



Department of biotechnology

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Master's thesis

Vertical farming particularly aquaponic system in Oslo

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Abbreviations

TAM	total addressable market
DMU	decision making unit
UN	United Nations
NFT	nutrient film technique
DWC	deep water culture
RAS	recirculating aquaponic system
R and D	research and development
UPS	unique selling proposition
LED	light emitting diode

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Abstract

The term Vertical Farming is coined by Dickson Despommier in 1999. The term "father of vertical farming" refers to his pioneering work in this area. Growing crops in vertically stacked layers is called vertical farming. It has some similarities to the use of metal reflectors and fluorescent lighting in greenhouses. There are different forms of vertical farming, hydroponic, aquaponic and aeroponics, this study will focus on an aquaponics system. Effect of temperature and pH on aquaponics will be monitored. pH for most of the aquaponic system ranges between 6.8 – 7.2, it is best for plant, fish and bacterial species. Water temperature ranges from 68-86 °F or 20-30 °C and for tropical fish range of temperature is between 71-89 °F (22-32°C) for cold water fish temperature ranges between 50-64°F (10-18°C) (aquaponics, G. g. 2021). Different kinds of plants and fishes that can be grown using an aquaponic system will be monitored. Plants that have short production cycles, high yield, short stature, yearly demand and require limited labour are best for an aquaponic system. Fish species tilapia, catfish, bream, hybrid and arctic char striped bass while for enjoyment are Goldfish and koi are excellent options because they look very attractive.

The aim of the thesis is to develop a successful business plan for the future company.

Different methods such as value chain analysis, SWOT analysis, value proposition canvas, and business model canvas are used to develop a business plan. Value chain analysis gave a close overview of the activities that take part in developing the value for the target customers. SWOT analysis showed the company can grow in the future and Arctic char and tomato are the potential products in the future, but the company has very few potential customers which is a threat to the company with the total budget 651000. The company can keep the project by delivering the right number of arctic char and tomato to target customers. The company will produce millions of kilo fish within 2025 to meet demand for high quality food.

Introduction to vertical farming

The term Vertical Farming is coined by Dickson Despommier in 1999. The term "father of vertical farming" refers to his pioneering work in this area. Growing crops in vertically stacked layers is called vertical farming. It has some similarities to the use of metal reflectors and fluorescent lighting in greenhouses. It often incorporates controlled-environment agriculture, which aims to optimize plant growth, and soilless farming techniques such as hydroponics, aquaponics, and aeroponics (Birkby, 2016).

The world's population is increasing significantly. The United Nations (UN) has predicted that the global population will increase by 40 percent in 2050 (mataifa, 2017). It means that we should have 70 percent more food to feed people on planet by 2050. Vertical farming is one of the methods which can be used for food production. Natural disasters, for example floods, storms, drought etc. and human's activities causes climate change which lead to reduction of productivity of land. Vertical farming allows more urban activities which gives more food to feed more people.

WHO has shown that in most of the farms people use fertilizers made of animal waste that are ideal for flies, and they cause diseases in plants ultimately people's health get effected by these pesticides and herbicides. Agricultural runoff also polluted natural resources, so it is better to use vertical farming to prevent these damages in our life. Natural ecosystem is changed by human's activities. Indoor vertical farming can be used to prevent destruction of natural ecosystems and can be used to maintain natural systems. Vertical farming uses less area only 10 percent of land could be used which reduces emission of CO₂, which ultimately use to prevent destruction of biosphere (wikipedia, n. d). Production of crops increased using vertical forming, which ultimately increases the economy of a country. Wasted urban structures can be turned into vertical farms to provide Fresh Food to underserved communities.

Vertical farming methods

There are different methods of vertical farming that could be used,

- Hydroponics
- Aquaponics
- Aeroponics

Hydroponic

Hydroponic system does not need soil, hydroponic is a Greek word hudor means water ponos for work means water working. There are 16 nutrients which are essential for plant growth. Three nutrients, carbon, hydrogen, and oxygen can be accessed from air and water exchange, the remaining 13 components dissolved in water with hormones his system has various benefits, produces high yield of calories per growing area (Robbins C, 2021). Negative effects of hydroponic is it required expensive nutrients for plant growth and dispose of waste materials.

Aquaponics

Combination of hydroponic and aquaculture system known as aquaponic system, which is ecofriendly, lead to cultivate fish with crops without use of soils. This produced symbiotic relation between plant and crops. This is an inexpensive method. fish produces nitrogen components which is taken by fish in return fish produces clean water, used by the plants. Aquaponics means fresh water but, in some countries, for example Israel and Australia work is ongoing by using saltwater algae and seaweeds, as plant elements and animal elements are sea urchins, sea mollusks, sea crustaceans. It consumes 10 percent of water used in traditional forming (Shafahi & Woolston, 2014).

Aeroponics

Aeroponics is a more efficient system than hydroponic, plants grow rapidly with sunlight and small amount of water without soil and nutrients media. This system needs 95 percent less water and space ("The Different Types of Aquaponics Systems," 2022) Plants produced through Aeroponic system are healthier and contains more nutrients as compared to plants produce through traditional method("The Different Types of Aquaponics Systems," 2022)

This system was started in the 1920's and early 1940 was used as a research tool. Genesis Rooting System was the first aeroponics setup, commonly called the Genesis Machine, by GTi in 1983 and in 1990s, test and trails was carried out by NASA on earth. They started to grow crops without soil and small amount of water. Aeroponics proved to be the best method for biomass production(Kumari & Kumar, n.d)

The aim of this thesis is to develop a business plan for vertical forming for small scale restaurant business in Norway using Aquaponic system.

Background theory

Modern indoor growth systems

Changes will occur in the upcoming 50 years because of high food and growth population throughout the world. The world population will reach by 9 billion in 2050. 80 percent of this population will be in cities. 800 million of land is for soil-based farming system which is equal to 38 percent of total global land. Due to increasing world population there is high demand for food which results in high demand for land to cultivate food. A new method that could fulfill this demand is vertical farming (Kalantari et al., 2017). Resource efficiency consistency and space efficiency have made indoor farming widespread and common.

There are different types of indoor farming. The Home-grown system is best for new hydroponic growers because it is cheapest and riskiest way of growing at home there are plenty of resources for those who want to make their own garden at home. Warehouse farming has caught the attention of investors and entrepreneurs as it is known to produce massive amounts of products. Vertical farming is another technique for indoor planting, it uses less space and resources. In this system plant is kept in space that all essential components for plants. Farmers can produce large amounts of food using vertical farming technique with less space. There are different types of vertical farming. Plants' growth through hydroponic system is 20 percent faster as compared to plant grow through soil bound counterparts (Despommier, D. 2011). Hydroponics technique involves growth of plants without soil. Plants root are immersed in solution with different nutrients, so essential nutrients can be absorbed by the roots of plant. Aeroponics is another form of vertical farming, it doesn't need soil and aquatic life to grow. Aquaponic techniques in which it involves fish farming and hydroponic plants to grow together without soil. The combination of aquatic organisms and plants without land-use helps plants to focus on absorbing nutrients and materials. Indoor crop production is very expensive, it cost high and all kind of crops could be produced using vertical farming (Runkle, 2019).

High quality crops could be produced using vertical farming. Crops produced through vertical farming are more suitable and reliable as compared to the crops produced through conventional methods. It contains more nutrients, better in texture and good flavor and having longer shelf life (Runkle, 2019). Hydroponic technique was invented by William Frederick in 1930s at California University. Vertical farming was invented by Swedish farmer named Ake Olsson in 1980s. He developed a spiral shaped rail system for plant growth in cities. This is

suitable method for food production in rural and urban areas, which provide economic, environmental and social benefits (Runkle, 2019).

Vertical farming requires four key areas which are physical structure, growth media lighting and sustainability features. In vertical farming crops are grown in vertical layers, light should be monitored in the room. Combined artificial and natural light is being used in vertical farming. Growth media in place of soil is used. Food produced through vertical farming is sustainable which pest free. In vertical farming climate has less effect on crops because it is an indoor technique (grower, 2022).

Vertical farming has some disadvantages, for example pollination will be difficult, cost effective for middle class farmers. It involves high cost for labor. It relies on technology that is why there will be problem related to power (Mishra & Sahoo, n.d).

In vertical farming temperature, humidity, light and gas are regulated artificially. The main purpose of vertical farming is to produce high amounts of food in small areas.

Vertical farming has increased in recent years because of widespread world population. in 2019 it was worth 4.4 billion dollars but in 2025 it will expect to be worth 15.7 dollars. Between 2018 to 2024 the vertical farming sector in the united state is projected to expand at a CAGR of more than 24 percent reaching 3 billion dollars annually (Mishra & Sahoo, n.d).

Fig. 01. comparison between vertical and traditional farming

Crop	Target PPFD Range	Crop	Vertical Racking Levels
High Wire Vine Crops	450 - 600 (toplight) 120 - 250 (intracanopy)	High Wire Vine Crops	1 layer of top-lighting + 1-2 layers of intracanopy lighting
Vegetables	350 - 600	Vegetables	2 - 3+
Leafy Greens	180 - 270	Leafy Greens	4 - 6+
Microgreens & Herbs	130 - 250	Microgreens & Herbs	4 - 6+
Floriculture	40 - 600	Floriculture	1
Mushrooms	0 - 100	Mushrooms	4 - 8+
Berries	220 - 350	Berries	1 - 2+

Figure 1: Comparison between vertical and traditional farming

Effect of temperature and pH on plants and fish in aquaponics

Water temperature is very important which should maintain in constant level in aquaponics. The temperature of the water is essential for breakdown of nutrients and waste. It is very important to maintain the temperature of water, which is best for plants, fish and for the health of bacteria. There are some factors that can affect water temperature such as capacity of heating system, material of tank, climate, volume of water, growth media, length of pipes, these factors maintain water temperature. Water temperature ranges from 68-86 °F or 20-30 °C and for tropical fish range of temperature is between 71-89 °F (22-32°C) for cold water fish temperature ranges between 50-64°F (10-18°C) (aquaponics, G. g. 2021) for Bacteria temperature ranges from 62-93°F (17-34°C). For different kind of plants temperature ranges between, for vegetables: 64-86°F (18-30°C) and for basil 62-86°F (17-30°C), for cucumber and lettuce it ranges between 46-68°F (8-20°C) and for Leafy Greens: 78°F (26°C) (aquaponics, 2021).

Effect of pH

pH for most of the aquaponic system ranges between 6.8 – 7.2, it is best for plant, fish and bacterial species. Many plants grow best in acidic pH range between 5 – 6.5 which include lettuce, leafy greens, herbs, tomatoes, peppers. Tilapia grows best at pH of 7 – 8 which is slightly basic pH. Nitrifying bacteria grow best at alkaline level at 8 – 9. The pH is changes with time it is difficult to maintain pH (life, 2013). If the pH is high, important elements such as iron is not available to the plants and iron deficiency diagnosed as yellowing of leaves particularly at the tips of leaf. A quick remedy for this situation is the use of chelated. If the pH decreases the nitrification decreases. Nitrifying bacteria converts ammonia to nitrate which is done at alkaline level of pH. At a pH of 5.5 or below this process is drastically inhibited. It also causes stress in fish result in disease and death of fish (Despommier, D. 2011). Fig N0. 02 shows main component of vertical farming.

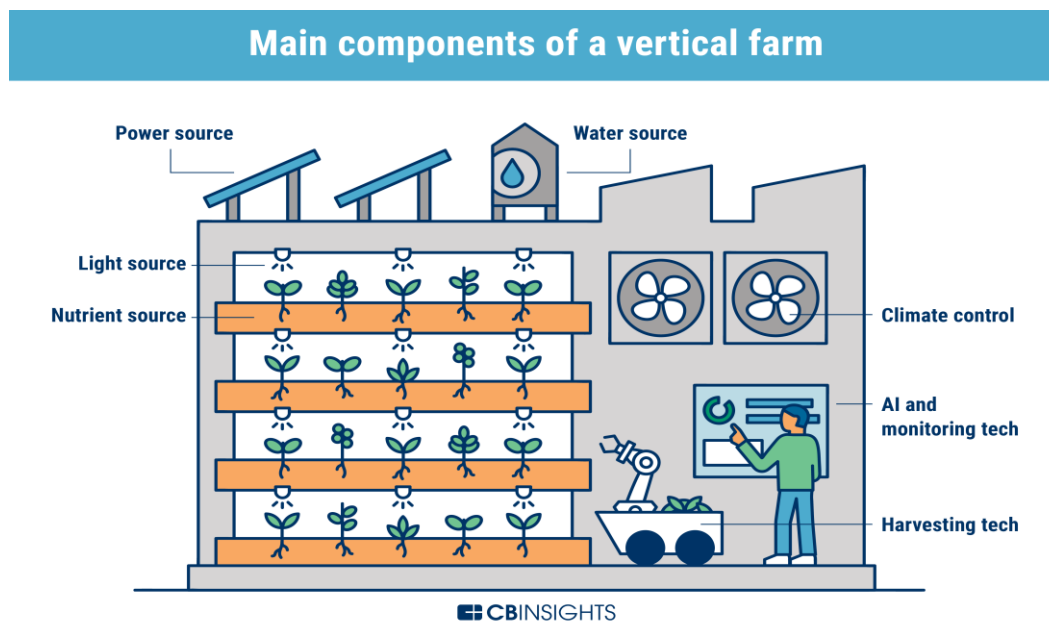


Figure. 02. Main components of a vertical farming

These are the main components are:

- A physical structure
- An energy source
- Lighting
- Climate control
- Water supply

- A nutrient source

Many modern vertical farms also employ AI technology that uses sensors and cameras to monitor plant health and adjust environments accordingly (Birkby, J. 2016)

Modern aquaponics

Modern aquaponics emerged in 1970s. In the last decade many farms producing fish and vegetables in circular systems have emerged in United States and Australia. Research on aquaponics aspect started in USA (Turnesk. M, *et all*, 2020.) According to (Summerfelt 2020), Perior in USA is the largest aquaponic producer. It is the first land-based farm that sent Atlantic salmon to market in USA.

Aquaponics in Europe

The aquaponic industry developed in Europe at slow rate, particularly within research institutes and extended with public fundings. Different kinds of aquaponic system have been constructed in European countries. These prototype aquaponics systems range from classroom to backyard farm system to full scale farm but few of them reaches to production area more than 100 square meter. In recent years with increased research and development in the field, the trend is moving toward large and more advanced system. The largest system is still small compared to conventional farm (Turnesk. M, *et all*, 2020).

In Europe development of aquaponic system started in 2014 to 2018 by European funded COST Action FA 1305 “the EU Aquaponics Hub. Aquaponics get the attention of European policy makers. The European Parliament Research have selected Aquaponics as a tool for making food more effectively that changes our lives (Turnesk. M, *et all*, 2020)

Aquaponics in Norway

Test site has been operation at Landvik in Grimstad at Bioforsk the Norwegian Institute for Agricultural and Environmental Research. Since 2014 they are operating a research site. They are operating two different systems, one normal which get fertilizers and other get nutrients from fish. Plants float on water. The number of plants that can be cultivated in aquaponics system depends on amount of feed fish get, number and size of fish. It ranges from 60 to 110 grams of feed per square meter (Tjomsland.A,2014)

Crops suitable for hydroponic and aquaponic systems

Certain kind of crops will be suitable because cost to build and operate vertical farm is very high. (Runkle.E, 2019) Crops has to possess specific characteristics or abilities to be suitable in a hydroponic system which are explained bellow.

Short production cycle: Crops that took short time to grow are suitable for vertical farming. Crops which grow in days not in months are best because it took low cost for lightning and operating aquaponic system (Runkle.E, 2019).

High harvestable yield: It means how much portion of crops could be sold. Crops like lettuce can be sold as entire plant as compared to crops like tomato, where only fruit can be sold. Energy which is used for leaves and stem growth and maintained is no longer use. It going to be waste (Runkle.E, 2019)

Short stature: Plants that have short growing distance between layers are more suitable for vertical farming. Space is used less efficiently with taller crops. The distance between the lights and the plants can be altered more lighting capacity is required for young plants. As plants grow closer to the light, the light intensity increases at the crop canopy and becomes more variable (Runkle.E, 2019).

Year-round demand: Crops is best for vertical farming which has demand throughout the year. Cultivating the same crops is easier as compared to another crop (Runkle.E, 2019).

Limited labor: Crops that required less labour is best for vertical farming because farming labor is a high cost. Automation decreases labour cost but requires a higher investment.

All kinds of plants can be grown using vertical farming methods. Plants like iceberg lettuce to tomatoes can be grown using vertical farming. Plants that need acidic soil cannot be grown in vertical farming because aquaponic tank needs neutral pH for fish health and it becomes hard to lower pH for these plants (aquaculture, 2022)

Fish species suitable for aquaponics

Edible fish is most common fish used for aquaponics, fresh water fish are best foe aquaponics. Some fish contain high component of protein therefore they are the best candidate for cultivating other can be kept for enjoyment. Fish species tilapia, catfish, bream, and hybrid striped bass while for enjoyment are Goldfish and koi are excellent options because they look very attractive. Furthermore, select a fish that can live in high density and consumed easily as

food by consumers fish is the nutrient source in aquaponic therefore it is important for fish to be healthy and happy reference (University, 2021)

Salmon tends to be the most time and resource-intensive fish variety you may try to produce in an aquaponics system, which might make it difficult for novices. Salmon can still be grown, though, if you know how to build a habitat that will support their development and survival. Here are a few things to think about when taking care of salmon in aquaponics systems. And these are water temperature, ph, sunlight, oxygen requirements and other (FAQ, 2020)

Types of euphonic systems

Different kind of aquaponics system is designed; every system has unique features that are suitable for different kind of crops. In aquaponic system good relation between plant, bacteria and fish is very important.

Tank for fish to grow, grow bed for plants to grow, pump that transfer water from fish tank to plant growing bed, growth media that support plant growth, stand pump that transfer water back to fish tank, water pump helps to recirculate water throughout the system.

There are three aquaponic system named.

- Media Based,
- Raft System,
- and Nutrient Film Technique

Aquaponics systems are very popular now a days therefore other kinds of system have been developed and utilized by aquaponics grower. There are two other aquaponics system named as:

- Vertical Aquaponics System
- Hybrid System.

An important point is which system should be selected while farming; we must see the advantages and disadvantages of the system and then see what fits best with our crop requirement.

How euphonic system works

In euphonic system symbiotic relation exist between plant and aquatic life particularly with different types of fishes Plants feed upon waste material released by fish in turn plants gives

fishes clean water. In aquaponics, fish are used to provide nutrients for plants, while bacteria are used to clean the fish's water. This process is aided by an aquaponics biofilter, which makes sure that nothing is wasted. The biofilter is made to transform ammonia (fish waste) into nitrites and eventually nitrates, which plants may use as food. Nitrifying bacteria, which dwell in the aquaponics system's grow medium, are necessary to do this. However, if your growth medium doesn't have enough surface area, your system won't have enough bacteria for it to function properly. Simply said, bacteria are what transforms ammonia into nitrates for your plants. You will require a biofilter if the surface area of your grow media is insufficient and there is no place to add more. The biofilter plays a crucial role in your system by ensuring that the fish have access to the clean water they require while the plants have access to the nitrates they require. A biofilter is a crucial component of the aquaponics process and ensures optimal efficiency. Which biofilter do you use, and when should you avoid using one?

In a sense, your aquaponics system's surface area is expanded by the biofilter. Your biofilter media's surface is colonized by bacteria. There are really two different kinds of nitrifying bacteria. In the first, ammonia is changed into nitrites, while in the second, nitrites are changed into nitrates. Once the bacteria have established, all that is required to function as a wholly natural filtering system is to maintain the water conditions and let the bacteria do their work. However, some aquaponics systems (DWC, NFT, and Vertical aquaponics systems) do not allow you to rely on the natural process; in these cases, you must install your own biofilter to increase the surface area of your system. In essence, you're providing the bacteria with a home and a place to live, and they'll still turn the fish waste into food for your plants (h. t. aquaponics, n.d). In RAS specific type of feed, which does not integrate easily is used. etabolic activity of animal reaches to peak after two to three hours of feeding (Balasubramanian C. P., 2020).

Aquaponics uses these two in a symbiotic combination in which plants are fed the aquatic animals' discharge or waste. In return, the vegetables clean the water that goes back to the fish. Along with the fish and their waste, microbes play an important role to the nutrition of the plants. These beneficial bacteria gather in the spaces between the roots of the plant and convert the fish waste and the solids into substances the plants can use to grow. The result is a perfect collaboration between aquaculture and gardening.

Media Based Aquaponics System

Media based aquaponic systems are common for small scale, and most popular for farming at home, do it by yourself because it is very easy to operate. It is a simple and most efficient system with space and initial low cost for beginners.

Containers with growth media are required for media-based aquaponics system to plant crops. Water moves from fish tank to growth media through bell siphon which moves water from one place to other for plants to get nutrients and then water transfers back to fish tank, where a new cycle begins.

Waste material is broken down in growth bed, sometimes worms are added to the media for breakdown of waste material. For media based aquaponic systems the fewest components are used, there is no filter for filtration which makes it easier to operate, it produces low quantity of crop because of limited growing space. Figure. 03 shows media-based aquaponics system and how it works.

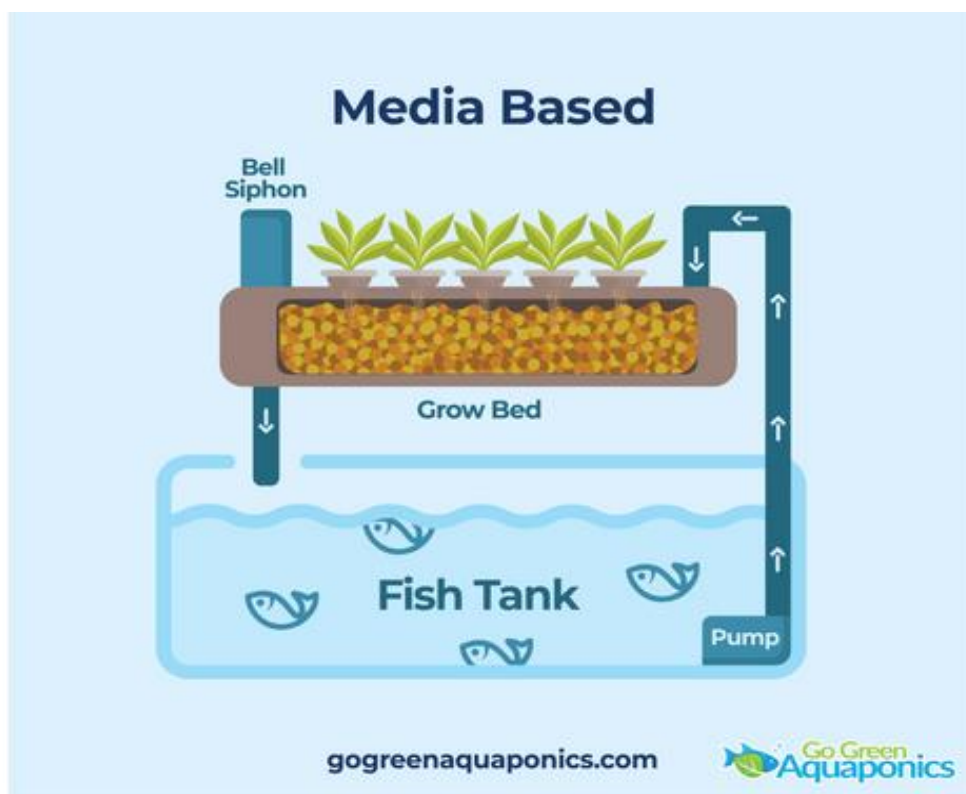


Figure 2: Media-based aquaponics system

Advantages of Media Based Aquaponics Systems:

This system is straight forward and simple to operate it. It is suitable for all kinds of plants from greens to larger plants. It doesn't need to much cleaning, red worms can be added for the

breakdown of waste materials, media act as filter that prevent back flow of waste material. Media particles contain air that supply oxygen to the roots. Media is very expensive, particularly good quality of media. Spaces between media may get clogged leading to anaerobic condition, which is very poor for plant growth. Cleaning of the grown bed is required, which is difficult and time consuming. It has low productivity that is why cannot be used for commercial purpose (blog, 2022).

Nutrient Film Technique

NTF means Nutrient Film Technique. It is hydroponic growing technique. It is simple but effective method, and it works in some environments. It uses horizontal pipes with stream of water that is rich with nutrients. NTF is common for commercial aquaponics and good for urban places where production and space are great challenge. Fig no. 04 nutrient film media for plant and fish growth.

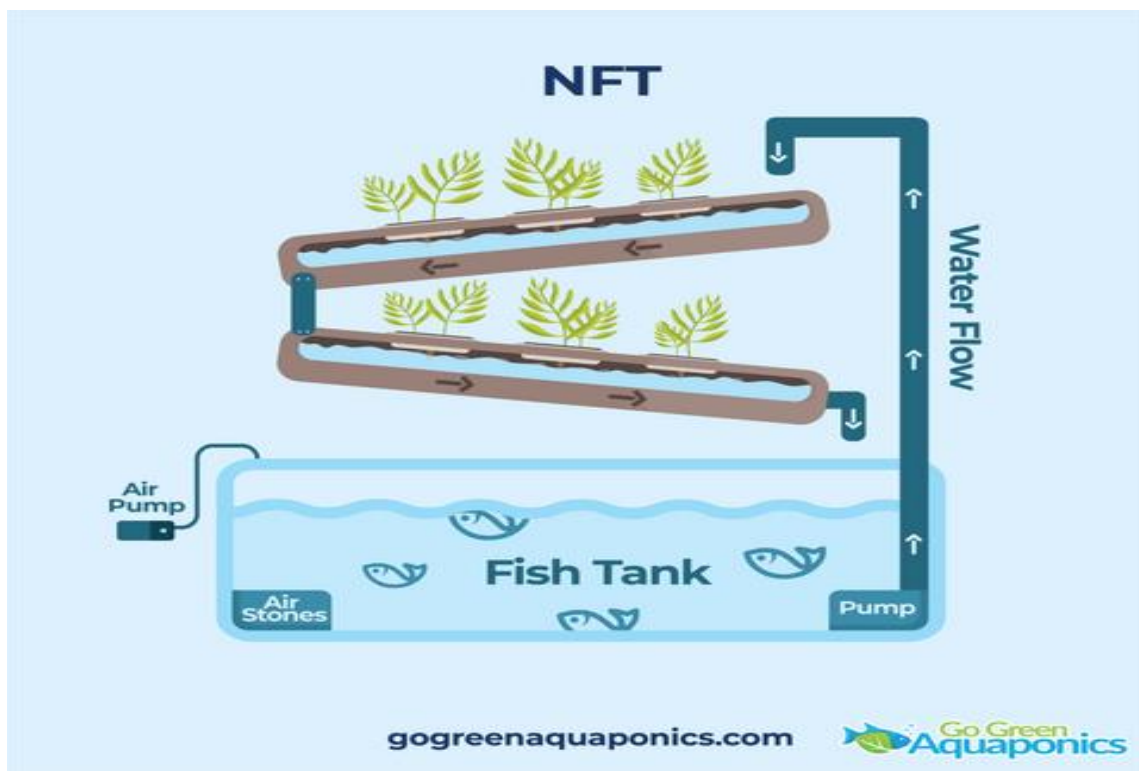


Figure 3: Nutrient film technique system

In this system plants grown on narrow channels. Thin film of water moves through the channels that provide water, nutrients, and oxygen to the roots of plants. In this system water flows through fish tank to the filtration components through NTF channels where plants grown and then move back to fish tank. A separate biofilter is required for NTF for beneficial bacteria

to live. It uses less space and few materials, easy to set up, no need of large land. It allows continuous water purification. It doesn't need grow media for plants to grow. Roots of plants remains above the water line, all the time for absorption of oxygen and to expel waste gases, which results better plant growth. Thin film of water flows in pipes that cause problem in controlling water temperature. Pipes are susceptible to clogging. It is good for small rooting plants.

Raft System

Raft system also known as Deep Water Culture (DWC). It is most efficient system. It has massive production capacity that is why it is good for commercial or large-scale industries. Figure. 05. shows raft aquaponic system

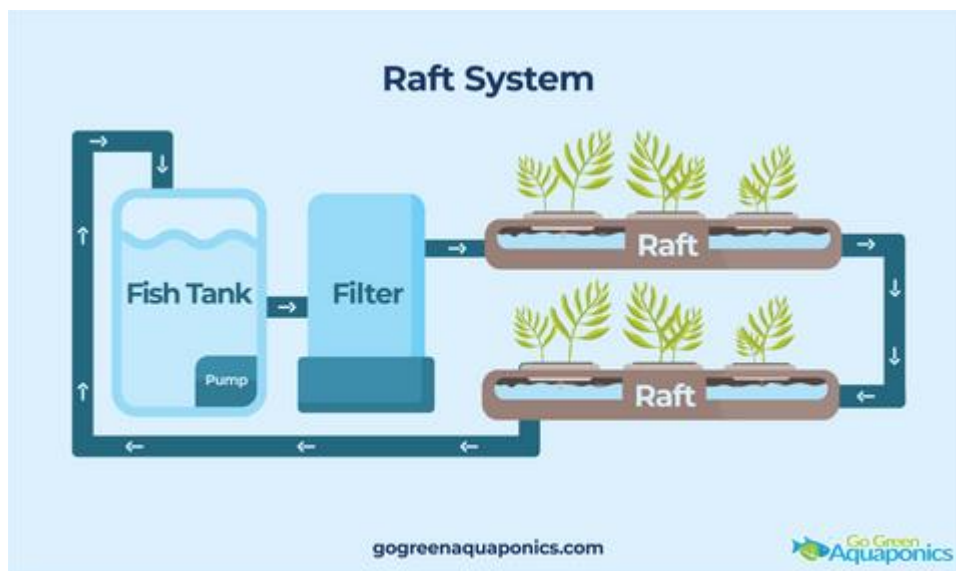


Figure 4: Raft system (Deep water culture system).

In a raft system, the nutrient-rich water circulates through the long canals, usually at a depth of about 20 cm, while rafts (polystyrene or foam board) float on top. The plants are grown on the raft boards supported within holes by net pots. Plant roots hang down in the nutrient-rich, oxygenated water, where they absorb oxygen and nutrients to grow rapidly. The nutrient-filled water flows continuously from the fish tank through the filtration process, then to the raft tank where the plants are grown, and finally back to the fish tank. Most often, the raft tank is separate from the fish tank. It requires cheap labor and gives high productivity. Roots are in contact with nutrients. Plants are easier to harvest. Water volume is more stable in raft system.

Good for commercial production. Large quantity of fish could be cultivated. It is restricted to grow small plants, and not suitable for some roots, fruits, and few other plants. Mosquito can be grown if not constructed properly, needs proper filtration system which increase cost. Microorganisms can attack root system as it is directly exposed to water. It has little surface area for beneficial bacteria to grow.

Vertical Aquaponics System

It uses nutrient film technique. In this system plants are grown in column above fish tank without soil. In vertical aquaponic system plants are grown in channels that are arranged vertically while in NFT plants are arranged horizontally. Figure. 06. shows the vertical aquaponic system.

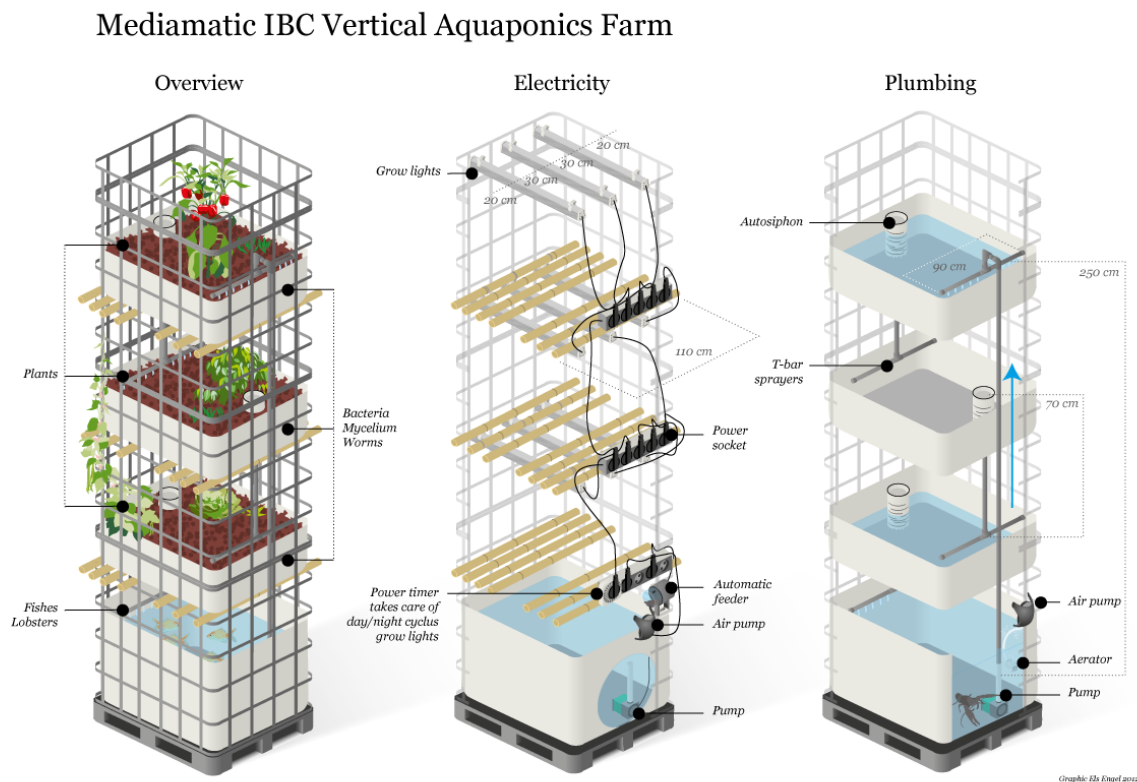


Figure 5: Vertical aquaponic system

Vertical Aquaponics System Design Plans - Bing images

It doesn't need large space for set up, it has more space for plant to stack vertically, it is not weather dependent, if plants are grown inside green house. It uses minimum water. It is good for urban farming. It is inexpensive and doesn't require to many materials to construct. It can

be operated indoor, outdoor or inside greenhouse. Pipes are susceptible to clogging. It is suitable for plants that have small roots. When pump fails roots may be deprived of water.

Hybrid Aquaponics System

In hybrid aquaponic system two or more methods are combined. There are different types of aquaponic system that work well. One example is combination of raft and media-based system. It is highly efficient and uses great space that is why.

There are several approaches to the hybrid system, and all can work well depending on the design. One example of a hybrid system is a combination of raft and media-based systems. Some aquaponics home growers and commercial aquaponics farmers use hybrid systems because of their efficiency and great use of space. Figure. 07. shows the hybrid aquaponic system

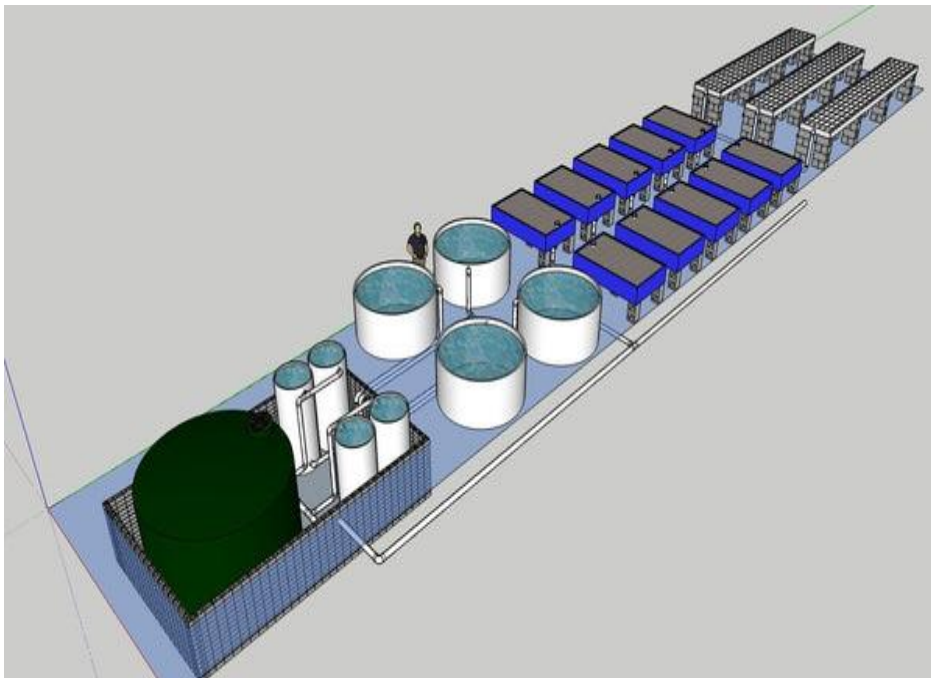


Figure 6: Hybrid aquaponic system

The hybrid system is more flexible for plants growth, it gives high productivity and growth. This system is more complex to manage and expensive to setup.

Factors to Consider in Choosing an aquaponics system

How much space is needed to operate an aquaponic system, make sure we have enough space to move, so that we can access plant and fish tank. Suitable location is another important factor

for plant and fish growth. The location should be near the water system and where we can get access easily. Plant type is another factor which is very important for selection of aquaponic system. plant and system should be same. Changes in environmental conditions, for example temperature and water source will affect productivity of crops directly. Dichlorination of water is very important. Technical capability is another important factor; having enough knowledge about the system is very important, Crops like tomatoes and peppers can grow with media beds and leafy greens like, lettuce can grow best (blog, 2022).

Case study

Fresh Food is a hypothetical company. This company wants to produce arctic char with vegetables using an aquaponic system. The company wants to sell their products to the high-end market, to the restaurants chain or small restaurants in Norway. They want to sell Arctic char and vegetables as a dish rather than selling fish to one market and salad to another. It can be possible through aquaponics, which cultivate fish and vegetables together. The company wants to establish a unit in Oslo because there is high chance for success of a business due to high restaurants demand. The company is looking forward to producing salad and fish together. The company is looking for small restaurants in Oslo. The company could have few customers, small scale restaurant owners. The manager of the company has promised to give sustainable and healthy salad and Arctic char.

Aim of the study

Main aim of the thesis is to build business plan for vertical farming aquaponic system.

Research questions:

- What products should Fresh Food focus on producing in their aquaponic system?
- What are the markets for Fresh Food's products, and what is their beach head market?
- What is the value chain for the products of Fresh Food?
- Which competitive advantage could production in an aquaponic system give the business?
- What is the company's strengths and weaknesses, opportunities and threats when producing their products in an aquaponic system? What is the "Gain and loss" of the company?
- How would a complete business model look like for Fresh Food when incorporating an aquaponic system into their production?

Material and Methods

Data collection

In conducting research and getting all information, primary and secondary data was used.

Database research

Secondary data include information from review articles, books, case studies and research papers. Web based data was also collected in this study. Information on vertical farming, aquaponics, aeroponics and hydroponics were utilized. The relevant articles, eBooks, journals, theses, and books were discovered using the Høgskolen I Innlandet database's Oria search engine. Other search engines such as Google, Google Scholar, Science Direct, Springer Link, ACADEMIA, ResearchGate, and NCBI were employed throughout the investigation.

Analytic tools

The following methods were used to analyze the aquaponics vertical farming:

Market segmentation

Basics objective of market segmentation is to find out customers on the bases of their need, ability to pay off end user. We must identify different qualities of market segment. The criteria used for market segmentation should be measurable and connected to customers behavior and demand.

Process of identifying segment of market a dividing customer into groups. It is a customer-oriented process. It could be applied to all types of markets. For dividing customers not different groups we should look at the common needs, common interests, similar life styles and same demographic profile. It means different segment of individual need different type marketing strategy. Different customers targeted through different offers, price distribution promotion etc. (Camilleri, M.A 20189)

Most of the companies does not have marketing resources which are very important to reach the audience. They should target a specific market with the highest demand for their products. Finally, company will be able to deliver some value to the customers and give them relief.in this way companies will be able to earn profit through their products.

Market segmentation is the actual process of identifying segments of the market and the process of dividing a broad customer base into sub-groups of consumers consisting of existing and prospective customers. Market segmentation is a consumer-oriented process and can be applied to almost any type of market. In dividing or segmenting markets, researchers typically look for shared characteristics such as common needs, common interests, similar lifestyles or even similar demographic profiles.

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Beachhead market selection

Beachhead strategy is like military strategy. In which first win small area then use this small area to get whole territory. Small market with specific characters, where we can sell new products. Choice of the market would be near resources, product, and market itself. We should build business at the area where already people using the product (CFI, 2022)

End user profile

When company design some product, they keep some people in their mind, they can be and cannot be end customers. Sometime end user seller who buys product and then sell it. They are not direct customers (indeed, 2023).

Competitive analysis and market situation

An approach through which we can analyse our competitors. It is a necessary instrument. through competitive analysis we can identify market trends and find out gapes in our products (Hermans, 2022).

it is also called total market available. It is a market size which gives huge revenue to the business through its product or services. It shows the efforts and funding that we put into a business.

Value proposition

The value which a company creates by making product and giving benefits to the customers. This term was used by McKinsey & Co. industry in 1988 in research paper. It includes tangible and intangible benefits .value preposition changes within industry and within different segment of same industry. Success of a company linked with value it creates for customers (Hassan. A, 2012

Value chain analysis

In 1985 value chain analysis was introduced by Porter, which describes activities range from concept production, distribution, and last disposal after use. When a product moves from one place to another, it added value to it (Hellin and Meijer,2006). With the value chain analysis, we can evaluate the entire industry and different systems within industry (Elvira A. Zamora,2016). Value chain is classified in two ways buyer- driven chains versus producer-driven chains. The producer-driven chains are characteristic of capital-intensive and technology- oriented industries dominated by large transnational corporations which play a key role in managing the production networks. Buyer-driven chains are common in labor-intensive, consumer goods industries where large retailers, merchandisers and trading companies play a central role in establishing production networks usually in developing (exporting) countries; while producer-driven chains are characteristic of capital-intensive and technology- oriented industries dominated by large transnational corporations which play a key role in managing the production networks (Abecassis-Moedas, 2006).

According to porters Value chains are spilt into two categories that makes all activities that are primary activities and support activities.

Primary activities:

Primary activities are one that goes directly in production and creation of product, execution of services which include.

Inbound logistics:

This is the activities related to modifying raw material and compound.

Operations:

Activities related to changing raw material or compound into final products.

Outbound logistics:

Activities related to distribution of products, which include packaging of products, sorting of products, and shipping of the products. Marketing and sales: these include activities related to marketing of the products which includes advertising, promotion and pricing strategy. After-sales services include activities after sale of final product which include installation, training, repair, quality assurance and customers' services. that take place after a sale has been finalized, including installation, training, quality assurance, repair, and customer service (online, 2020).

Secondary activities

Secondary activities help primary activities to become more effective and efficient. It includes the following components.

Procurement:

Provide sourcing of raw materials, components, equipment, and services.

Technological development:

It includes activities related to research and development, for example product design, market research, and process development.

Human resources management:

These activities related to human services inside the industry which include recruitment, hiring, training, development, retention, and compensation of employees

Infrastructure:

It includes financing and planning.

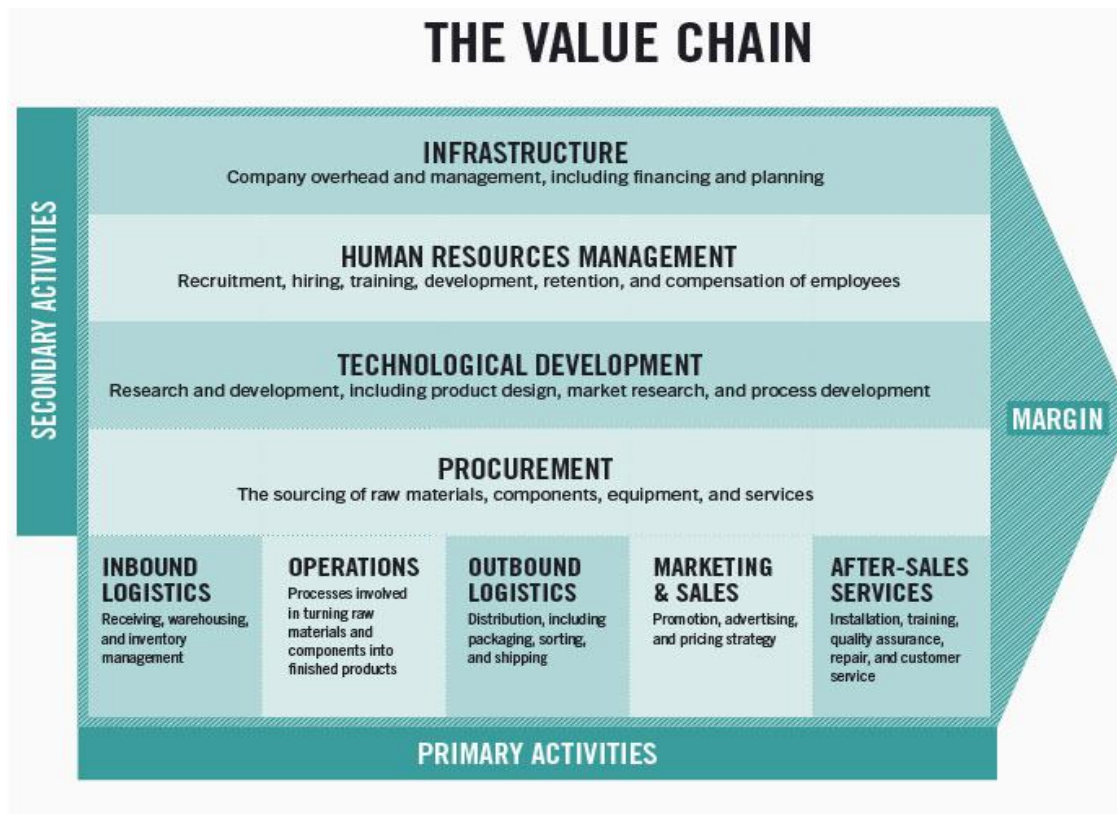


Figure 7: Diagram shows value chain analysis.

Unique Selling Proposition and Product Positioning

Unique selling proposition makes our business unique from other competitors. These are the clear characteristics which make our business unique in the market and customer is willing to pay although it is expensive one. UPS makes us different from others in the market and create unique features in our business. It should have following character. It should be defensible; we should focus what our customers wants while making UPS. It should not be only slogan (shopify, 2022)

Distribution

Distribution is a basic component in a company sale. It makes product to available for sale in the market. It is done through distribution channel. Flow of product from company to the market and the customers will buy the product. It is done through distributor who is middleman between a company and to the stores reference.

SWOT analysis

It is a tool for managing and planning within an organization, it is used to evaluate organizations planning and strategy and builds organizational and management strategy. Examining the organization and its environment known as SWOT Analysis. (Thompson et al., 2007: 97). It helps manager to identify organization and environmental factors. It has two dimensions or factors, internal factors, and external factors. Internal factors include strengths and weaknesses, external factors include opportunities and threats. Objective of Swot analysis is to use the knowledge that organization has abbot external and internal factors and formulate strategies accordingly. Fig.09. SWOT analysis explains different steps to analyze industries internal and external factors.

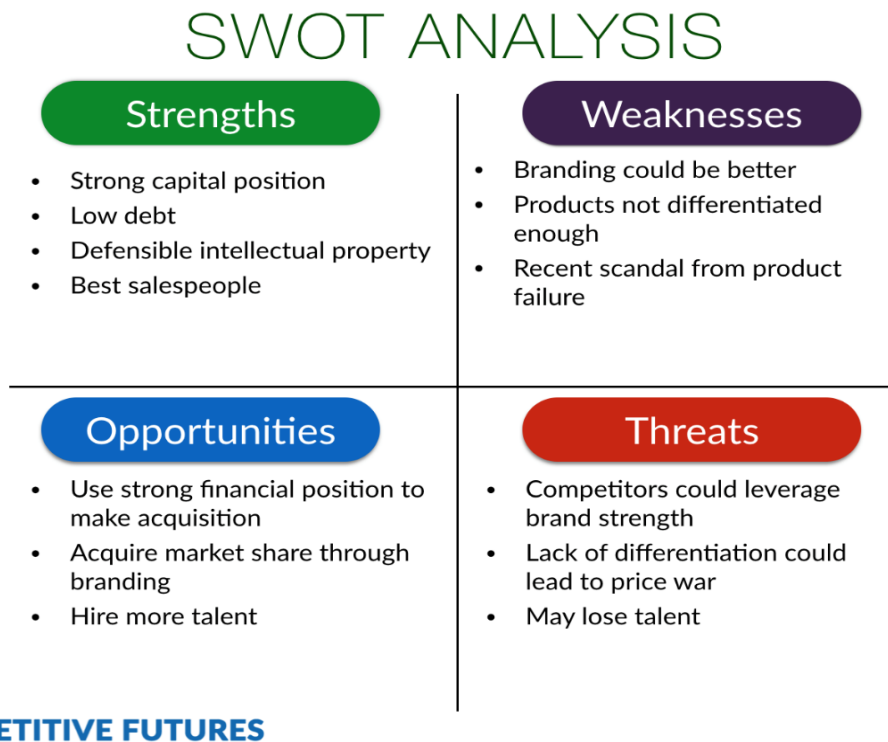


Figure 8: SWOT analysis for fresh food

Value proposition canvas

Value Proposition Canvas has been created by Alexander Osterwalder Yves Pigneur, and Alan Smith. It helps to identify that company's product and services positioned around customers need. The primary purpose is to make exact balance between product and market. Value proposition canvas deeply explores customers segment and value proposition. We should keep the following points in our mind for construction value proposition. Identify customer, their needs, and expectations, develop a product according to customers need, compare product we have before with user needs, find out market that fits our product, we should not produce a product that nobody needs finally don't waste time. Value proposition canvas consist of two blocks, value proposition and customers need. They are basic core of business model canvas it means what and for whom producing the product. It is divided into two sides.

Right side is client profile divided into job to be done, pain and gains. Left side is value proposition and divided into further four components, Products & Services, Gain Creators, and Pain Relievers.

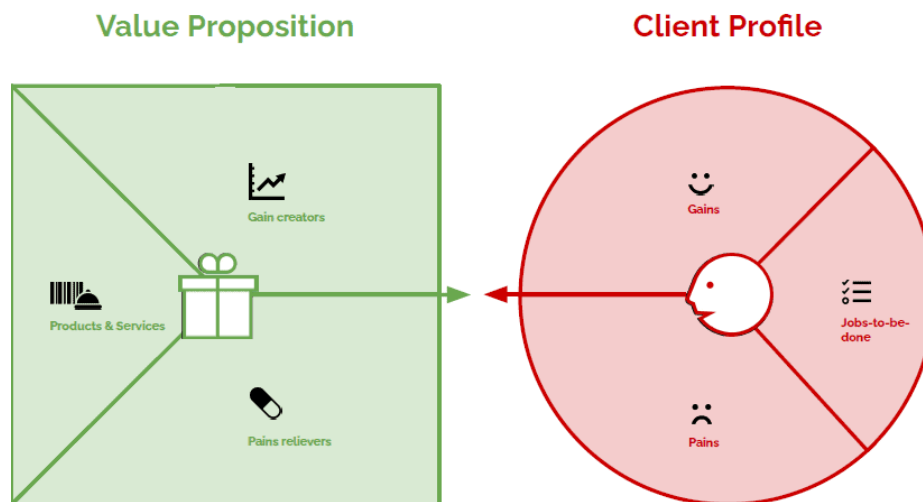


Figure 9: Value proposition canvas.(amware, 2021)

Business model canvas

The Business Model Canvas template

One of the most widely used business model in throughout world and develop by Alexander Osterwalder. This model is user friendly and focuses intention of different parties on one page. Blank canvas is divided into nine blocks which should be filled.

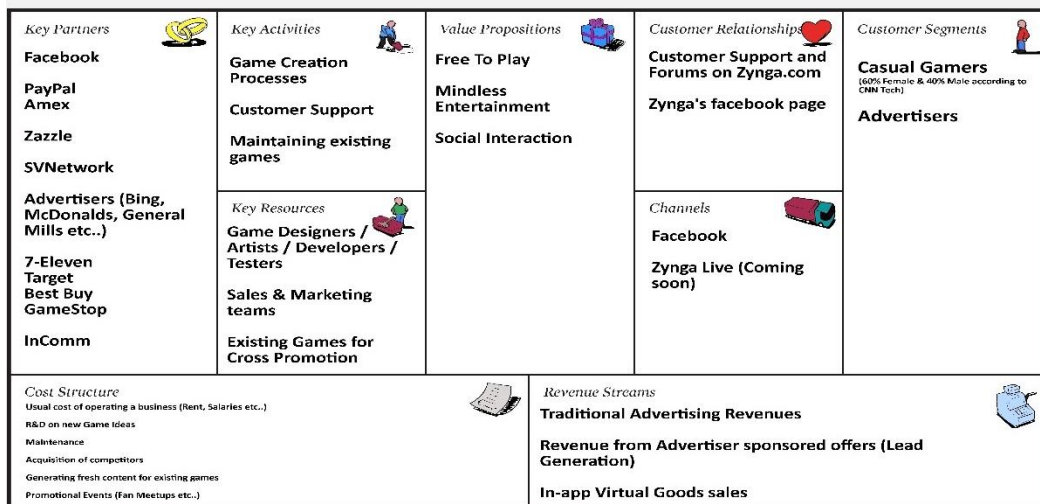


Figure 10: Business model canvas

Customer Segments:

Find out customers for whom we are producing product, and what kind of value we can generate for them.

Value Propositions:

What values are giving to our customers, differentiate your product from other competitors.

Channels:

How we can reach our customers. Find out all the ways by which we can deliver value to our customers.

Customer Relationships:

All activities we use to create relationship between our customers, to give them guarantee about our product. In this way we can prevent our customers to migrate to other competitors.

Revenue Streams:

This block shows how our business will make money, how we can generate money from our product to give value proposition according to customers need.

Key Resources:

It includes all resources we need for developing our business which include all kinds of resources for example, human resource, software, hard ware, machinery and others.

Key Activities:

It includes all activities we need to give value to our customers, included development and maintenance of technologies, production and manufacturing, and logistics and distribution.

Key Partners:

It includes people who are our partner in business, include service provider, supplier, and others.

Cost Structure:

This is last block on business canvas which give information about value proposition. In this why we will be able to define cost of our products.

By designing business model, we will be able to view business as whole on one screen, which become very easy to look at each component and relate them together.(analyst, n.d)

Results and discussion

What are the products of fresh food?

The company is making vegetables and fish together using aquaponic technique. This system has advantage that it can produced two products with single input. It uses RAS system to increase fish harvests while preserving water, intensive, tightly regulated recirculating aquaculture systems (RAS) clean and recycle fish wastewater. Aquaponic systems, a subset of RAS, improve water usage efficiency and minimize waste by incorporating a hydroponic component that yields marketable plant harvests.

Market segmentation is a process of identifying market and dividing customers into groups and subgroups. A consumer-oriented process is applicable for market segmentation of fresh food. For segmentation for fresh food industry researcher will look for common interests, similar lifestyles, and same demographic profile of customers. Different segments require different marketing programs. Customers are targeted through different offers, prices, and combination of market variables (Camilleri, 2018).

Market segmentation for fresh food industry..

Business to business market segmentation for Fresh Food industry. researcher will select small scale restaurant or hotel as their market because fresh food will produce product in an amount which will be enough for small scale restaurants or hotels. Products of fresh food are little bit expensive, which cannot be afford by all the people in a society, only small portion of population can afford products of fresh food, because processing will use high technology and they use highly processed ingredients. Market segmentation for fresh food industry is.

- Restaurants in Norway
- Grocery stores in Norway
- Wholesale retailer in Norway
- Convenience stores
- Supermarket
- Hotel business (Intelligence, 2023)

End User Profile for Beachhead Market

We will select an end user for our product. It is very important to change the mentality of the customers to sell our product by giving them value through the product, rather than to force potential customers to buy our product. For Fresh Food End users will be restaurants and hotels owners who will buy our product and ultimately sell to the end user.

End user

End users are the people who will ultimately use the product of fresh food. Restaurants owners and hotels are our customers for the product of fresh food industry. The people who will ultimately use the product are the end users. The end user for the fresh food company is the public who will consume our products. End users will visit restaurants or hotels to consume our products.

Persona

Concept for persona was introduced by Cooper, it based on solid field research, it is based of group of people that have same requirement. It is generally made to help designers to understand and to clarify users' goals and their behavior. It clarifies end uses description (Chang et al., 2008). For our thesis persona are manager of the company who can represent the customer of our product. He or she will end use of our product and consume it (Table 1). I tried to create a persona using end user profiling matrix.

Table 1: Construction of persona

Position	Manager in the restaurant
Name	Lora stained
Title	Restaurant manager
Gender	Female
Age	40 years
Income	45000 per month
Location	Oslo Norway
Inspiration	Friends, and follow colleges
Fears	Norwegian concern about quality of food, they prefer to have high quality food.
Motivation	Good quality of food is motivation for our persona
Hobbies	Reading books, planting trees and making food
Values	Creating value for people who are dying due to hunger
Proxy product	

Watering whole	She finds people through online forums, by making direct contact with people, online research, advertisements, you tube, etc.
Day in life	She wakes up early, finishes breakfast, and then goes to the restaurant, talk to customers, after work go back home, doing gym, watch u tube and then take night tea and the read boo, and go to bed at 10pm.
Priorities	High quality food tasty food with reasonable price. Trying to sale fish and salad at same time

Decision making units.

The people who will make decisions in a business are known as decision making units. Decision making unit (DMU) for fresh food industry consists of people with Vito power, stakeholders for fresh food industry. These People makes decision for fresh food. These people have different roles in the success of industry. DMU has different members for examples users, influencers, buyers, initiators, deciders, and gatekeepers, all of these having different roles for fresh food industry. Stakeholders give funds to the company and make decisions.

Champion.

In this case the champion is the manager of the company who will motivate the user to buy products produced by fresh food.

Primary Economic Buyer:

The buyer who possesses the financial resources necessary to execute the deal. In certain instances, the consumer is at fault. Influencers, Veto Power, Purchasing Department, and so on.

Those who directly or indirectly impact the Primary Economic Buyers the restaurants owners. The food restaurant owner is the primary economical buyers Fresh Food. Typically, the final consumer is an individual who enjoys trying tomato and actic char.

Value proposition for Fresh Food

Fresh Food industry the value preposition is more tasty, healthy food, in short growing area and in short time, with less uses of water result in production of environmentally more sustainable food. If the product produced by fresh food fulfills the needs of the customers, then they will be willing to pay for the product produced by fresh food. We can say that products of fresh food are tasty, healthy, and affordable than customers will show interest in the product. Such a kind of value proportion will enhance sales of our product and food.

Beachhead market for Fresh Foods

The purpose of beachhead market is to focus on why that organization and its resources, market revenue and client should accelerate For Fresh Food business model beachhead market is chain of small-scale restaurants in Norway. People in Norway are very fond of eating, and they want to have healthy, high-quality food which should be sustainable. Fresh Food has made promises to give people healthy sustainable food. So, for in this thesis, researcher will select the small-scale resultant chain in Norway as beachhead market for Fresh Food. Fresh food is solving problem related to food quality in Norway because people of Norway are fond of eating and they want to have good quality food, fresh food company has been promised to produce high quality of food. (Kavanagh, 2011b).

Competition and market situation today for Fresh Food

The fresh food industry is using new technology which gives a competitive advantage to our company. The product produced by fresh food is unique and there is no use of pesticide, which improved the standard of food, and there is high demand for organic food. People show more interest in growing crops in their own home. As people are aware of their health so they prefer pure food without contamination. This thing makes fresh food the best alternative for good quality food. Fresh food uses highly developed technology which gives another competitive advantage to the company. It will be difficult to supply food to the increasing world population by 2050. This situation led to the development of food producing companies, for example fresh food. Scientists, businesspeople, farmers, and consumers are becoming interested in aquaponics, which combines soilless organic farming with a recirculating aquaculture system (RAS). It is a significant and perhaps sustainable approach for producing organic foods that are good for the environment near to where the consumers are. Aquaponic systems are intended to be micro-ecosystems that mimic natural processes. In essence, this method creates a symbiotic environment by combining hydroponics, aquaculture, and beneficial microbes. The negative environmental effects of aquaculture and hydroponics are turned into benefits within this synergy. Compared to operating the two systems separately, aquaponics greatly minimizes the needs for fertilizer input and waste management. Due to its high rates of nutrient and water recycling, it is environmentally beneficial. Traditional agricultural techniques can be replaced by aquaponics, especially in areas where water shortage is an issue. Compared to conventional soil farming, aquaponic systems use much less water. Compared to traditional

agriculture, aquaponic systems have a big advantage in that they produce better yields in less space (Krastanova, 2022).

Total Addressable Market (TAM) Size for the vertical farming methods.

Analysis that defines total revenue potential of current product or services. It gives us a full picture of what is our total available market and landscapes. It is important to find out how much effort we should give to our business to make our business a new venture. ("market survey, "). TAM for this thesis is about 1000 of people who will consume our product and will experience what we are producing in fresh food.

To calculate TAM, we should know Average revenue per user and total number of potential customers so TAM will be, suppose we have beachhead market of 100 people and ARU will be 10 then total addressable market will be

TAM= ARU* total number of potential customers

TAM= 10*100

TAM=1000.

Value chain analysis

The principal market regulatory aspects of agricultural policies, such as target prices and production quotas, as well as import taxes and quotas, significantly influence the agro-food value chains in Norway. In Norway, the aquaponics sector is heavily consolidated, especially at the wholesale but also at the retail levels. The costs of the market regulatory regulations should be weighed against the possible benefits in terms of high food prices, a lack of diversity, and a lack of innovation (ilibrary, 2021). Value chain analysis provided details on the processes, activities, and projects. The business operated to provide clients with value and to

earn money through its products and services. Value chain analysis was done in this study from, and each stage was thoroughly explained here.

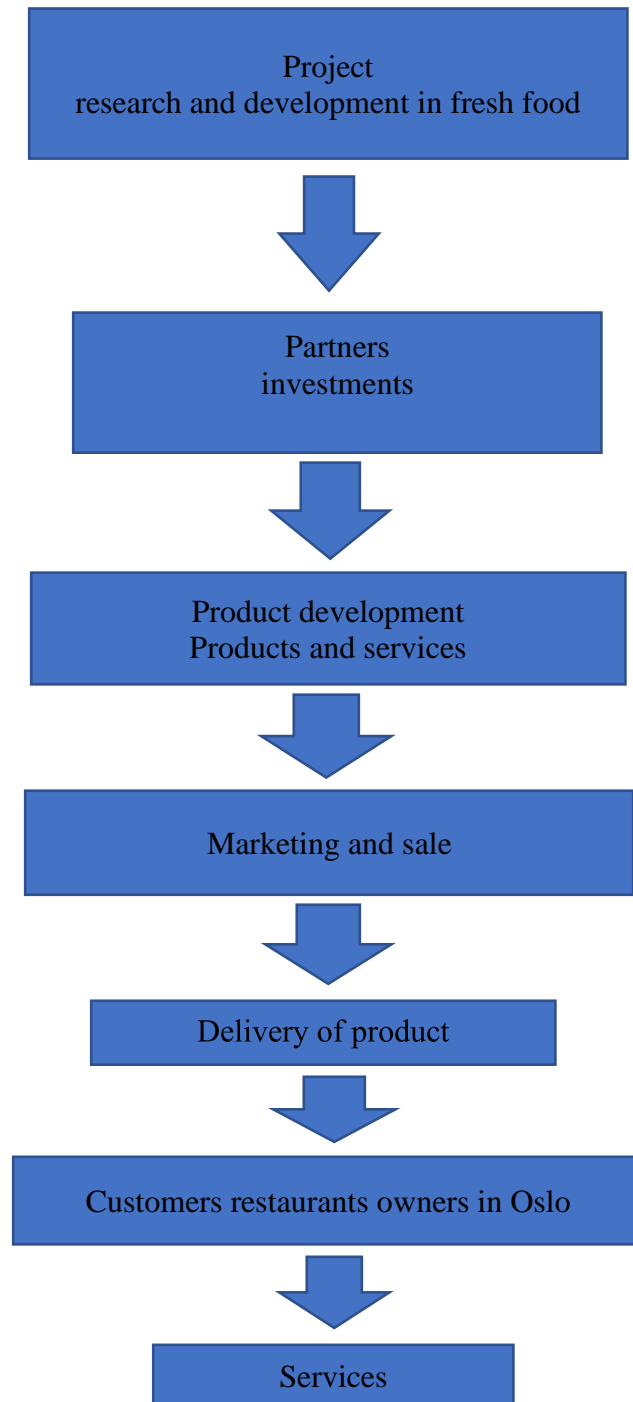


Figure 11: Value chain analysis for fresh food (a future company which is not established yet) in Oslo

Research and development

Fresh Food is still a hypothetical company in Norway. Purpose of the company is to produce sustainable healthy food for people. People of the Norway prefer healthy food which will produce by Fresh Food. The food produce in Fresh Food industry will be pest free it produces more sustainable food. Research and development of food industry in Norway is consisted of six steps which are new feeds and processing (bio)technology development, Novel feed components' effects on growth efficiency and nutrient uptake, health of fish and vegetables is affected impacting the quality of food, create strategies to boost feed effectiveness for genomic breeding initiatives. Evaluation of environmental and economic sustainability ("About Foods of Norway," 2015). The project objectives include creating and developing sustainable food and supplying it to the people.

Partner and investment

The initiative will be taken by Fresh Food, which have interest to launch sustainable food. Partners in this research include NIBU because they are working on vertical farming aquaponics, Ms students, Phd students, scientists, food industry, engineers who have a separate area of expertise. Regional research fund NIBU and project partners both will part to the study. Money will be invested in this initiative Fresh Food company from the other investors.

Product development

Aquaponics system base: The first and most important component of any aquaponics system is a 100-gallon tank. Depending on whether you want to get a glass or acrylic tank. The 100-gallon tank is optimal for aquaponics. A filtration system is required for every tank. Look for a high-power external or canister filter for a 100-gallon tank. Anything weaker than these won't be able to keep your tank clean. An air pump keeps the plants' and fish's oxygen levels steady. For the media bed setup and nutrient film configuration covered below, irrigation tubing is required. Grow lights and water heaters are alternatives. Choice the media according to your choice of fish and plant. I will select Actic char because it can tolerate high density culture and have excellent culture yield. And I will secret media based culture for the growth of fish and vegetables. We need to monitor culture at regular interval of time.

Delivery of final product

The finished product created by Fresh Food is called tomato and arctic char and which is gathered in trays with care and until it is given to clients. Final products are separated and packed in cardboard boxes surrounding Styrofoam and then send to the consumer small restaurant chain in Norway.

Marketing and sale

The value chain analysis's primary component is the marketing of the items. The new product is placed in the correct market with the right clients through effective marketing and product promotion. The target market can be reached through marketing to inform them of the competitive advantages of sustainable, the product is not exposed to chemicals, pesticides, herbicides, and other chemicals. carry their goods and win them over by offering incentives like a profit margin, free samples, or trade exhibitions. Due to the several processes in this procedure, which range from contract negotiations through product orders for retail placement, it may be extremely drawn out. For marketing food items, in Fresh Food is one of the most crucial factors is the packaging. The logo, colour scheme, and design all have a big impact on how customers view your goods. This is important when we buy raw material. To stand out on the shelves from the competitors, packaging must be alluring enough. The company can use social media for product promotion. People may quickly and easily search for their preferred cuisine on Twitter, Facebook, or Instagram by using hashtags. The company can manufacture chips, for instance, you may use the hashtag chips to make our product visible to everyone who puts "chip" into Twitter or Instagram. Use appropriate #hashtags as well. Price of the product also very important in publicity of the product (abasto, n.d).

Target customers for Fresh Food

Services

After selling their goods, Fresh Food must continue to have positive interactions with their clients. A strong customer relationship aids in maintaining market position. Customers and Fresh Food company should have solid working connection with each other. They educate new people Another essential component to sustaining a startup firm is a strong client relationship.

Selling proposition for Fresh Food

A unique selling proposition is the statement that makes our business different from other competitors. It also called selling point. It might talk about features, properties, qualities, or price. It tells us about single qualities that we have, and other competitors do not have.

("What is a unique selling proposition? USP examples and definition," 2022). The objective of Unique selling proposition is to target a specific market segment and to give them value which we promised to give to the customers. It makes us different from other competitors (Hirschberg, 2022). We are producing food without the use of chemicals which makes product of fresh food different and unique, we can say that product produced in fresh food industry are chemical free product highly sustainable but little expensive. It has all kinds of nutrients which are essential for our body. our selling proposition make us different from other competitors. Target market for Fresh Food business is small restaurant chain in Norway, because resultant owner will buy our product they used to sell tomato and Arctic char in their restaurant by making different dishes.

Cost structure for aquaponics

Fresh Food has a high labour expense; more than half of the budget goes to employees. It requires skill workers for example, engineers, electricians, mechanical soft wares cost of energy is another observation. In one study it was started that 12 percent of energy cost was used to run aquaponic system but in 2015 it raised to 37 percent (Cristea, 2019). Other costs include the cost for seeds, fertilizers, fish eggs, fish food, trays, growth media, and other tools which are used to run aquaponic system in the company.

Distribution of the product

The food supply is a complex process with different activities from its raw farm. Food supply starts from the producer, which is the Fresh Food industry. Raw farms of food are created and after processing and transferred to the consumers. Fresh Food will use transportation logistic to transfer food to the consumer. Fresh food have online surface, to transfer product to the consumers (Benke & Tomkins, 2017). The company have also online service or we can buy directly from the company.

Business model for Fresh Food

There are the following marketing options for the company for selling of tomato and Arctic char.

produced in Fresh Food.

- Wholesalers market
- Restaurants in Norway
- Grocery store
- Food stores

High quality tomatoes which are a little expensive are produced in fresh food industry with annual yield ranges from 20 tons to 30 tons. Through this method sustainable tomato and arctic char can be produced. Fresh food is threat to the traditional companies because they are producing highly sustainable food. People in Norway will prefer to have sustainable chemical free food at high cost rather than food with low quality with the use of chemicals. Table No.02 explain business model canvas for fresh food industry.

Table 2 : Business Model Canvas is prepared for Fresh Food, which is based on the nine building blocks canvas model of Osterwalder and Pigneur below.

Key Partners	Key activities	Value Proposition	Customers Relationships	Customer segments
<ul style="list-style-type: none"> • Fresh Food restaurant owner and farmer for fresh food engineers, electricians. • Fish breeding company • Seed producing companies. 	<ul style="list-style-type: none"> • Raise fish and plant production, maintain system, sale and marketing, crop harvesting and cutting. marketing. Maturation of fish eggs transfer to the buyers target customers make it available for the next time. 	<p>High quality, sustainable, tasty, affordable, and produced in small area use less amount of water.</p>	<ul style="list-style-type: none"> • Direct meeting with customers • Personal Assistance 	<p>Restaurants owner, retailer stores, and grossery stores.</p>

<ul style="list-style-type: none"> • Sale persons • Research insituities • Service people 	Key Resources <ul style="list-style-type: none"> • Human resources • Infrastructure (breeding station and land-based system, freshwater resources). • Char brood stock • Capital to keep the project 		Channels <ul style="list-style-type: none"> • Online website • Delivery of products through post service • Airline service for international export • Personal contact 	
Cost Structure <ul style="list-style-type: none"> • Research and development, Infrastructure • Employee salaries • Equipment, feeding cost • Research and developing programs salaries of employes infra structure cost marketing cost operating cost 		Revenue Stream Suppose the company is selling 20 tons of fish and getting 5 kroners of profit per kg of fish and tomato so revenue stream will be 1000 kroner by selling 20 tones of fish.		

Business model canvas Food industry consists of following components.

Key partners: Men power who can help to operate food producing components in the Fresh Food company. For Fresh Food are fish and vegetable producing companies using aquaponics, research institutes, sale person, service people who can help in operation of the system in Fresh Food company.

Key resources for Fresh Food industry are experienced people, who are experts to run aquaponic culture within the Fresh Food industry, fish, and plant exporter, who can export to the Fresh Food company for production of sustainable pest free food.

Key activities for Fresh Food industry are to raise plant and fish together, when they reach to the maturation stage to separate the fish and tomato to separate boxes. Another most important key activity for Fresh Food is to maintain the aquaponic system within the company, maintain cleanliness inside the aquaponic system.

A value proposition is the value which we give to the customer in the farm of product and give them relief from their pain. High quality, sustainable, tasty, affordable, and produced in small areas use less amount of water.

Another important factor for Fresh Food is **relationship with the customer**. Fresh food has a strong relationship with the customer. They are so flexible that customers can contact them

anytime they want to. They are free to give their opinions about fresh food products. Customers can criticize products of fresh food company according to their experience with the product.

Customers segmentation is the customer who can Fresh Food target. In this case small scale restaurants owners are customers of Fresh Food company. Another factor is **channels**, how customers can contact to the Fresh Food industry. They can contact the Fresh Food industry online, using wats app, Instagram and twitter or they can contact directly to the Fresh Food industry.

Cost structure is the total cost we will use to develop aquaponics. It includes the cost for research and development, salaries for the employees. It also includes infrastructure cost and feeding cost and equipment's. final and most important is revenue cost. How much profit will we get in operating vertically in Fresh Food industry.

Value proposition canvas for Fresh Food.

it is a tool, which is used to develop direction between product and services that Fresh Food will promise to provide to the customers. How this project will solve issue related to quality of food, and it will be very crucial for aquaponics in Norway. it will give us details of how fresh food will be leading company in future.

Fresh Food will develop food for the people of Norway, the food produced inside using aquaponics.

Product and service: Fresh Food is hypothetical Norway; they have promised to give fresh and sustainable vegetable particularly tomato and arctic at affordable price. They produced tomato which will be available to the small-scale restaurant in Norway.

Gain creator:

Norwegian people will prefer to have high quality of food. They prefer healthy food with all nutrient but due to urbanization, people are converting land to house and there is scarcity of land for production of healthy food, in this case fresh food is creating value for the Norwegian people by producing high quality food.

Pain relievers: Fresh Food can solve the problem of food quality in Norway, and it promises to produce more sustainable healthy food and fresh Norwegian people.

Customer Profile:

For example, for making customer profile I will select one person from beach head market his name is Alisha, she is female, lives in Norway. She needs high quality food, so fresh food can solve the problem by making high quality food, indirectly our customer will get his or her product which can solve the problem of our customer.

Pains: It is small hypothetical industry and will be commercialized in Norway. Crop production through traditional farming is not enough and is not high quality because they are using fertilizers which contaminate the food, so they have problems which is related to food quality because use of the fertilizers and other chemicals.

Gains: fresh food does not use pesticides, herbicides or other chemicals and fresh food is producing exactly what our customer want healthy food, which use indoor method and can be produced throughout the season.

Customer jobs:

Fresh food is making the tomato and fish, for their customers who are restaurants owner, they will sale the product to the end user. Fresh food builds up their aquaponic culture and grow the company tomato and Arctic char together using indoor method.

SWOT analysis: SWOT analysis was done to find out strengths and weakness (internal factors) internal factors and threats and opportunities (external factors), which are very important for the success of a business. **Table no.03**

Table 3: Swot analysis for fresh food industry

	Strength	Weakness

Internal factors	<p>Less use of water. highly efficient. growth time will be shorter. High quality. Advanced technology. Less fossil fuels.</p>	<p>Building cost is high. High usage of energy. Need for skilled person.</p>
	Opportunities	Threats
External factors	<p>Political subsidies. selling opportunities. niche market. Less competition because its up growing company Helping the community. lifestyle trends. green power LED. Laws are in favor of vertical farm. Economically energy efficient</p>	<p>Urban development planning. lobbying. competition from greenhouses difficulty in selling products. Will consumer give us good response</p>

Strength

Strength of fresh food analyzed on the bases of following components. First will be the water usage. 70 percent of water could be used for crops and to raise animals. Aquaponics uses 70 percent of water to grow in aquaponics system which is being used in fresh food. Another factor which is limited growing timing for the crop and for fish. The company is using less fossils fuels and highly developed technology which gives big strength to the company.

Weaknesses

Technology needed for cultivation of crops make it high cost and expensive, LED light, irrigation system nutrient reservoir and water, all supporting ranks, computer that control climate, make is most expensive system, high amount of energy is the second cost driven factor that make Fresh Food company that is very expensive. According (Kozai, 2016). LED light costs 70 to 80 of total energy cost, which makes LED the most important factor. Fresh food does not use sun light it depends on an LED light system. the width of the product is how many different companies carry (Kotler & Keller, 2012). Which is weakness for Fresh Food. Fruits that grow with trees are difficult to grow in fresh food because they have low space. Fresh Food does not have enough capacity to serve the whole market. Fresh Food will need more financial resources to maintain its production process. Fresh food also needs skilled people to operate properly. High building cost is also another weakness. Other companies can target Fresh Food and can compete and can produce more products like this company. The company will need funding and economic stability to maintain the project. Skilled workers are also needed for the success of the project. Project leader is the main person who should be qualified and very important for success of the business.

The cultivating station does not have enough space to expand the production of crop. The Fresh Food industry is very small industry in Norway due to a lack of cultivating program and have few farmers who are skilled for cultivation. With a few developments this industry can grow nationally and internationally. Building cost is very high which so this is another weakness for Fresh Food. Staff wages is another weakness for Fresh Food company because we it is not highly developed company so it cannot bear high wages.

Opportunities

The company has potential and a bright chance to grow nationally and internationally in the future. Fresh Food is a small but growing industry in Norway and in different countries that will lead to high demand for the best quality products. Fresh Food have high selling opportunities. Competition is low because it is not a developed company. It doesn't have many

competitors in the market. Fresh Food will produce sustainable food which could be used to overcome food shortage help the community and for Norwegian people high quality food will be produced. This is an economically efficient method. Selling opportunities are high because it meets people's demands. Competition is very low because there are very few companies who are working to produce products like produced by the fresh food company. It helps the community by giving them high quality food. It is an economically efficient method that uses LED which is another advantage to the fresh food industry.

Threats

Aquaponics vertical farm could develop in urban cities which is a threat to the Fresh Food. It results in a shortage of housing buildings. Great competition exists between them. As the products produced through aquaponics are very expensive that is why may be small number of people get attracted to the products produced in fresh food. Our company will use different kinds of technology, particularly nanotechnology, which is another threat for newly developing company. There are different laws against aquaponics vertical farming which should be followed, if we did not follow this law, it would be a threat for Fresh Food.

Business plan for vertical farming

A business plan is a written document that describes the aims and goals of the company and strategies that the company will adopt to achieve its goals. The business plan for Fresh Food is an overview of the company's aims, products, management, market, and financial strategies.

Executive summary

Despite the fact that Norway's Fresh Food business is hypothetical and there aren't many vertical farmers, manufacturers there, Fresh Food has a substantial market potential both domestically and abroad. Encompasses composition and nutritional content, labeling and advertising of food, origin and authenticity, production standards, labeling and advertising of food, and other information that helps customers to make educated decisions based on the values that are important to them (angiencies, 2021)The primary objective of Fresh Food is to supply with high quality food. Fresh Food has a skilled management team with research, and a commercial team that consists of breeders, business specialists, and partners in genetic research. Breeders of arctic char and salad have successfully created a product which is high quality in taste and contains all nutrient.

Business idea and implementation

Marketing and service

The marketing of the product is the key element in value chain analysis primary component is the marketing of the items. The new product is placed in the correct market with the right clients through effective marketing and product promotion. The target market can be reached through marketing to inform them of the competitive advantages of salad and arctic char, such as its pest free, sustainable healthy food which is also land-based systems. Fresh Food used various marketing strategies like internet marketing Norsk røyeforum is a website that promotes the growing of Fresh Food product in Norway, one-on-one interactions and encounters with vertical farmers, and product marketing via the Fresh Food Facebook page. The company may specifically target the domestic and global market, get in touch with the farmers, and advertise its product by outlining its competitive edge. Additionally, important to the marketing of the goods is the cost of the item.

Market analysis for Fresh Food

There are only few aquaponic producers in Norway, and they are using the local char population for char farming and production is extremely low and normally they sell it to the domestic market. Market analysis of fresh foods showed that aquaponics industry is still unsaturated nationally. Most of the aquaponic produce.

The aquaponics market is anticipated to grow at a CAGR of 9.6% from 2022 to 2027. The aquaponics market's supply chain was significantly damaged by the COVID-19 outbreak. Farmers had to raise a lot of live fish and other aquatic animals as a result of supply chain interruptions caused by the pandemic, which increased their cost, danger, and expense (intelligence, N.d) The aquaponics market in North America held the biggest proportion in 2021. The region's greatest contribution came from the United States, followed by Canada. In the area, aquaponics is a modest but quickly expanding sector with a number of collaborations between academic and research institutes and private businesses. This element was crucial in the development of aquaponic farms and in raising public awareness of them. However, aquaponic agricultural production on a large scale in Iceland still internationally char market has a potential to grow and demand of char is more compared to its production. In south and north

Norway there are 7 char farmers who are buying eyed roe. Market in inland county is not so big. There are 4 farmers who are interested in developing the char farms in inland county. Fresh food company will be the biggest potential customer in future when they built facility, and they would need 1-1,2 million roe from the breeding program. Another two groups are still planning and applying for permits) with the aim for a medium sized facility and each will produce tons of biomass. One group has completed all the permits and ready for building the facility. It is small scale facility and will produce 60 tons biomass. All of them will need the right amount of roe. Slaughter size of char is approximately 1 kg, and the mortality of the fry might be 5-10 %. Norwegian roe is also in demand in international market such as EU, Austria, Germany, and Sweden. In Norway, char market is less popular due to its limited production, market where consumers know the char it is in demand due to its unique taste and considered as luxurious fish. Char introduction in all seafood market and proper branding and promotion will make it a high choice fish in market. Currently, char is known in bigger cities. fish in restaurants, local food market, and sushi restaurant. (intelligence, N.d)

Market trend for fresh food

Fresh food provides all the information about their product, their ingredients. They give information about the product they are selling, which means market trend for fresh food is rising and people are showing more interest in buying fresh food products. Industry is using highly developed technology which also attracts customers. People are showing a positive trend towards fresh food products. If we make a graph for fresh food it will show an increasing trend in sale of fresh food product.

Competitive advantages of the of Fresh Food

Elements that create competitive advantages in the market have been identified: A few of these elements include effective and dependable aquaponics culture processes that can assist us in growing and selling our produce at competitive prices, a strong network, and excellent relationship management. Strength as a team also gives us a competitive advantage. Fresh Food has a skilled team of workers who are very dedicated to their work. They are well educated and have expertise in their field. The company has some of the most effective aquaponics systems and advanced machinery and equipment that give strength to our company. They have a wealth of knowledge and expertise in a variety of specialized sectors of the industry. In addition to the synergy among our carefully chosen team members, we also have some benefit.

Another competitive advantage we are bringing to the market is the fact that we have built our company so that we can run an all-encompassing aquaponics system that will be engaged in a variety of activities, including crop cultivation, plant transplant services, and a food processing and packaging plant. By doing this, we will be able to take advantage of all the opportunities that exist inside the sector.

Finally, all our employees will receive excellent treatment, and their welfare package will rank among the finest in our industry's category. They will then be more than happy to work with us to grow the company, contribute to the accomplishment of all our goals, and help us meet our deadlines. ("Vertical Farming Business Plan," 2023). In an aquaponic system we don't need to add chemicals, food we will use to grow fish will be used as in put product. Fish will feed on the food and remove waste material from the gills this waste material is used by the plants to grow, in this system s\we get to product while we are giving only one input that is fish food, this makes another competitive advantage to the aquaponic system (communication with supervisor)

Sales Forecast

Based on the results of the study, we can infer that Fresh Food has the ability to generate sales which is influenced by both its size and its specific type. The company is confident that we will reach or even surpass our predetermined sales target because the company has refined its sales and marketing techniques. The company has been able to assess the agriculture sector through a vertical commercial farm business, evaluate our chances inside the sector, and produce the following sales prediction. Werner Kloas, a researcher at the Leibniz Institute of

Freshwater Ecology and Inland Fisheries, noted that the yields are also considerably greater than in conventional aquaculture. In a closed recirculation system, you can typically create 2.5 grams of fish for every 10 liters of water, according to him. "You can now get up to 100 grams of fish and grow 500 grams of tomatoes at the same time with a fully functional aquaponics system." This method may be used to cultivate tomatoes, eggplants, lettuce, other herbs, and vegetables. Even planting grain and corn might theoretically be doable, but the infrastructural investment would be too large to make it economically feasible. Fruits like apples and oranges that are perennials are inappropriate (schauenberg, 2021).

Marketing and sale strategies

The company understands some of the vertical farms are struggling to turn a profit because they are unable to sell their products, so our company has made decision to build food processing facility to increase annual revenues. Our sales and marketing team will be chosen based on their knowledge in the vertical farming sector, and they will get ongoing training to ensure that they are prepared to fulfil their own goals and objectives of Fresh Food. Our goal is to make Fresh Food as a leading company in vertical farming in the world, that is why we have made different strategies to become one of the leading companies. Fresh Food will use the upcoming marketing techniques to advertise industrial farm products.

Send letters to stakeholders in vertical farming business, the one which depends directly on agriculture industry for raw materials for example, hotels, restaurants to introduce out company.

Promote Fresh Food and its products through publications and websites devoted to agribusiness and food. Attend seminars, trade shows, and other events relating to vertical farming. Utilize the internet to advertise Fresh Food through face book. Instagram, twitter by posting different pages or by making videos because now a day internet is very common and almost everybody use internet and we can use these medias for publicities of our products.

Direct marketing activities Promote the usage of word-of-mouth advertising.

Publicity and advertising strategy

A company that wishes to go beyond the street corner or they are based in must be prepared to market and promote the product of the company as we want to expand Fresh Food, we should develop strategies for establishing our brand as a company that develop most

sustainable pest free and fertilizers free producing company, through all possible channels. The platforms listed below can be used to help to promote fresh food companies. Post advertisements on platforms for print like newspapers and periodicals and electronic media. Support appropriate neighborhood-based events and programs Utilize the internet and social media sites like Instagram, Facebook, Twitter, YouTube, Google, and others to market our company. Periodically hold roadshows in specific neighborhoods. Distribute our flyers and posters at the desired locations. Call businesses and residents in our target locations to let them know about Fresh Food. Include a listing for our vertical farming company in the local yellow pages. Promote Fresh Food company on our official website and use tactics that will drive traffic there. Make sure that all our employees are wearing branded shirts, and that our company's emblem is prominently displayed on all our cars, etc.

Our Pricing Strategy

The easiest way to penetrate the market and to acquire customers is to sell product at competitive price and we will, and we should manage our price according to other competitors.

Startup Expenditure Budget

There are a few important elements to consider when estimating the startup costs for a vertical farm for Fresh Food. The building of the vertical farming buildings is the most significant investment. The primary locations listed below are where we will invest our initial funds to establish our vertical farm.

Table 4: Amount in Kroner to start up business in Norway hypothetical calculation.

Components for aquaponics	Price
Insurance policies	2,500 nok
Purchase or lease a piece of farmland	50,000 nok
To prepare the aquaponics	75,000 nok
To purchase machinery	25,000 nok
Purchase of and eggs for fish	20000nok

Launching website	600nok
Employ payment	100,000nok
Additional Expenditure	2,000 nok
Total cost to build aquaponics	350,000nok
Sum	6251000nok

In aquaponics, a ratio has been established, but it is only a suggestion. Based on the considerations, only you can determine the ideal ratio for your system. However, while you're still learning the ins and outs of aquaponics, you need to follow the rule of thumb to prevent errors that might result in system failure. You can experiment with your system once you've learned enough. Suppose we are producing 50 tons of tomato and we will produce 25 tons of fish in one aquaculture system.

As a general guideline, it is advised that the grow bed to fish tank ratio be roughly equivalent to 1:1, with the fish tank volume being equal to the grow bed volume. The feeding rate has the strongest correlation with the fish to plant ratio. If your growing space is 100 square meters through the solid filtering system, you must reduce solid discharge as much as possible. Less solid breakdown will result from solid discharges, which will leave the plants with fewer nutrients. Fish waste may be mineralized into plant-useable nutrients by using this process. It is also possible to calculate the ratio in gallons per cubic foot (6 gallons of fish tank to every cubic foot of grow bed). Depending on fish density and water flow rate, you may increase this ratio in larger aquaponics systems to 1:3 or 1:4, respectively. Larger systems can stock fish at a density of one fish per 8–10 liters of water because to rapid water flow and ample aeration. The most crucial thing to keep in mind is that you must choose your aquaponics system's ratio depending on if there is sufficient biofiltration, the feed rate ratios will provide a healthy ecology for the fish, plants, and bacteria. The feed rate ratio should only be used as a reference for balancing an aquaponic system since other factors. Use this ratio while creating and launching your own aquaponic system to make sure you don't make any blunders when you first start off. You may modify these ratios to meet your demands once your system has matured and you are familiar with aquaponics (aquaponics, n.d)

Generating Funds/Startup Capital for Fresh Food

No matter how great your business idea may be, if you lack the financial resources to support it, it may never materialize.

When it comes to beginning a business, such as vertical farming, finances are a crucial consideration.

Undoubtedly, obtaining startup financing for a business is a difficult process that an entrepreneur must complete. These are the places where Fresh Food Vertical Farms, will seek funding from:

- A portion of the starting funds could be raised through stock sales and personal savings.
- Get a portion of the startup money from friends and other members of your extended family.
- Get the bank to provide a higher portion of the initial capital (loan facility)

We have been able to raise roughly 100,000 Nok (personal savings of 80,000 Nok and a soft loan of 20,000 Nok from family members), and we are in the process of securing a loan facility from our bank for a total of 250,000 Nok. The loan has been approved and will soon be credited to our account after all the paperwork has been properly signed and filed.

Sustainability and Expansion Strategy

The destiny of a company is determined through the number of consumers, capacity and expertise of its staff and their investment strategies and organizational structure of company. If a company lacks any one of these elements, it won't be long before it must shut its doors. Building a company that can live on its own cash flow without requiring outside funding one Fresh Food is up and operating is one of our main objectives.

Fresh food can reduce profit margin for a while because it know that it will get more customers if they will give high quality products to the customers.

Fresh food will see to it that the proper framework, structures, and procedures are in place to guarantee the welfare of our workforce. corporate culture is built to propel our firm to greater heights, and our business plan places a high priority on educating and retraining our staff. We are confident that if that is done, we will be able to hire and keep the greatest employees in the business, and they will be more dedicated to helping us create the company of our dreams.

Vertical agriculture technologies and challenges to overcome.

When plants are grown indoors, environmental conditions that are difficult to predict for farmers are avoided. Vertical farming in greenhouses still has a lot of difficulties. All plant needs must be accurately met in vertical farms. They should do this by relying on technology that remove human error and hasten the measures that need to be performed if a plant's condition changes. As much as changing weather might kill a plant, late adjustment can too.

Challenges of developing Fresh Food

A greater initial outlay for tools and gadgets including storage units, sensors, LED lighting, and smart irrigation software. A lack of technology vendors offering ready solutions at reasonable costs. Restrictions on the kind of crops that may be cultivated indoors and yet make as much money as those planted outside. The necessity to maintain an ideal atmosphere and increased energy usage for all equipment. Cooperation between partners to get the tools, software, and specialists needed for the development of vertical agriculture.

Lack of legislation and defined criteria for product quality and origin transparency. Lack of publicly available data on how to deploy the proper mix of technologies and successful plant recipes. Uncertain demand for products grown on vertical farms owing to increased pricing (patner, 2021)

Conclusion

Value chain analysis of fresh food was performed for each stage found and added at each step to get results. A market analysis showed a niche market for vertical farming aquaponics which makes the business profitable. The research questions are addressed in this thesis, beachhead market analysis was done for fresh food industry which gives us beachhead market for fresh food industry. Value Proposition Canvas was used to evaluate the product to customer demand. Value proposition analysis showed that the fresh food can meet the demand of people to have highly sustainable food. SWOT analysis was performed to find out the company's internal and external factors. SWOT analysis showed that aquaponic producer in Norway can make vertical farming a profitable business by using the fish and plant produced using aquaponics in fresh food industry. This is an indoor method which can be used in urban areas. The competitive advantage of the company is that it can produce two products with single input. From outside, we provide only fish food which is secreted as waste material through the gills of fish and this waste material was used by the plants to make their food. Profit gain analysis was performed which shows that the company is giving relief to the customers from their pay by giving them value through product produced in fresh food industry. The business model canvas was developed on the base of nine blocks. It gave an overview of the company's projects and successful operations. Fresh food company needs financial and legal support from the concerning authorities to make their project a success in the coming years. The company with addressable market of 1000 people which is hypothetical calculation. And solve the problem related to the quality of food.

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