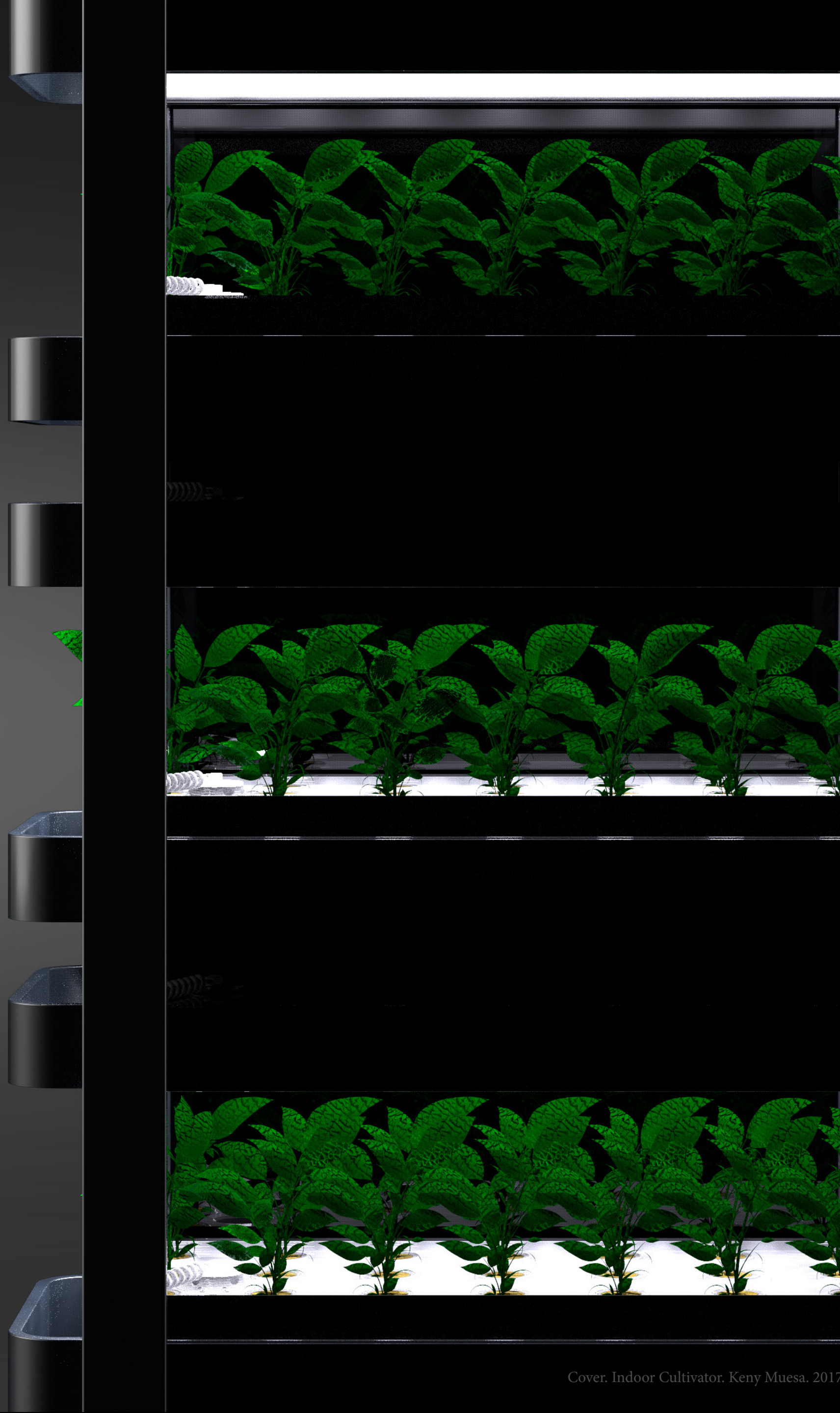


Restaurant Cultivator
Concept of a Restaurant Operated Indoor Garden
Industrial Design Thesis 2017

Lahti University of Applied Sciences

Institute of Design and Fine Arts

Keny Luca Muesa Martin



Abstract

This project began in November 2016 by approaching Plantui Oy about a possible subject of my thesis. I met with the company's Chief Technology Manager and we discussed the potential subject of the project. It was agreed, that I would propose a subject of my own interest, taking into account a desire from the company to have the final concept in English.

I wanted to create something new and significant that would, at the same time, serve the best interests of Plantui Oy. I researched the topic by identifying the current and future trends from a strategic perspective. After reviewing hydroponic gardens and determining the competing manufacturers, I discovered the market being full of products for domestic use. Restaurants and other users with a need for larger capacity were almost completely ignored.

Restaurants have always adapted to the current trends. The Endurance Crisis mentioned in the 2016 Finnish *Sitra Megatrend listing* does not make any exceptions, as the leading restaurants are constantly striving to act more responsibly and to educate by example. (www.sitra.fi) According to the world's top chefs, the main factors affecting the restaurant world in 2017 are reducing waste and strengthening sustainable development. (www.edition.cnn.com)

Based on my observations, I came up with a concept of a hydroponic garden for professional use. By modifying Plantui's existing technology, I perceived a functional concept of a restaurant based indoor garden. The company's Chief Technology Manager approved of my topic, as it was in accord with their ongoing product development and with their visions for the future.

Keywords: hydroponic gardening, self-sufficiency, indoor garden

Tiivistelmä

Projektini alkoi marraskuussa 2016 lähestymällä Plantui Oy:tä opinnäytetyön mahdollisuudesta. Tapasin Plantui Oy:n teknologiajohtajan, jonka kanssa keskustelimme mahdollisesta aiheesta ja sovimme, että ehdotan heille mielestäni sopivaa aihetta. Plantui Oy:n toivomuksena oli saada lopullinen konsepti englanninkielisenä.

Tavoitteenani oli luoda jotakin uutta ja merkittävää, mikä palvelisi samalla myös Plantui Oy:n etua. Aloitin varsinaisen aiheen etsimisen kartoittamalla alan nykyisiä ja tulevia trendejä lähinnä strategisesta näkökulmasta. Tarkasteltuani erilaisia hydroponisia puutarhoja ja määrittäessäni kilpailevia valmistajia, huomasin markkinoilta löytyvän monipuolista tarjontaa kotikeittiöiden tarpeisiin. Yllätyin kuitenkin havaitessani, kuinka ravintolat ja muut suuremman kapasiteetin tekijät, kuten suurkeittiöt, oli jätetty lähes kaikkien yritysten tuotevalikoimissa kokonaan huomiotta.

Ravintolat ovat aina mukautuneet ajan trendeihin ja omalta osaltaan myös luoneet niitä, eikä suomalaisessa *Sitra 2016* -megatrendilistassa mainittu kestävyyskriisi näytä olevan poikkeus tässäkään suhteessa. (<https://www.sitra.fi>) Johtavat ravintolat pyrkivät jatkuvasti toimimaan vastuullisemmin ja ohjaamaan muita omalla esimerkillään. Vuoden 2017 ravintolamaailman trendejä ja vaikuttavia tekijöitä ovat maailman huippukokkien mukaan muun muassa kestävä kehitys sekä hävikin minimointi. (<http://edition.cnn.com>)

Tekemieni havaintojen perusteella ehdotin Plantui Oy:lle opinnäytetyöni aiheeksi konseptia ravintolakäyttöisestä hydroponisesta puutarhasta. Muokkaamalla heidän jo olemassa olevaa teknologiaansa uuteen muotoon olisi mahdollista saavuttaa toimiva konsepti ravintolan sisätiloihin sijoitettavasta puutarhasta. Plantui Oy:n teknologiajohtaja hyväksyi esittämäni aiheen, sillä se oli linjassa yrityksen omien tulevaisuudensuunnitelmien ja käynnissä olevan tuotekehityksen kanssa.

Avainsanat: hydroviljely, omavaraisuus, sisäpuutarha

Content

1.	<i>Introduction</i>	6.	<i>Creative process</i>	8.	<i>Evaluation</i>
2.	<i>Plantui OY</i>	6.1.	Objective	8.1.	Product
3.	<i>Design brief</i>	6.2.	Idiom	8.2.	Further development
4.	<i>Restaurant currently</i>	6.3.	Material requirements		
4.1.	Farm-to-table-movement	6.4.	Dimensions		
4.2.	Restaurant cultivation	6.5.	Ideation		<i>Reference list</i>
4.3.	Restaurant cultivation today	6.6.	Gardening units		Printed references
4.4.	Benefits of self-sufficient food production	6.7.	Technical solutions		Internet references
5.	<i>Requirements for a restaurant operated indoor garden</i>	6.8.	Shelving system		Picture references
5.1.	Laws and regulations	7.	<i>Final product</i>		
5.2.	Hydroponic gardening	7.1.	Indoor Cultivator		
5.3.	Prerequisites for growth	7.2.	Main components		
5.4.	Productiveness	7.3.	Light unit		
5.5.	Development needs	7.4.	Growing unit		
		7.5.	Shelving system		
		7.6.	Usability		
		7.7.	Product images		
		7.8.	Measurements		

1. Introduction

The purpose of this thesis is to explain the history of restaurant cultivation and to investigate the reasons behind it. The work was carried out in two stages. The first section familiarizes the reader with factors associated with restaurant cultivation and the influential phenomena behind it. The first section also elaborates extensively the challenges and difficulties that restaurants encounter in self-sufficient food production. The purpose of this section is to explain the different stages and minimum requirements for a restaurant operated indoor garden from the viewpoints of the user, as well as the legal and operational dimensions.

In the second section I present my own insights about a restaurant operated indoor garden through a product development process, where I focus on the main issues affecting its development. I am providing a modern solution with the product concept of a hydroponic garden to solve the problems emerged during the research and also to confront the recent development and the needs of restaurant cultivation. By describing the process, I seek to clarify the benefits of the modular design and the new opportunities it presents in the world of restaurant cultivation. The final product was actualized based on Plantui Oy's flagship model *Plantui 6 Smart Garden*.

I designed a concept that strives to solve the current challenges of the restaurants' indoor cultivation. The final product of the concept consists of several individual farming units, that can be loaded into a shelf unit with a desired quantity of Plantui Plant Capsules. The multilevel hydroponic garden unit guarantees rapid and cost-efficient results.

2. Plantui Oy

The mandator of the project is Plantui Oy, a Finnish Design and Food Tech company, that specializes on hydroponic indoor gardens. The company was formally established in 2012, but the idea behind the company was born in 2007 of their former designer, Janne Loiske.

They have created a fully automated Smart Garden, which ensures the user a successful and easy gardening experience. Plantui Oy has excellently managed to connect the dots between design and food tech, and their flagship product *Plantui 6 Smart Garden* platform was awarded with the *Red Dot Product Design Award* in 2015.

Since 2015, Plantui Oy has been globally expanding its business and building a wider sales network. They have two different Smart Garden Platforms, and they are constantly widening their line of product accessories and the Plantui Plant Capsule selection. They are also focusing in developing their product range further to conquer new areas, such as restaurants.

Plantui's vision builds up on three major global trends: urbanization, cooking & local food and health & wellbeing. Plantui believes that in the future greens will be grown near to where they are consumed – at homes, offices and local restaurants. (www.plantui.com)



IMAGE 6. Plantui Smart Garden. Plantui Oy. 2017

3. Design brief

The definitive product to be designed is a hydroponic garden suitable for restaurant use.

The design work includes a research about restaurant cultivation, hydroponic gardens and subjects related to the topic. After the research the work continues studying and scaling Plantui's current technology. The key factors detected in the research and ideation process are developed as one final concept.

The objective of the work is to design a hydroponic garden that is appropriate for Plantui's product portfolio and for professional use. The product is to be used and located either in kitchen or customer premises. The product appearance should reflect Plantui's essential freshness and functionality. The ultimate product must be used easily and effortlessly. An important starting point is the usability of the product – the harvesting must be able to produce crops in the three different growing stages.

The products target groups are restaurants and cocktail bars.



IMAGE 7. Plantui Smart Garden. Plantui Oy. 2017

4. Restaurants currently

The restaurants have been following customers' demands since the earliest civilizations, and the growth of the restaurants correlates with the growth of the cities. In the Ancient Roman Empire, there were small food establishments, tabernas, offering both food and drinks to their customers. (Cornell & Lomas, 1996, 46) The tabernas were often located next to the well-known routes serving the travelling people.

Trough the expanding and assimilation of the diverse Ancient Empires, among others, the restaurants spread around the globe, adapting to their new locations. (<https://www.thebalance.com>) The modern restaurant, as we know it today, was born in Paris in the 18th century. After the French Revolution, due to the people's insistence, the new restaurants compensated for the crowded, noisy and dirty taverns. (www.mtholyoke.edu)

However, from the ancient times to modern restaurants, the idea has remained the same. Eating out is considered as an important event where people socialize and savor the local delicacies. (<http://www.foodtimeline.org>)

However, serving local food with traditional recipes is just not enough with the intensifying globalization. It has given rise to a big change among the restaurants, as well as in the extensive exportation of products, ideas and other aspects of culture. (<http://smallbusiness.chron.com>)

The globalization has permitted the restaurants to serve exotic foods, and also to tender out their ingredient suppliers from further than before. This is where most of the problems begin. When a customer orders a typical seasonal plate of the area in a local restaurant, the ingredients might be produced and delivered from the other side of the world. (Nuetzenadel, 2008, 130)

The main reason to provoke and raise the Farm-to-table movement was an urge to serve the freshest food possible. It was established to ensure that the local food is actually made with seasonal ingredients produced by local farmers. (Benjamin & Virkler, 2016, 81)

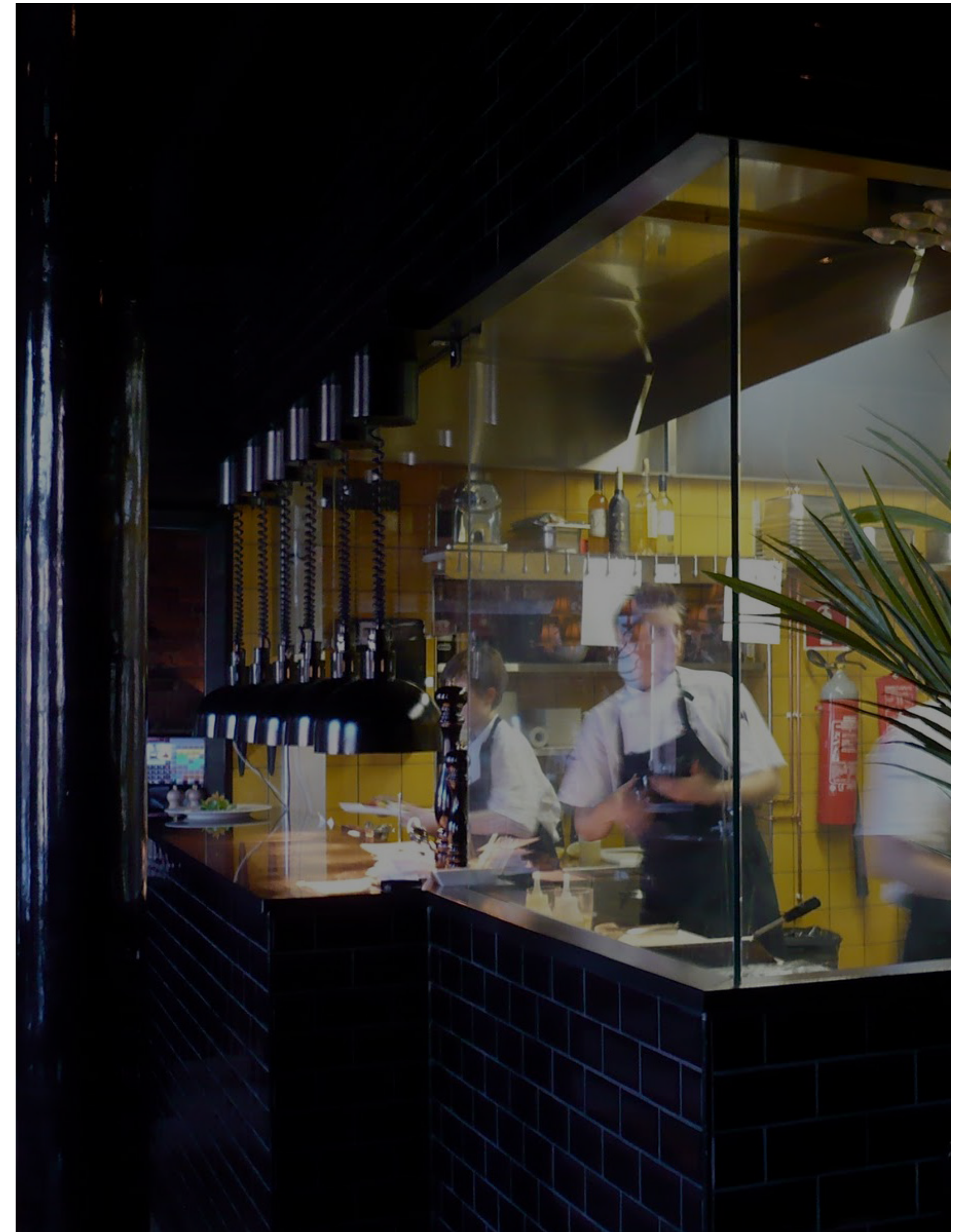


IMAGE 8. Kitchen. Paula Hietaranta. 2011

4.1. Farm-to-table movement

The *Farm-to-table* phenomenon started in California in the early 2000's. It was a social movement promoting fresh and local food in restaurants and school cafes. The basic idea behind the movement was to cut corners and acquire all the food straight from the producers, by establishing direct sales relationships. (Benjamin & Virkler, 2016, 90)

The influential factor was the thought and focus behind the movement – to really know where your food comes from. The traceability of the food was a spark for many restaurants to join the movement. It forced the restaurants to think and to take their motivations further by serving their customers fresh, healthy and local food ingredients, focusing on the safeness of the food. (<http://www.sustainabletable.org>) Since the beginning of the movement, it has given the restaurants the power of identifying and promoting the origin of the food to their customers.

Even with the honorable origin of the *Farm-to-Table* movement, it raised and enabled some problems after becoming more mainstream. Restaurants felt obligated to join the movement in order to maintain their business. As expected, some restaurateurs sighted an opportunity to twist and exploit the good intentions of the movement. They took advantage of the beliefs and allegiance of the customers by falsely advertising the origin of their food. (<http://www.saveur.com>) In some occasions, the restaurants got caught of falsely claiming that the ingredients were grown by the local farmers – even when the supposed ingredient was out of season or it had not been provided in the area at all. Some of the restaurateurs admitted fooling the customers by twisting the truth about the origin of the ingredients, because of the difficulties in getting fresh ingredients for the popular dishes. (<http://www.vanityfair.com>)

These frauds clearly affected the credibility and trustworthiness of the movement. It lead some restaurants to take their actions further, to gain back the trust and believe of their customers. Some of the most visionary restaurants behind the *Farm-to-Table* movement wanted to correct the occurred, and started *On-Site Farming*. It was also known as in-house farming, as a counterweight for the malpractice occurred on the farm-to-table movement's expense. (<http://www.farmxchange.org>) This allowed the restaurants a better respond to their customer's demands and concerns about the origin of the greens used. The restaurants growing their own food are now frequently called *garden-to-table* restaurants – the food comes straight from the garden to the customer's plate, sometimes in just a few minutes. (<http://www.ahealthiermichigan.org>)



4.2. Restaurant cultivation



IMAGE 10. Chefs in Garden. The Brit. 2016

For the restaurants located in urban surroundings, gardening is not always easy or even possible. Allotment gardens are usually located on the outskirts of the cities, making the transporting and refilling of the stock extremely challenging. This problem led to the so-called *Roof-to-Table* movement, invented by some of the most trendsetting restaurants. The actions of these restaurants really made an impact – the rooftop gardens attract customers to eat and to see how the served food is actually grown. The rooftop garden is a clever and a potential solution for some restaurants, but unfortunately, like the allotment gardening, it is only suitable for a small percentage of them. (<http://openforbusiness.opentable.com>)

For the majority of city-based restaurants, it is very difficult to establish rooftop gardens due to the inequality of urban areas. There are many perpetrators affecting the possibilities: construction permits, building acts and other similar laws and jurisdictions. Another key factor in lowering the possibilities is the climate. It restrains most of the restaurants from harvesting their own herbs and salads during other than the summer season. With the current rooftop gardening methods, most of the restaurants are only able to get seasonable benefits, yet still having to pay and maintain the rooftop garden area during the whole year. This is a major disadvantage that holds up for many restaurants from joining the movement and pursuing a full, or even a partly self-sufficient future. (<http://www.cityfarmer.org>)

Even though the Farm-to-Table movement brought the localness and freshness of the food back to the consciousness of the modern people and communities, it is an old phenomenon. Local food has been grown in city gardens since the first civilizations in the Middle East, where the small communities were mostly self-sufficient. The knowledge of cultivation expanded from the Middle East to the Mediterranean around 4800 BC from where it spread across Europe. (<http://www.localhistories.org>) City gardening has always experienced adversity and it has been affected by many factors, such as the beginning of industrialization in the 18th century. (<http://webs.bcp.org>)

As controversial as it is, the bad times have always increased the amount of gardening in the cities. For example, during the World Wars, city gardening had a big part in the sustenance of the food stocks. The wars pushed up the quantity of city gardening, but it was not the only composer. (<http://www.nationalww2museum.org>) The latest massive impact on city gardening was during the recession in the late 2000's and early 2010's. As mentioned before, during critical times people attend the traditional solutions and rely more on self-sufficiency – in the middle of difficulties lies the opportunity. (Waterford, 2015, 171)

4.3. Restaurant cultivation today

Fortunately, this time restaurant cultivation seems to have come back to stay. It remains a part of the future vision with its new solutions and multiple benefits. It could be a determinant factor on the current economic problem of the restaurants, bringing them long-term profitability in various ways. (Nordah, 2009, 50)

Since the beginning and spreading of the *Farm-to-Table* movement, the restaurants appear to be the leading visionaries, when talking about the city and rooftop gardening. A good example of a leading restaurant is Savoy in Helsinki, Finland. Since they started cultivating on their own rooftop garden in 2010, it has become an important part of their image and procedures. By cultivating their own food, Savoy wanted to take part on reducing the capital's carbon dioxide burden. They have a vision of being the forerunners of food producers in the city – leading and educating other restaurants to join the same path.

Savoy's garden has achieved acknowledgement from customers about the food's traceability, and about the journey of the food from the garden to the plate being really fast and short. (<http://www.ruokatieto.fi>) Regardless of the success and fame Savoy has had during these seven years of rooftop gardening, they have the same common problem with others. They can only benefit from their self-sufficiency during a short period of time, which means them having to rely on external suppliers for most of the year.

The world keeps urbanizing, so we need to be able to variegate and develop new ways of growing our food. Again, Savoy seems to be leading the Finnish restaurants in the right direction, and the restaurant's dedication to the matter has been globally noticed. The restaurant was contacted by the famous Mitsubishi Plant Factory spokesmen two years before their try-out started in December 2016. Savoy has placed the Mitsubishi Plant Factory's Plant growing System Solution in their hallway. Unfortunately, the herbs and salads grown in the indoor gardens can only be used for decorative purposes, because of the garden's limited capacity. (<http://www.hs.fi>)

This proves us the urge for indoor gardening. Now, when the technology around hydroponic gardening seems to have taken extremely progressive steps, it is time for it to be tamed by restaurants on a bigger scale. This way, the whole gardening process could be developed to be more effective and the outcome more efficient. It would also, without a doubt, have an influence on the customer's attitudes towards indoor hydroponic gardening, when the customers could see the true benefits of hydroponic gardening in a restaurant. This could have them considering gardening themselves and even buying hydroponic gardens directed to domestic use, such as Plantui's current models. Who knows, maybe hydroponic gardening will be next big movement, sparked by the current trends of raw food, organic, vegan and localness. Could *Hydroponic-to-Table* be the next leading trend for the restaurants?

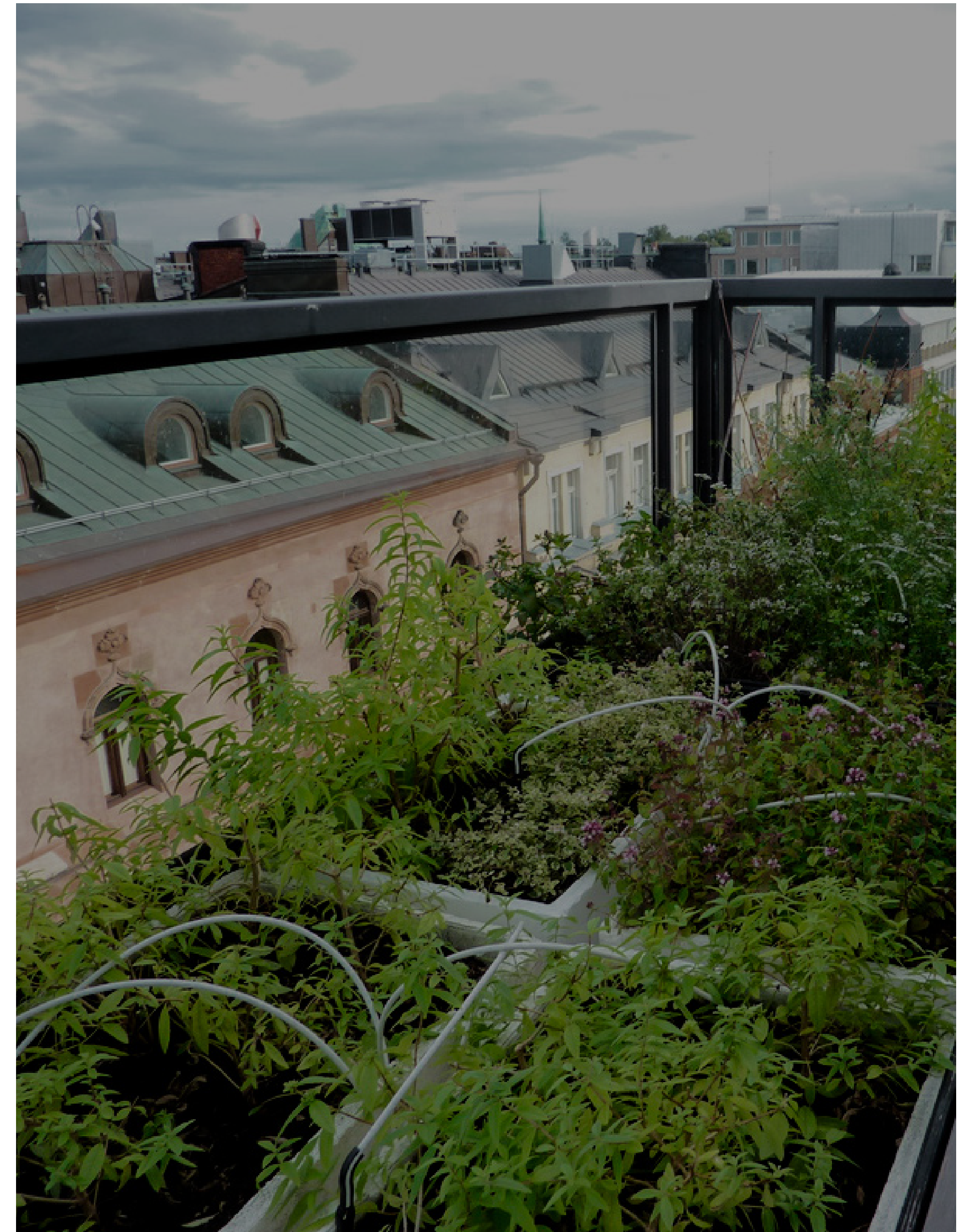


IMAGE 11. Resturant Savoy rooftop. Heikki Kähkönen. 2016

4.4. Benefits of self-sufficient food production

If the equipment manufacturers could offer the restaurateurs better solutions for indoor cultivation, the restaurants could aim to have at least a partially self-sufficient salad and herb stock. After the initial investment on the machinery, the restaurateurs would quickly feel the return as savings on their stock purchasing. In the end, growing their own herbs and salads would cost them less than having to buy them elsewhere and paying for the delivery. So, even though the initial investment is needed, indoor gardening would offer the restaurants a good economic and a conscious change in the long-term. Considering the above mentioned with many other factors and surprising reasons, it is evident that the restaurants should start using restaurant operated indoor gardens. (<http://www.farmxchange.org>)

The gardens are very aesthetic. The indoor gardens do not only create a calm and fresh ambience, but when located in the dining area, they can also be used as a part of the establishment's lighting entirety. The gardens provide fresh food, beautiful lighting and atmosphere, but there is more — when cultivating inside the restaurant, the plants can bring huge peripheral benefits in improving the indoor air conditions. And the plants do not only improve the quality of the air, but they also discourage the entry of insects to the restaurant, when planting herbs such as mint, close to the entrance and windows. (Sneller, 2010, 155)

If the indoor gardens are located in the walls, they can work as a soundproof by decreasing the echo in the hall and the noise of the customers' crosstalk.

The indoor gardens would not only look good from the inside, but they would also make a beautiful scenery to the street, providing the possible customers an attractive view. This enables the restaurants to utilize the indoor gardening even more in their (green) marketing: strengthening the brand, standing out and attracting positive reputation and prestige to their business. (<http://www.farmxchange.org>)

Many establishments and restaurants are forced to leave a part of the lights on during the night time – not only for the more attractive view, but also for burglary protection. The indoor garden's sleep timers could be adjusted to illuminate during the night time. This way the gardens would also decrease the restaurant's electricity costs, as no additional lighting would have to be left on.



Many times the whole restaurant depends on suppliers and wholesalers, who might not always be reliable or precise enough. This is one of the major benefits that the indoor gardens provide for the restaurateurs – more control over the quality of their herbs and salads, as they themselves are responsible of the whole process, from seeds to full-grown plants. This freedom allows them to schedule and calculate the time and estimate the quantity required. This gives them an easy and a cost-efficient way to access the rare, expensive and otherwise hard to find herbs and salads.

The ones that could have one the highest benefits of indoor gardening are the ethnic and culturally-specific restaurants. They might require and be dependent on plants that are not usually sold by the basic suppliers or wholesalers. The growing demand would allow Plantui Oy to expand the Plantui Plant Capsules™ selection for even more rare and elusive plants. Plantui Oy could also offer empty capsules from the Plantui Experimental Kit for the restaurateurs who are striving to stand out and achieve even more flexibility on their menus. Since many of the rarest seeds can be easily bought from the internet, these experimenters could help in exploring how these plants grow in the indoor hydroponic gardens. This way the restaurateurs would have unlimited possibilities to grow whatever greens they need.

Nowadays people are extremely conscious and they want to know where their food actually comes from. With the indoor gardens, the restaurants could please their customers, as they would see the whole process and have a visual certainty on what they are eating. Restaurant operated indoor gardens would not only help the restaurateurs and please the customers, but in a larger scale it would also help to fight the climate change and global warming. The use of these gardens would reduce the amount of carbon expended from shipping the greens from all over the world. By considering all these factors, the restaurants would not only improve their customers overall dining experience but also remarkably improve their own status.



IMAGE 13. Chef holding plants. Yrtti Ahlberg. 2017

5. *Requirements for a restaurant operated indoor garden*

In Finland, there is no specific legislation about the hydroponic gardening inside any food establishments. The food establishments, in this case, include all the buildings and premises, or parts of an outdoor or indoor space, in which food meant for sale or for conveyance is prepared, stored, transported, marketed, served or otherwise handled. (www.evira.fi)

It is mentioned in the Food Act legislation, that there are no required notifications for primary production of wild plants and mushrooms (352/2011-22 § 4 mom section 3, www.finlex.fi) It is therefore permitted, but it must not pose any risks to other activities in the food establishment. By the laws mentioned above, restaurants can start to cultivate and keep a self-sufficient stock without having to apply for any authorization.





IMAGE 15. Chef and wall garden. LiveWall. 2017

5.1. Laws and regulations

Even though there are no specific laws or regulations about hydroponic gardening inside the food establishments, there are some legislations and demands towards a primary production, that need to be taken into consideration.

In some cases, when harvesting in specific places, it needs to be reported to the Finnish Food Safety Authority. For example, the Finnish Ministry of Agriculture and Forestry has composed in the Food Act (23/2006, chapter 2, section 8) certain demands, in which it is noted that adding any vitamins, minerals or any other comparable substances with a nutritional or physiological effect to the food, is only permitted, if it does not present a hazard to human health.

A food business operator who prepares a foodstuff that falls within the scope of the Supplements Regulation, has such foodstuff prepared, or imports such foodstuff, shall notify the ministry.

This demand would concern the food establishments when using the Plantui's restaurant operated indoor garden, as it is intended to use the right number of additive nutrients to ensure the optimal growth of the plants. Food establishments would also have to retain different requirements in mind, when operating an indoor garden.

For example, in the General Hygiene Provision (852/2004, the annex 1.) and in the National Primary Production Regulation (1368/2011) is noted, that in the case of products of plant origin the food business operators are to ensure, as far as possible, that the primary products are protected against contamination, regarding any processing that the primary products will subsequently undergo.

The food business operators are also to comply with appropriate Community and National Legislative Provisions relating to the control of hazards in primary production and associated operations, including measures to control contamination arising from the air, soil, water, feed, fertilizers, plant protection products and biocides and the storage, handling and disposal of waste. (Official Journal of the European Union L 139 of 30, 25.6.2004, 10)

The food business operators producing or harvesting plant products are to take adequate measures, such as appropriate cleaning and, where necessary, disinfecting in an appropriate manner the facilities, equipment, containers, crates, vehicles and vessels. They need to ensure hygienic production, storage conditions and the cleanliness of the plant products. They are required to use potable water, or clean water, whenever necessary to prevent contamination.

It needs to be ensured that the staff handling foodstuffs are in good health and undergo training on health risks to prevent, for example, as far as possible, animals and pests from causing contamination. They are required to consider the results of any relevant analyses carried out on samples taken from plants or other samples, that have any importance to human health, and to use plant protection products and biocides correctly, as required by the relevant legislation. (Official Journal of the European Union L 139 of 30, 25.6.2004, page 10-11)

Food business operators are to keep and retain records relating to the measures put in place to control hazards in an appropriate manner and for an appropriate period, commensurate with the nature and size of the food business. Food business operators producing or harvesting plant products are to keep records on any use of plant protection products and biocides, any occurrence of pests or diseases that may affect the safety of the products of plant origin, and the results of any relevant analyses carried out on samples taken from plants, or other samples that have importance to human health.

The food business operators may be assisted by other persons, such as, agronomists and farm technicians, with the keeping of records. (Official Journal of the European Union L 139 of 30, 25.6.2004, page 11-12) The following of these regulations would allow Plantui Oy to offer additional services for the customers, as record keeping or maintenance, to gain more income and to keep the customers close and satisfied.

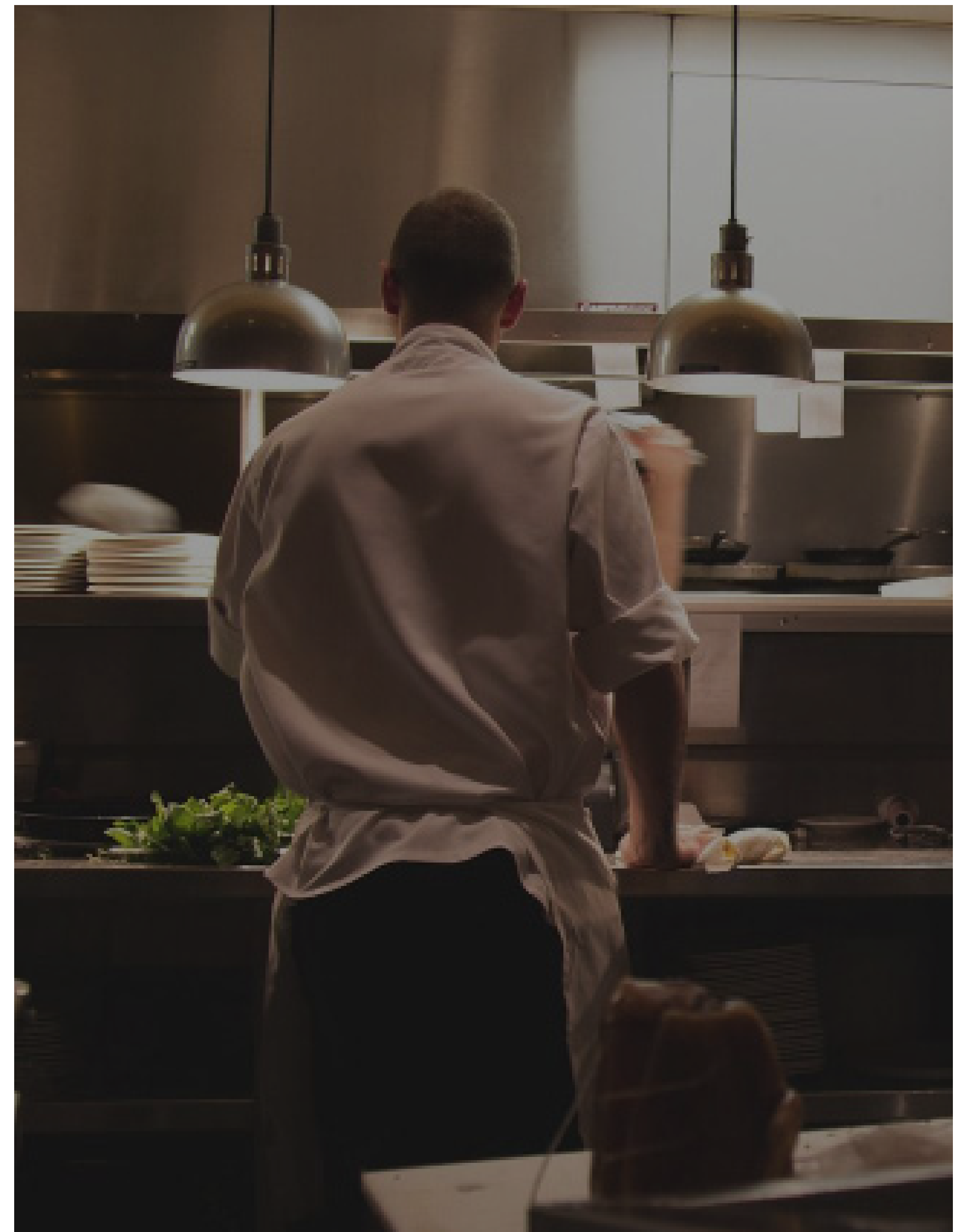


IMAGE 12. Chef cooking. Unknown. 2017

5.2. Hydroponic gardening

Most of the smart gardens in the market are based exclusively on hydroponic gardening. It is a way of cultivation that is performed with another liquid nutrient solution rather than soil. (<http://dictionary.com/browse/hydroponics>) The word comes from from two Greek words, '*hydro*' meaning water and '*ponics*' meaning labor. The hydroponic gardens are believed to be our only considerable solution in the future, but it is nothing new. It dates back to the first civilizations of the Middle East, to the ancient hanging gardens of Babylon, which were hydroponically built and engineered. Babylon was not the only ancient civilization that had harnessed hydroponics – the Floating gardens of China and those of the Aztecs of Mexico show that when there was no suitable soil for agriculture, they invoked on hydroponics. (Arteca, 2014, p571)

Hydroponics were discovered again around the 1950's, when the scientists started to experiment with gardening with less soil. Since then, different operators have harnessed hydroponics for production with outstanding results. Hydroponics seem to be so insuperable and versatile, that even Nasa started to explore the possibilities for the astronauts to grow their own food during space programs, and the possibilities of using hydroponically grown food on planets such as the Mars. (<https://www.nasa.gov/missions/science/biofarming.html>)



IMAGE 17. Hydroponic gardening. Mary Calvillo. 2017

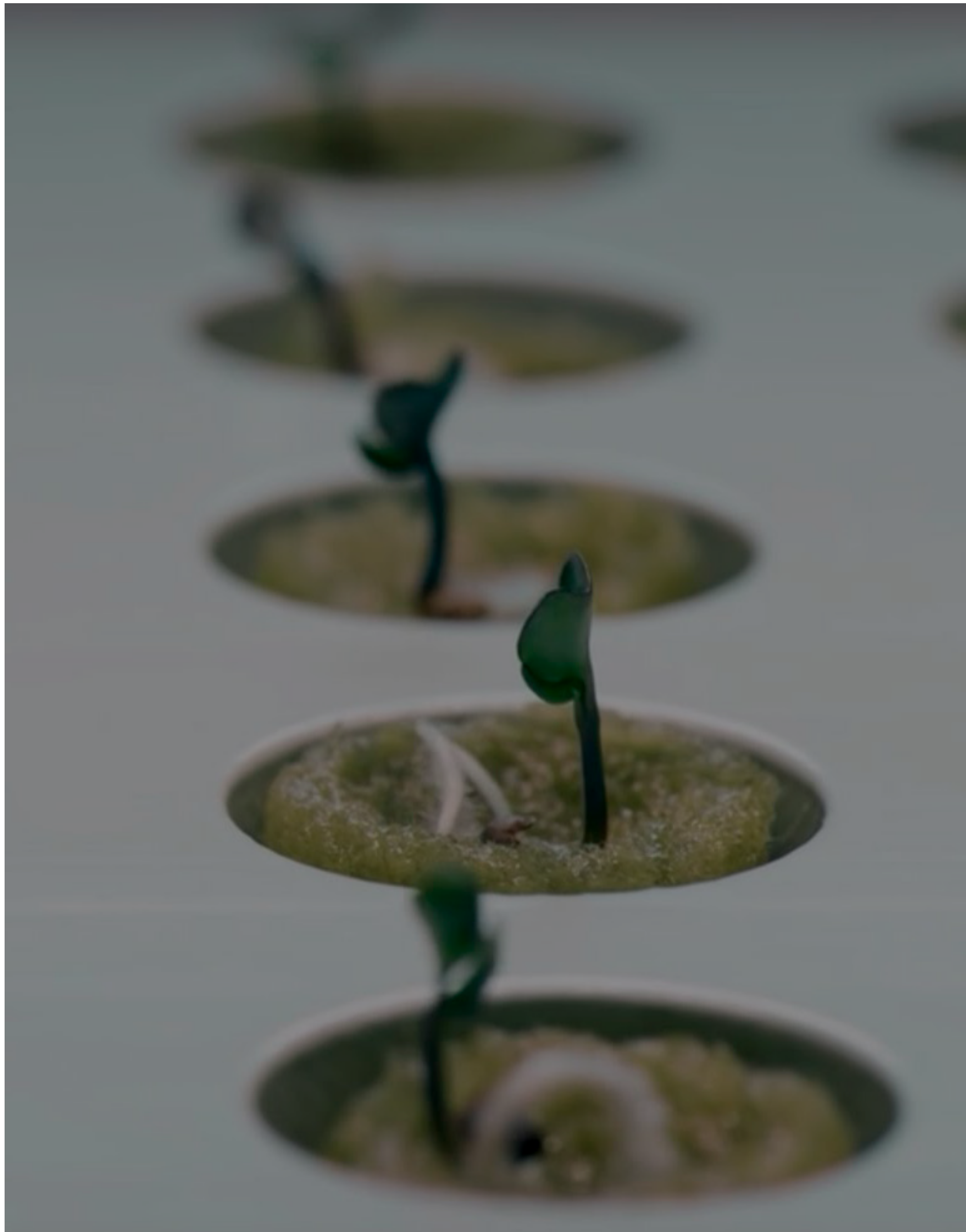


IMAGE 18. Hydroponic gardening. Unknown. 2017

Hydroponics are proved to have plenty of preferable attributes: it can avoid many of the common problems when growing plants with soil, such as cutworm and soil-borne diseases which normally effect or can even ruin your crop. This means that herbicides and pesticides can be avoided during the growth, allowing the cultivation to take place inside the food establishments, as the process is not presenting any hazard to human health. The method also gives the planter more control over the nutrients used to feed the plants, by adding the nutrient straight to the irrigation water, the optimum growth can be ensured. There is no soil used in the process, but the seeds are not, however, planted straight into the water. Instead they are planted into an alternative growing aggregate.

The aggregate can be produced from many different substances, such as sand, vermiculite, gravel, coconut coir, clay balls or perlite. The *Plantui Plant Capsules*™ are made of lava stone wool, in order to ensure optimal water and oxygen levels for the plants. The rock wool capsule supports the plants, when their roots grow to the nutrient solution. (<http://plantui.com>) Today more and more manufacturers seem to be designing and producing hydroponic gardens for the markets, but they variate a lot. Plantui Oy has patented their growth process, which covers the photosynthetic light spectrums and the intelligent watering and nutrient feed. With the Plantui growth lights the plants get just the right amount and quality of light for their optimal growth. The light and watering are automatically adjusted by the *Plantui Smart Garden*™ during all different growth phases of the plant. With these conditions, it grows healthy, fresh and extremely tasty greens. (<http://plantui.com>)



IMAGE 19. Window farm. Unknown. 2017

5.3. Prerequisites for growth

With the existing technology of the hydroponic systems, almost any plants can be grown indoors to their full effect – as long as the prerequisites for the growth are fulfilled. The hydroponic method is a great help when gardening, but it does not compensate poor growing conditions. Hydroponically grown plants have the same general needs and requirements for successful growth as the field-grown plants. Hydroponics should be considered as a tool or a utility, which provides the support and the necessary inorganic elements during the growth process. (<http://www.aces.uiuc.edu>) Plants also need air to respire, the more they grow, the more oxygen they need. This is why they cannot be located on closed spaces without a proper ventilation. If the plants do not get enough oxygen during the germination, they might rot and eventually die. (<http://www.vellag.com>)

Another key factor for the growth is water, as the plants normally contain up to 85–95% of water. A plant takes the water up via its root hairs, moving it through the tiny cells, until it eventually evaporates the water through its leaves, in a process called transpiration. When passing through the plant, the water carries many plant nutrients from the roots to the rest of the plant. So, even though the plants lose nearly all their water through the *transpiration*, they must still have a sufficient amount of water available at all times, for the chemical reactions and for transporting nutrients. If the plant is unable to get enough water, it is also unable to get the nutrients which are needed for the growth. (<http://plantui.com>)

While the plant carries the water around, it also distributes the products of photosynthesis in the leaves. As the water transpires, the plant needs to either try to save the existent water or draw in more. The amount of transpiration depends on many factors, such as air humidity, temperature and the wind. When cultivating indoors, the dry air might be problematic for some plants. (<http://plantui.com>)

Plants use transpiration to remove the excess heat. They evaporate the water through tiny openings called *stomata*, while they take carbon dioxide from the air. This allows the plants to exchange the gases that are necessary for the cellular processes, such as photosynthesis. (<http://www.vellag.com>) The plants usually function during the daytime, as the *stomata* are closed at night. Therefore, the photosynthesis and transpiration only take place during the daytime. (<http://plantui.com>) This is the reason why the sleep timer is such a crucial part of the Plantui indoor gardens, as it allows a natural growing cycle for the plants.

The seeds of our most regular plants normally need a correct temperature to germinate, which is usually between +10–45°C, with some plants requiring higher temperatures than others. Most plants need the temperature to be at least +6°C to grow. On the contrary, extremely hot conditions, above +40°C, can cause stress to the plant and seriously damage its growth. (<http://www.vellag.com>)

Plants also need a natural amount of light during the day, as the light works as an energy source for the plant. The amount of photosynthesis that plants can realize, depends on the length and intensity of the light. Photosynthesis is a process based on the energy from the sunlight. In the photosynthesis process, the plant uses the energy gained from the sunlight to produce glucose from carbon dioxide and water, which can then be converted into pyruvate, which releases adenosine triphosphate by cellular respiration. Ultimately, carbohydrates (stored energy) and oxygen (given off in the atmosphere) are produced and released. (<http://www.rsc.org>)

Plantui has created a fully working solution to substitute the sunlight. They use three high-end led lights per plant, to provide the best intensity and spectrums needed for the photosynthesis. With the automatically controlled Plantui growth lights, the plants get just the right amount and quality of light for their optimal growth. (<http://plantui.com>)

As mentioned above, the plants need certain nutrients to grow. There are many chemical substances required for a plant to grow, and in their natural environment plants absorb minerals through their roots from the soil to survive. As hydroponic gardening is literally gardening with water, without soil, the nutrients must be added straight into the water. The lack of nutrients can cause the plants various symptoms, such as slow growth, abnormal color of the leaves and an increased risk of catching plant diseases. (<http://plantui.com>)



5.4. Productiveness



IMAGE 21. Hydroponic system. Agronegocios. 2017

Hydroponic gardening has been proved to have several advantages over soil gardening. It is said, that the growth rate can be even 30–50 percent faster than soil gardening on equivalent conditions. (<https://www.hydroponics.net>) Even the yield of the plant seems to be faster, as the extra oxygen permits it to stimulate a faster root growth. It is known that the plants absorb nutrients better and faster from the water, when they have ample oxygen in their root system. When using hydroponics, the plant does not have to search the nutrients from the soil, thus enables it to use only the minimum amount of energy to find and break down the nutrients. This is one of the major reasons for the success of hydroponics, as the plants can use the saved energy in growing faster and producing more fruit. (<https://www.hydroponics.net>)

5.5. Development needs

Different manufacturers of hydroponic gardens are continuously developing and launching new versions for restaurants. When benchmarking the current manufacturers, there can be found many similarities in their products. As hydroponic gardening is fairly complicated and has many problematics in itself, all the manufacturers seem to have made the same conclusions. They all seem to have developed massive and firm cabinets, that can only grow at three levels at a time. This solution is quite obvious, as the cabinet model allows the manufacturers to hide all the functional parts inside the structures. The cabinet models do have structural and constructional benefits, but they still lack some major functions and for this reason cannot be operated to the maximum. If they are not developed any further, the restaurants cannot get the maximum benefit and capacity from their use, and the gardens could end up being just decoration or a green marketing mean.

One of the major problems of the cabinet's solid body is that all the cleaning, planting and harvesting has to take place on the spot, making the locating of the cabinets extremely challenging. The solid body also disallows the varying of the planting – because of the immovable levels the different stages of plant growth cannot be optimized. As the height of the light source stays the same throughout the whole cultivation process, it does not permit the right amount and quality of light for their optimal growth. The lack of light critically slows down the growing and the photosynthesis of the plants.

The growing speed is not the only problem with the immovable light unit. The solid structure of the light unit also consumes the capacity gained from vertical gardening, as it takes the same amount of space for the plants in the germination stage as it does for the fully-grown ones. As a matter of fact,

the solid and predesigned height of the light unit determines the plants the restaurateurs can grow on their hydroponic gardens, as some herbs and plants make yields that are too high for their solid gardens. This is what generates a significant waste of space.

Another problem in the growing process of the current products is the divergence of the plant's growing speeds. On the contrary, Plantui recommends their users to combine plants that are categorized on the same growth speed on each germination time. (<http://plantui.com/plant-capsules/>) Otherwise, the faster growing plants may obstruct the growth of the slow growing plants, like they do in the current solid models. Most of the current models only allow the users to grow three crops at the time on each cabinet, which puts the user in a situation of either using or losing the whole crop at a time.





IMAGE 23. Hydroponic garden. Ecea Systems Inc. 2017

The current models for restaurant use are designed to function as singular units and not as larger entities. With these solid models the only possibility for a restaurant to extend their self-sufficiency and growing capacity is to continually buy new oversize cabinets.

However, increasing the amount of the gardening cabinets would not resolve their problems, since the cabinets would still not be managed as an entirety, but as singular units. The manufacturers should contemplate the hydroponic gardens for restaurants with more transformability. As for the restaurateurs, to gain the maximum benefit from their hydroponic gardens, they would need more ductile and variable solutions. Also, when pondering the new opportunities and alterations, the bulky size of the current cabinets needs to be taken into consideration. Understandably, the restaurateurs normally aim to maximize the customer capacity, so the new solutions must be compact and of easy care.

With a new, completely non-traditional and a truly competent product, Plantui Oy can achieve a fully working hydroponic garden for restaurant use. It enables a high range of varying and optimizing the whole growing process to the users' needs, easy scaling of the growing levels when needed and an easy way of finding the best working solution for each restaurant. In the end, what all the manufacturers should bear in mind is, that the hydroponic gardens are only an everyday instrument for the restaurants, used to accomplish benefits and self-sufficiency.

6. Creative process

Hydroponic gardening is considered as the best solution for growing plants inside, so locating the smart gardens in food establishments and harnessing their use to professionals seems like a natural continuum to the advancement of the indoor gardens short and revolutionary passage. Although many of the companies have failed when trying to productize different indoor gardens, there seems to be coming more and more competitive solutions. Most of the already launched indoor gardens are designed for domestic use, which are not easily scalable for a larger capacity use. Even if they could be scaled for a larger size, they would still not suit the professional use because of their features. Most of these products have a common issue regarding the capacity – they can only produce one crop at the same time.



6.1. Objective



The main point behind my designing process was to create an opposite solution for the current restaurant operated, solid hydroponic gardens. I wanted to create a product that can be easily modified and implemented according to the necessity of different restaurants. A product that can be truly varied on its location and therefore enabling the restaurateurs to create a successful growth circulation for various herbs and salads. The product is not meant to be only a decoration or a green marketing utensil, but a lifestyle product that truly helps the restaurateurs to maintain an ongoing crop, permitting them to target self-sufficiency.

To make hydroponic gardening inside food establishment more popular, the initialization of the gardening should be as easy as possible. In the design process, I tend to create a working solution that is easy to use and handle, minimizing the maintenance and the care of the product usability. The final product also needs to be removable, so that contrary to the current solid models, the maintenance and care of the product can be done in the kitchen area. To gain these attributes and to achieve my objective, I played with the idea of having individual garden units. How could I design an independent hydroponic garden that could still work in or as a larger entirety?

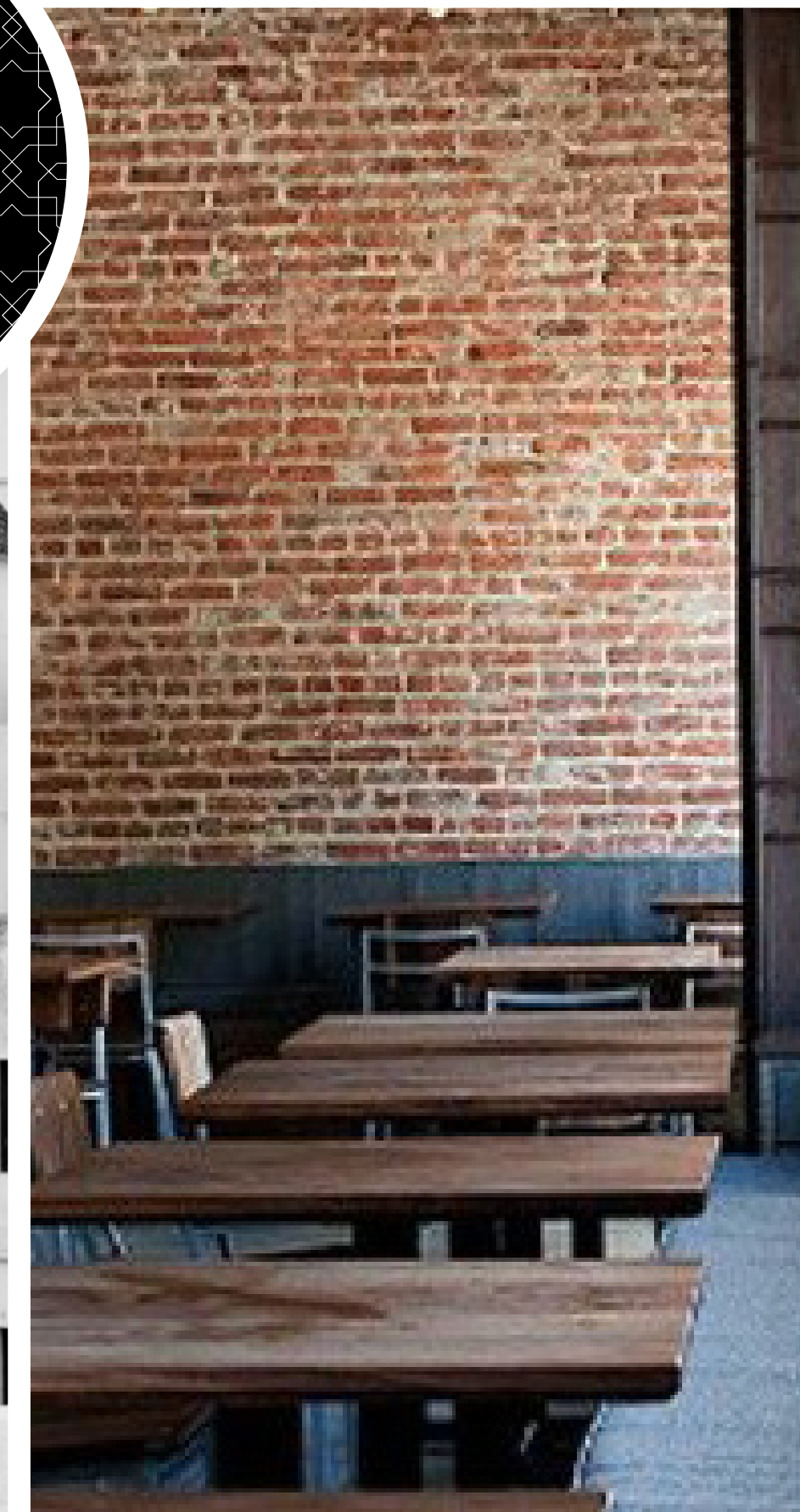
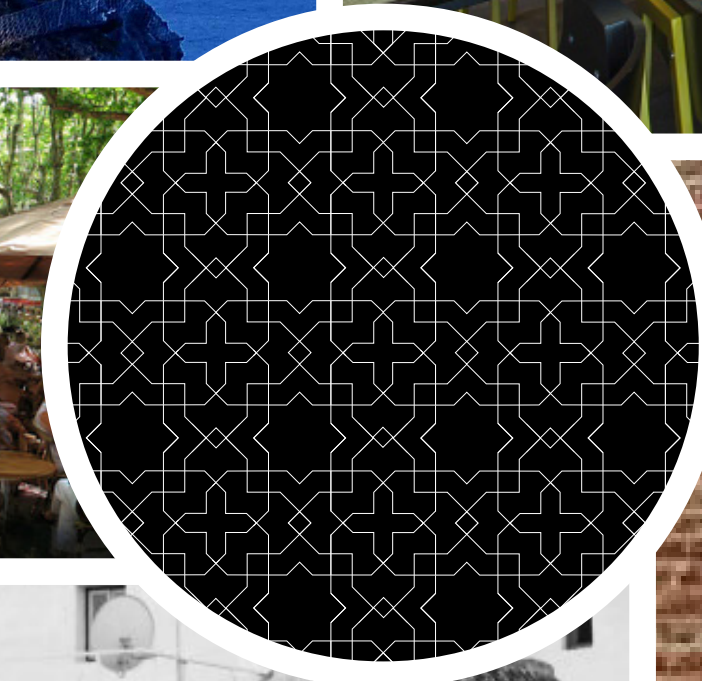
6.2. Idiom

The design language of the product is based on the characteristics defined in the brief. The product should have the same principles, spirit and freshness as the current products in Plantui Oy's product portfolio. For the inspiration of the idiom, I travelled back to the origins of the city gardening in Europe. As the knowledge of cultivation expanded from the Middle East to the Mediterranean, I adopted elements from both cultures. The main element from the Middle East was the artistic decoration pattern, arabesque, which is based on rhythms. The pattern allows a never-ending continuum, a similar attribute behind the final product.

As the plants have a constant need of fresh air, it was important for the product to be ample enough. I wanted the indoor garden to make people feel like dining outside, in a Mediterranean terrace. The protective verdancy is a constant reminder about the immemorial oasis.

For the garden unit, I acquired the multilayeredness of the houses in the Mediterranean villages – their random order and the versatile style together creates a balanced and a neutral harmony. At nighttime when those villages arise from the darkness, their lights reconstruct a tangible atmosphere.

The final product needs to emphasize simplicity. It is important that even the parts are dividable and removable, thus they have look uniform when assembled. So even with the moving parts, the relationship between them and the basic components of the product, need to exude clarity and provide practical solutions and experiences for the user.





All products or materials intended for food contact has to be designated with clear phrase or with the generally accepted fork-glass symbol

EUR-Lex

6.3. Material requirements

Most of the laws and regulations that have to be taken into consideration while designing the final product are related to the equipment and material requirements. The European Union has listed the possible plastic materials and articles intended to come in to contact with food. (the Commission Regulation (EU) No. 10/2011 of 14 January 2011)

The materials used in the product must be approved for their purpose in the region of the European Union. With plastics, this means that since the monomer level, all the source materials and components must be accepted. Plastics have the most detailed material specifications compared to other materials. (<http://eur-lex.europa.eu>) All the metals must be processed with a corrosion resistant coating. Even with the good qualities of the coating, there can occasionally emerge some corrosion on the surface, which in most cases is caused by the chloride ion or some microbes. In both cases, the most essential way to prevent the corrosion from forming is cleanness. (<http://kehittyvaelintarvike.fi/>)

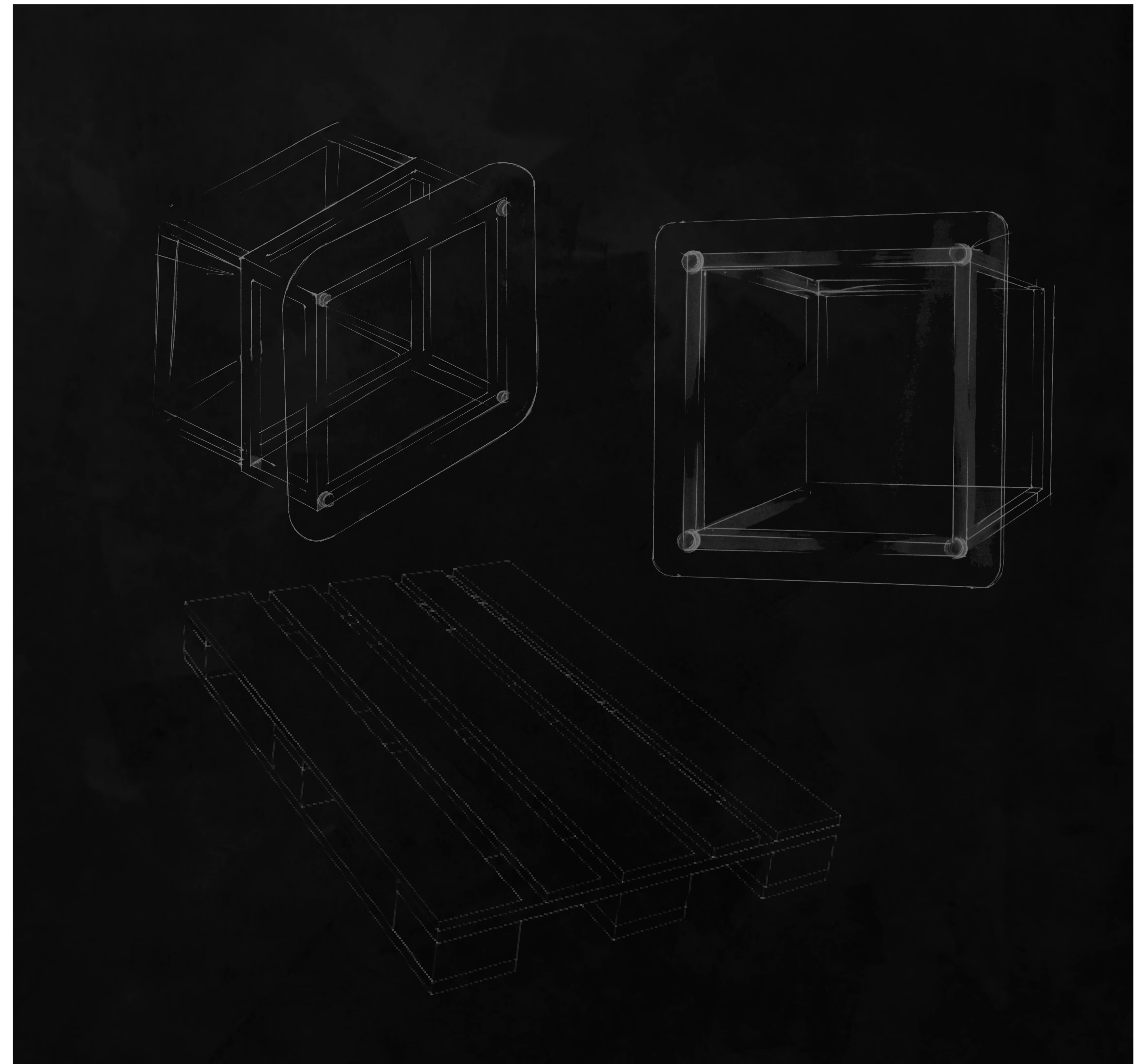
To avoid any abuse, the European Parliament has set the Regulation (EC) No 852/2004, in which it says that all the equipment comes into contact with food are to be effectively cleaned and, where necessary, disinfected. Cleaning and disinfection are to take place at a sufficient frequency to avoid any risk of contamination. (<http://eur-lex.europa.eu>)

6.4. Dimensions

There were many factors influencing the size of the final product. One of the first restrictions came from the customer, Plantui Oy, as they asked for the final product to fit on the European pallet (800cm-120cm). This was worth noticing, as it allows lower shipping costs for the products.

Another remarkable factor for the size of the product was its weight. There must be enough water for the plants and for the pump to properly function, but at the same time it must not be too heavy, or the moving and relocating of the seedbed and the water bowl becomes very challenging for the user. Having enough space for the water was also crucial in facilitating the product usability, as it prevents the user from having to fill the water bowl too often.

For these reasons, I ended up using the same amount of water per plant as in the Plantui 6 Smart Garden. There is an average of 0.5 liters of water for each plant, which means that the total amount of water in the bowl is around 10 liters. The quantity of water in keeps the final weight moderate to be lifted and handled properly even when full. By holding the same amount of water than the previous models of Plantui's gardens, it also achieves formally important features. This way the depth of the water bowl stays proportionate comparing to the rest of the product, and the plants have an essential gap between each other.



6.5. Ideation

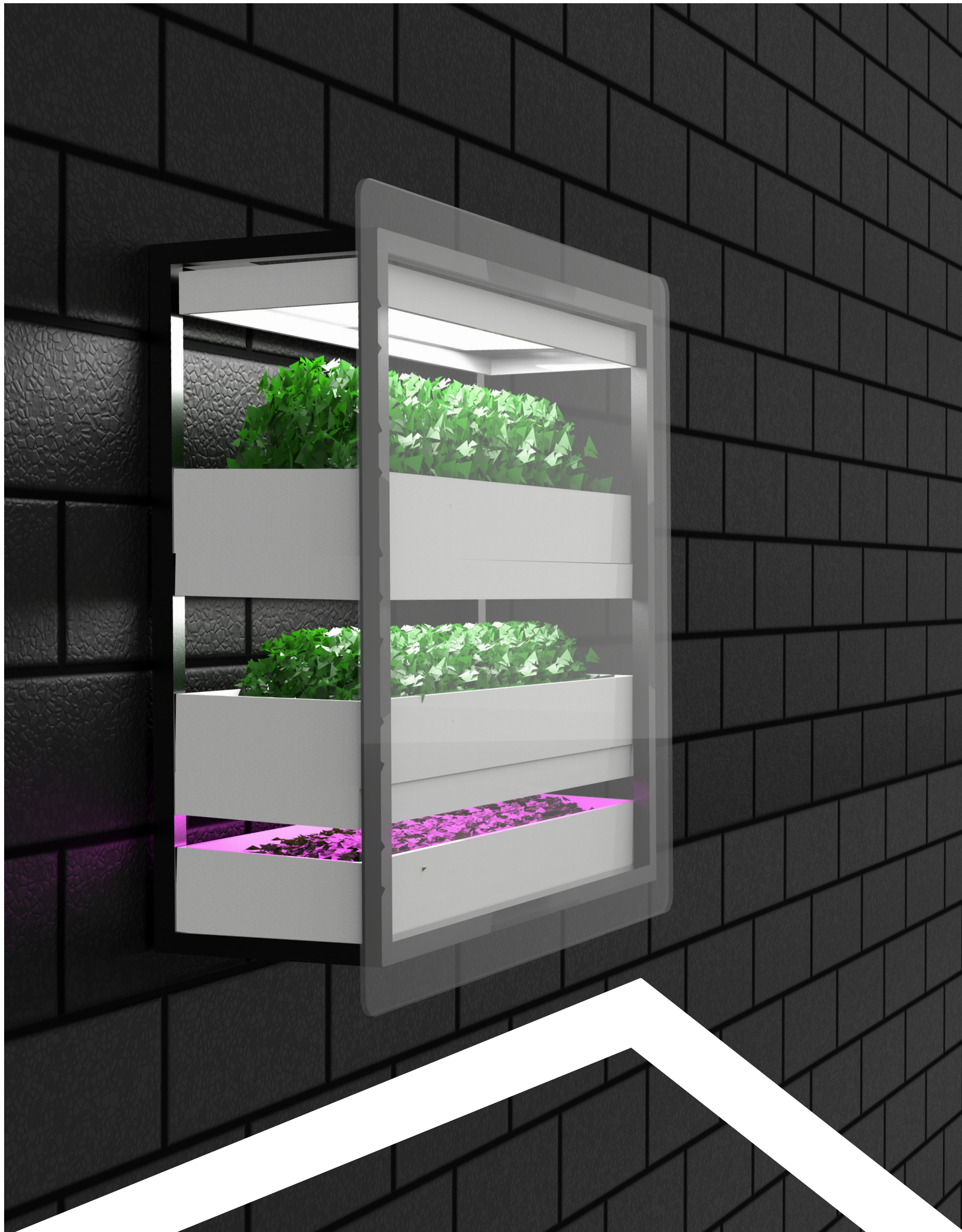
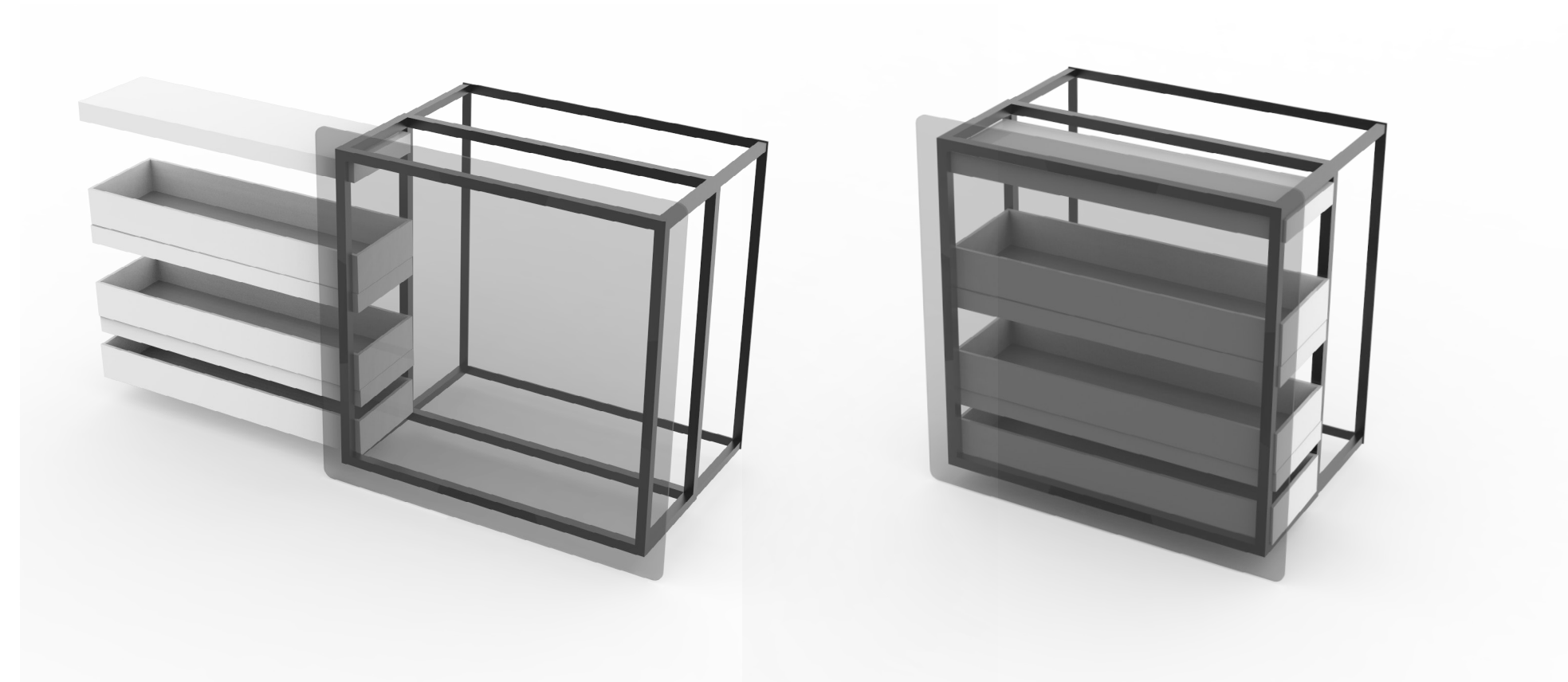


IMAGE 33. Hydroponic garden. Keny Muesa. 2017



I started the ideation process by studying different possibilities of an adjustable shelving system. Firstly, I wanted to examine the functional requirements and become aware of the needs of the shelves. Only then could I focus on the shape of the light unit and of the water bowl. I intended to take into consideration all the moving parts of the product, and to solve the problems originated from the movability, such as grazing and erosion.

I presented to the customer my vision of a shelving system that is possible to drag out from the wall during the use. This way the restaurateurs could place multiple shelving units side by side, without compromising the usability. The light unit and the water bowl are attached to the shelf by only one side, which gives the user a better attachment and lifting position. With this solution, some of the shelves could be placed up on the walls, thereby saving a great amount of flooring space.

6.6. Gardening unit

After examining the shape and the functional requirements of the shelving system, I focused on the gardening unit. The designing resulted really challenging, because even though they are two completely separate parts (light unit and water bowl), they should still have a unified idiom, and they need to be attached to the shelves with a similar mechanism.

First, I designed a water bowl which had flaps on the side. Using the flaps would have allowed the user to place the units on sliding tracks, which would have simultaneously hidden the shelf tracks under the water bowl's flaps. However, this solution would have required units of angular shape, which I think would quarrel excessively with Plantui's current product portfolio.

The angular shape of the boxes made them too heavy-looking, so I started solving the problem by rounding the ends and edges of the units. I solved the hiding of the shelf tracks by adding round-shaped carrying handles around the unit. The new solution of the handles also improved the handling and lifting of the unit in and out from the shelf.

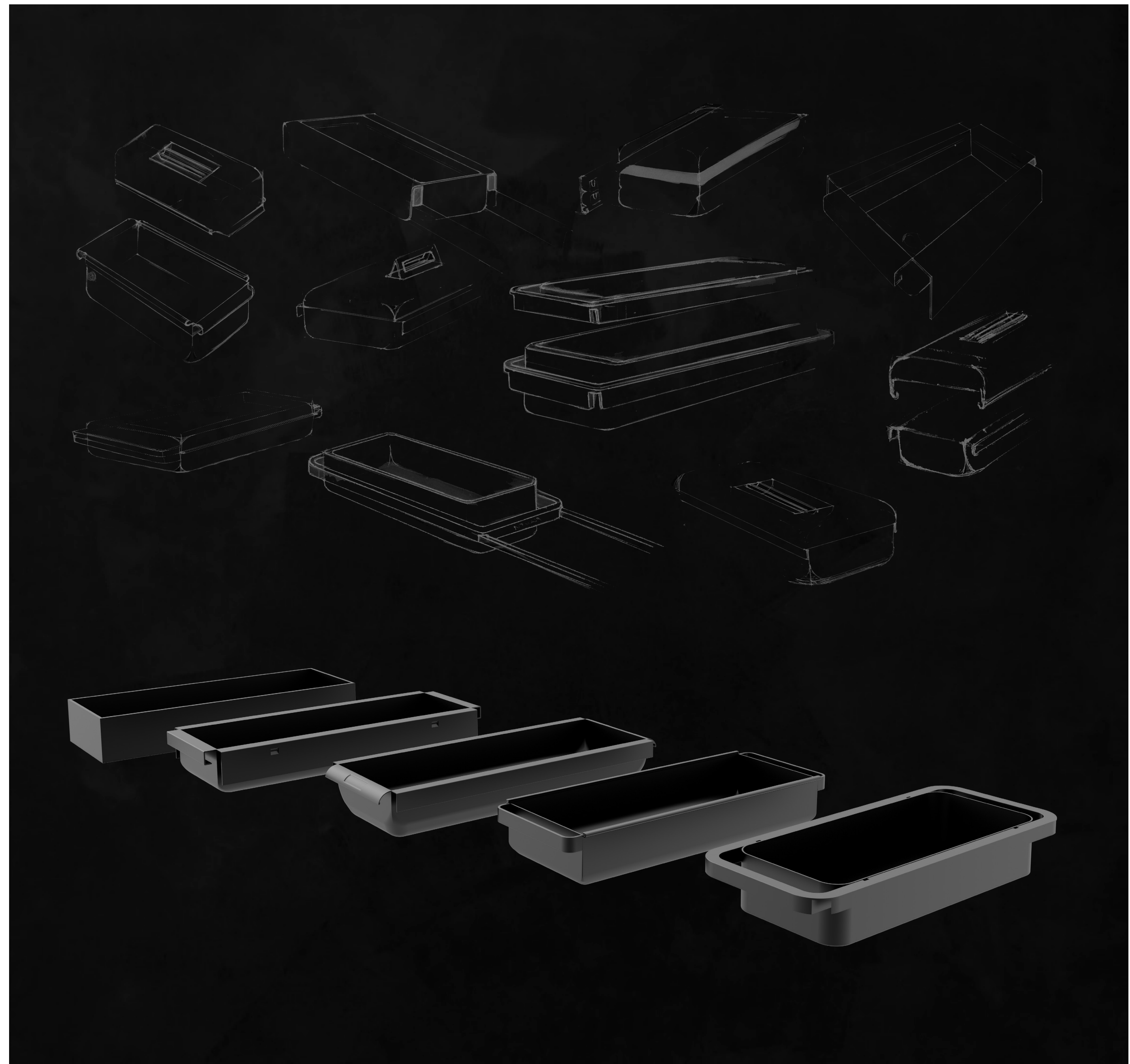
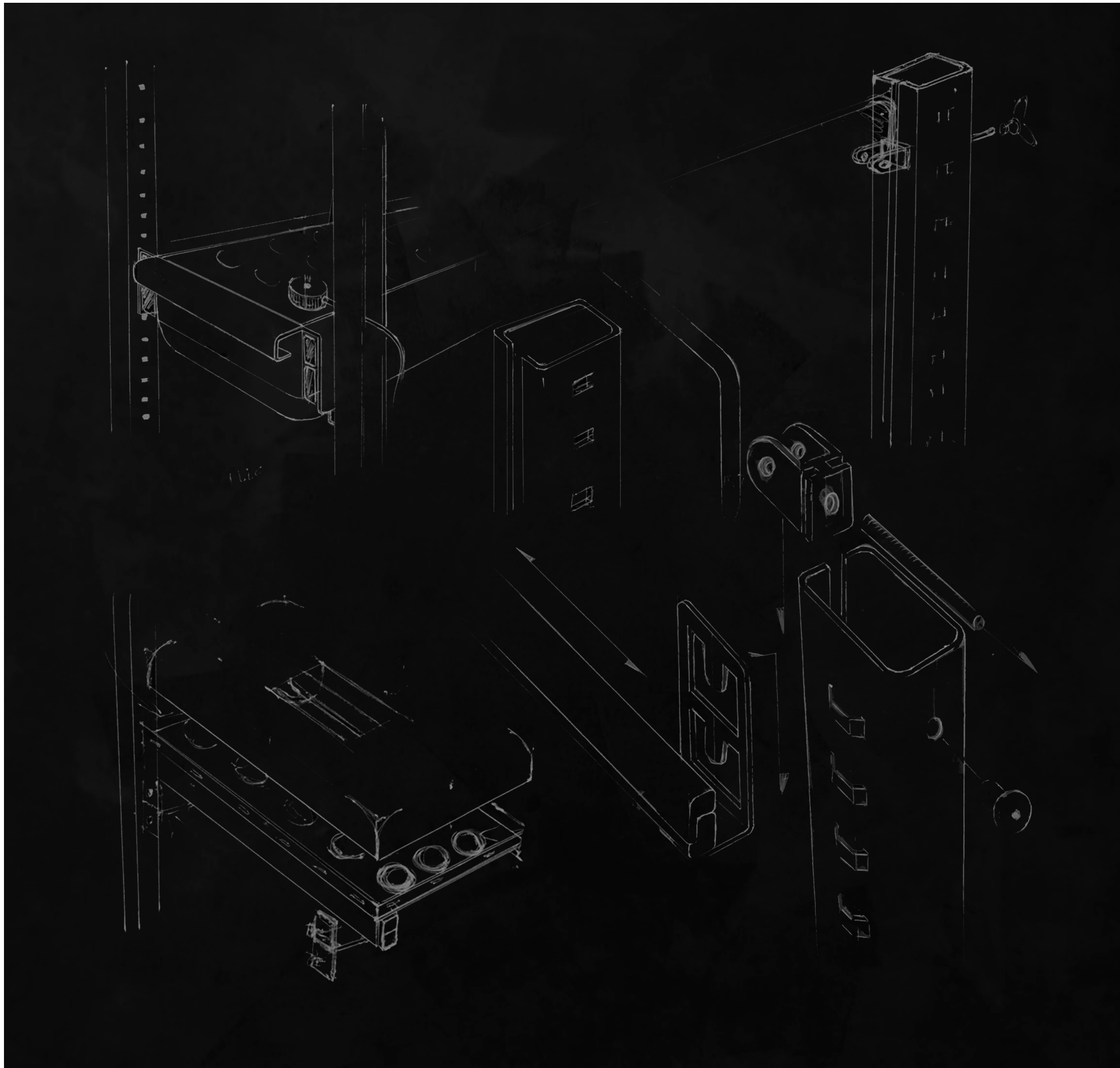


IMAGE 34. Gardening units. Keny Muesa. 2017

6.7. Technical solutions



When I reached the objective of the idiom for the growing unit, I started to plan more in detail the technical solutions of how the shelf track solution would work in practice in the final product.

I also studied the protective lens mount and the setting the glass inside the frame, to prevent it from being exposed to any knocks or causing damage to the restaurants customers. I wanted to keep the track attachment and detachment as simple as possible, to enable the practical usability of the garden. Therefore, I designed the attachment mechanism to work without any tools required.



IMAGE 36. Gardening units. Keny Muesa. 2017

6.8. Shelving system



After designing the rails and other moving parts, I made a 3D model in order to facilitate the designing of the final concept and to gain a better understanding of the entirety of the product. The model allowed me to test the rails of moving far enough from the frame, and for the boxes to descend on the tracks effortlessly. From the draft, I noticed that the handles I had designed around the boxes looked clumsy and took up too much space. This is where I made a compromise – I changed the rail model for a thinner side rail and lifted it in sight to get more space for the farming and lightning units



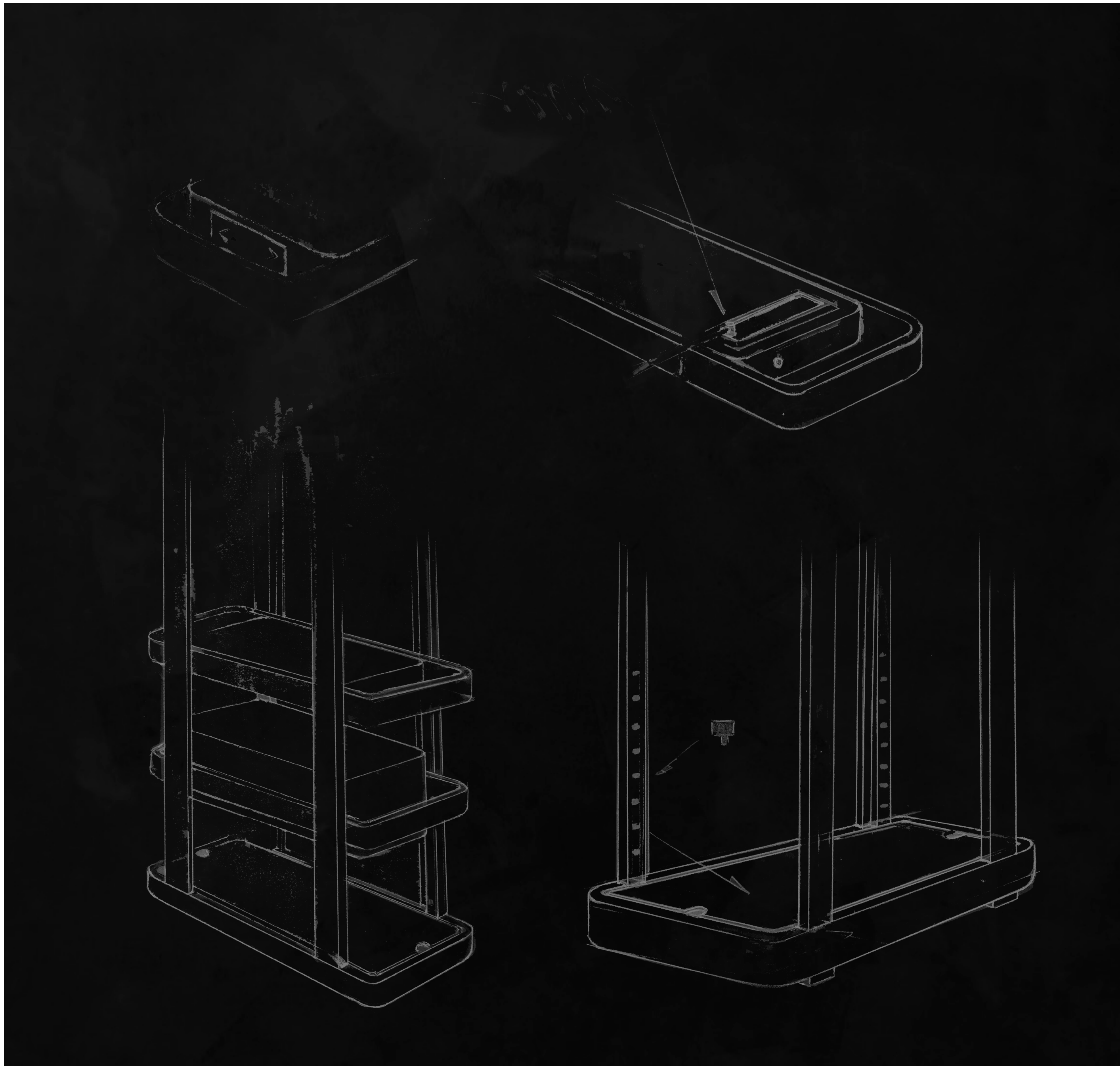


IMAGE 39. Sketches. Keny Muesa. 2017 IMAGE 40. Gardening unit. Keny Muesa. 2017



In addition, I decided to modify the structure of the frame and the glass mounting, to get the electric wires from the units to run along the frame and to be hidden from the customers' view. One of the positive things about the model was its height – I managed to find the correct proportions for the shelf controllers, and this way maintaining always the right amount of space between the farming and the lightning unit. This way the warming LED-light do not heat up the water.

7. Final Product



Fresh herbs
zero effort

-Plantui-

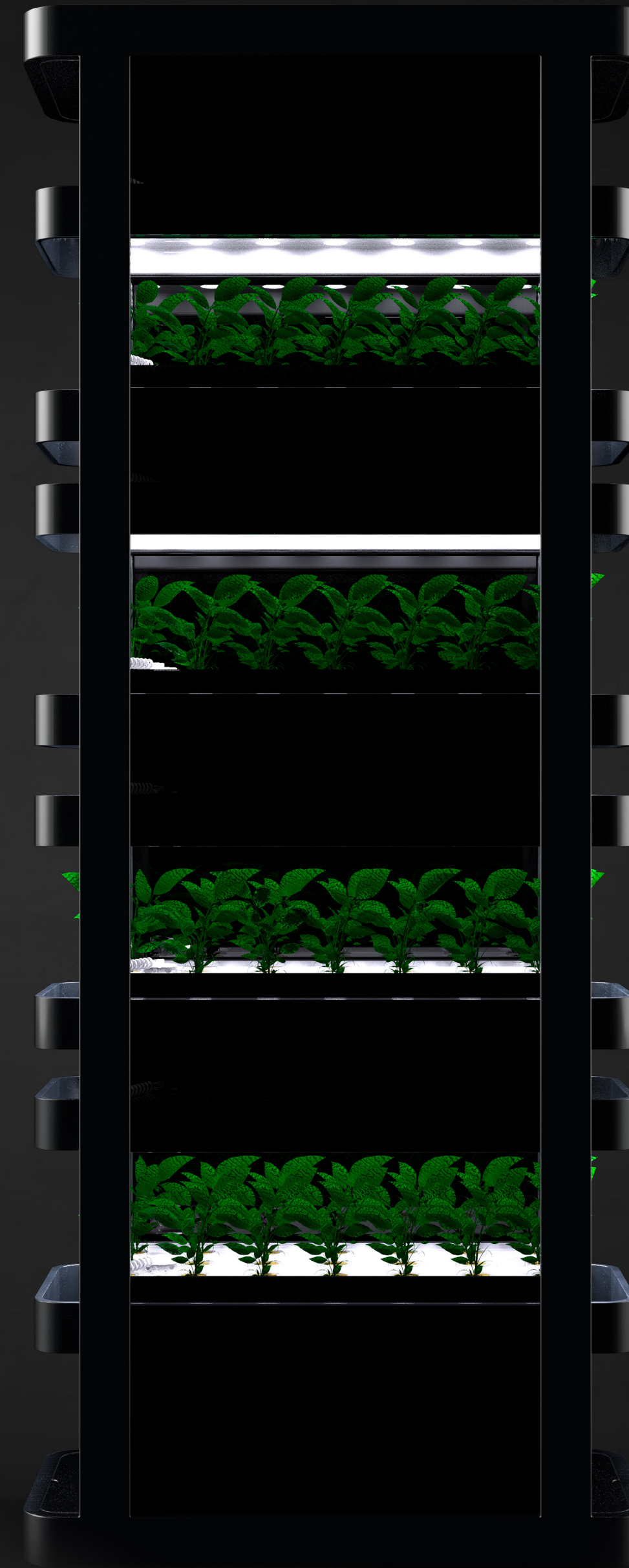




IMAGE 42. Indoor Cultivator. Keny Muesa. 2017

7.1. Indoor Cultivator

The final product is a modern and minimalistic modular cabinet that consists of individual gardening units. The elegant design language of the cabinet also enables its use as a beautiful decor element, which helps the restaurateurs to provide their customers fresher and tastier dining experiences.

The modular structure offers the restaurateurs unlimited options, that allow them to create their own continuous cycle of growth for the plants they need. With the cabinet, the restaurants can grow herbs and greens in multiple stages at the same time. If they need to maximize their capacity, they can easily acquire multiple cabinets for each stage of growth. Relocating the growing units between the cabinets is easy with the simple fastening mechanism, as it allows the setting to take place with minimum effort. This guarantees the user an easy and a hassle-free cultivation experience.

Owing to the modular structure and the movable light and growing units of the cabinet, all the maintenance, planting and sanitation can be realised safely in the restaurant's kitchen areas with minimum disturbance to the customers.

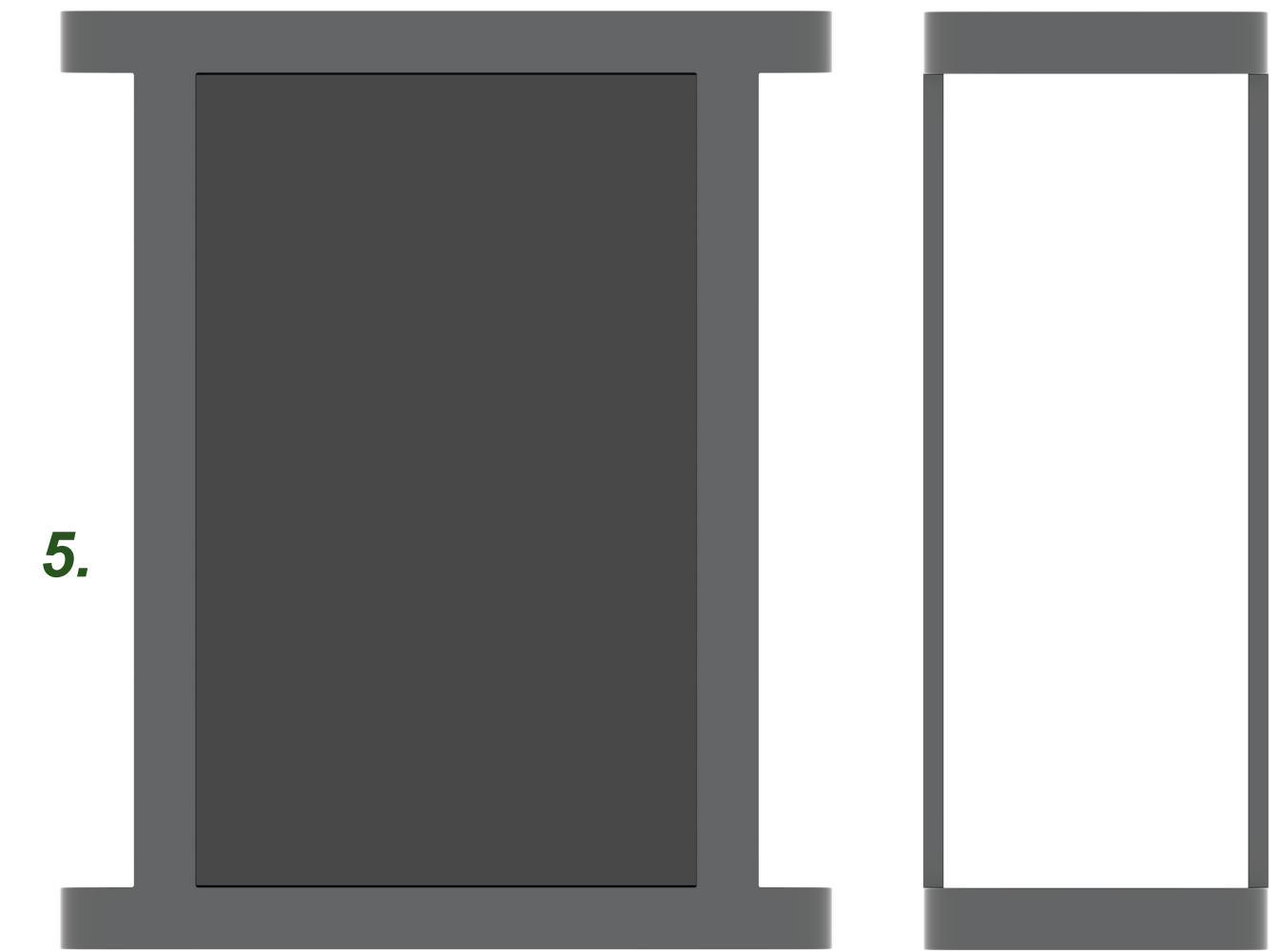
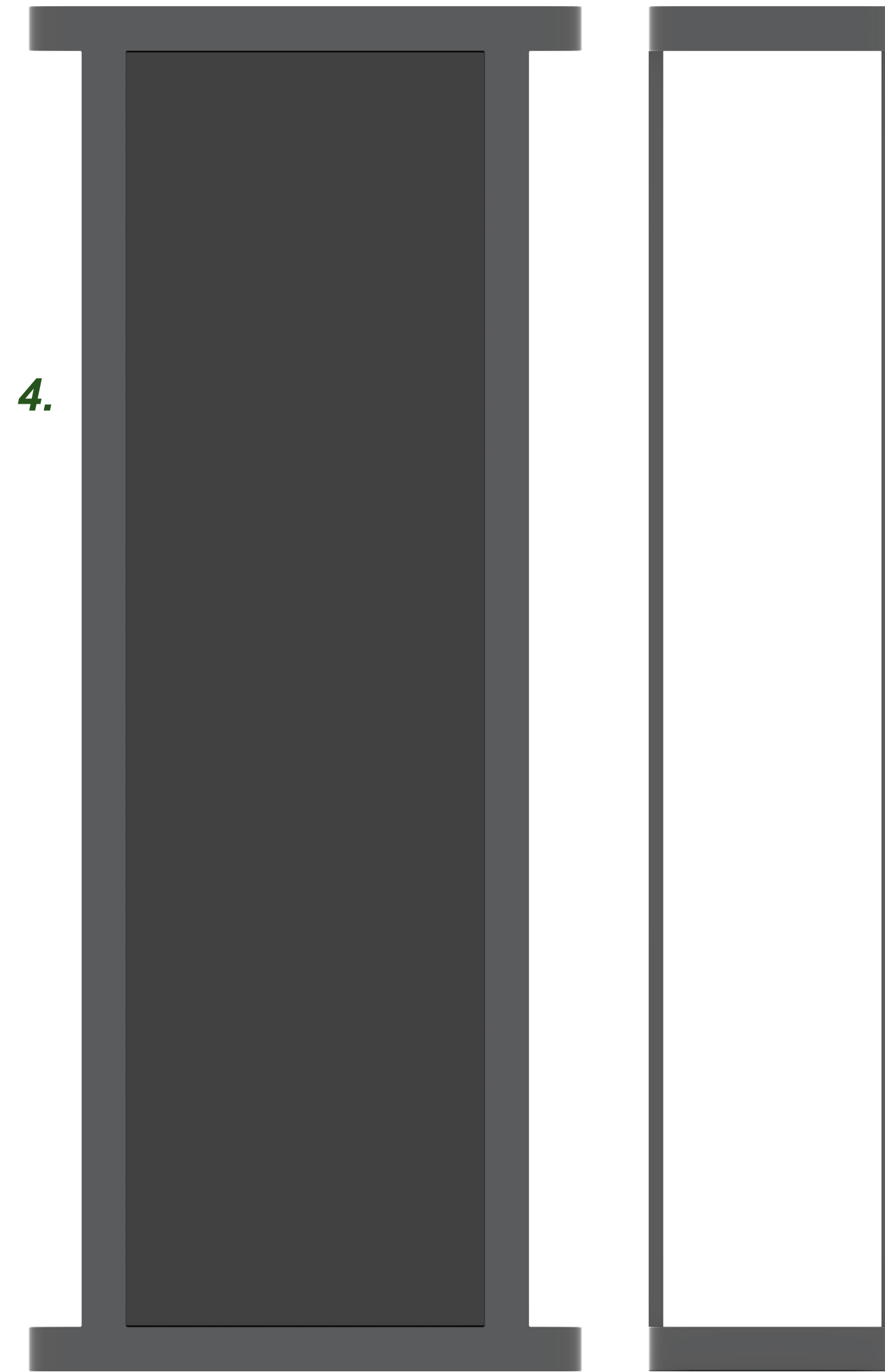
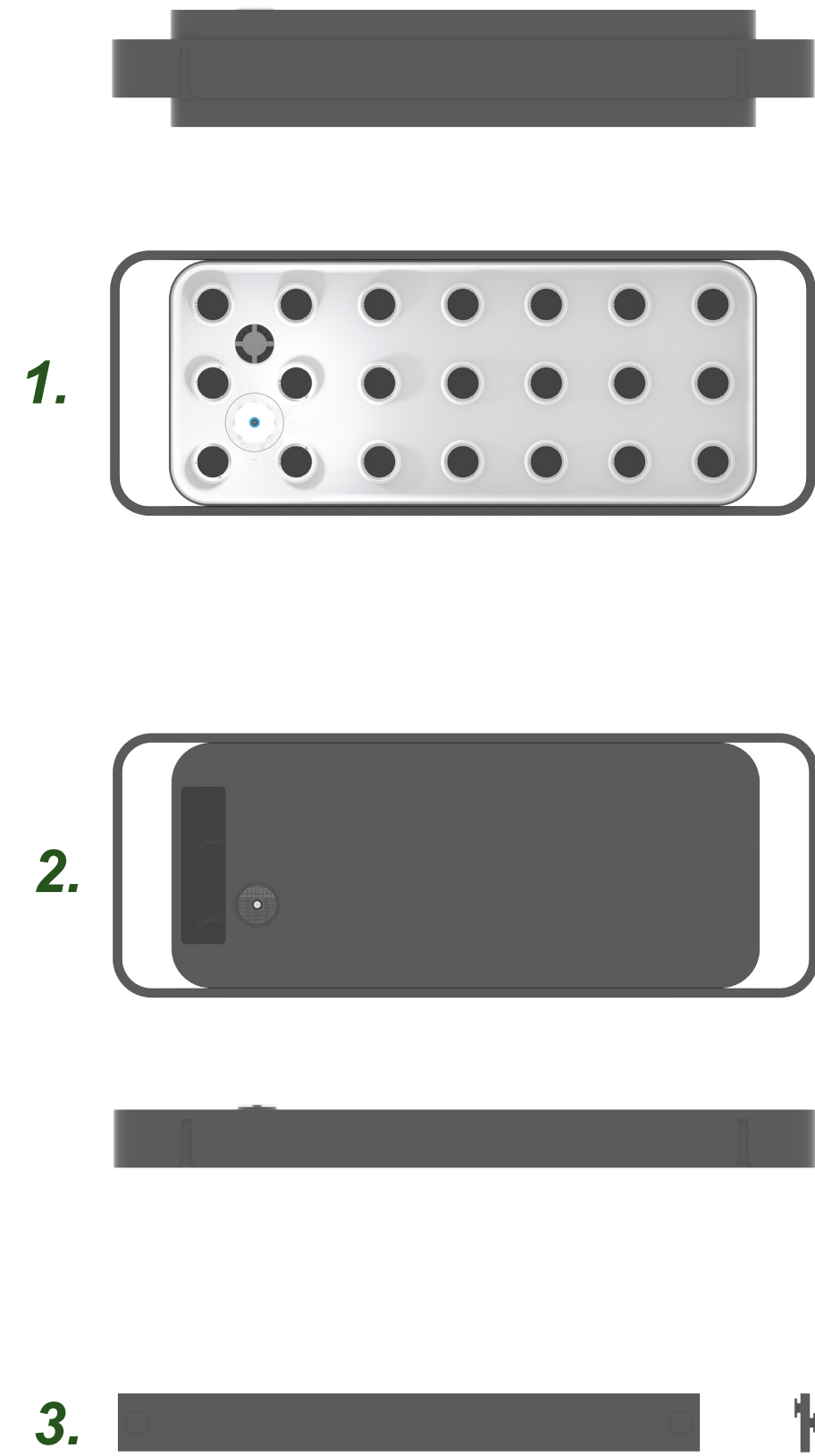
The Indoor Cultivator is a cost-effective solution for restaurants, because the restaurateurs can start the acquisition of equipment with a single cabinet and the needed amount of light- and growing units. If necessary, the cultivation capacity can be easily increased by supplementing the existing cabinet with new light and growing units, or by increasing the number of cabinets.

The Indoor Cultivator is available in two different sizes. The distinction of wall and floor cabinets creates a wider possibility for different interior solutions and facilitates significantly their placement in the restaurant environment. During the germination stage, the wall model holds up to a total of three light and growing units, while the floor model can contain up to seven units at the same stage.

Due to its small size, the wall model can easily be placed on the walls of restaurant's dining areas and also be used as a table divider. It provides solutions for different kinds of bars and lounges, as it can be located next to the counter, allowing the bartenders to use fresh herbs in the cocktails. When located inside the kitchen area, it can be located above the assembly counter. It gives the chefs an easy way of using fresh herbs and of giving the portions an ultimate finishing touch.



7.2. Main components



1. Growing unit
2. Light unit
3. Slides
4. Floor shelf
5. Wall shelf

7.3. Light unit

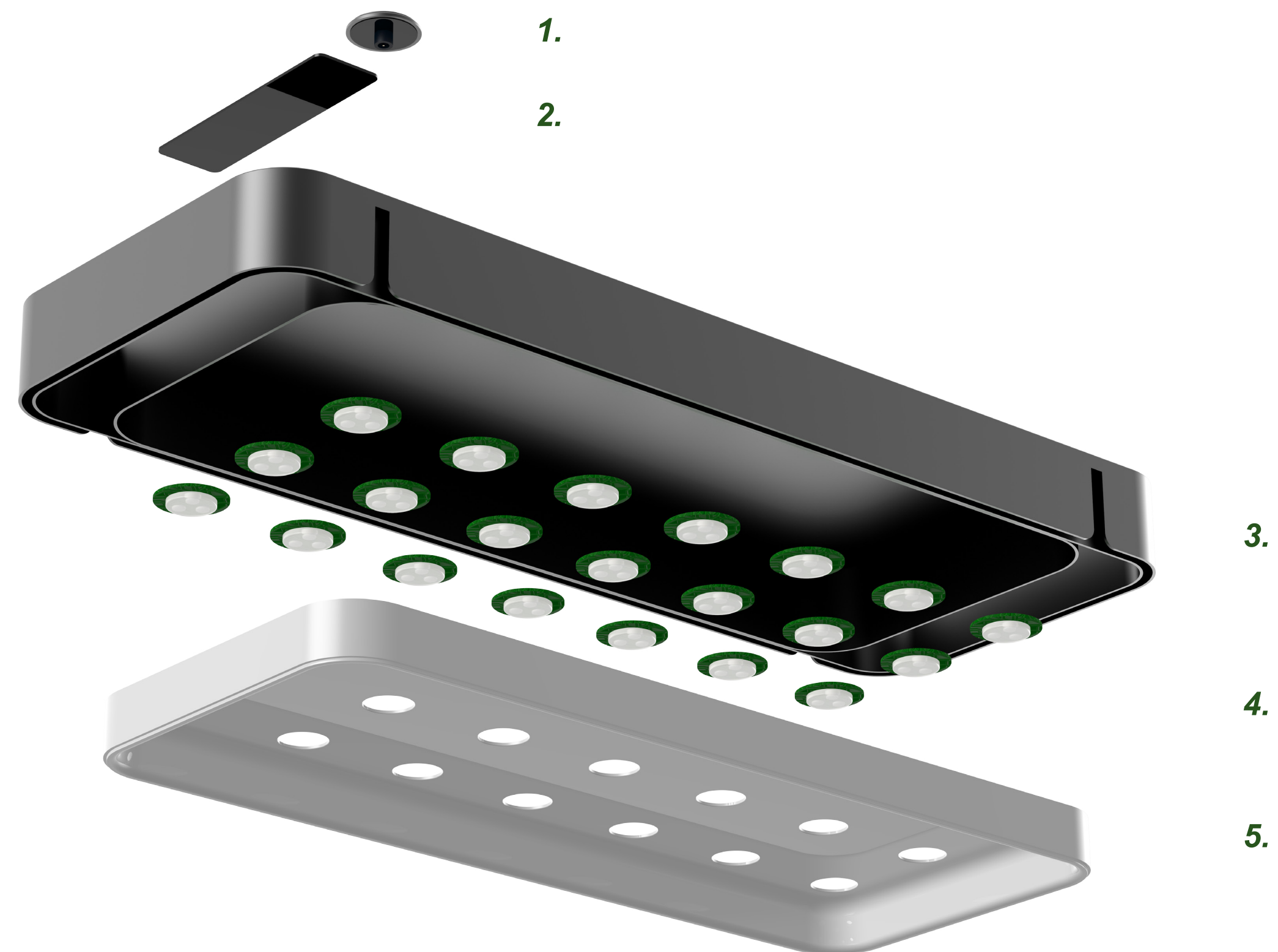


The light unit consists of five main components:

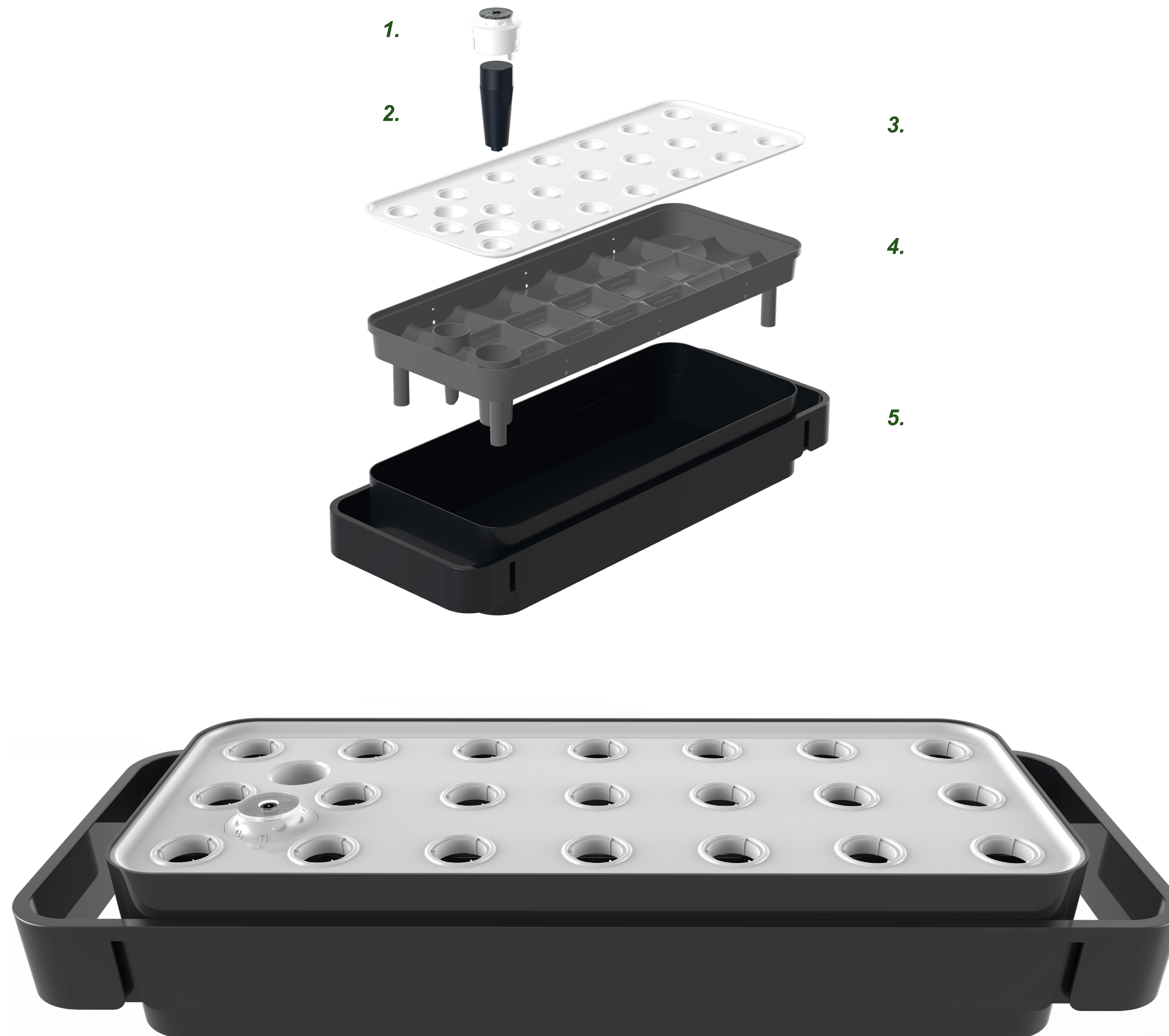
1. Light hat
2. Control panel
3. Frame
4. LED-lights
5. Light cover.

The unit has 60 high-end led lights to provide the best spectrums for each stage of growth. The lights are controlled from a touchscreen control panel, where the user can easily adjust the garden's 'sleeping time' and the quality of the light needed for a certain stage of growth. Power to the light unit is supplied through the light hat. A light signal at the top of the light hat indicates when the unit is in use. In case of a problem, the color of the light signal changes and notifies the user about a possible malfunction.

The light cover is made from ABS-plastic by compression molding. The shiny plastic and the concave shape of the cover steer the light directly down to the plants, reducing the dazzle and any negative stimulus among customers. The metallic frame of the unit is made of stainless steel, which is treated with a corrosion resistant coating. The handle and the main part of the frame are manufactured separately and spot welded together. The clefts located on the sides of each handle allow an easy fastening to the slides.



7.4. Growing unit



The growing unit is combined of five different main components:

1. Clamping device
2. Pump
3. Plant tray
4. Water tray
5. Frame/water bowl.

The growing unit has a capacity to grow up to twenty plants at once. It holds up to ten liters of water which provides an appropriate irrigation rhythm. The total weight of the unit when full is about 12 kilograms. The water filling occurs from the hole located at the edge of the plant tray. The location of this hole enables the growth unit to be filled with water even when it is placed in the shelf. During the filling, the concave shape of the plant tray prevents any spatters in the shelf's protective glass and the water from spilling along the edges.

The power in the pump is supplied from the top of the clamp. There is a light that indicates when the device is in use. The pump lifts water to the water tray various times in a day, and the spare water drips from the holes located at its sides, with only the right amount of water remaining for the plants to use.

Despite its weight, the sturdy and solid structure of the growth units' handle helps the user to lift and transfer the unit easily, even when its full. The wide grip helps to maintain a balance when carrying the unit full of water, without splashing from the edges. As in the light unit, the water and the plant tray are made with compression molding from ABS-plastic, which is officially accepted for food contact. The frame and the handles are also manufactured using the same method.



IMAGE 47. Growing units. Keny Muesa. 2017

7.5. Shelving system

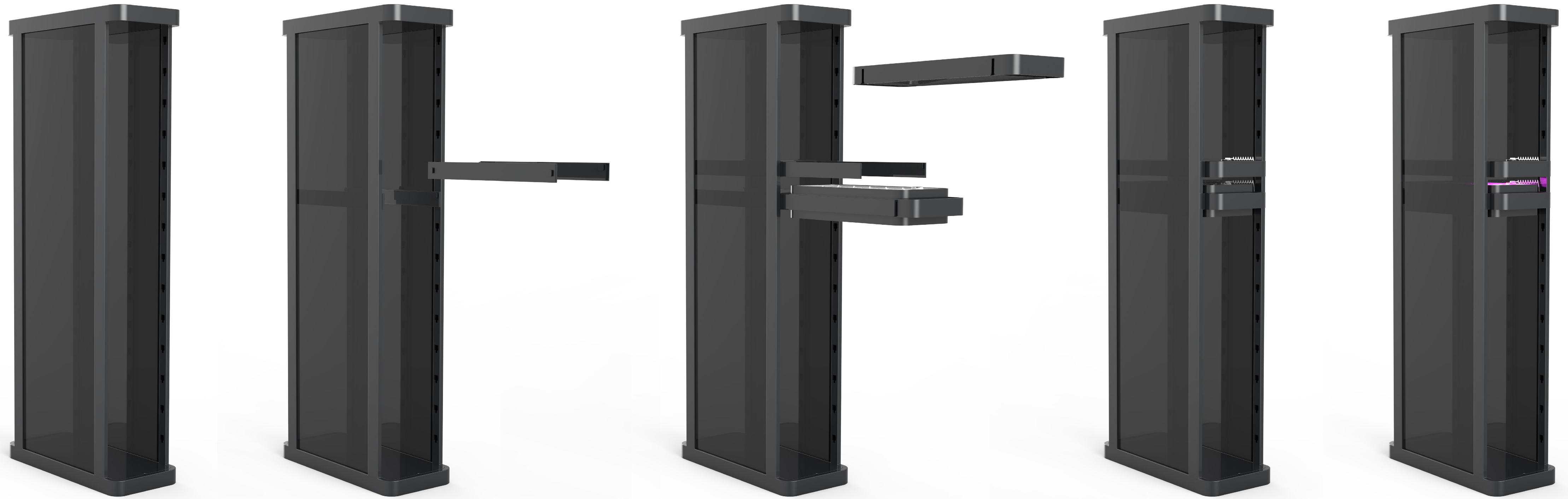


The Shelf consists of three components:

- 1.** Protective Glass
- 2.** Metallic frame
- 3.** Maintenance hatch

The holes in the shelves allow inserting of the slides. The sturdy body of its structure holds the weight of the units. The glass is dark in order to prevent dazzle and at the same time it ties up the colors of the product and this way makes the whole cabinet seem more unitary. The glass is attached from the inside, so it is safe from any damage. The shelf keeps the plants protected and at the same time it allows them the required amount of fresh air.

7.6. Usability



Germination



Seedling



Harvesting



7.7. Product images



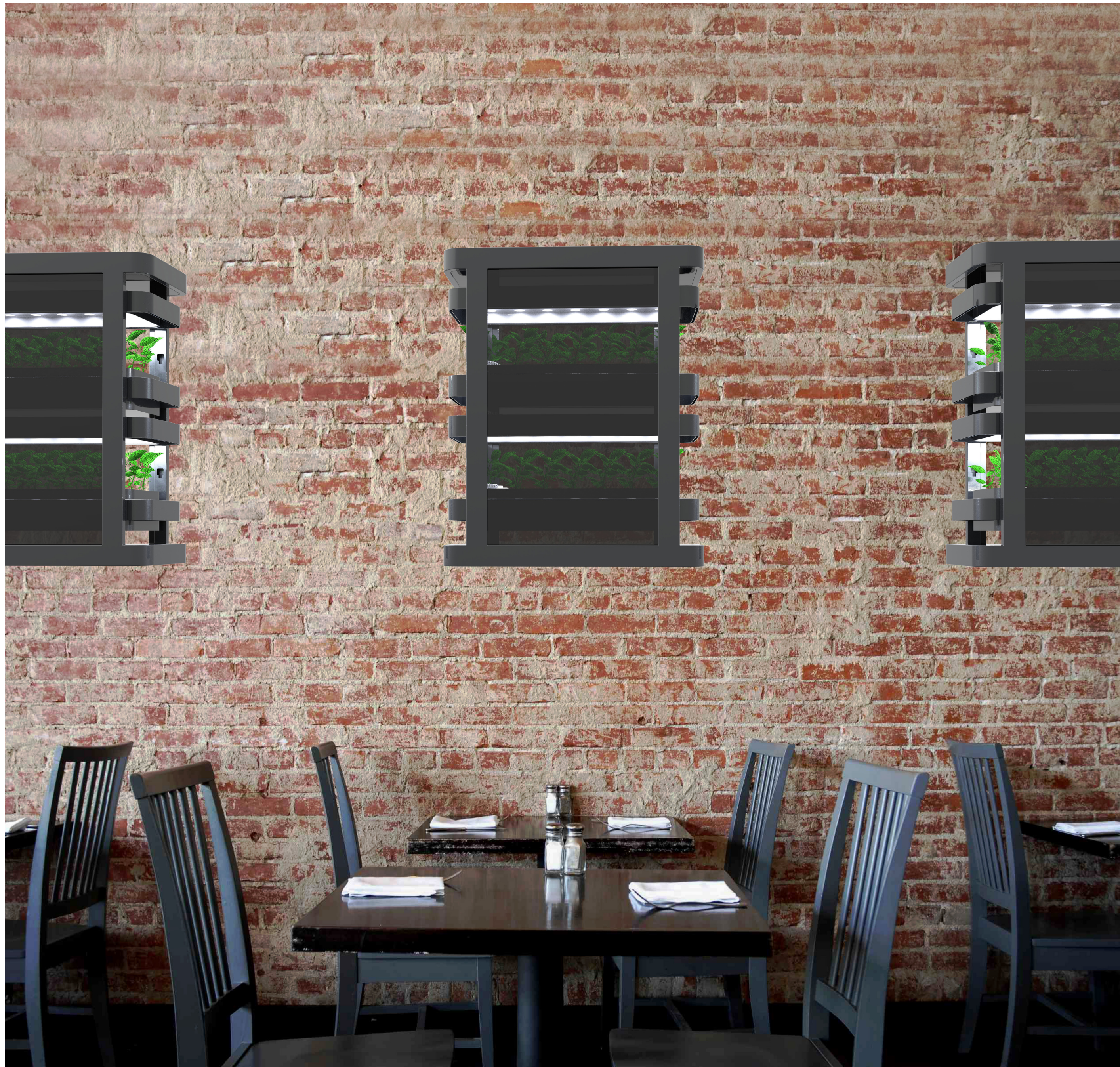
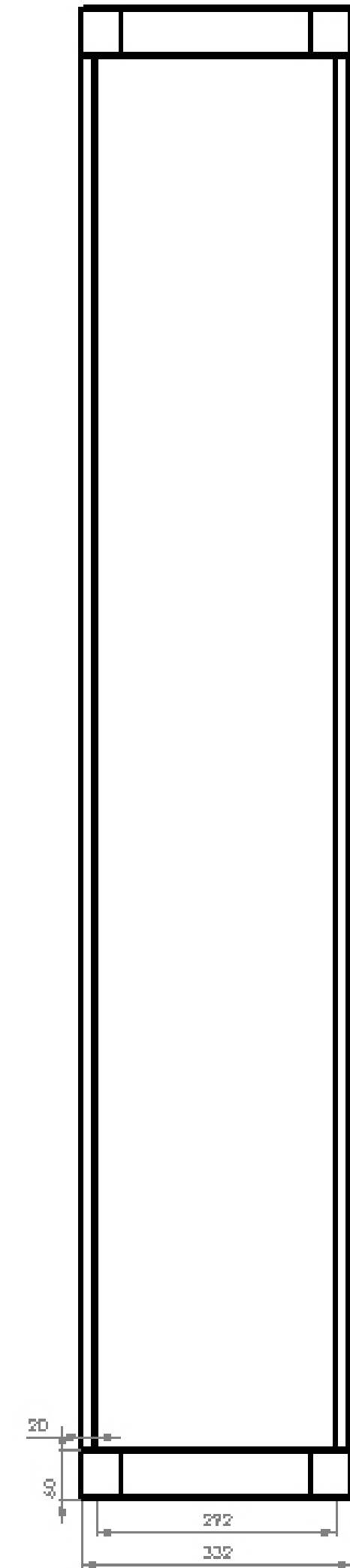
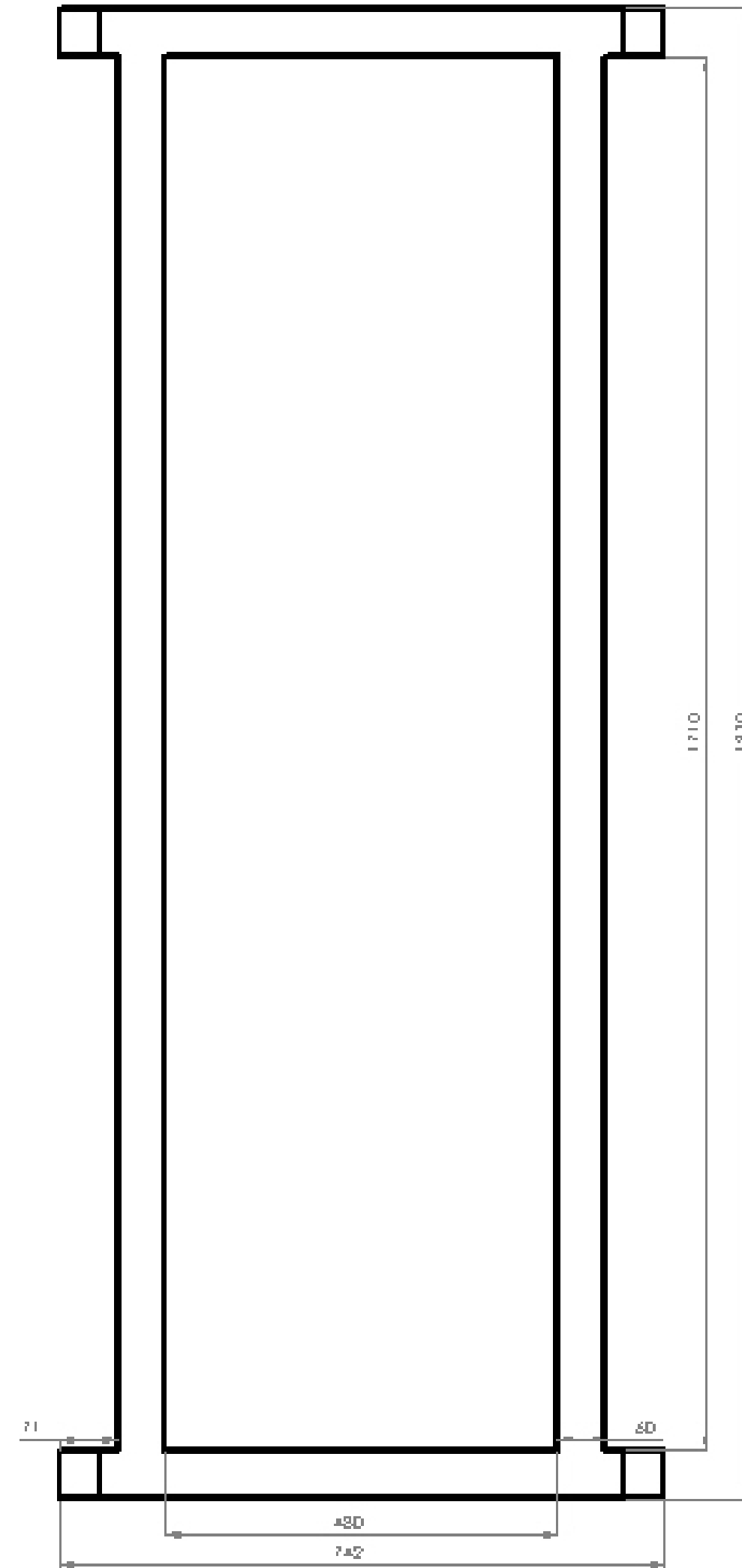
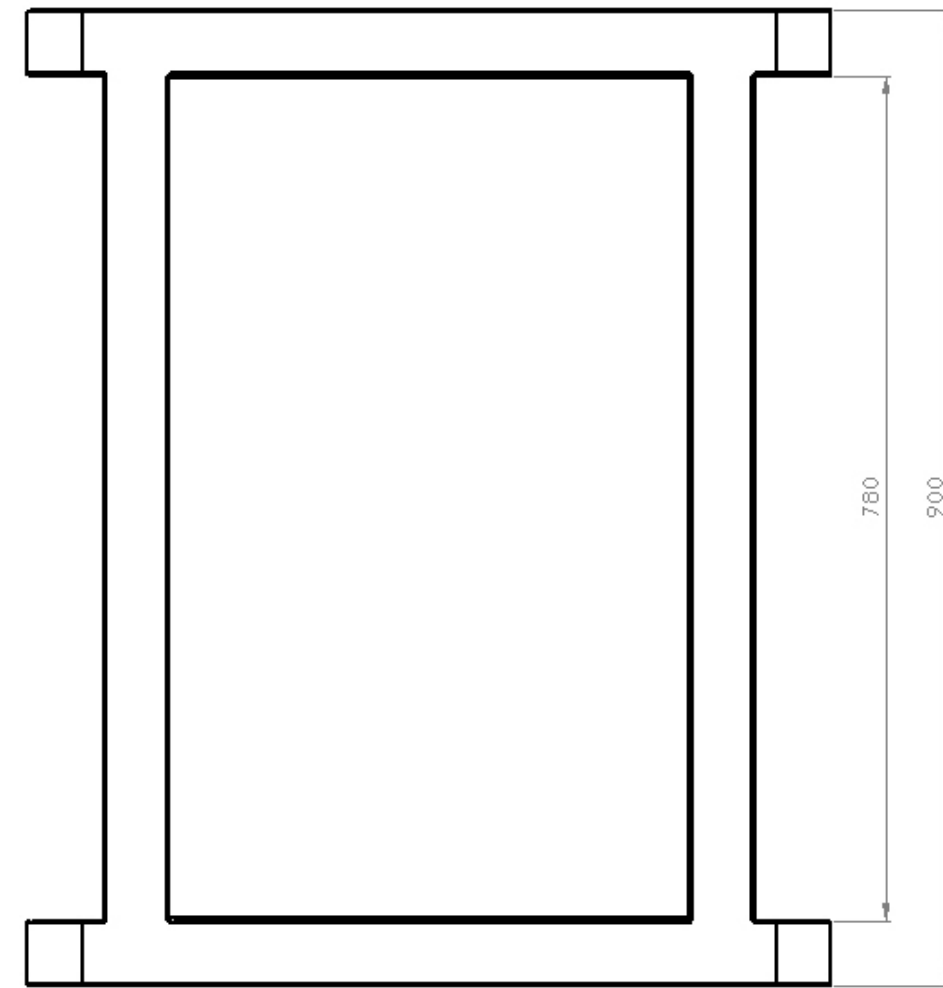
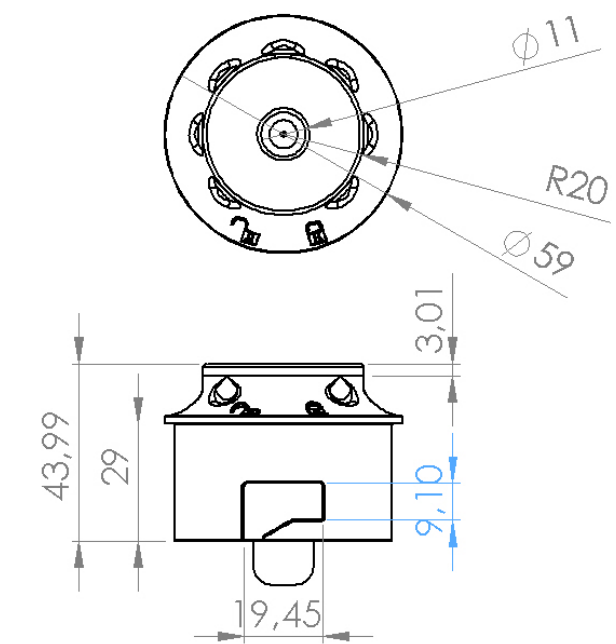
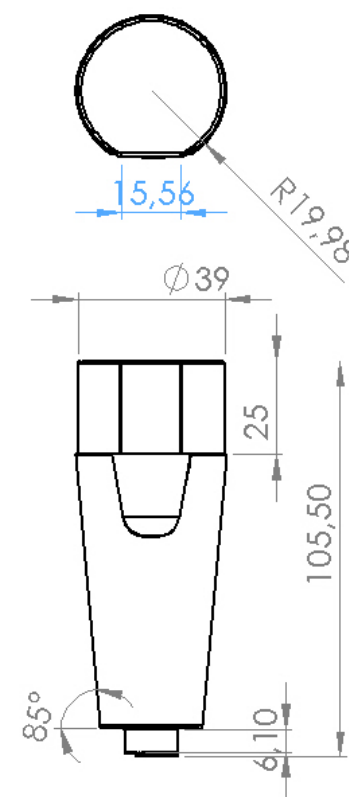
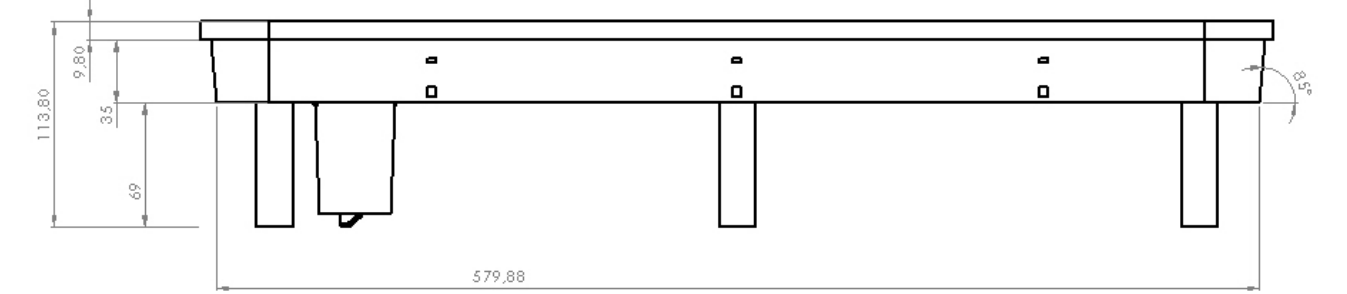
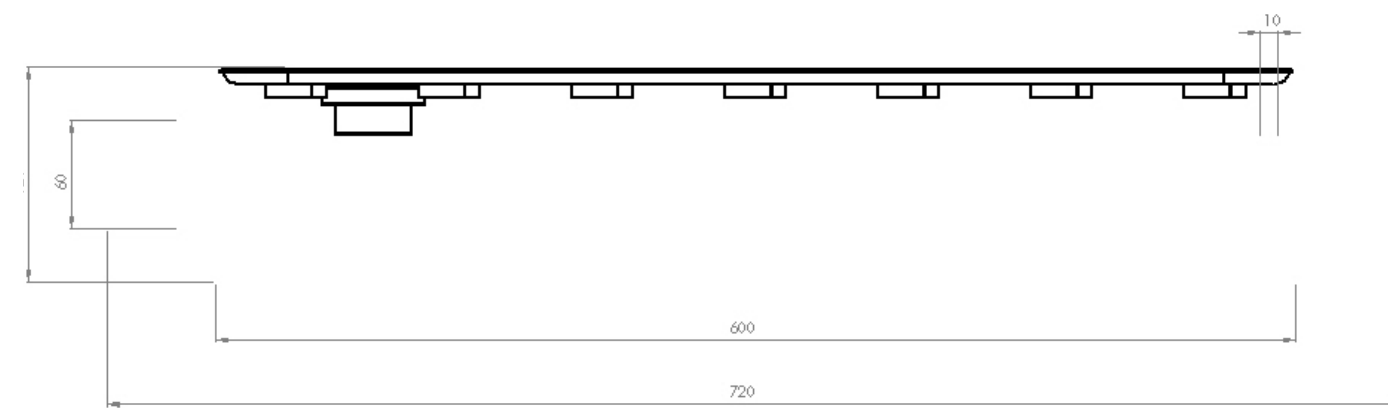
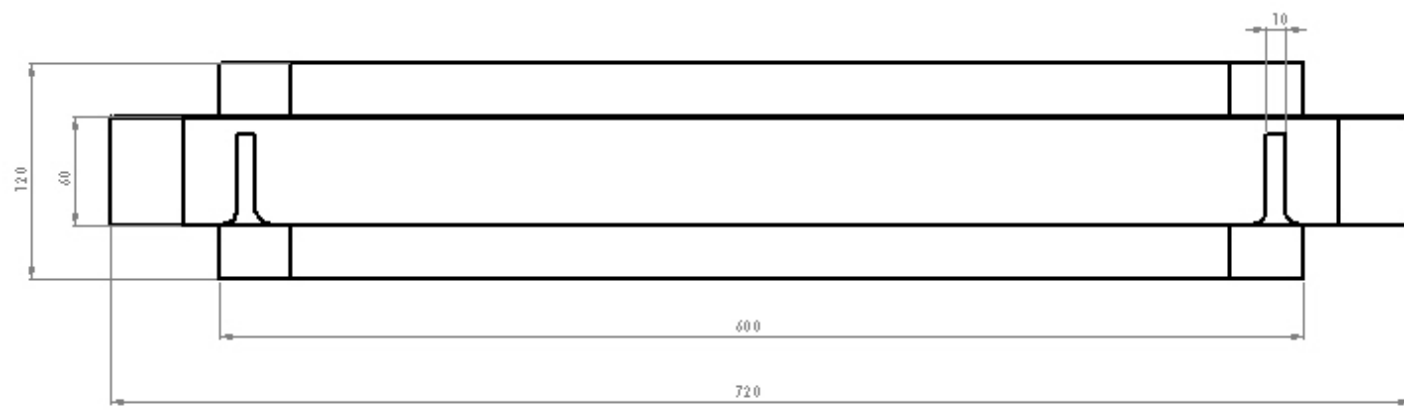
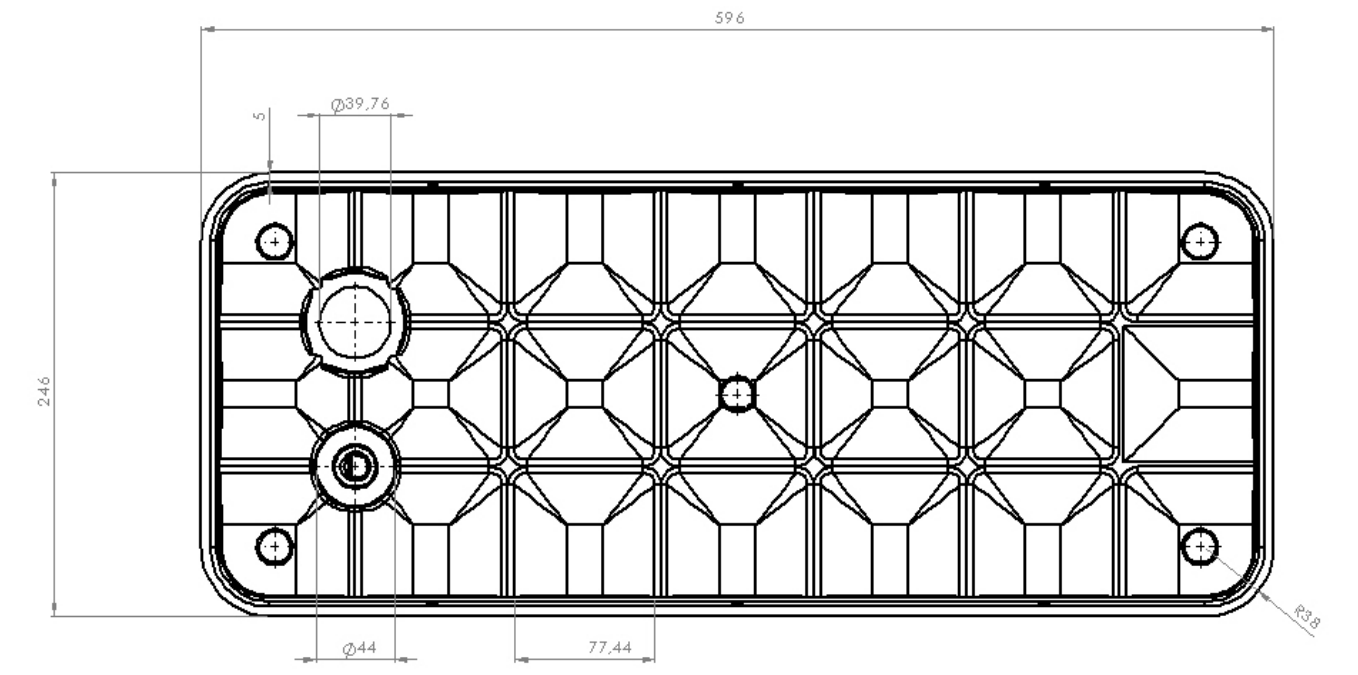
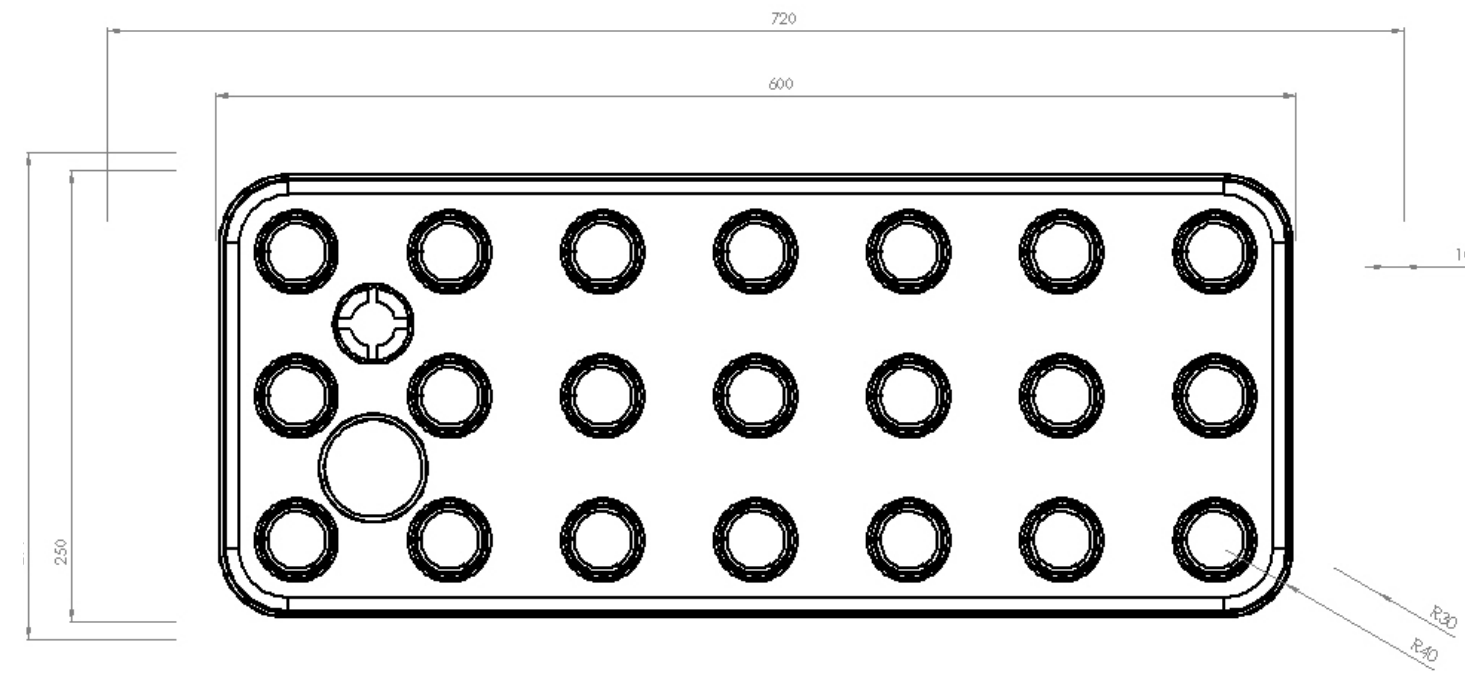
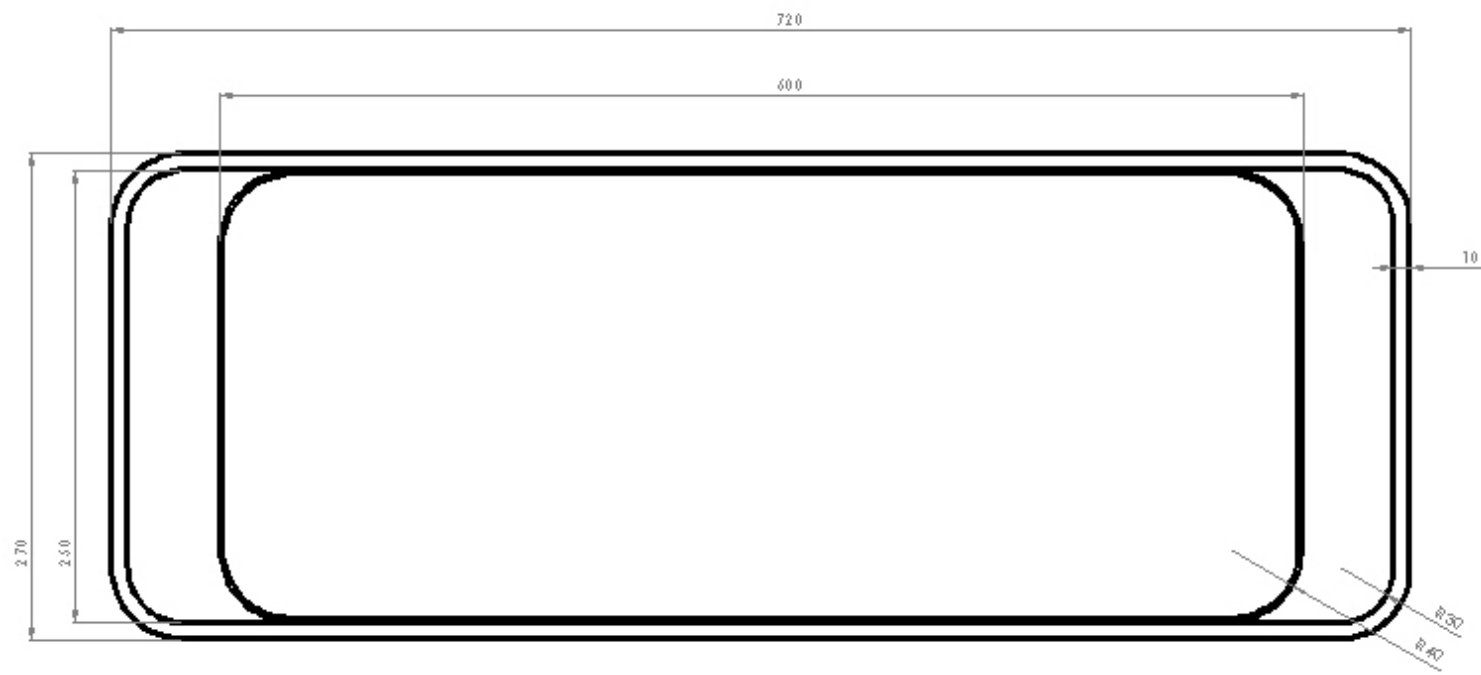


IMAGE 53. Brick wall restaurant. Unknown. 2017 IMAGE 54. Indoor Cultivators. Keny Muesa. 2017

7.8. Measurements





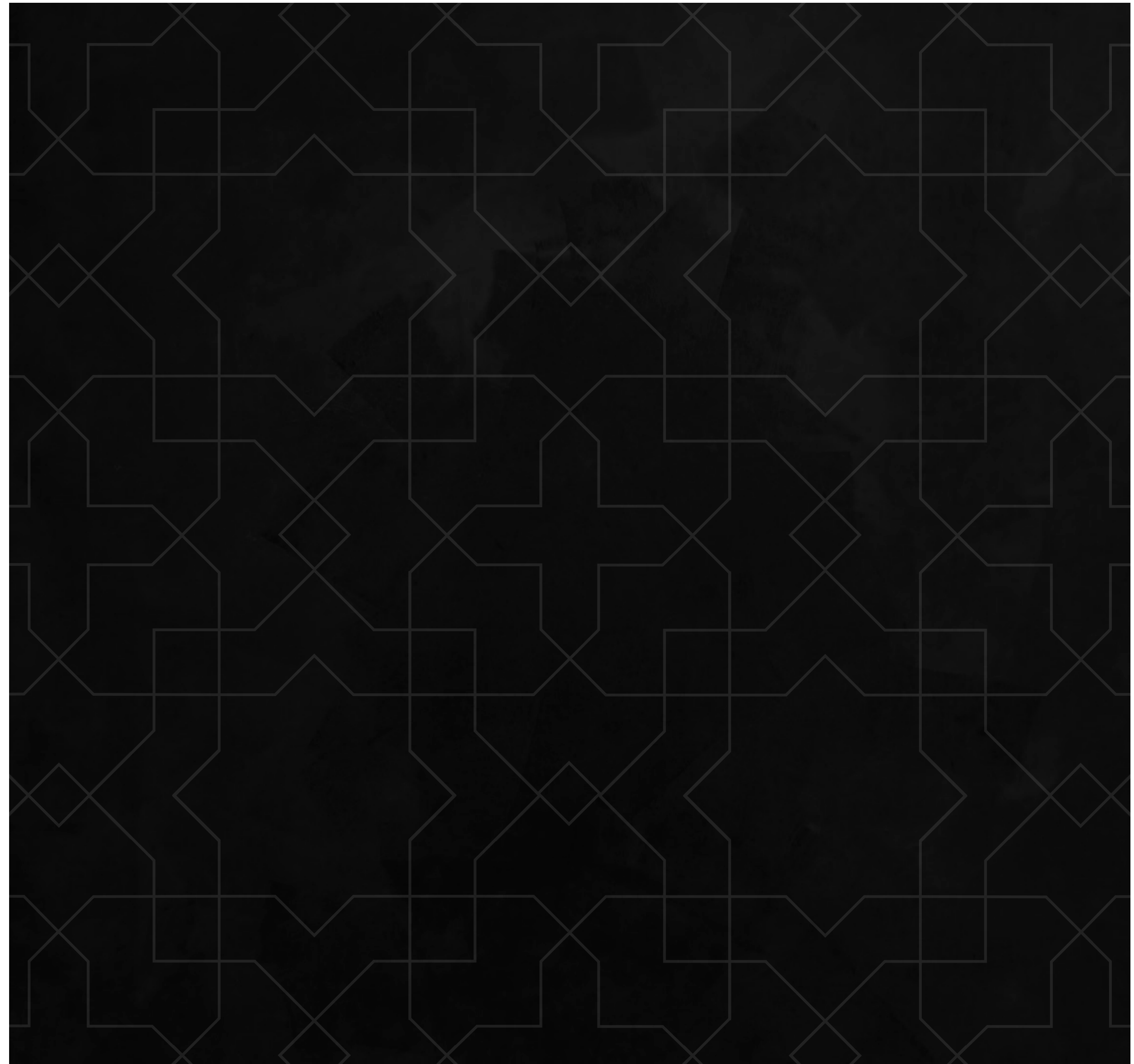
8. Evaluation

In all respects, this thesis project was realized effectively and according to the original plan. Even though I started the actual designing project slightly behind the original schedule, I was able to bridge the gap during the process.

I found the topic relatively unknown at the beginning of this project. All the research, studying and an overall familiarization with the topic seemed a little laborious at times, because of its large scale. However, I was able to manage the subject widely enough to handle the entirety and to find the most important key factors related to the topic. With the information I learned during and through the process, I was able to produce a concept, that not only complies with the legal and operational dimensions, but also with the customers' requirements and wishes.

I worked independently for the majority of the time. Appointments with the customer were always agreed in advance and scheduled to match the different designing stages. These meetings were very instructive and, when necessary, the customer guided me with all the technology requirements and other technical functions. The communication between us was really good and I was able to show a considerable amount of progress in the development of the concept in each meeting.

During this thesis project, I have demonstrated being capable of carrying out a product development process to the point of a functional concept. I have also produced much needed material and information for further development. All things considered, the work has been extremely educational and I have clearly acquired more skills in project managing, communication and software use.



8.1. Product

Considering the design and functionality of the product, the pre-defined objectives for it were achieved. I harnessed Plantui's technology in a completely new format, taking advantage of and using parts of it that are already in use in their current product portfolio. The product figures as a whole, and its appearance does not change during the different stages of growth. It stays as a well-balanced entirety, where the light and growth units work by binding the overall shape, generating a complex and elegant design.

The ergonomics of the product for the end-user, in a usability point of view, were taken into account. The Indoor Cultivator simply works and cultivates enough to be used in a restaurant environment. Despite of its modularity, it does not require much effort from the restaurants.



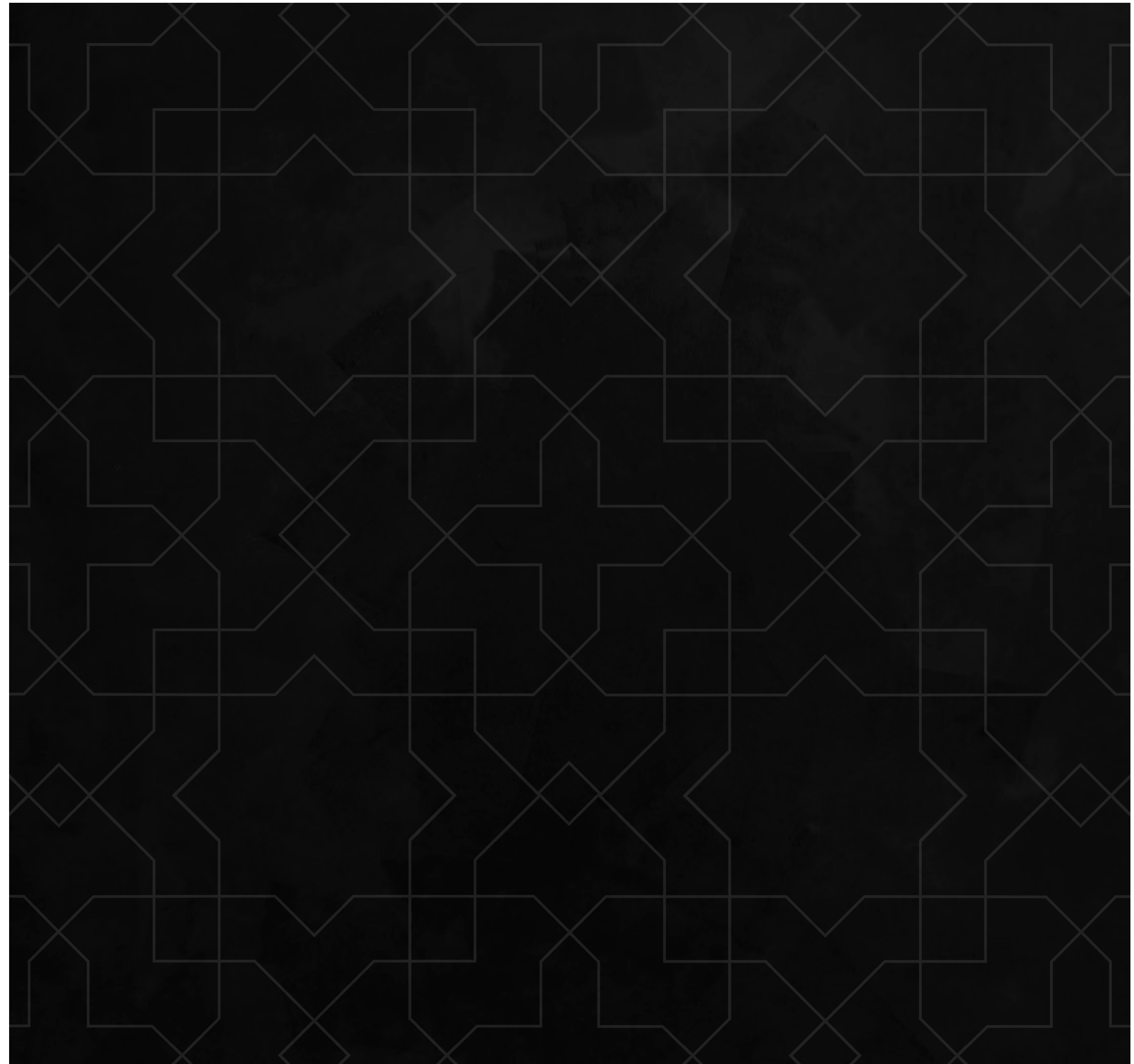
IMAGE 57. Arabesque pattern. Keny Muesa. 2017

8.2. Further development

I presented my final concept in a meeting with the representatives of Plantui, where we reviewed the whole project and discussed the possible further development of the concept. It is completely feasible, but the company's Chief Technology Manager proposed some minor changes to lower the total costs of production.

Another point to note during the further development is the editing of the plant and water trays. By splitting the parts in half and relocating the pump and the water inlet on opposite sides, the size of the molds in the production could be halved. This solution would considerably reduce the price of the required molds for the production step. However, modifying the components would not affect the usability, as the mirrored parts fit together seamlessly.

Another important factor regarding the usability of the product is the development of the power supply. With some changes in the product, the electricity could be conducted along the rails. This facilitates the use of the device, as the user would not need to attach any individual power cords to the gardening units. It has been drafted, that the power could pass automatically along the rails into each separate unit. Thus, when the units are lowered, connected and pushed into their place, they would automatically receive the required electric power. This solution would substantially reduce the operational phases when using the product.



Reference list

Printed references

- Tim J. Cornell & Kathryn Lomas. 1996. *Urban Society In Roman Italy*. Revised ed. Newcastle: Taylor & Francis.
- Alexander Nützenadel & Frank Trentmann. 2008. *Consumption, Markets and Politics in the Modern World*. London: Bloomsbury Academic.
- Darryl Benjamin & Lyndon Virkler. 2016. *Farm to table : The Essential Guide to Sustainable Food Systems for Students, Professionals and Consumers*. New Hampshire: Chelsea Green Publishing.
- Douglas Waterford. 2015. *21st Century Homestead: Urban Agriculture*. USA: Lulu.com.
- Darrin Nordah. 2009. *Public Produce: The New Urban Agriculture*. USA: Island Press.
- Mark R. Sneller. 2010. *Greener Cleaner Indoor Air: A Guide to Healthier Living*. Tuscon: Wheatmark.
- Richard N. Arteca. 2014. *Introduction to Horticultural Science*. 2nd Edition. Boston: Cengage Learning.

Internet references

- Plantui Oy. 2015. Executive Summary [cited 30 Jan 2017] Available from Internet: http://plantui.com/wp-content/uploads/2015/10/Plantui_IM_151008.pdf
- Lorri Mealey. 2017. A History of the Restaurant [cited 06 Feb 2017] Available from Internet: <https://www.thebalance.com/a-history-of-the-restaurant-2888319>
- Robert Schwartz. 2001. A Brief History of the Restaurant in France [cited 06 Feb 2017] Available from Internet: https://www.mtholyoke.edu/courses/rschwartz/hist255-s01/pleasure/history_restaurant.html
- Lynne Olver. 2015. Food Timeline FAQs: professional food service [cited 06 Feb 2017] Available from Internet: <http://www.foodtimeline.org/restaurants.html>
- Craig Berman. 2017. How Does Globalization Affect Restaurants [cited 06 Feb 2017] Available from Internet: <http://smallbusiness.chron.com/globalization-affect-restaurants-77851.html>
- The Global Entrepreneur. 2014. Globalization, Fast Food and the "Threat" to Local Culture [cited 20 Feb 2017] Available from Internet: <http://www.theglobalentrepreneur.com/globalization-fast-food-threat-local-culture/>
- Ph Hydro. 2014. On-site soilless gardening for restaurants [cited 20 Feb 2017] Available from Internet: <http://www.powerhousehydroponics.com/on-site-soilless-gardening-for-restaurants/>
- Grace Communication Foundation. 2017. Local & Regional Food Systems [cited 20 Feb 2017] Available from Internet: <http://www.sustainabletable.org/254/local-regional-food-systems>
- Corby Kummer. 2015. Is It Time to Table Farm-to-Table [cited 27 Feb 2017] Available from Internet: <http://www.vanityfair.com/culture/2015/05/farm-to-table-what-does-it-mean-anymore>
- Katherine Whittaker. 2016. So-called Farm-to-table-restaurants [cited 27 Feb 2017] Available from Internet: <http://www.saveur.com/farm-to-table-fraud>

- Maria Earth. 2013. 10 Surprising Reasons Why Your Restaurant Should Start a Garden [cited 01 Mar 2017] Available from Internet: <http://www.farmxchange.org/10-reasons-why-your-restaurant-business-should-start-a-garden/>
- A Healthier Michigan. 2015. Garden to Table: Restaurants That Grow Their Own Food [cited 01 Mar 2017] Available from Internet: <http://www.ahealthiermichigan.org/2015/08/12/garden-to-table-restaurants-michigan/>
- Olivia Terenzio. 2015. 9 Tips for Making a Restaurant Rooftop Garden Thrive [cited 01 Mar 2017] Available from Internet: <http://openforbusiness.opentable.com/tips/9-tips-for-making-a-restaurant-rooftop-garden-thrive/>
- Canada's Office of Urban Agriculture. 2003. Rooftop Gardens [cited 08 Mar 2017] Available from Internet: <http://www.cityfarmer.org/rooftop59.html>
- Tim Lambert. 2017. A Brief History of Farming [cited 08 Mar 2017] Available from Internet: <http://www.localhistories.org/farming.html>
- Bcp. 2005. The Industrial Revolution Begins in England [cited 08 Mar 2017] Available from Internet: <http://webs.bcp.org/sites/vcleary/ModernWorldHistoryTextbook/IndustrialRevolution/IREffects.html>
- The National WWII Museum. 2017. Fun Facts About Victory Gardens [cited 08 Mar 2017] Available from Internet: <http://www.nationalww2museum.org/learn/education/for-students/ww2-history/at-a-glance/victory-gardens.html?referrer=https://www.google.fi/>
- Newsweek. 2009. Urban Garden Grow During Troubled Times [cited 10 Mar 2017] Available from Internet: <http://europe.newsweek.com/urban-gardens-grow-during-troubled-times-81659?rm=eu>
- Ruokatieto Yhdistys. 2010. Edelläkävijäravintolat [cited 10 Mar 2017] Available from Internet: <http://www.ruokatieto.fi/uutiset/edellakavijaravintolat-amentavat-makuja-omilta-palstoiltaan>
- Juho Typpö. 2016. Helsingin keskustan Savoy [cited 10 Mar 2017] Available from Internet: <http://www.hs.fi/nyt/art-2000005014240.html>
- Plantui Oy. 2017. Plant Capsules [cited 11 Mar 2017] Available from Internet: <http://plantui.com/plant-capsules/#plant-capsules>
- Gary Antosh. 2017. Naturally Purify Indoor Air [cited 11 Mar 2017] Available from Internet: <https://plantcaretoday.com/8-aromatic-indoor-herbs-that-purify-air-naturally.html>
- Evira. 2015. Ohje ilmoitettujen elintarvikehuoneistojen elintarvikehygieniasta [cited 11 Mar 2017] Available from Internet: <https://www.evira.fi/globalassets/tietoa-evirasta/lomakkeet-ja-ohjeet/elintarvikkeet/elintarvikehuoneistot/ohje-ilmoitettujen>
- Ministry of Agriculture and Forestry. 2006. Food Act [cited 12 Mar 2017] Available from Internet: <http://www.finlex.fi/en/laki/kaannokset/2006/en20060023.pdf>
- Finlex. 2006. Elintarvikelaki [cited 12 Mar 2017] Available from Internet: <http://www.finlex.fi/fi/laki/ajantasa/2006/20060023>
- Official Journal of the European Union. 2004. Elintarvikehygienia [cited 13 Mar 2017] Available from Internet: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:226:0003:0021:FI:PDF>
- Eur-Lex. 2004. Hygiene of foodstuffs [cited 13 Mar 2017] Available from Internet: [http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32004R0852R\(01\)](http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32004R0852R(01))
- Simon Ashley. 2012. Hydroponic Gardening [cited 16 Mar 2017] Available from Internet: <http://www.sgaonline.org.au/is-hydroponic-gardening-a-viable-alternative/>
- Greentrees Hydroponics. 2017. Hydroponics [cited 16 Mar 2017] Available from Internet: <https://www.hydroponics.net/>
- Plantui Oy. 2017. Need Help [cited 16 Mar 2017] Available from Internet: <http://plantui.com/help/>
- Anna Heiney. 2004. Farming for the Future [cited 16 Mar 2017] Available from Internet: <https://www.nasa.gov/missions/science/biofarming.html>
- ACES. 2017. Requirements for Plant Growth [cited 03 Apr 2017] Available from Internet: http://www.aces.uiuc.edu/vista/html_pubs/hydro/require.html
- RSC. 2017. Photosynthesis [cited 03 Apr 2017] Available from Internet: <http://www.rsc.org/Education/Teachers/Resources/cfb/Photosynthesis.htm>
- Eur-Lex. 2011. Materials intended for food contact. [cited 05 Apr 2017] Available from Internet: <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32011R0010>
- Leena Carpén. 2005. Mikrobiologinen korroosio [cited 05 Apr 2017] Available from Internet: <http://kehittyvaelintarvike.fi/teemajutut/36-mikrobiologinen-korroosio-elintarvike-laitteistoissa-voi-yllattaa>

Picture references

IMAGE 6. Plantui Smart Garden. Plantui Oy. 2017 [04 Apr 2017] Available from Internet: <http://plantui.com/about-us/for-media/>

IMAGE 7. Plantui Smart Garden. Plantui Oy. 2017 [04 Apr 2017] Available from Internet: <http://plantui.com/about-us/for-media/>

IMAGE 8. Kitchen. Paula Hietaranta. 2011 [05 Apr 2017] Available from Internet: picture: <http://4.bp.blogspot.com>

IMAGE 9. Plants in plastic basket. American College of Healthcare Sciences. 2017 [04 Apr 2017] Available from Internet: https://www.achs.edu/sites/default/files/slidetest18_1.jpg

IMAGE 10. Chefs in Garden. The Brit. 2016 [06 Apr 2017] Available from Internet: <https://i1.wp.com/napafoodandvine.com/wp-content/uploads/2016/11/463f0c31936fd2215defa5650414b1aa.jpg>

IMAGE 11. Resturant Savoy rooftop. Heikki Kähkönen. 2016 [06 Apr 2017] Available from Internet: <http://viisitahtea.com/artikkelit-2/uutiset/savoyn-ravintolapuutarha-ymparivuotiseksi-japanilaisen-autonvalmistajan-tekniikalla/>

IMAGE 12. Chef cooking. Unknown. 2017 [06 Apr 2017] Available from Internet: <https://cdn.idntimes.com/content-images/post/20160921/foto-4-199e852bf91e11ceeb52113b2be32908.jpg>

IMAGE 13. Chef holding plants. Yrtti Ahlberg. 2017 [06 Apr 2017] Available from Internet: <http://www.ravintolanokka.fi/nokka/wp-content/uploads/sites/8/Nokka-PientilatYrttiAhlberg-40.jpg>

IMAGE 14. Cube bar. Hieu Doan. 2014 [08 Apr 2017] Available from Internet: <http://www.evermotion.org/vbulletin/attachment.php?attachmentid=118566&d=1398837923>

IMAGE 15. Chef and wall garden. LiveWall. 2017 [09 Apr 2017] Available from Internet: <http://livewall.com/living-wall-benefits/vertical-gardens/>

IMAGE 16. Chef cooking. Unknown. 2017 [09 Apr 2017] Available from Internet: <https://www.google.fi/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&ved=>

IMAGE 17. Hydroponic gardening. Mary Calvillo. 2017 [09 Apr 2017] Available from Internet: <http://learnhydroponicfarming.blogspot.fi/2016/05/how-to-plant-mustard-greens-with-wick.html>

IMAGE 18. Hydroponic gardening. Unknown. 2017 [09 Apr 2017] Available from Internet: <https://www.google.fi/search?noj=1&bih=740&biw=1536&tbs>

IMAGE 19. Window farm. Unknown. 2017 [13 Apr 2017] Available from Internet: http://1.bp.blogspot.com/-YLQH4XR5Roi/Th2J_yQYZgi/AAAAAAAAAB24/9UpGXHvxo2w/s1600/Brooklyn+Storefront+System+2.jpg

IMAGE 20. Foam cube. Unknown. 2017 [13 Apr 2017] Available from Internet: <https://ae01.alicdn.com/kf/HTB1RFAjLVXXXXbEXXXq6xXFXXm/Period-flooding-21pcs-of-net-cup-Hydroponics-system>

IMAGE 21. Hydroponic system. Agronegocios. 2017 [13 Apr 2017] Available from Internet: <http://www.orizont.es/wp-content/uploads/2016/07/hidroponia3.jpg>

IMAGE 22. Foam cube. Unknown. 2017 [13 Apr 2017] Available from Internet: <https://imgs.6sqft.com/wp-content/uploads/2016/05/03044049/foop-seedling.jpg>

IMAGE 23. Hydroponic garden. Ecea Systems Inc. 2017 [13 Apr 2017] Available from Internet: <http://nebula.wsimg.com/6ee44aef6a8ee488f630e0281dce238f?AccessKeyId=DD70AC12446F47783561&disposition=0&alloworigin=1>

IMAGE 25. Green restaurant. Scout Magazine. 2015 [20 Apr 2017] Available from Internet: <http://scoutmagazine.ca/2015/11/19/restaurant-porn-dig-this-israeli-eatery-with-live-herbs-dressing-its-walls-ceilings/>

IMAGE 26. Restaurant brick wall. Unknown. 2017 [20 Apr 2017] Available from Internet: <http://www.cgb-chape-liquide.fr/details-betons-cires-murs/ambiance-loft-1-40-lyon.html>

IMAGE 27. Spanish village. Unknown. 2017 [20 Apr 2017] Available from Internet: <http://photo.liputan6.com/lifestyle/yuk-melancong-ke-desa-serba-putih-di-spanyol-2631725>

IMAGE 28. Terrace. Unknown. 2017 [20 Apr 2017] Available from Internet: <https://fi.pinterest.com/pin/445715694352477317>

IMAGE 30. Mediterranean town. Unknown. 2017 [20 Apr 2017] Available from Internet: <http://www.stylereg.net/travel-leisure/10-most-beautiful-villages-in-europe/>

IMAGE 31. Symbol. Unknown. 2017 [25 Apr 2017] Available from Internet: <http://www.protecfina.fr/protecfina-contact-alimentaire.html>

IMAGE 52. Leroy restaurant. Zsuzsanna Kertész. 2014 [25 Apr 2017] Available from Internet: <https://www.behance.net/gallery/21754469/Studio-Arkitokter-LEROY-SUSHI-Restaurant>

IMAGE 53. Brick wall restaurant. Unknown. 2017 [25 Apr 2017] Available from Internet: <https://s-media-cache-ak0.pinimg.com/originals/ea/0c/6e/ea0c6e1835c0b5767dddbe085e541520.jpg>