [Nov. 5, 2017].

[13] A. Andersson & S. Bryngelsson. (2007, Mar.). “Towards a healthy diet: from nutrition recommendations to dietary advice.” Scandinavian Journal of Food & Nutrition [Online]. 51(1), pp. 31-40. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2606986/> [Nov. 5, 2017].

[14] S. M. Solon-Biet, A. C. McMahon & et. al. (2014, Mar.). “The Ratio of Macronutrients, Not Caloric Intake, Dictates Cardiometabolic Health, Aging, and Longevity in Ad Libitum-Fed Mice.” Cell Metabolism [Online]. 19(3), pp. 418-430. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5087279/> [Nov. 12, 2017].

[15] S. Conner. “RE: WRIT 340: USC Wrigley Institute Questions” Personal E-mail (Nov. 20, 2017).

[16] California School Garden Network. “Scientific Method.” Internet: <http://www.mastergardenerssandiego.org/schools/gardenbook/curriculum/scientific_method.html> [Nov. 15, 2017].

[17] In-class Presentation, Topic: “USC Wrigley Marine Science Center on Catalina Island: The Good Pipeline.” GFS 205, University of Southern California, Los Angeles, California, Oct. 17, 2017.

[18] A. Stoll-Kleemann & U. J. Schmidt. (2016, Oct.). “Reducing meat consumption in developed and transition countries to counter climate change and biodiversity loss: a review of influence factors.” Regional Environmental Change [Online]. 17(5), pp. 1261-1277. Available: <https://link.springer.com/article/10.1007/s10113-016-1057-5> [Nov. 8, 2017].

[19] A. Lindquist. “Beyond Hippies and Rabbit Food: The Social Effects of Vegetarianism and Veganism.” Internet: <http://soundideas.pugetsound.edu/cgi/viewcontent.cgi?article=1004&context=csoc_theses>, 2013 [Nov. 8, 2017].

[20] A. Aubrey. “Can Arnold Schwarzenegger Persuade China to Eat Less Meat?.” Internet: <https://www.npr.org/sections/thesalt/2016/06/24/483407108/can-arnold-schwarzenegger-persuade-china-to-eat-less-meat>, Jun. 24, 2016 [Nov. 8, 2017].

[21] North Shore Pediatric Therapy. “What’s the Difference Between Positive and Negative Punishment?” Internet: <https://nspt4kids.com/parenting/the-difference-between-positive-and-negative-punishment/> Jan. 4, 2012 [Nov. 8, 2017].