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Future of Sustainable Greenhouse in Jyväskylä

Potential customers and their attitudes toward sustainable greenhouses and urban horticulture

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The future of the sustainable greenhouse in Jyväskylä

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Description

The goal of this thesis was to determine in what ways people want to access sustainable greenhouses. This thesis also examined the willingness of consumers to invest in sustainable greenhouses in order to grow their food.

The literature review consists of two parts. The first part deals with the LOHAS consumer as a potential customer of sustainable greenhouses. This part also focuses on sustainability in farming and urban horticulture. The second part of the literature review discusses various types of traditional greenhouses and how many systems have be integrated with each other to make up sustainable greenhouses.

The research was conducted using a qualitative research method. The focused interview was chosen as the data collection method, and six people were individually interviewed. The interviewees were members of the Kangas area farming experiment including others interested in urban farming.

The results suggested that people are interested in the sustainable greenhouse but that the greenhouse has to be fully functional in the harsh Finnish climate without consuming a huge amount of money on energy. Some people are against offseason production since it is less sustainable and the taste is not authentic. A community can invest in sustainable greenhouses or a housing company can own a greenhouse with allotment gardens for the tenants to let.

Keywords (subjects)

greenhouse, sustainable greenhouse, urban farming, urban horticulture, LOHAS, Kangas area, qualitative research.

Miscellaneous

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1 INTRODUCTION

Simon Kay-Jones is an architect and he is planning to design a sustainable greenhouse. He assigned the author to find the attitudes, interests of the people within the city of Jyväskylä toward investing in either a private or public sustainable greenhouse. The research aim of this thesis is to find out the ways in which people want to access to sustainable greenhouses and an attempt to find out their willingness to go as far as investing in a sustainable greenhouse and growing their crops and plants in it. Therefore, this thesis attempts to answer the following two research questions:

1. Who are the potential customers of a sustainable greenhouse?
2. What elements of a sustainable greenhouse do the consumers prefer?

Environmental awareness is getting higher and higher every day and people around the world are becoming increasingly conscious of how their consumption behavior affect the climate. We have finally recognized that at our current levels of consumption the planet cannot sustain us or it is carrying the capacity for humanity ad infinitum (McDonagh, & Prothero 2014, 1186). Over the past 10 years, environmental issues have steadily encroached on businesses' capacity to create value for customers, shareholders, and other stakeholders (Lubin, & Esty 2010, 43).

Today's consumers have started looking not only at the appearance but also at factors such as flavor, nutritional value, method of cultivation and absence of pesticide residues in the produce they buy. The consumers show interest in the way food is produced, for some this come from their concern for health. An important group of consumers are critical of contemporary farming because it strongly relies on pesticides. (Albajes, Gullino, van Lenteren, & Elad 2002, 416.) Sustainability is an emerging mega-trend and people are trying to follow that trend.

Many of the fruits and vegetables in the supermarkets are produced in greenhouse nowadays. Greenhouse production however requires a lot of energy, water and agro-chemical, and it generates enormous quantities of waste (Vox, Teitel, Pardossi,

Minuto, Tinivella, & Schettini 2010, 3). As mass production using the traditional greenhouse is not a sustainable way to continue, the sustainable greenhouse has come to play and it has the potentials to replace the traditional way of production. However, it is a fairly new concept and it is not easy to implement. There are people who are more aware of environmental problem more than others and they are changing their lifestyle to adapt to the phenomenon. In addition, urban farming can be mentally beneficial to those who wish to belong to a community.

In this thesis, the sustainable consumer and urban farming are discussed in chapter 2. Chapter 3 shows many types of traditional greenhouse and sustainable greenhouse system. After the literature reviews, the research theory and implementation are discussed in chapter 4 and 5. Lastly, chapter 6 and 7 cover the analysis of the data and the conclusion respectively.

2 SUSTAINABLE CONSUMER AND URBAN HORTICULTURE

In this chapter, the author will explain LOHAS consumer and the characteristics and attributes associate with LOHAS consumer. In the next chapter, the author will illustrate greenhouses and the concept of a sustainable greenhouse system. To conclude it all, a connection between the LOHAS consumer and the sustainable greenhouse system will be drawn at the end of this chapter.

2.1 LIFESTYLE OF HEALTH AND SUSTAINABILITY

LOHAS is an acronym for Lifestyle of Health and Sustainability which is used to describe a type of consumer who vigorously seeks out healthier and more sustainable lifestyle, product and service alternatives and also the market for the products and services they buy. LOHAS consumers' lifestyle and purchasing decisions are exhibited by their values regarding personal, family and community health, environmental sustainability and social justice. (What is LOHAS?)

19% of the population is characterized as LOHAS (Understanding the LOHAS Market Report 2013, 15). LOHAS is a relatively new, uncommon term and many people can be characterized as LOHAS without being aware of it. There are many aspects of lifestyle that LOHAS concerns such as food, building, car, etc. However, the author will only focus on food products and sustainability related to food consumption and production.

Kangas area is a new area within the city of Jyväskylä. One of the strategies of Kangas area is the smart use of resources. Kangas is one of the first two areas in Finland that are trying out the One Planet Living approach. Sense of community and sustainability can be found in the urban farming that has been operational in Kangas area since summer 2012. Kangas area are designed with car-free lifestyle in mind. (Kangas in English.) Most of the members of Kangas urban farming society are green consumer and they might possess many attributes that compatible with LOHAS. Moreover there are also other people who do not live in the area but have the same mindsets. The reason the author includes Kangas urban farming society in this part is because they are the main research target for this thesis.

2.2 SUSTAINABILITY AND URBAN HORTICULTURE

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Our Common Future). Sustainability is also a trend, which is more important in food and agriculture than ever. From perspective of deep ecology, all forms of agriculture damage the natural environment. In poor developing countries, most of the environmental damage done by agriculture itself i.e. the exhaustion of soil nutrients due to shortened fallow times. In wealthy industrial society, environmental damage from farming usually results from too much input use such nitrogen fertilizer. (Paarlberg 2013, 116–118.)

Environmental activists and agricultural scientists give different answer to the question environmentally sustainable farming. Environmentalists prefer small scale diversified farming systems that rely fewer inputs purchased off the farm, and on

system that imitate nature rather than dominate or engineer nature. Agricultural scientists tend to assume that less damage will be done to nature if using high-yield farming system with the integration of high technology because already farmed land can have higher yield while allowing remaining land to be saved for nature. (ibid., 116–118.) This situation is also applied for traditional greenhouse production.

On the 23rd of May 2007, researchers from both North Carolina and Georgia Universities estimated that the urban population was 125,849 people more than the rural one (Mayday 23: World Population Becomes More Urban than Rural). That means urban farming became more relevant than ever.

Urban agriculture or urban farming can be defined as the growing of plants and the raising of animals within and around cities. While horticulture is a subcategory of urban farming; it is the cultivation of fruits and vegetables generally represents the major component. (FAO's role in urban agriculture; Orsini, Kahane, Nono-Womdim, & Gianquinto 2013, 703.) The terms urban farming and urban horticulture can be used interchangeably. Although transportation of food is the source of only 11% of greenhouse gas emission within food sector, the method of growing and the waste generated contributes the most to the emission (Paarlberg 2013, 181).

Beside from the environmental aspect, urban agriculture has other benefits such as health; food and nutrition security; local economy development; and social inclusion and gender relations. Social integration would be the most important advantages of urban farming because people of different groups (i.e. immigrant, indigent or left women, unemployed, elders, disabled, etc.) can participate in the activities. (Orsini et al. 2013, 701–702.)

2.3 ORGANIC AND LOCALLY GROWN FOOD

Prior to the invention and development of synthetic nitrogen fertilizers in the twentieth century, all food production worldwide was in fact organic (Paarlberg 2013, 166).

Organic production can be defined as an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. Organic foods are grown without the use of synthetic pesticides, growth hormones, antibiotics, modern genetic engineering techniques (including genetically modified crops), chemical fertilizers, or sewage sludge. (Winter, & Davis 2006, 117.) The growth of organic farming is a response to the increased demand of consumers for organic food which is believed to be superior in term of quality and safety (Blair 2011, 7). Organic fruits and vegetables are proved to have fewer pesticide residues and lower nitrate levels than do conventional fruits and vegetables (Winter & Davis 2006, 123). Nevertheless, health professionals from outside the organic community have found little or no advantage from organic food (Paarlberg 2013, 171). Despite all the benefits of organic food, organic farming is still doing damage to the environment but at a minimum level. Organic food is also an emerging trend that is going around the globe especially in the developed countries.

The interest in organic food also expands to locally grown food, which is of course, fresher than the food shipped over a great distance. Not to mention the emission from the transportation of food shipped from other countries or even continent. Consumers prefer to buy food from a local producer because they want to support local economy and they have the knowledge of where and how the food is made. The nutritional advantages can be real because locally grown food will have an optimal ripeness comparing to the food shipped elsewhere. Apart from cost of nutrition, safety, or convenience, direct food sale from farmers to local consumers does bring important social benefits. (Paarlberg 2013, 177–178.)

Locally grown organic food is therefore an ideal practice for a LOHAS consumer whether they buy from farmers or they grow it themselves in a sustainable greenhouse.

2.4 SOCIALLY RESONSIBLE INVESTING

When making purchasing decision, consumers often consider multiple choices and alternatives then ultimately decide based on many internal and external factors. One of those internal factors is the sacrifice a consumer willing to make. Potential sacrifices for environmentally friendly products including price, convenience, brand perception, style, product quality, and effectiveness. Despite that, LOHAS consumers do not consider that as a sacrifice because they think the environmentally friendly product is the right product. (Understanding the LOHAS Market Report 2013, 108.)

There are 3 keys pillars of sustainability which are economic, social, and environment. Economic dimension is not a priority of LOHAS consumer comparing to other dimensions which are social and environment as mentioned above. LOHAS consumers value sustainable building which is a smart and energy efficient sustainable greenhouse. Therefore, a sustainable greenhouse would fit in this criteria of social responsible investing and sustainable building.

3 GREENHOUSE

3.1 TRADITIONAL GREENHOUSE

A greenhouse is an enclosed space that creates a different environment to that found outside due to the confinement of the air and to the absorption of shortwave solar radiation through a plastic or glass covers (El Ghoumari, Tantau, & Serrano 2005, 346). Greenhouse cultivation is the most intensive form of crop production with a yield per cultivated unit area up to 10 times superior to that of a field crop. Crops include vegetables, fruits, and ornamental plants are cultivated worldwide

under greenhouse conditions. Microclimate is created within the greenhouse by the technology, and it can be managed resulting in higher yield, quality and lengthening the availability of the product in the market. (Vox et al. 2010, 2.) In the book Greenhouse Technology and Management, Manohar and Igatidnathane (2007) have made an elaborate classification for greenhouses. Greenhouses can be classified based on its shape, utility, construction, and covering materials. (7–15.)

Based on shape

Lean-to greenhouse is a greenhouse placed against the side an existing building except the northern side (in northern hemisphere). This lean-to-design makes the best use of natural sunlight and minimizes the requirement for roof supports. The roof of the existing building is extended with appropriate covering material and the greenhouse is properly enclosed. (Radha & Igatidnathane 2007, 8.) This type is also suitable for cold climate and makes the best use of passive solar energy which will be discusses later on. Figure 1 illustrates a side view of a lean-to greenhouse.

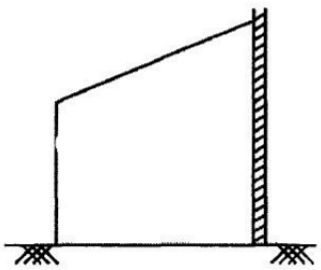

***Figure 1**: Lean-to greenhouse (Radha & Igatidnathane 2007, 8)*

Greenhouse of small size and is constructed on a leveled ground can use the Even span greenhouse design which has two roof slopes with equal pitch ad width. For single span type, the span generally varies from 5 to 9 m, whereas the length is around 24 m. The height usually varies from 2.5 to 4.3 m. (Radha & Igatidnathane 2007, 8.) Figure 2 illustrates the side view of an even span greenhouse.

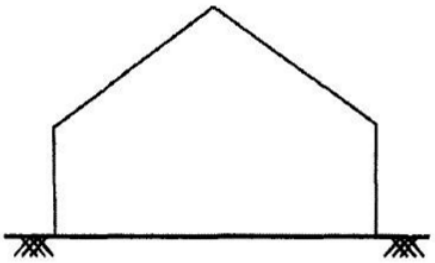

***Figure 2**: Even span greenhouse (Radha & Igatidnathane 2007, 8)*

On hilly terrain, uneven span greenhouse is constructed with the roofs of unequal width which make the structure more adaptable and durable to the side slopes of the hill. This type of greenhouses is no longer adaptable due to nowadays automation. (Radha & Igatidnathane 2007, 9.) Figure 3 illustrates the side view of an uneven span greenhouse.

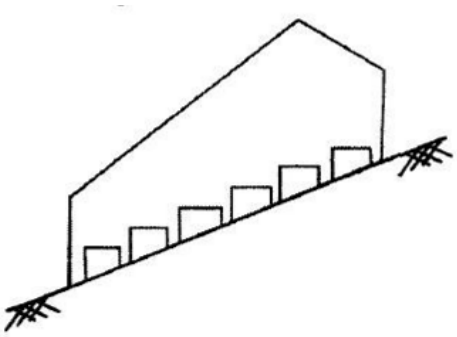

***Figure 3**: Uneven span greenhouse (Radha & Igatidnathane 2007, 9)*

Ridge and furrow greenhouse uses two or more A-frame greenhouses and it is connected to one another along the length of the eave. The eave serves as a furrow or gutter to carry rain and melted snow away. The walls inside the greenhouses are taken away, which makes the greenhouses into a structure with a single large interior. Combining of interior space reduces labor, lowers the cost of automation, improves personal management and reduces fuel consumption, as there is less exposed wall area through which heat escapes. The snow loads must be taken into consideration in northern countries since the snow cannot slide off the roofs as in case of the single greenhouses. The snow can even collapse the whole structure.

(Radha & Igatidnathane 2007, 9.) Figure 4 illustrates the side view of a ridge and furrow greenhouse.

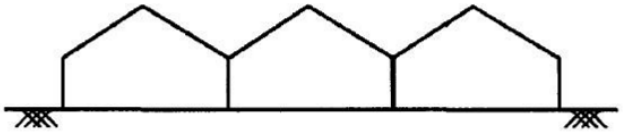

***Figure 4**: Ridge and furrow greenhouse (Radha & Igatidnathane 2007, 9)*

Saw tooth greenhouse is somewhat similar to the Ridge and furrow greenhouse but with natural ventilation system mechanism. Specific natural ventilation flow path develops in a saw tooth type greenhouse. (Radha & Igatidnathane 2007, 10.) Figure 5 illustrates the side view of a saw tooth greenhouse.

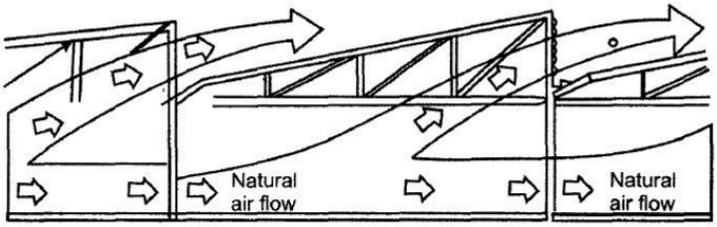

***Figure 5**: Saw tooth greenhouse (Radha & Igatidnathane 2007, 10)*

In quonset greenhouse, the pipe arches or trusses are supported by pipe purlins running along the length of the greenhouse. The covering material generally used for this type of greenhouses is polyethylene (plastic). This type of greenhouse is slightly less expensive than the gutter connected greenhouses and are useful when a small isolated cultural area is required. These greenhouses are connected either in free standing style or arranged in an interlocking ridge and furrow. In the interlocking ridge and furrow type of greenhouses, truss members overlap sufficiently to allow a bed of plants to grow between the overlapping portions of adjacent houses. A single large cultural space thus exists for a set of houses in this type, an arrangement that is better adapted to the automation and movement of laborers. (Radha & Igatidnathane 2007, 10–11.) Figure 6 illustrates the side view of an interlock quonset greenhouse.

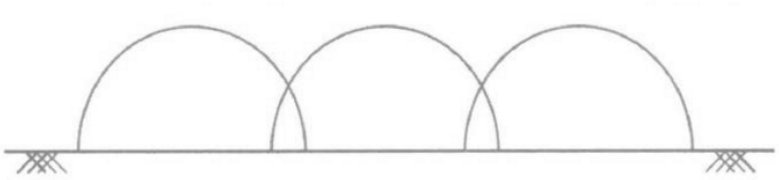

***Figure 6**: Interlock Quonset greenhouse (Radha & Igatidnathane 2007, 11)*

Based on Utility

Greenhouses classification can also be done by classify its functions of utilities. Artificial cooling and heating of greenhouse are the two different utilities which are more expensive and elaborate. Therefore, based on the artificial cooling and heating, greenhouses are classified as the uses of active heating system or active cooling system. (Radha & Igatidnathane 2007, 11.)

During the night time, the air temperature inside greenhouse decreases and to avoid the cold bite to plants due to freezing, some amount of heat has to be supplied. During the night time, the air temperature inside greenhouse decrease if it is cold outside and in order to avoid cold bite to plants due to freezing, the heat needs to be provided. The requirements for heating greenhouse depend on the rate at which the heat is lost to the outside environment. Various methods are adopted to reduce the heat losses, such as using double layer polyethylene, thermopane glasses (two layers of factory sealed glass with dead air space) or to use heating systems, such as unit heaters, central heat, radiant heat and solar heating system. (Radha & Igatidnathane 2007, 12.) In Nordic climate, winter season is lengthy and thus heating is vital but not exclusively.

During summer season, it is sought after to reduce the temperature of the greenhouse than the surrounding temperature outside for effective crop growth. As a result suitable modifications are made so that large volumes of cooled air are drawn into greenhouse. This type of greenhouse either consists of evaporative cooling pad with fan or fog cooling. This greenhouse is designed in such a way that it

permits a roof opening of 40% and in some cases nearly 100%. (Radha & Igatidnathane 2007, 12.)

Based on Construction

Structural materials predominantly influence the type of construction, although the covering materials is also influence the type. Span of the greenhouse dictates the selection of structural members and their construction. The higher the span, the stronger the material should and the more structural members are used in order to make a sturdy truss frame. Simpler design can be used for smaller spans. Hence based on the construction, greenhouse can be classified as wooden framed, pipe framed and truss framed structures. (Radha & Igatidnathane 2007, 12.)

Greenhouses with span less than 6m, only wooden framed structures are used. Side posts and columns are made of wood without the use of a truss. Most commonly used are pine wood for it is inexpensive and possesses the required strength. Timber is also a good material with good strength, durability and machinability, though it is available locally. (Radha & Igatidnathane 2007, 12–13.)

If the greenhouse structure span is around 12m, pipes are used for the construction of greenhouses. Side posts, columns, cross-ties and purlins are constructed using pipes. Trusses are also not used in pipe framed type of greenhouse. The pipe components are not interconnected but depend on the attachment to the sash bars for support. (Radha & Igatidnathane 2007, 13.) Figure 7 illustrates a greenhouse with pipe framed structures.

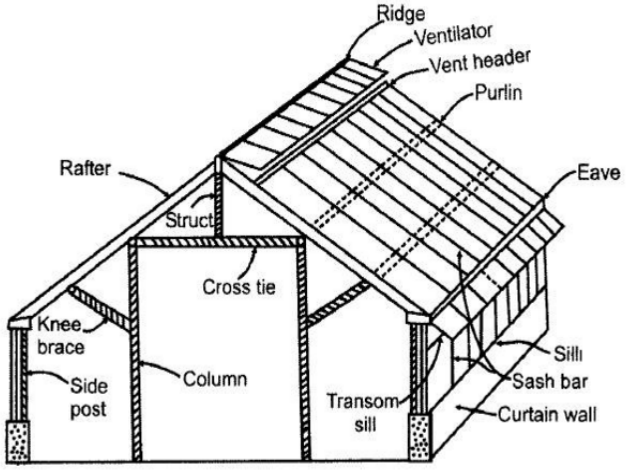

***Figure 7**: Pipe Framed Structures (Radha & Igatidnathane 2007, 14)*

If the greenhouse span is greater than or equal to 15m, truss frames are used. Flat steel, tubular steel or angle iron is welded together to form a truss enclosing rafters, chords and struts. Struts are support members under compression and chords are support members under tension. Angle iron purlins running throughout the length of greenhouse are bolted to each truss. Columns are used only in very wide truss frame houses of 21.3m or more. Most of the glass houses are truss frame type. (Radha & Igatidnathane 2007, 13–14.) Figure 8 illustrates a greenhouse with truss framed structures.

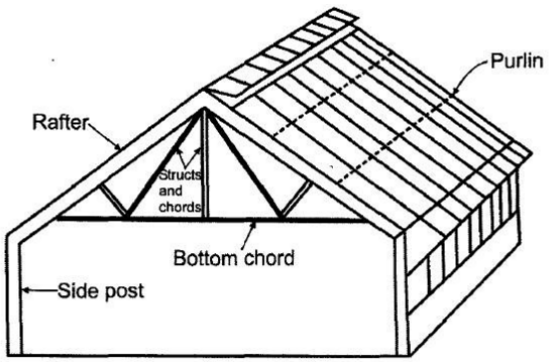

***Figure 8**: Truss Framed Structures (Radha & Igatidnathane 2007, 15)*

Based on covering materials

Covering materials are the prime and most significant component of the greenhouse structure. Covering materials have the direct influence on the greenhouse effect

inside the structure, and they modify the air temperature inside the greenhouse. Based on the type of covering materials the greenhouse are classified as glass, plastic, plastic film and ridge panel greenhouses. (Radha & Igatidnathane 2007, 14.)

Prior to 1950 only greenhouse with glass as covering material existed. Glass greenhouse has the advantage of greater interior light intensity. These greenhouses have higher air infiltration rate which leads to lower interior humidity and better disease prevention. Lean-to, even span, ridge and furrow type of designs are used as the construction of glass greenhouse. (Radha & Igatidnathane 2007, 14.)

Flexible plastic films including polyethylene, polyester and polyvinyl chloride are used as covering material for plastic film greenhouse. Covering material made of plastics for greenhouse has become increasingly popular as they are affordable and the cost of heating is less comparing to glass greenhouse. The main disadvantage of plastic film for covering material is its short lifespan. For example, the best quality ultraviolet (UV) stabilized film can last for four years only. Quonset design as well as gutter-connected design is suitable for using this covering material. (Radha & Igatidnathane 2007, 15.)

Polyvinyl chloride rigid panels, fiber glass-reinforced plastic, acrylic and polycarbonate rigid panels are employed as the covering material for ridge panel greenhouse. These panels can be used in the quonset type frames or ridge and furrow type frames. This sort of material is more proof against breakage and the light intensity is consistent throughout the greenhouse comparing to glass or plastic film. High grade panels have long life even up to 20 years. The main disadvantage is that these panels tend to collect dust as well as to harbor algae, which results in darkening of the panels and subsequent reduction in the light transmission. There is significant danger of fire hazard. (Radha & Igatidnathane 2007, 15.)

Traditional greenhouses are classified based on its shape, utility, construction, and covering materials. And that concludes all the basic types of traditional greenhouses. Next chapter is about the sustainable greenhouse system.

3.2 SUSTAINABLE GREENHOUSE SYSTEM

The global climate change has made a great impact on every corner of the world and the awareness of the situation is being raised every day. Sustainable development is now the solution and it needs to be applied to every aspect of our live including the food we consume and how it is produced. Greenhouse production however requires a lot of energy, water and agro-chemical, and generating enormous quantities of waste. In reality, there are few researches concerning the sustainability of greenhouses since sustainable greenhouse is a fairly new term. Vox and colleagues (2010) have made an elaborate and intricate research on sustainable greenhouse systems which the author will use as the main source of information. Sustainable greenhouse systems, which must be resource-conserving, socially supportive, commercially competitive and environmentally sound, rely on cultivation techniques, equipment management and constructive materials aimed to reduce agro-chemicals, energy and water consumption as well as waste generation. (3.) Since it is a system, a greenhouse can be tailored to the needs and desires of the users. The goals can be achieved by means of the following ways.

Microclimate Management

The structure of a greenhouse generates a new environment inside the greenhouse which is better known as microclimate (Duarte-Galvan, Torres-Pacheco, Guevara-Gonzalez, Romero-Troncoso, Contreras-Medina, Rios-Alcaraz, & Millan-Almaraz 2012, 927). Figure 9 illustrates the many variables that can be controlled within a microclimate. The objective of the full microclimate control of a greenhouse is summarized as plant production within closed environment striving to bring each plant to its generic potential (Albright 2002, 48). The greenhouse microclimate control is currently one of the main objectives of engineering in precision agriculture (Duarte-Galvan et al. 2012, 936).

From the basic shelter greenhouse to the fully computerized actively conditioned greenhouse, the level of control on the microclimate can vary greatly. In recent years, many have made substantial efforts in order to optimize the greenhouse house microclimate plus sustainable approaches. The parameters which affect the

microclimate such as temperature, humidity and CO2 concentration are the central focus. (Vox et al. 2010, 3.) Those parameters can be manipulated in order to optimize the microclimate within the greenhouse. The heating and cooling of the greenhouse must also be taken into consideration since it is fundamental to the system.

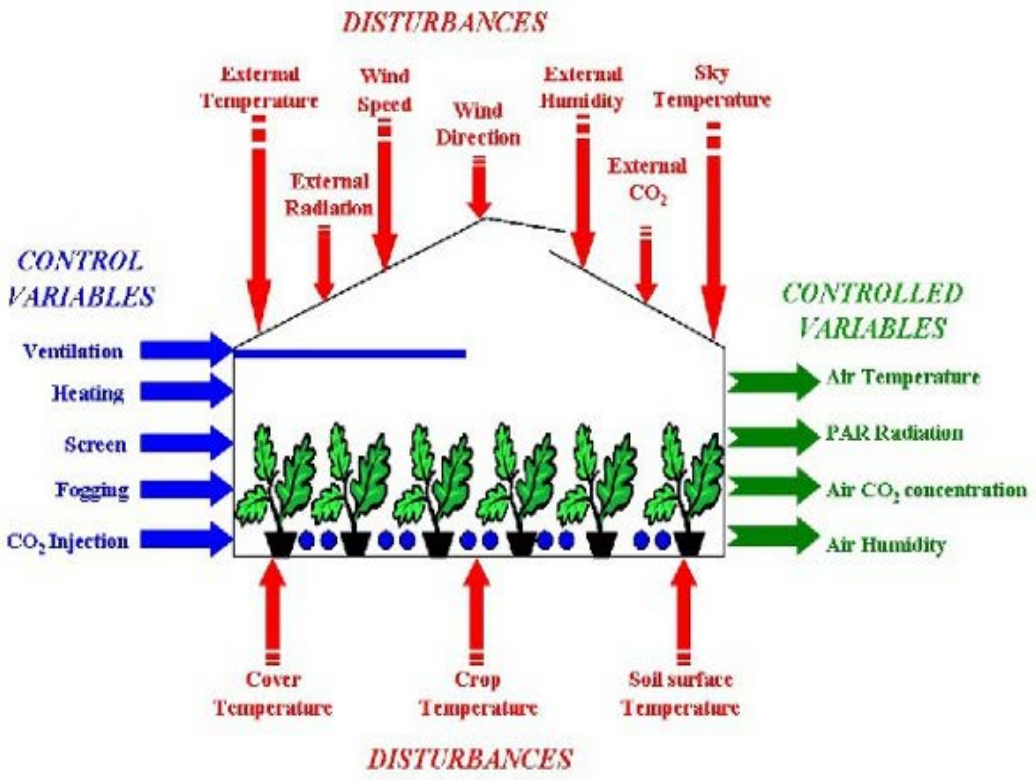

***Figure 9**: Climate control variables (Pawlowski, Guzman, Rodriguez, Berenguel, Sanchez & Dormido 2010, 292)*

Plant growth in the greenhouse is heavily reliant on the temperature manipulation. The idea of simply decreasing the set point temperature reduces the energy consumption but it also results in reduced income. The manipulation of the greenhouse air temperature to reduce the energy usage is a common practice. (Vox et al. 2010, 4.) This method of increasing sustainability can be applied to non-commercial greenhouse since no profitability is required. Higher average temperatures can be achieved using higher day time temperatures. This allows the lower night time temperatures which results in lower heating fuel costs. The method is call passive solar energy.

Humidity in greenhouses is managed for two main reasons which are to avoid too high humidity to prevent fungal infection and to regulate transpiration. The method

of using covering films with anti droplet formulation properties is an effective way of handling a high humidity level. Due to the way in which these chemicals are released from the film, this property only has a limited life of one to two seasons. It is difficult to accurately predict its effectiveness, as it is dependent on several factors, including the rate of formation of condensation on the covering surface, the general greenhouse climatic conditions and the effect of pesticides and fungicides sprayed to protect the crop on the plastic film. (Vox et al. 2010, 5.)

In order to produce high quality crop in greenhouses, the amount of CO_2 required can be at rates higher than the ones allowed by the typical atmospheric concentration. It is also necessary to mix greenhouse air to guarantee healthy plant microclimates and prevent localized CO_2 deficiencies. The reduction of CO_2 exhaust from greenhouses is important in the light of the Kyoto treaty on CO_2 emission levels. (Vox et al. 2010, 6.)

Energy Sources

Greenhouse equipment such as fans, fertigation (the process of injection of fertilizers) and lightning need to feed on electricity which can be generated from renewable energy sources. One the sustainable energy source is solar power which can be converted to electricity by means of photovoltaic systems (Knier 2002). The high manufacturing cost and the rate of converting sunlight into electricity (known as the electrical energy conversion efficiency rate) are the drawbacks of the solar panel application to the greenhouse usage (Bagher 2014, 58). The usage of the solar panels is limited in northern countries since the amount of solar radiation is significantly lower than southern countries. There are new study and experience on the new concept concerning using transparent solar panels as covering material. That concept was proposed by Souliotis, Tripanagnostopoulos, and Kavga (2006) but it has not made much progress.

The other source of sustainable energy is wind turbines which generate electricity, can be integrated in a stand-alone system or can be connected to the grid (Vox et al. 2010, 26). However, the investment cost and maintenance of turbines might not be

suitable for greenhouses. The disadvantages of the alternative energy sources are always the costs and the efficiency when compared to fossil fuel. Nevertheless, if the country or the region has its own sustainable energy plan then the problem will be almost eliminate itself.

Covering material

Covering materials are an important component of the greenhouse which protect crops from weather conditions, influence greenhouse microclimate altering the growing conditions of the crops comparing to the external climatic condition (Vox et al. 2010, 27). As aforementioned, glass, semi plastics and plastic films are the most common covering materials and are used widely. Nevertheless, energy losses through covering material are high and those materials are rather unsustainable especially plastics since it is petroleum based. Even so replacing conventional plastics with biodegradable materials in agricultural applications does not reduce the amount of waste, but it does provide the opportunity to choose an alternative waste treatment strategy, i.e. organic recovery (Kapanen et al. 2008, 120).

In order to increase the sustainability in greenhouse, innovative covering materials need to be applied along with effective heating and cooling systems. Biodegradable materials for agricultural purposes formed with raw materials from renewable original have been developed in recent years to be used as environment ally friendly alternatives to petroleum based material. Those materials are biodegrade starch based films and water-born coatings; though the materials are still at their experimental stage.

Plant nutrient and water delivery

Hydroponic is a term for technique for growing plant in media other than soil (substrate culture) or in aerated nutrient solution (water culture) (Vox et al. 2010, 44). Hydroponic system enriches the water with nutrient necessary for plants in a closed system, which protects the water from evaporating and prevents discharge to the outside environment (Roberto 2003, 10). Hydroponic is necessary for

optimization of water and nutrient delivery to the plants in order to reduce water and nutrient consumption and drainage with ground water and soil preservation. There are 6 basic types of hydroponic system which are Wick, Water Culture, Ebb and Flow (Flood & Drain), Drip (recovery or non-recovery), N.F.T. (Nutrient Film Technique) and Aeroponic. (Basic Hydroponic Systems and How They Work.) Figure 10 illustrates 6 basic types of hydroponics.

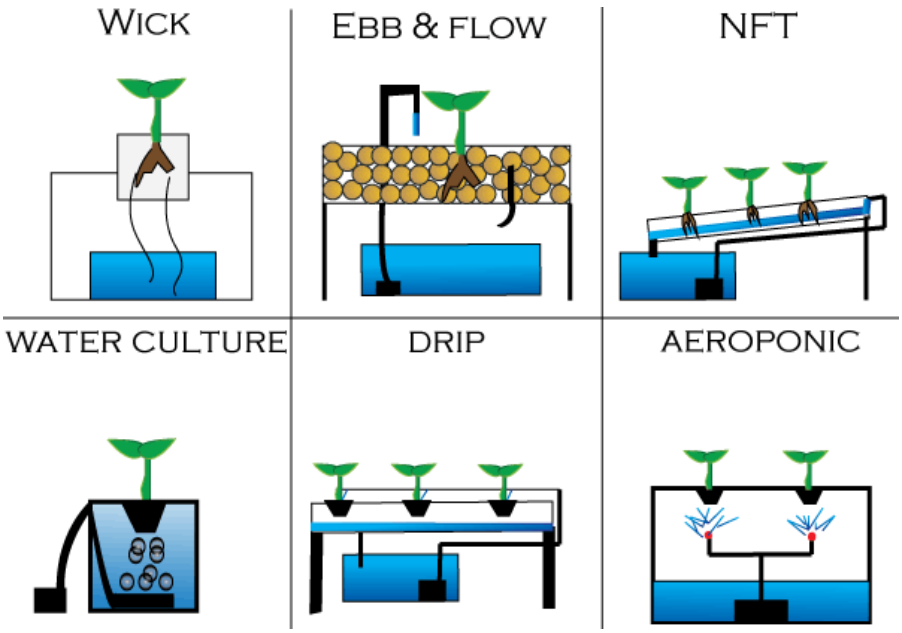

***Figure 10**: 6 Different Types of Hydroponic Systems (nosoilsolutions)*

Hydroponics has many advantages such as eliminate soil borne pest and disease, significantly increase yield, reduce crop maturation cycle and crop and plant are free of chemical traces, etc. (Roberto 2003, 12; Vox et al. 2010, 52). There are also disadvantages but the most important one is the high capital cost. However, hydroponics is worth investing if one's aim is to increase the sustainability of the greenhouse.

Management of pest and diseases

The traditional method of pest and disease management has often based nearly exclusively on the use of pesticides and agrochemicals. The sustainability of the greenhouse can be increased by applying the integrated management of pests and

diseases with a significant reduction of agrochemical. Integrated crop protection involves combining various sustainable crop protection methods in order to avoid diseases and pests or to suppress them. Using computer supported climate control management is one of the method, pest and disease infection can be reduced and influence plant development. (Vox et al. 2010, 53.) The other method is biological pest control relies on the conservation of natural enemies of insect pests in agroecosystems (Letourneaua, Andob, Jedlickac, Narwanid, & Barbiere 2015, 215). When compare biological pest control with chemical control, biological control tends to be long-term; low costs of the biological approach to pest control are tend to be widely accepted by growers (Yang, Zang, Wang, Guo, Xu, Zhang, & Wan 2014, 100). Integrate those method to achieve an optimal environment to protect crop from pests and diseases and to harm the environment as little as possible. Chemical agents are used only to a very limited extent (Kogel).

Consumers have become more and more aware of the risk of pesticide-residues in fresh plants and crops, a huge demand for non-chemical control methods is emerging in many countries. Integrated systems for greenhouse pest and disease control have been developed and implemented in northern Europe and Canada. (Albajes et al. 2002, 2.)

Deep Winter Greenhouse

The term 'passive solar building' mentioned above is a term used for building which significantly utilizes solar gains to reduce heating and possibly cooling energy consumption based on natural energy flow. Depending on the climatic conditions and building function, compatible heating/cooling system can be integrated with the passive solar system. The goal is to minimize the cost of heating/cooling while maximize the thermal requirement of the building. (Athienitis, & Santamouris 2013, 1–3.)

Severe cold weather and perpetual darkness climate of northern Europe is not necessarily the bane of greenhouse. Technology can be applied to make the greenhouse sustainable without wasting huge amount of money on operation costs

such as heating. As mentioned in types of greenhouse in ‘Traditional Greenhouse’ chapter, lean-in greenhouse can makes the best use of natural sunlight and minimizes the requirement for roof supports. Passive solar greenhouse is lean-in greenhouse with the greenhouse facing south which will boost the heat intake from the sun while preventing heat loss by insulating the north or even the east and the west (Avis 2011).

One compelling example is the Svalbard Global Seed Vault which is a secure seed bank situated in a remote arctic archipelago in Norway. The vault is dubbed as 'The doomsday Vault' by The Guardian because the vault has been entrusted by the world's governments with the safe keeping of the most prize varieties of crops on which human civilization was raised (Goldenberg 2015).

That is one example of a massive scale building in the northern climate. It is however possible to make a small scale greenhouse using passive solar technology. Gunderson (2014) wrote an article about a family owned greenhouse that operates year-round in Minnesota, USA which has a cold climate. The greenhouse combines passive solar energy and underground heat storage which are durable and doable. The plants survive largely on natural winter light and there is no artificial light bank. The greenhouse used the long plastic roof gutter filled with soil hanging from the ceiling to grow plants; this method provides more space for growing. The greenhouse’s yield is sufficient for the owners and the 10 other family. (Gunderson 2014.)

In Finland, the climate is harsher than in Minnesota but it is possible to build a greenhouse in cold and dark climate without spending substantial amount of money on heating.

Other methods

Recently, Dr. Dieleman (2016) from Wageningen University wrote an article suggested that the replacement of conventional High Pressure Sodium lamps to low carbon LED in horticultural greenhouse production will reduce carbon footprint by up to 45%. There are however some identified key barriers which are financial situation

of the growers, economic viability, and limited experimental evidence for LED based production systems in all addressable markets.

Vertical farming has now been widely accepted within urban farming community as a method to increase the capacity of the farm with urban environment (Despommier 2010, 227). Vertical farm opens up many possibilities for growing produce within small confine of a city.

3.3 SUMMARY

The traditional greenhouse in the food production industry is superefficient when it comes to providing food for the majority of the population. However, it is extremely unsustainable and it is heading toward an inevitable end as Paul Roberts (2008) predicted. As a result, LOHAS consumers are distancing themselves from the producers; those producers continue to neglect the needs of the LOHAS consumers since they belong to the minority.

In addition, the number of years of work for ornamental greenhouses and the ranking of workers according to the judged level of the current dermal pesticide exposure were related to sperm concentration, velocity, vitality, and morphology, even after the adjustment for confounders. Prolonged years at work and a high ranking of current dermal exposure were associated with a deterioration in these measures of semen quality. (Abell, Ernst, & Bonde 2000, 498.)

When a traditional greenhouse is integrated with a sustainable system, the result will be a sustainable greenhouse. The goal sustainable greenhouse is to reduce the usage of energy, water, and agro-chemical; and minimize the amount of waste from the production.

4 RESEARCH DESIGN

According to Hair, Bush, & Ortinau (2006, 63) there are three types of research design which are Exploratory, Descriptive and Causal. Exploratory research usually contain data which obtained by using primary or secondary data sources and the data is interpreted with an unstructured format. Typical exploratory research techniques are for example focus-group interviews, in-depth interviews and pilot studies. This type of research design is suitable for this thesis since the research will determine the nature of the research problem and thoroughly explore the research problem.

Descriptive research is also chosen for this thesis because this type of research is a good method to describe the current phenomena such as attitudes and preferences. The goal of causal research is to discover the cause-and-effect relationships between variables. (Hair et al. 2006, 63–64.) Therefore, causal research is not chosen. Research design helps the author to build the structure of the thesis from the beginning of the process. The design varies between different researchers and the researchers design it however it fits the purpose and the researchers themselves.

4.1 RESEARCH METHOD

Research methods are plans and procedures for research that span the steps from broad assumptions to the detailed method of data collection, analysis and interpretation (Creswell 2013, 3). The choice of the research method should be based on the phenomenon, but on the other hand, different research methods suit different people (Kananen 2011, 43). There are three research methods: qualitative, quantitative and mixed methods.

This thesis represents qualitative research which is a method for exploring and understanding a social or human problem of individuals or groups (Creswell 2013, 4). Furthermore, when the phenomenon is quite new and unknown, only qualitative research is possible (Kananen 2011, 41). Qualitative research has four characteristic:

process, meaning, and understanding are on the main focus; the researcher is the primary instrument and the key to data collection and analysis. The process is inductive; and the produce is richly descriptive (Merriam & Tisdell 2016, 15).

Quantitative research is a method for testing theories by examining the relationship between variables (Creswell 2013, 4). The sustainable greenhouse is a new concept and it is little known publicly and commercially. Therefore there is little data for quantitative research. The third method is mixed methods which of course is not used for this context.

4.2 DATA COLLECTION

Data are nothing more than ordinary bits and pieces of information found in the environment and data conveyed through words have been labeled as qualitative data (Merriam & Tisdell 2016, 105). Qualitative data consist of direct quotation from people about their experiences, opinions, feelings, and knowledge obtained through interview; detail descriptions of people's activities, behaviors, and actions recorded by observation; and from excerpt, quotation, or entire passage extracted from various types of documents (Patton 2015, 14). Therefore, collection of data for qualitative research is simply retrieving data through focused interviews, observations, and documents.

Focused interview is the most common method of data collecting for qualitative research. A focused interview can either be an individual or focus group interview. Both types of interview have its own advantages and disadvantages. Group interview will save time comparing to individual interview which increase the workload accordingly to the number of interviews. However, a group interview needs to be conducted in ways that all thoughts and opinions of all the participants are considered equally in case of different social dynamic among the participants. As a result, all of the interviewees or the participants need to be given an opportunity to contribute to the research data. (Kananen 2011, 52.)

Interviewee selection and saturation

In qualitative research, a researcher usually cannot define the number of interviewees in advance. The number of the interviewees depends on the research problem and the research material. The interviewees should be selected in view of the phenomenon i.e. they are involved in or affected it. The number of interviewees depends on the research materials and the research problem (Kananen 2011, 52–53).

Interview questions

It is sensible for the interviewer to conduct the focused interview from general to specific pace. If the interviewer proceed from one level to the next too quickly, the information yield from the interview might be vague or some piece of valuable information can even be missed. Questions can be divided in to open-ended and close-ended questions. Close-ended questions offer a limited number of alternatives and responses and aim at acquiring information on the alternatives only. Open-ended questions used words such as what, why, and how. Those type of questions cannot be answer with one word or idea. Open-ended questions are more suitable for collecting data of qualitative research rather than close-ended question. Leading question reveal bias and assumption that the researcher make which may not accurately reflect interviewees' minds, therefore leading questions should be avoided. In some extreme cases, leading questions may be considered unethical because the answers from those question are coerced. (Merriam & Tisdell 2016, 121–122; Kananen 2011, 55–56.)

The interviewer should be flexible and prepared to follow unforeseen paths during the interview because the answers provided by interviewee generate follow-up questions. Researcher often makes mistake of planning theme and even individual questions beforehand and then asking the questions without attempt to create the interaction and reflection with the interviewees. (Kananen 2011, 54.) The results from the interview should be able to answer the research questions and ultimately fulfill research aim.

How to manage an interview

The interviewer strives to create an atmosphere in which people can feel comfortable talk openly about themselves and express their opinions. The interview is a relaxed and conversational since this is how people normally interact. By designing the interview along the lines of every conversation, the interviewer can learn about what is most important to people. One valuable trait the interviewer can possess is being a good listener – the confidante. Despite that, the interviewer usually refrain from expressing their own view; thus the flow of the information is largely but not exclusively one-sided. Interviewer should always assume neutrality with regard of the interviewee's knowledge; that is regardless of how antithetical interviewee's positions to interviewer's beliefs and values. It is crucial to avoid any argument or debate between the interviewer and the interviewee. (Taylor, Devault & Bogdan 2016, 115; Merriam & Tisdell 2016, 128.)

4.3 ANALYSIS AND INTERPRETATION

Data analysis is the process of making sense out of the data. The process of making meaning out of data involves consolidating, reducing, and interpreting what people have said and what the researcher has seen and read. (Merriam & Tisdell 2016, 202.) Qualitative research is flexible and there is not clear research path. Flexibility can even go so far that the interpretation of every researcher is considered right, unless no clear mistakes are made in the data collection, analysis or interpretation. (Kananen, 2011, 43.)

The process of data analysis that the author follows is a linear step-by-step process. The findings and results from the data which obtained from the categories or the themes will answer the research problem. The term 'category' or 'theme' is commonly used in most texts dealing with basic data analysis. However, the reader should not confuse with the themes of the interview questions. The step-by-step process includes category construction, sorting the categories, naming the categories, and lastly theorizing. (Merriam & Tisdell 2016, 204.)

The process begins with reading the first interview transcript along with the field note or document. The researcher makes notations, comments, and queries on the data to mark the data as important, relevant, or interesting to the thesis and the research questions. The process of marking the bits of data as relevant is called coding. With the next set of data, the same process is repeated. As a result, notations, comments and queries of all the data can be compared and categories can be made based on the similarities between the sets data. The challenge is to construct categories or themes that capture some recurring pattern that cuts across the data. (Merriam & Tisdell 2016, 204–207.)

The process of constructing categories will create many categories that need sorting. The categories need to be renamed to reflect the data precisely (Merriam & Tisdell 2016, 209). The categories of data can be visualized as "buckets or baskets into which segments of text are placed" (Marshall & Rossman 2015, 224). Now the categories are satisfactory and they are sorted according to the author's need. There are numerous software and programs such as NVivo that assists the researchers in naming and sorting the categories but the author decided not to use them. The author made the whole process manually since this is the author's first major academic work.

The last step of the process is theorize from the data and the categories that have been made. The qualitative data analysis is all about identifying themes, categories, patterns, or answer to the research questions (Merriam & Tisdell 2016, 216). Since there is no statistical test to tell when an observation or pattern is significant, the researcher must first rely on their own sense making, understandings, intelligence, experience, and judgement (Patton 2015, 572). The point is to think about categories and speculating as to how they may be interrelated to each other; interrelationships can be listed and a theory constructed. When categories are reduced and refined and then linked together, the analysis is moving toward the development of a model or theory to explain the meaning of the data. (Merriam & Tisdell 2016, 220.)

In short, the data analysis is to make sense of the data in order to answer the research problem.

4.4 RELIABILITY AND VALIDITY

The research needs to be conducted rigorously in order to have any effect on the theory or the practice of a field; they need to exhibit insights and conclusions that ring true to readers, practitioners, and other researchers (Merriam & Tisdell 2016, 238). The reliability and validity of a thesis can be increased by several simple ways, but they have to be taken into consideration from the very beginning of the research process. Reliability refers to the consistency and the repeatability of the measurement and research results. Validity refers to whether your thesis answers the questions it is intended to answer. (Kananen 2011, 66–67.)

5 CONDUCT THE INTERVIEWS

5.1 INTERVIEW PREPARATION

The community of Kangas area in Jyväskylä has been working on urban farming since 2012. There are about 15 people involved in first year when it started; and about 20 people in the recent years (Browne 2016). Those people are the green consumers, trendsetters, and they have expert knowledge concerning issue. The author has speculated that these people may fit the LOHAS' principles. Not only that, the Kangas area is new and modern area which was established by the city of Jyväskylä in order to promote green and sustainable lifestyle. Therefore, Kangas urban farming society are the perfect target for the sustainable greenhouse concept. Beside from that, the author also interviewed people from outside the community whom was considered also to be LOHAS consumers. The author hoped the results will confirm this hypothesis.

The tutor for the author suggested that the author should contact Laura Brown who used to be a coordinator for Kangas area farming. Laura Brown was contacted by the author and she was asked to find potential interviewees for the thesis. The author’s email was given to the interviewees so they could make contact. Apart from that, some people who are not members of Kangas farming were also interviewed due to

the fact that they are considered LOHAS and have some interests in urban farming. As a result, six interviewees were chosen and interviews were done. The interviewees are in different age group from middle age to senior and both male and female.

The author decided to choose interview, specifically individual as the method to conduct the data collection for this thesis. The reason this method was chosen because it was the most suitable for the research, situation, and as well as for the author. Another reason was that it suited the 'Finnish introvert' (Brandt, Gomes & Boyanova 2011, 264) type of personality among the interviewees who prefer one-on-one conversation. Moreover, according to Hofstede, Finland scored very high in Individualism in cultural dimensions which means the people value 'I' more than 'We' (Hofstede). Individual interview will help Finnish interviewees voice their opinion with ease rather than silence or agree due to peer pressure and give their best performance. Although the Kangas farming is a collective community, people may feel more comfortable speaking about their involvement in smaller groups.

There are 19 questions for the interviews of this thesis research. However, the number of questions were asked during the interviews were different depended on the responses. The question can be found in the appendix 1. Those questions are divided into themes for the purpose of categorizing the data. The theme should cover the phenomenon as well as possible (Kananen 2011, 54). The themes' purposes are to answer the research questions and ultimately research problem. There are three themes which consist a series of the questions. The questionnaire was tested with the author's friend and the estimated length of the interview is 15 minutes.

The first theme is Consumer profile with the purpose is to find what sort of consumer the interviewees. This theme is also used to identify the whether the people of the Kangas farming community fit into the principles of LOHAS consumer. There are 4 questions in this theme.

1.1 How old are you?

1.2 Can you tell me about your education?

1.3 What kind of consumer are you? (How do you describe yourself as a consumer?)

1.4 What is important to you when you buy food? What about fruits and vegetables?

The second theme contains set of questions which purpose is to find out the urban farming in Kangas area and the activities surround it. Not only that, the author also hope to find out what kind cultivation methods and technologies are being used in Kangas urban farming. This theme will also find out the people participate in such activities. There are 7 questions in this theme.

2.1 How long have you been participating farming in Kangas?

2.2 What kind of activities do you do with Kangas farming? How often do you do that? What do you enjoy doing?

2.3 What are the 3 things motivate you to take part in it?

2.4 What benefits do you see from community farming?

2.5 How do you do the farming? (Technology, method of cultivation)

2.6 What kind of produce do you grow on your farm? How is the quality of those produce?

2.7 How much do you grow? (Just for fun, enough to eat, a lot to give away)

The last theme has questions to find out the future of a sustainable greenhouse as place to grow produce for Kangas community and the integration of greenhouse to urban farming as well as other places in Jyväskylä. Summer is the only season that the people of Kangas community are able to grow produce, greenhouse would be a tremendous addition to the area as a mean to grow produce all year round. This theme will also find out the desirable design of the greenhouse the people in Kangas community wish to have. This including all the types of traditional greenhouse and the components of a sustainable greenhouse system. There are 7 questions in this theme and one extra question.

3.1 What do think about growing produce in a greenhouse during winter time?

3.2 In your opinion, what challenges do you see a greenhouse here have? (Heating, material, energy, capital costs)
3.3 Do you have any solutions to those?
3.4 Have you ever heard of the term 'sustainable greenhouse'? What are the first things come to your mind when you hear that term? (Show sustainable greenhouse system)
3.5 What is your opinion about it?
3.6 How would your dream greenhouse be like? (With soil, etc.)
3.7 Are you willing to invest in a greenhouse (as part of a community/privately)? Why? How much do you think you can invest?
0.0 Do you have any idea or opinion you would like to express? (Do you have anything on your mind?)

5.2 INTERVIEWS

The interviews were conducted in March to April, 2016. Four females and two males were interviewed. Those interviews were mostly carried out in an informal setting such as cafés and Skype. The length of the interviews were roughly 15 minutes to 25 minutes on the record and there were some off the record discussion between the interviewee and the author. The author tried to create a relaxing atmosphere in order to reduce the seriousness of the situation so that the interviewees could freely speak their mind. Especially for a Finnish Introvert (Brandt et al. 2011, 264), it is difficult for the people to speak more than what they are asked if they do not feel comfortable. All the interviewees allowed the author to record the interviews and use their name in this thesis if necessary. The interviews were fulfilled and the author received information good quality and sufficient for the thesis. All the interviewees allowed the author to record the conversations and use their names in the thesis if needed.

The physical sit-down interviews were recorded with the author's personal phone and the Skype interview was recorded using an add-on Call Recorder. All the sound recordings are for private use only but the transcriptions of the interviews are

available. The transcriptions were done manually since this the author's first major academic project. There are however apps and programs which can transcribe the interviews but they were not used. The transcriptions include almost everything except for some irrelevant pieces of information and pauses.

6 RESEARCH RESULTS AND ANALYSIS

The analysis process was done with the guideline in the theory section above. The results will splits into 3 sections according to the themes of the interview questions. The results will make understanding of the data given by the interviewees. The conclusion will be drawn from these results.

6.1 LOHAS CONSUMER PROFILE

With the provided answers, the author has classified the all of the interviewer as LOHAS consumer. The people fit more than one principle and make their decisions based on socially responsible and sustainable living; which is why they are considered LOHAS consumer, some more than others.

All the interviewees are ages ranging from late 20s to late 60s; currently single or have their own family. The interviewees have different areas of expertise in term of education and jobs such as communication, designer, teacher, etc. which are unrelated to each other. This proved that LOHAS consumers can be in any age, gender, education, and job demography.

Organic food seems to be an important factor when the people buy their groceries. The organic food that are purchased are mostly vegetables and fruits. There is one interviewee who emphasize that he only buys organic meat which stands out among all the interviewees.

> *Interviewee 2: The most of the stuffs we buy, we try to buy organic food. And if we buy meat, we only buy organic. ---. Organic if possible for fruits and vegetables.*

Not only organic food is considered, locally produced food is also a big factor when choosing the alternatives

> *Interviewee 1: Organic. As much as possible, Finnish. But we don't have much, that's a problem. It doesn't have to be organic as long as it was produced somewhere near so I know where.*
>
> *Interviewee 6: Well, for example, when I buy produce for preparing food, I try to buy local or Finnish or organic. Mainly Finnish organic, I don't think imported organic is always ethical. Because it could be just a way to have higher prices.*

One interviewee like local fruits and vegetables which are produced in his own town, not just Finnish. He is also like local game for meat.

> *Interviewee 3: Local, as much local as possible. I'm not vegetarian, eat anything you can get. Local fish, local meat, local elk, or anything that available, reindeer meat and all kind of veggies and fruits which mostly sold in summer time.*

Some of the interviewees considered themselves as green or even LOHAS consumer with ethical decision making or electronic car driving.

> *Interviewee 3: Actually, I'm a green person. ---. I like to drive a car; but as soon as they have the electric car which has at least 400 km range, I'll buy that one immediately. There is a Tesla which has 600 km range but that's too expensive for my budget.*
>
> *Interviewee 2: Well, I would say that I take into consideration the ethical side of consumption. Maybe basic of consumption and then one step more ethically thinking, but I'm not really beyond that. So I could do more ethical choices than I do now.*

Clothing buying decision is also mentioned among female interviewees. However, it will not be discuss in this thesis. But make no mistake, fast fashion industry also make a sizable impact on the sustainable development of the globe. In short, people who were interview is considered LOHAS and they are thinking globally and acting locally.

6.2 ATTITUDE TOWARD URBAN HORTICULTURE

Urban farming or urban horticulture is a hobby needing the right technologies and efforts to for it to work as a source of vegetables and fruits; this will be further discussed later. City life is busy and rush. The idea of urban farming is to take a break from that busyness but not everyone has that luxury. Urban horticulture is definitely not for everyone. Furthermore, when doing so in a community, problems will surely arise such as commitments, conflicts of interests, etc.

> *Interviewee 2: But then again it would cost something and the people have to be involved in it that much that they would actually pay for it and do something for it. And it's voluntary so it hard to get people kind of engage in the actions that they really want to do it and they will be there.*

> *Interviewee 4: The main reason I wouldn't want to do the farming is because that I feel my life is so busy at the moment. I can imagine that when my kids are older, when I don't have to work so much overtime, it would be nice to have a hobby. Also the reason why I'm not interested is I kind of feel that I need to do that but I still have to go to shop and buy. It's difficult to believe that because I make an effort in farming and still have to go to shop to buy. It doesn't make my life easier. If I have more time to spend, it could be a nice hobby. It's quite unbelievable to think that we could grow food there for our family.*

Urban horticulture has some benefits that were listed by the interviewees and they seem to enjoy doing those activities. The most important benefit mentioned by all of the members of the Kangas area farming society is the sense of community. Other benefits are related to mental and physical health. One interviewee told the author that he had taught his children the values of farming and teach them how plants are grown.

> *Interviewee 1: Basically there are 2 kinds of. For some people, it's a kind of mentally good thing. The other thing is you know how to grow vegetable, you know how to get better.*

> *Interviewee 2: I think it's always nice to be part of a community like that. I see that we are also teaching our kids some of the values from grow food. It doesn't really appear in the market how they make it.*

> *Interviewee 3: Actually, I'm a green person. Meaning that I can save as much on this (laugh). I mean green on gardening, on food. And of course I buy all the equipment to do the gardening, not by hand, and I want to be efficient as possible. It has two proposals, I save money by not going exercising, dancing and gym because I can do that in the garden. The second one is health, I don't have to go to the doctor, again save money.*

Furthermore, a sense of community is what motives some people to join the Kangas farming society in the first place. "Talkoot" in Finnish is an expression for friends and neighbors to get together and performing some tasks. The word is borrowed from the Swedish word 'talko' (Reuter 1991). Community is an important factor to get people to stay in urban farming such as the Kangas farming society.

> *Interviewee 4: I was more interested in creating the community and make it possible for other people to farm, I'm good at organizing things. So it's easy for me to get the supplies and I contacted everybody and I asked for the soil to be brought there. So I made it possible for other people even though I don't need a garden like that for myself."*
>
> *Interviewee 5: I enjoy the picnic (laugh). And I enjoy the… How do you say the… What is the word that we go there together and have things done at the same… The word in Finnish is "Talkoot" and if you look for it later on. There are people of all ages and children and it's nice to be part of the community so diverse.*

As for the quality and quantity of the produce yielded by urban farming, the people said that they have good quality vegetables and fruits, some are better than what they buy in the supermarket, some are worse. The quantity is a big issue, they do not have enough and to feed the family. Despite the issue of quantity, the interviewees grow many varieties of fruits and vegetables.

> *Interviewee 1: It's very many, really many: herbs, salad, carrots, beetroots, spinach, little bit tomato in the greenhouse; many kinds of herbs which is kind of expensive in Finland, not coriander.*
>
> *Interviewee 2: As I said, strawberries, peas, and all kind of herbs, and what else... we have some onions and... Mostly salad, strawberries and herbs.*

Urban horticulture is a hobby of these people and they are enjoy the activities and the company of their peers. It is quite a healthy hobby but challenging nonetheless for those who live in a cold, harsh climate in middle of a city.

6.3 FUTURE OF SUSTAINABLE GREENHOUSE

Some of the interviewees know what a sustainable greenhouse is while others are not entirely familiar with the term. However, with some explanation they were able to grasp the terminology. Almost every interviewees show positive feeling toward the concept and think it worth trying. One interviewees discuss her concern of a sustainable greenhouse in a community setting.

> *Interviewee 1: I think the challenges are mostly, the biggest challenge is how to organize it, the coordinating, who is operating; that's the biggest thing I think. Is it a third sector or is it a company, it's a big different.*
>
> *Interviewer: Do you have any solutions for that problem?*
>
> *Interviewee 1: The best thing would be when you buy an apartment so the housing company also own a greenhouse and all the people who rent or buy apartments can use it. They can have 3 square meters or something.*

While other express his concern regarding technical issues such as heating and water source during winter. Although the interviewee knew that there are solution for all the problems but he also thought that those solution might be too advance to apply to everyday and small scale operations. Sustainable greenhouse manufacturers should take this factors into consideration when advertise for their products.

> *Interviewer: What do think about growing produce in a greenhouse during winter time?*
>
> *Interviewee 2: I think it's a good idea. But I think if it's possible. Well of course it's possible but how energy consuming it would be because the winter is quite cold. It's a fascinating idea.*
>
> *Interviewer: Beside from the energy, what challenges do you see to a greenhouse here have?*

Interviewee 2: If we're gonna do it for the whole year; first the people are interested then they are kind of, not forget it, but they don't put so much effort in the work. But the big question for me would be the energy side, how could we made it so that it is warm enough. And one more thing that, in the winter we use the water in the river, but in the winter it would be frozen if we use the same spot we use in Kangas.

Interviewee 2: I think that this plant nutrient stuffs and microclimate management as such would be not easy to do but it all boil down to the energy. But for this it sounds really interesting. It's something that the people of Kangas would test using this. I'm think if this too high five (advance) for small scale and community use. But I think in the Nordic climate, the energy would be the biggest issue.

The interviewees were asked how they would like to have a greenhouse, the male interviewees said that they would like to be involved in the building process. The materials of the greenhouse is also important.

Interviewee 2: I think that I like how we do it in Kangas, we have used recycle parts. We have old windows and we use those. It's nice to build it yourself. But then again, if we use the old window, it would be really heavy. The one we have built there, it was not that easy as we thought it would be. But it's nice to involve in the actual building you make yourself.

When were asked about their willingness to invest in a community, their answers are the same. However, the amounts of money they would willing to invest are different.

Interviewer: Are you willing to invest in a greenhouse as part of a community?

Interviewee 1: I would be if it near my house. About 500 or 1000 euro.

Interviewee 2: I would say that maximum 100 euro, not more than that. Something below that would be possible.

However, the answers were different when some of other interviewees were asked about their opinions about investing a sustainable greenhouse or would be interested in growing in one. The reason they do not like the idea of growing in sustainable greenhouses all year round is that the amount of artificial input to the

plants which can be unsustainable. Additionally, they appreciate the seasonality of the produce, they want the taste of the produce to be as authentic as possible.

> *Interviewee 3: ---. The veggies from those new greenhouse are tasted differently because they use artificial light.*
>
> *Interviewee 6: But I would like to educate consumer so they would once again learn what seasonality is. I have a feeling that they have lost the idea of seasonality because of the deep freezer, fridge, and so on. They should learn to appreciate seasonality more because of the taste. Taste is different.*

After the analysis, it seems that sustainable greenhouses can be a product that people want to have but it needs to have some components which will be discuss in the next chapter.

7 CONCLUSION

The data from the interviews and literature reviews has been collected and interpreted. With the results and the analysis of the data, the objectives can be met and the conclusion can be drawn.

1. **Potential customers for the sustainable greenhouse.**

People who fit the principles of LOHAS and care for locally produced organic food and also having the hobby of growing and gardening should consider testing a sustainable greenhouse. According to the results, LOHAS consumers can be of any age but those who participate in the farming usually have a family of their own. In a sustainable greenhouse people can grow many produce that they like and enjoy the satisfaction of growing their own food. The greenhouse can extend farming season to cover the whole year in the Nordic climate, for example, in Finland. Not only that, many people started urban farming not just because for the love of environment and farming, they also wanted to create a community in which likeminded people can hang out and share their experiences. The people do not necessarily think globally but they act locally.

That being said, urban farming is definitely not for everyone, not even for all LOHAS consumers. One should put effort into doing anything if one wishes to success; the commitment to urban farming can be difficult for many people. It is so much easier to buy food in the supermarkets and still care about sustainable development.

2. Elements of sustainable greenhouse that the consumers prefer.

There are many types of traditional greenhouse that can be used for various purposes in different settings and locations. The sustainable greenhouse can be achieved by integrating the technologies and systems needed into the greenhouse. Existing greenhouses can be renovated in order to make them more sustainable. It is not necessary to buy new greenhouses to achieve sustainability. A greenhouse can be tailored according to the needs and wants of the user.

Since the greenhouse has an urban farming setting, the space is not sufficient for growing on the ground. Therefore, vertical farming can be added to the greenhouse to increase the capacity to grow more inside the greenhouse. The cultivation method also needs to be quick, simple, and effective to match the lifestyle of a city. The greenhouse should become a reliable and stable place for growing food in order to attract buyers. One can grow fruits, vegetables, and herbs in a greenhouse sustainably without the need to buy those more again in the supermarket. The structure of the greenhouse is also a selling point if the greenhouse is made from recycle materials and it is easy to assemble. Furthermore, the greenhouse has to be fully functional in the harsh Finnish climate without requiring a huge amount of money on heating, water, lightning, etc. to attract more potential customers. Interests in microclimate management and hydroponics were expressed by the interviewees. However, they are not entirely necessary to have since the technologies are fairly advance and costly.

The low cost of a greenhouse is an important factor for some consumer but it is not easily done since many different modern technologies are needed. But if we look at a

bigger picture, the high initial capital cost can save more money in a long run while conserving the environment.

3. **The ways that people want to access to sustainable greenhouses and their willingness to invest.**

Many people want to part of a community of urban farming and access a communal greenhouse. Therefore ownership of the greenhouse is also an issue. If the greenhouse is owned privately then there will be no problem, the greenhouse can operate anyhow the owner wishes. The problem arises if a greenhouse is shared by a community, the ownership can cause many disagreements regarding the operation costs since it involves money. Not to mention the organizing of the work within the greenhouse. Despite that, members of a community can come up with an agreement to invest in a greenhouse together. Everyone have their own space of growing within the greenhouse or they can share it with anyone they want.

One solution is that the housing company can own the greenhouse and allow its tenants to use it. The company will oversee the day-to-day operation and coordinating accordingly. This method can be applied to many housing company even the student ones. Sustainable greenhouses can fill out the empty spaces and create a place to grow produce for many people. Another possibility is that the city build and owns greenhouses throughout the city so that people can rent a patch of land to grow their produce. Both methods open many doors and increase the accessibility to a greenhouse for many demographic group and ‘connecting people’. It would be a sight to behold to have greenhouses full of green produce during long winter. This also have drawbacks such as vandalism, growing cannabis, etc.

There are also people who said that they do not fully support growing produce in a greenhouse offseason due to the fact that those produce require artificial inputs. Artificial inputs make the cultivation method more unsustainable and the taste of the produce is not as good as the produce from the right season.

The results from the interviews suggest that people who are interested in the matter are willing to invest. However, the amount of money they are willing to invest go varies from under 100€ to as high as 1000€. People will only invest under the conditions of the greenhouse stated above and it needs to be near the community. Sustainable greenhouse can be invested for a LOHAS community so that people in that community can grow their produce. Sustainable greenhouse can fulfill some of the values and principles of LOHAS consumer which can be seen in figure 11. In addition, greenhouse produce can be sold in the farmer market to gain financial profits which can compensate for the startup costs.

LOHAS consumer's values	**Which criterion can sustainable greenhouse fulfill?**
Organic and locally grown food	✓
Organic and natural personal care products	
Hybrid and electric cars as well as city bicycles	
Green and sustainable building	✓
Sustainable or Ecotourism	
Energy efficient electronics/applicances	
Socially responsible investing	✓
Natural household products	
Complementary, alternative and preventive medicine	
Fair trade products	
Literature in the Mind/Body/Soul, Holistic Health, and New Age genres	✓

***Figure 11**: LOHAS consumer values (LOHAS)*

Despite that, the results states that not everyone is participating the urban farming in order to make a source of food but rather they want to be part of a community.

The sustainable greenhouse should be an actual place in which people can actually live or a house warps inside a greenhouse. But that is a topic for another day.

7.1 THESIS EVALUATION

The reliability concerning this thesis is the consistency of data. The data could vary if another interview were to carry out due the fact that the language conducted in this research is English, which is not the first language of the interviewees nor the interviewer. Despite that, interviewer and interviewees are sane and competence in their language skills. It is not an issue that will render the thesis unreliable.

Human is the main instrument in the interpretation of data and information which are also provided by human. Human behavior is never static therefore interpretation can differ for different people (Merriam & Tisdell 2016, 250). The author tried to interpret the data from an objective point of view and theorize accurately.

The number of interviewees may also affect the reliability of the thesis. The author wished to interview six people from the Kangas farming which is about 25% of the whole members but there only four who were interviewed. There are actually six members who are interested but ultimately only four contacted the author for the interviews. However, the author thought the results were satisfactory. The mystery of the Finns which the author fail to comprehend, mayhap some liquid courage is the solution.

Internal validity deals with questions regarding how the research findings match the reality. How accurate does the research capture the picture. As said above, human is the primary instrument of data collection and analysis in qualitative research, interpretations of reality connect directly to the researcher's observations and interviews (Merriam & Tisdell 2016, 243). Moreover, the author should ask more specific questions regarding the technical parts of a sustainable greenhouse because the answers from the interviewees are quite general.

External validity or generalization deals with whether the results can be applied to other situation. This thesis was meant to find out how the LOHAS consumers within city of Jyväskylä or Jyväskylä municipality feel toward sustainable greenhouses. The results can extend to the whole Finland since the people of the whole country may have similar mindset. No just that the climate is also somewhat the same in whole country; although daylight time and temperature may differ between the north and the south,

7.2 FURTHER RESEARCH

There are some topics involving sustainable greenhouse and urban farming can be further studied to give the thesis more clarity:

- Laws and regulations regarding the ownership and operation of greenhouses in Finland.
- Greenhouse around house has been built in Sweden. The house which people live in appear to be inside a greenhouse.
- Vertical farming can save space allowing more plants to be grown inside a greenhouse. This was mentioned in the conclusion but there is no theoretical background in the literature review chapter.
- Seasonality is important to some people because they want the authentic taste of the produce. In order to achieve the authenticity, minimum artificial inputs are needed.

7.3 EPILOGUE

At the moment, our soil, freshwater, oceans, forests, and biodiversity are being rapidly destroyed and degraded. The climate change is putting even more pressure on the resources we depend on, increasing the risks associated with disasters such as droughts and floods. (Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.)

In his book titled The End of Food (2008), journalist Paul Roberts argued the that the world's large-scale, hyper-efficient industrialized food production systems were inevitably going to be collapsed because the industry had damaged soils, water system, and other natural infrastructure by the methods of agriculture such as the excess usage of synthetic fertilizers (205–236). Mark Bittman (2013) wrote on the New York Times that a food diet kills more people than gun violence and it is the root cause of heart disease, cancer, stroke, diabetes.

Not only does the climate change affects agriculture but agriculture also contributes to climate change by producing large amount of greenhouse gases including carbon dioxide, nitrous oxide, and methane. The agriculture sector alone accounts for 13% of the greenhouse gas emission (Figure 12). Without a change, the global food system will continue to degrade the environment and threaten food security in the future. This problem is often connected with consumers' behaviors, attitudes and concerns as the production is driven by the markets and demands (Advanced Manufacturing and Food4Future Factsheets, 2). It is time to rethink how we grow, share, and consume our food (Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture).

Nonetheless, those facts above are not irrefutable, there are maybe hopes yet for humanity. Many people all over the world have realized that and they are changing their lifestyles, and their behaviors to cope with the changes. Many movements have been established in order to oppose the current food industry. Slow food is one of those movement protecting food biodiversity, build links between producers and consumers, and raising an awareness of some of the most pressing topics affecting our food system (What we do).

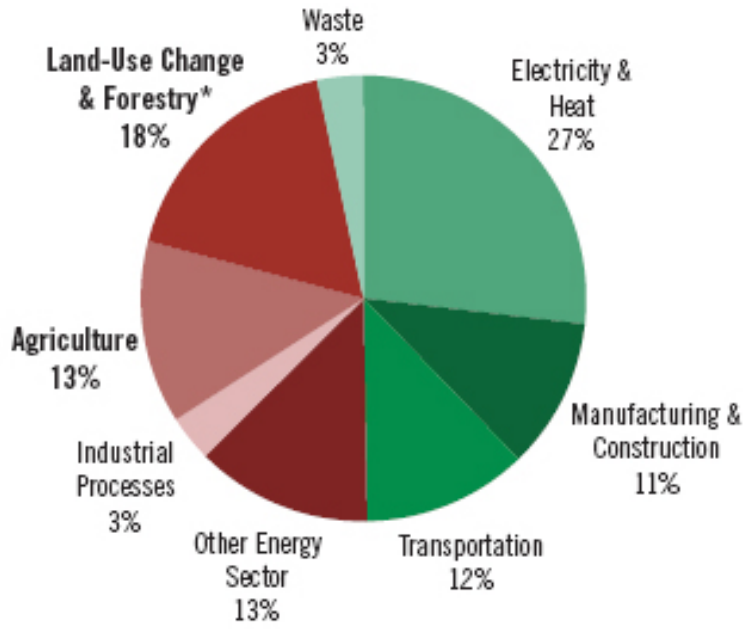

***Figure 12**: Sources of global Greenhouse Gas emissions (Introduction to the Energy Sector and Its Greenhouse Gas Emissions)*

Andersen and Kuhn (2014) even argued in their documentary Cowspiracy that animal agriculture has made a substantial impact on the environment and the solution to reverse this as well as remove the hunger is for the world to go vegan. But that is easier said than done because people would choose a steak over a salad in a heartbeat. The key is moderation as suggested in the book Milk, Meat & Climate by Risto Isomäki (2016).

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APPENDICES

APPENDIX 1: INTERVIEW QUESTIONS

Theme 1: Consumer profile

1.1 How old are you?

1.2 Can you tell me about your education?

1.3 What kind of consumer are you? (How do you describe yourself as a consumer?)

1.4 What is important to you when you buy food? What about fruits and vegetables?

~~(Show LOHAS' set of principles)~~

~~1.5 Do you consider yourself a LOHAS consumer?~~

Theme 2: Current activity at Kangas farm

2.1 How long have you been participating farming in Kangas?

2.2 What kind of activities do you do with Kangas farming? How often do you do that? What do you enjoy doing?

2.3 What are the 3 things motivate you to take part in it?

2.4 What benefits do you see from community farming?

2.5 How do you do the farming? (Technology, method of cultivation)

2.6 What kind of produce do you grow on your farm? How is the quality of those produce?

2.7 How much do you grow? (Just for fun, enough to eat, a lot to give away)

Theme 3: Future of Sustainable Greenhouse

3.1 What do think about growing produce in a greenhouse during winter time?

3.2 In your opinion, what challenges do you see a greenhouse here have? (Heating, material, energy, capital costs)

3.3 Do you have any solutions to those?

3.4 Have you ever heard of the term 'sustainable greenhouse'? What are the first things come to your mind when you hear that term?

(Show sustainable greenhouse system)

3.5 What is your opinion about it?

3.6 How would your dream greenhouse be like? (With soil, etc.)

3.7 Are you willing to invest in a greenhouse (as part of a community/privately)? Why? How much do you think you can invest?

0.0 Do you have any idea or opinion you would like to express? (Do you have anything on your mind?)

APPENDIX 2: INTERVIEWEE LAURA BROWNE

Interviewer: **How old are you?**

Interviewee: I'm 35

Interviewer: **Can you tell me about your education?**

Interviewee: Yea! I have studied in the university, in 3 universities. I don't have a degree so my highest degree is (…). I have done, I have studied in the University of Tampere, university in Scotland, University of Jyväskylä.

Interviewer: **Can you tell me what kind of consumer are you?**

Interviewee: Well I think I'm pretty much the definition of LOHAS consumer. Apart from travel, we travel a lot so we do air travel, and we have a private car. I, we spend most of our money on groceries. We buy fresh produced, organic, or locally grown when possible. We eat a lot of home grown vegetables throughout the year. We don't buy many clothes, we buy second clothes for kid whenever possible. We spent a lot of money on electronics. I guess I love cooking so I spend lot of money on food.

Interviewer: **How long have you been participating Kangas farming?**

Interviewee: 2 or 3 years. The first year, definitely. But I don't have my own box there anymore.

Interviewer: **Why is that?**

Interviewee: Because we are usually away most of July so I noticed that… We are always travel when it is the time to look after the box. We have a summer house nearby, only 20 km meters away so we have vegetables grow there. So we didn't really need the Kangas to get our own produce.

Interviewer: **Can you tell me about your gardening in your summer house?**

Interviewee: Ok! There is… root vegetables, mostly carrots. There's a big potatoes ground, we look after with my parents and the neighbors and they are professionally farmed. There is a smaller vegetables patch with carrots, parsnips, and turnips but

not very much. Then there are some peas, usually and there is a lot of different types of lettuce. And the main thing is (…) vegetable, they grow really big, they take a lot of watering. Then we have an herbs garden. There are also a variety of raspberry, we have strawberry as well but not many. There are some small cucumbers.

Interviewer: **So you grow those stuffs with your neighbors?**

Interviewee: Only the potatoes. And the rest is between my parents and my family.

Interviewer: **How much do you grow? Is it enough for you to eat without going to the supermarket or is it just for fun?**

Interviewee: For my parents, it is enough, there are 2 of them. They eat, they grow their own vegetables there, and they have enough potatoes. But it's only seasonal; in the summer they don't need to buy more vegetables. But in the winter they have to buy. Maybe July or August they don't have to buy anything. For root vegetables, they don't have to buy anything all year. They have enough but not many varieties. If they need different, they need to go shopping. But for us, it's just for fun. We get lots of stuffs during summer. But we're here all the time. We mainly buy our stuffs, sometimes my mother give us some.

Interviewer: **Do you have a greenhouse in your summer house?**

Interviewee: My parents has a detachable house in the garden so they have a greenhouse there. They only have tomatoes there in the greenhouse.

Interviewer: **If Kangas has a greenhouse, would you be interested in growing veggies in there?**

Interviewee: No. Because I think it was nice to try for me but I don't really like it. It's not my thing. Whenever I do farming, I can help other people. But if I'm responsible for it, I don't get the result that I want; a lot of effort and little result doesn't make me happy. I would be interested in buy the produce from other people. I don't want to do it myself. It's enough for me to help my mother. Let's say in 10 years' time, if I wasn't traveling so much during the summer, I would be interested.

Interviewer: **What about a greenhouse that operational during the winter?**

Interviewee: No, I wouldn't wanted to spend time farming in the winter. Winter is difficult time and we have very little energy during winter. Yea… No.

Interviewer: **At the beginning, what motivate you to take part in?**

Interviewee: I was more interested in creating the community and make it possible for other people to farm, I'm good at organizing things. So it's easy for me to get the

supplies and I contacted everybody and I asked for the soil to be brought there. So I made it possible for other people even though I don't need a garden like that for myself.

Interviewer: **How many people participate in the Kangas farming?**

Interviewees: There are about 15 people involved in first year when it started; and now there are about 20 people.

Interviewer: **I think that's all the question I can ask you. Do you want to say anything else?**

Interviewee: The main reason I wouldn't want to do the farming is because that I feel my life is so busy at the moment. I can imagine that when my kids are older, when I don't have to work so much overtime, it would be nice to have a hobby. Also the reason why I'm not interested is I kind of feel that I need to do that but I still have to go to shop and buy. It's difficult to believe that because I make an effort in farming and still have to go to shop to buy. It doesn't make my life easier. If I have more time to spend, it could be a nice hobby. It's quite unbelievable to think that we could grow food there for our family.

Interviewer: Thank you very much.

Interviewee: No problem.