A VIABILITY ASSESSMENT OF COMMERCIAL AQUAPONICS SYSTEMS IN ICELAND

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A Viability Assessment of Aquaponics in Iceland

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ABSTRACT

Aquaponics is an emerging practice that incorporates a hydroponics-based setup up for soilless propagation of plants along with the utilization of rearing fish in a recirculating aquaculture system. This study has been developed to determine if aquaponics production could be a viable alternative or accent to the current means of production of plants and fish species in Iceland, based on import trends, local production, energy allotments, cultural nuances and consumer habits. The thesis analyzes a literature review for previously-held theories on purchasing habits for consumers, provides a review of agriculture and aquaculture production and adopts a consumer analysis survey over motivators for organic/sustainable fish and produce. Ultimately, the thesis suggests that aquaponics is a viable option in theory, given the conditions of the environment and access to resources; however, for it to be a successful venture will take a higher level of awareness and precise promotion in domestic ventures that reaches out to both locals and tourists. The consumer models suggest a niche attitude for Icelandic consumers that can be capitalized on to help provide a more positive attitude that manages price barriers as incentives and gives a more transparent environmental appeal.
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Chapter 0: Thesis Introduction

It is no surprise that Iceland’s characteristics demands some level of ingenuity and creativity with regards to providing food sources. As with many island-nations, there is a high demand for imports and a typically fragile ecosystem at hand. Food security can become very difficult to attain, even with greenhouse production and access to many fishing ports. With the additional aid of affordable energy and access to geothermal water, however, the capacity for production appears to be limitless. This opens various strategies and ventures to facilitate the demands for a varied diet at affordable prices in an environment that is faced with a rapidly growing tourism sector. Because of this, greenhouse production, specifically focused in hydroponic and aquaponics production, could become a strong alternative.

The aim of this paper is to assess as to whether aquaponics, a hydroponics-based setup for soilless propagation of plants along with the utilization of rearing fish in a recirculating water systems, would be a viable method for agricultural and aquaculture practices in Iceland. Aquaponics was chosen over hydroponics as it offers the availability of dual propagation of both fish and produce and is considered a more organic alternative to hydroponics in several aspects (Graber et al., 2009). This strategy also could hold an appeal to a larger target audience with extended avenues for ecotourism and educational developments. This is detailed by Goddek et al., (2015), where the benefits from the “products that are quality and pesticide free certified (e.g., organic) [can] achieve a higher prize in the market and leads to a healthier population.”

This study will achieve this assessment in four parts, namely looking at current literature on models that reflect purchasing behaviors for organic and environmental produce; an assessment of the agricultural trends through local production, import statistics and demand; an overview of the aquaculture industry and its developments; and, finally, a consumer analysis concerning motivators for purchasing organic produce and fish. The goal being to synthetize statistical data, perceived values/niches, and actual behaviors together into a comprehensive narrative.
The literature review was based heavily around applications and developments of several models for gauging consumer attitudes and purchasing habits in purchasing organic food, namely the Attitude-Behavior-Context Theory (ABC), the Value-Belief-Norms Theory (VBN), the Theory of Planned Behavior (TPB), the Theory of Reasoned Action (TRA), and the Alphabet Theory. The review is compiled in part to help discover how the divide between consumer intents and actual behaviors are fostered. It is also used as a means to assessing the developments of the above theories and their individual strengths and weaknesses. It is very important to see how previous surveys were conducted with regards to various aspects of purchasing food and the literature suggests that the conditions of price, availability, quality, health/nutrition and environmental efficacy play a large part in evaluations. This was later adapted and reapplied in the Chapter 4 survey.

Along with a general understanding of theory, it was necessary to deliver some effects of background, to see how the literature would be reflected and applied in an Icelandic context. However, before that can be applied, it is first necessary to look at the manner in which the general temperament of the area conditions the market. This would encompass an analysis on the conditions of both the agricultural and aquaculture industry (as aquaponics involves sales and distributions of both). Thus, Chapter 2 and 3 involve a detailed analysis on the respective markets in order to see where the demand is heaviest, which end users would be best to target and what niches are not being met.

Essentially, this was a means to narrowing down the scope of this study to factors which were most relevant. In the agricultural sector this was achieved by first looking at import trends for produce, sorted by HS number, per month over a two-year period and measuring the trends in imports. This gives an idea as to what is generally being brought in and how heavy the frequencies are for the various items. Next, a similar analysis is performed over the same period on local production to see how it compares as well as to whether there is overlap in production and what the general relationships are. Once general trends and products were met, an understanding as to how the conditions manifested and what rational there was for these nuances was provided via population data, literary sources, tourism information and
surveys. Having given a rounded narrative, it becomes clear where production is lacking, where demand is not being met and a general understanding of the opportunities and threats to starting an operation.

Providing the same assessment on aquaculture took a somewhat different approach, which looks at the development of the aquaculture industry in relation to outputs. This chapter studies statistical data from aquaculture, and assesses various species as well as the development of businesses throughout the years. The assessment gives a cultural outlook to the aquaculture industry and describes the overall impact it has in Iceland. Most importantly, this assessment contributes similarly to the agricultural study, further detailing what obstacles and barriers there are to future developments. The assessment investigates how various fish could be applied and the extent to which they could profit in Iceland.

The study concludes on various suggested strategies, which are tailored to aquaponics in respect to both the agricultural and aquaculture market. Thus, the study provides insight into attitudinal surveys about fish, to see how it was perceived and what the attitude-behavior relationship is. This helps to decide how aspects of education, ecotourism, available information and environmental appeal also contributes to sales. There are further considerations between domestic and international sales and what incentives each strategy held. Clear indications of various outlets in education, ecotourism, research and advertising/labelling practices reveal that a commercial aquaponics industry could best thrive in an environment that offers sustained appeal where the production method fosters a relationship with the brand and gives a level of personal reward for the purchases.

With this information, Chapter 4 took on a consumer survey to measure how the data translated into motivators for consumers. The idea is to look at the indicators of health, price, quality, accessibility and environmental quality as attributes that effect purchasing decisions. This is derived from the previous chapters and the literature review. The final survey draws heavily from previous studies and mirrored the questions set by Nie and Zepeda (2011) in part, as the Alphabet Theory presented in the work is found to be very comprehensive and the best method
to gauging consumer motivators. Nevertheless, survey incorporates metrics derived from a myriad of sources set in the literature review.

Pretesting was done twice, with the first presurvey compiled via a convenience sample through various internet forums, which was used to ensure consistency and proper variance in responses. A full analysis is provided in Chapter 4. The goal of framing a convenience sample via the internet is to distribute and see how responses trended globally and not solely in an Icelandic fashion. This also measures if the metrics are suitable as well.

The second presurvey, carried out through a convenience sampling to local businesses, indicates business motivators with regards to both produce and fish were different in many capacities to the final survey. The results indicate in areas where quality and taste were highly important with a petition for local sourcing, although price barriers vary drastically between the second sample and the final sample group. The survey is the core of the thesis, as it supports the previous chapters and translates them into a comprehensive analysis that explains attitude, behavior, intention, context and barriers. The open-ended questions also assess how consumers and businesses view availability and where various products could be implemented in a working aquaponics system.

Having gathered this information, the final chapter adapts this into a full viability assessment for aquaponics. It reiterates target audiences and methodologies as well as key products to focus on. Key points of the study indicate that pushing aquaponics as an agent for education is very important to fostering a positive reception and expanding the clientele base; many consumers have environmental concerns for waste and overuse of plastics, and proper labelling practices could help dissuade this; utilizing front end and back end production could help bolster brand recognition and provide an outlet for ecotourism; and finally aquaponics can work if more people are aware of how it works and why the premiums are justified for a specialty project. Considerations of using shared lots for community aquaponics, food banks or community supported agricultural programs could also be explored in a successful aquaponics
system, as it creates a sustained community value that is scalable to the monetary investment and deliverable to large groups of varying expertise.

0.1 What is aquaponics?

In order to fully understand the extent of this project, it is necessary to first go into some more details about what aquaponics is and how it works, to best elicit why this is important. Aquaponics is a process for cultivation that relies on utilizing both aquaculture and hydroponics to produce vegetables. The core of the process involves pumping water from a fish tank into some level of soilless medium where the roots can achieve a direct uptake of nutrients and later be filtered back directly into the aquarium as nutrient-rich water. This process works relatively close to such a closed system, where the only additional inputs are feed for the fish and periodic disbursements of chemical solutions such as Ca, Mg, Fe, K to help balance the systems. Systems can use a naturally growing agent duckweed or azolla fern to act as an assisted natural feeder, although an input of fish feed is required. The system works like hydroponic systems, where a chemical solution is supplemented by fish waste. The solids in the water allow for the nitrification of ammonia, converting into nitrates, which in turn creates a healthy, balanced system.

There is a large variance of setups available in an aquaponics system, as the only requirements for a working system is the recirculation of water. As such, the four most common techniques are nutrient film techniques (NFT), deep water culture (DWC) systems (also known as raft systems), media grow bed solutions and vertical systems. Each system works to different advantages and disadvantages and is largely contingent upon available space, desired crop, population density of plants and the user’s aesthetic desires. An ideal balance needs to be maintained in the systems to prevent an accumulation of chemicals, prevent diseases spreading to crops and maintenance of healthy water balance. To date, most commercial systems utilize NFT or DWC due to convenience in setup and most effective nutrient uptakes. Figure 0.1, taken from *The Aquaponics Guidelines* (Thorarinsdottir et al., 2015), displays a media grow bed, NFT and DWC system.
There are various advantages and limitations between each design and technical aspects vacillate between chemical uptake/distribution, stocking densities of fish, the distribution and variety of produce grown. Systems contain additional instruments, such as oxygen stones, additional biofiltration agents, ebb and flow regulators, heating instruments as well as red worms or nitrifying bacteria. The fish stock can be used ornamentally or for consumption. To date, aquaponics is primarily utilized by hobbyists in home and garden systems, with a large information gap between hobbyists and commercial practitioners (Hart, 2013). Consequently, the allotted size and yield requirements for working commercial systems are locally-based and resultant of trial and error.

It should be emphasized that because of the wide scopes of aquaponics as a practice, it holds a lot of considerations towards proper standards for commercial operations. This is due to systems balancing fish stock, vegetation and system nutrient balances. Furthermore, there is the consideration of approach, insofar as the discipline can focus on (1) technical aspects and automation, (2) chemical balancing, (3) market analysis and breakeven prices, (4) consumer habits, (5) system designs, (6) localized data and market trends, (7) energy requirements, (8) comparative results on other methods of propagation, (9) health and safety, (10) nutrient densities and health benefits and (11) environmental efficacy and waste management to name a few. Table 0.1 gives a cursory look at different challenges faced in the growing field of aquaponics, both internal and external, where internal refers to operational issues faced by the entity starting a commercial business and external depicts the view of consumers and effected bodies in how they can perceive and react to aquaponics (e.g. regulations, consumer perception, willingness to pay for produce). The utilizations of aquaponics have been a growing field of interest with a high demand due to the potential it offers. There are not only the benefits of
much more efficient resource allocation over longer periods, but also healthier plants with a better aesthetic appeal and a capacity for a dual-market with both aquaculture and plants and an overall safer practice in production (Yamamoto, 2013).

Table 0.1: Internal and External Challenges Facing Commercial Aquaponics Industry.

<table>
<thead>
<tr>
<th>INTERNAL PROBLEM</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>System collapse</td>
<td>Root rot, fish disease, nutrient deficiency</td>
</tr>
<tr>
<td>System failure</td>
<td>Pump failure, electrical shortage, flow issue</td>
</tr>
<tr>
<td>System scaling</td>
<td>How to scale system to demand? Operational sizes? Upgrading systems?</td>
</tr>
<tr>
<td>Pest infestation</td>
<td>Insect, unwanted bacterium, fish disease</td>
</tr>
<tr>
<td>Product choice /</td>
<td>Choosing appropriate products (fish and produce), primary or secondary</td>
</tr>
<tr>
<td>system balance</td>
<td>products; product rotation</td>
</tr>
<tr>
<td>Lighting and fixtures</td>
<td>The proper amount of lighting, equipment and set up. Whether to use LED</td>
</tr>
<tr>
<td></td>
<td>lighting, additional heating instruments, filtration systems.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXTERNAL PROBLEM</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal / certification</td>
<td>Auditing, processing, licensing, organic/sustainability certification</td>
</tr>
<tr>
<td>issues</td>
<td></td>
</tr>
<tr>
<td>Clientele basis</td>
<td>Novelty and security in processing; unique market demands v. space,</td>
</tr>
<tr>
<td></td>
<td>pre-negotiating contracts</td>
</tr>
<tr>
<td>Cultural</td>
<td>Increasing awareness, education, and expanding advocacy</td>
</tr>
<tr>
<td>Health and safety</td>
<td>Proving evidence for health and safety concerns</td>
</tr>
<tr>
<td>Ideological</td>
<td>Exemplifying soilless cultivation as acceptable and reliable</td>
</tr>
<tr>
<td>Market issues</td>
<td>Low demand, not growing right product, failure to utilize market channels, subsets</td>
</tr>
</tbody>
</table>

0.2 Boundaries and Scope

The intent of this paper is to look at each aspect in isolation (i.e. literature regarding organic motivators, agriculture in Iceland, aquaculture in Iceland and survey analysis), which can manifest an overall template of the region. Love (2015) had performed the first peer-reviewed, published survey of commercial aquaponics systems, with roughly 1084 respondents, suggesting that at least as much commercial operations exist in the US. Since his publication, few full-scale surveys have been conducted in the US, EU or globally. As boundaries are still developing, many small-scale, educators and hobbyists could have been considered as a commercial operator in Love’s sample, provided they at some point sell their produce. What this expresses is that with a small sample of emerging commercial systems, it is difficult to
separate aquaponics into its parts (i.e. aquaponics in regards to agriculture, aquaculture, etc.) when it encompasses varying scales and functionalities.

To do a study on aquaponics, it was decided to look at commercial systems broken down in their respective fields as it relates to an Icelandic market. Thus, each chapter is integral to framing a proper aquaponics narrative. Chapter 1 envelopes theories and methodologies that reflects consumer attitudes towards organic purchases. It is important to look at organics, as the green aspect of aquaponics (fresh, local) can greatly contribute to an ideal marketing tool and can be used in sales to give aquaponics produce an advantage that can be presented against current producers. Chapter 2, focusing on agriculture, gives indications of where produce is currently sourced from, production capacities and niches that can be facilitated for produce.

This is replicated in Chapter 3, where an in-depth study of the aquaculture industry details the strengths, weaknesses, threats and opportunities of the industry. Chapter 4 translates the literature and previous studies into a survey which diagnoses consumer attitudes and behaviors with motivators towards organic food. Finally, this information is synthesized in Chapter 5, which offers a final assessment of the viability of aquaponics, along with detailed breakdowns of the market conditions and opportunities that could arise from various commercial strategies. This allows the viability assessment to consider how both the fish and plant sales can most effectively be tailored, as well as sentiments from the local consumers as to where their product values are set.

Each chapter will entail the various limitations presented in the study, and Chapter 5 will discuss future prospects and suggested points for continued research and application. Specific boundaries could be addressed as well as peripheral focuses not fully addressed in the previous chapters, such as legislative considerations. This study once again will not be looking at the criteria between different systems, and will be omitting a detailed study on the different technical aspects derived from system designs. It will be working under the assumptions of general output maintained through raft and NFT systems and will only cite optimal technical feasibility when pertinent. Studies over technical considerations have been done frequently in
the past, and only possess a limited application that could feasibly be adopted into this viability study.

Finally, this information is coming from a foreign perspective of Icelandic conditions and cultures. This does imply that there will be localized and historical nuances that are tailored to a unique perspective in writing this paper. It would be interesting to see future adaptations of this study put into a Native perspective (for a look at the limitations of surveying in Iceland, see Chapter 4). Having a wider range of resources used to readapt this study to distinct market groups would be ideal in the future.
REFERENCES


Chapter 1: A Review of Established Theories on Consumer Behaviors in Purchasing Motivators for Organic Products

Abstract: Consumer purchases are highly influenced by a wide range of attributes. In particular, determining the value of goods can be quite difficult, especially when looking at organic products. In turn, many theories have been developed to help predict consumer behaviors and purchasing habits, each with their own strengths and weaknesses. Whereas a large number of models are used to predict various subsets of behaviors, current surveys and literature seem to suggest that providing for demographic and information seeking behavior is often difficult to reconcile along with perceived and actualized behaviors as well as values. The research has shown that the Alphabet Theory, which capitalizes on demographics, information seeking, knowledge, context, attitude, behavior and context happens to give the most fitting representation of consumer habits with regards to purchasing organic produce, although each theory works in its own merit and can be used in conjunction with one another. This information can be used later to help refine surveying techniques that most accurately reflect the consumers’ desires.

Keywords: Literature Review, Organics, Produce, Motivators, Consumer Habits, Survey, Attitude-Behavior Context, Theory of Planned Behavior, Theory of Reasoned Action, Value-Belief Normative Theory, Alphabet Theory, Schwartz Values

1.1 Chapter Introduction:

Due to a highly regulated market with standardized trade agreements and monitored price fluctuations, fish and produce sales maintain a high level of predictability; however, considering purchasing habits and the drivers for these decisions can prove to be much more difficult. Consumers are complex individuals, often making both informed and circumstantial decisions on their purchasing. The question of who does the shopping, dietary and religious restrictions, demographics, availability, financial limitations and health considerations also play a pivotal role in these operations, not to mention hedonistic rewards that are also associated with the purchasing processes (Hausmann, 2000). Understanding the interplay between these devices can help both consumers and producers to increase efficiency, maintain highest price points and mitigate waste. Furthermore, strengthening the understanding of what motivates a consumer will evidence much more practical advertising and encourage a more streamlined approach to such that tailors specific end users while increasing avenues for dialogue and information to others (Campbell et al., 2010).
Unfortunately, this is not as clear-cut as one would like to hope, as the agents that drive a consumer’s decision can vary. The purpose of this literature review serves as a synthesis on the work currently on consumer perceptions towards buying produce and fish and what motivates their decisions. The intent is to identify the general trends and later frame it into work within various disciplines of agricultural and aquaculture production. Both reflections on fish and produce will be properly reflected in this review, although produce was more heavily sourced within the literature that accompanied the theoretical models to be evaluated. Fish was more often framed for motivators surrounding knowledge and sensory factors, whereas produce purchasing intent was modeled along behavioral practices.

This review is quite important as theories on consumer purchasing habits and motivators stretch a very wide berth of scholarship. Consumer behavior can be assessed in different manners, ranging from marketing perspectives to psychological behaviors. This paper looks at the intention held in each school of thoughts and attempts to find common patterns that emerge in the various models designed for an assortment of disciplines. In other words, it is largely an attempt to find out how different surveys take a wide scope of variables that could effectively be constructed into a survey giving clear indications of consumer motivations. However, as pointed out by Hughner et al. (2007), survey methods often fall short, where “such methods facilitate the collection of data from larger sample sizes and enable greater predictive capability, they are not sufficient in understanding the complexity inherent in consumers’ organic food beliefs and consumption behaviors.” Implicit assumptions put forth by consumers color the interpretation of questions and can lead to biases in responses (Hughner et al., 2007).

Because of this, no universal standard has been set on measuring value motivators (as each discipline has a distinct focus) and appropriating research for this type of study, the qualitative and quantitative studies are both organized to researcher’s discretion. There are distinct advantages provided from each method, where “…the qualitative and mixed methods studies are of a rather exploratory nature…mainly focus[ing] on consumer preferences and local food in general,” whereas “…quantitative studies were more frequently based on specific products, such as apples, meat, or milk, to name the most important ones” (Feldmann and
Hamm, 2015). From a cursory investigation in the available literature, it has been discovered that the factors *quality*, *price*, *environment*, *accessibility*, and *health* were most repeated, leading to further research of these agents in the Chapter 4 survey.

Aside from the motivators mentioned above, there are also considerations of age, location, demographic, current knowledge, access to information, personal beliefs, environmental (community) pressures, altruism, universalism, and ethical values. This also takes into effect whether the results are intrinsic to the individual or extrinsic to the paradigm. For example, price can act as both a barrier (Eide & Toft, 2013) and as a factor that reinforces ethical beliefs, as seen in Trudel and Cotte (2008), where consumers would not only purchase ethical goods at a premium, but only purchase unethical goods at a strong discount. This also falls in line with whether the study is focusing on consumerism as an aversion to punishment and negative consequences or an agent towards some level of (self or environmental) fulfilment.

### 1.2 Parameters of Research:

The literature was sourced through multiple databases in Google Scholar, using different Boolean combinations. Common word searches included Willingness to Pay (WTP), Theory of Planned Behavior (TPB), Theory of Reasoned Action (TRA), Value Belief Normative Theory (VBN), Attitude Behavior Context Theory (ABC), the Alphabet Theory, “organic”, “green”, “local” and “motivators”. TPB, TRA, VBN, ABC and Alphabet theories were the key models assessed. There were other search parameters associated with the search operations that did not lead notably significant results or novel research that exceeded a minor number of papers. The literature accepted needed to focus on food consumption or purchasing.

Willingness-to-pay was decided as it is often used in organic surveys as a “baseline” indicator of consumer values (Millock & Hansen, 2002). WTP is a measure often used in surveys to find the maximum value one would pay for a product, or a select range that they find ideal for purchasing said product. Even though it will often be based on overestimates or underestimates of value, the indications work well in tangent with other models for consumer behaviors to determine *why* these assumptions were presented and *how* consumers determined
this level of valuation. Therefore, the literature review utilizes WTP studies to find out how the models can correct consumer estimates.

The five models were assessed as they present a steady trajectory in development, and the models are often used in tangent in studies. Older models, such as the New Ecological Paradigm were mentioned when relevant, but not included in the study as their approach is now dated. Food-related lifestyle models were investigated, but were omitted as a criterion for focus due to time and resource restraints. Some minor theories were presented along the five main models, although there was not a sufficient level of representation to adequately address these theories. Andreasen’s Social Marketing Model, Gifford’s Social Dilemma System Model, and Rogers Diffusion of Innovations Theory were omitted entirely.

No exclusions were set with the country of study. The US hosted the highest frequency of publications and studies set, at 25%. European countries totaled another 25%, with half of those looking at cross-country models. A large number of publications were available in Asian, South American and Australian studies although the author found that 1 in 3 were not suitable for this review, as the scope of the studies exceeded the intent of the review or the methodology used for review was found to be unsatisfactory. Global studies synthesizing organic food purchasers by Hughner et al. (2007) and sensory expectations by Piqueras-Fiszman and Spence (2015) were included.

Irrelevant data contained papers that were in a very niche field, those that overlapped with consumer models in other fields such as fashion or papers who looked at green consumerism in general. Studies that looked at organic behavior in multiple industries, such as fashion and automobile industries in addition to organics were omitted, as their content did not provide a strong enough focus. From this, the remaining papers evaluated were reviewed and then tagged by their respective categories. The categories were also tagged by their abstract keywords. The author found it necessary to look for only the most recent data, barring most papers older than 2008.
In the development of this review, many efforts in the preliminary research first found semantic obstacles to be common. In particular, organic and green were often used interchangeably and not focused on EC 834/2007 criterion or US organic certification criteria. Organic standards are relegated by strict standards that are based on trade regulations and labelling practices, which most consumers are not aware of. Thus, in various surveys, the term organic has a wide variance of adaptations. This is a problem, as EC 834/2007, as set by the regulatory agency IFOAM, dictates mainly peripheral factors such as methods of cultivation and GMO produce of any caliber prohibit the product from being organic (European Community, 2007). Many consumers are unaware of these standards, and instead use personal beliefs to justify their purchases or merely gut impulses which they use information to later justify (Pieniak & Verbeke, 2010). Thus, personal ideologies reflect interpretation over other conditions with regards to consumers’ interpretation of organic or green products.

From a sample of 40 of the works of literature reviewed, 25 focused on consumers’ views on organic produce either directly or indirectly, with a wide range of varying standards. Van Doorn and Verhoef (2015) define organic as “particular forms of sustainable products and sustainable consumption behavior, which may also include green energy consumption, recycling, and so forth,” with a focus on Western regulatory practices. Conversely, Ahmad (2010) directs their studies in Malaysia in accordance with the 2000 US National Organic Standards Board regulations (“defined by how it cannot be made rather than how it can be made, must be produced without the use of sewer-sludge fertilizers, most synthetic fertilizers and pesticides, genetic engineering (biotechnology), growth hormones, irradiation and antibiotics”) and hinges this against the undefined natural standards, which was used to help frame the survey questions. Kriwy and Mecking (2012) recognize EU Standards for organic produce, and weigh this definition against local German regulatory practices. In addition, Gumarikiza and Curtis (2013) provide no definition at all.

Ultimately, organic standards are understood by the survey developers and are used as a means for framing the surveys, but were not introduced to the participants in any of the selections. This becomes an obstacle insofar as there is a high degree of redundancy in proposed
theories and arbitrary divides, both between works and towards participants, that could have otherwise been fostered stemming from the semantic obstacles in the studies.

Terms such as local or ethically were equally disputed, which seemed to cause complications in many working theories for similar reasons. Local, in particular, has no set boundaries and is often implicit of other characteristics, such as the relationship of the producer to the area. Local produce can entail proximally close options without being technically local, as the cutoff point for attributing factors (i.e. buying seeds, equipment and transportation equipment abroad) typically vacillates. Furthermore, a limited understanding or a relatively high knowledge of the methods for production or large supply chain operations force consumers to entail a more visceral level of justification for local qualifications. This has been seen in James et al. (2009) where higher knowledge of agricultural practices paradoxically produced a lower willingness to pay for local products, due to a more nuanced understanding of purely “local” contributions.

These terms have a somewhat curious application as efforts to apply features of sustainability are often curtailed by the loose levels of applicability. This also causes division in communities, where people that are pro-organic create arbitrary divisions, such as subjective organic standards between hydroponics or aquaponics or complaints about the “chemical” additions put into water solutions, where chemicals are derivative of an unnatural, harmful compound. This can be derivative of the chemical solutions being equally unsustainable to fertilizer compounds or based in more pseudo-sciences. Fortunately, these opinions are not accredited in scientific studies. However, when working with survey data, many efforts to explain organic or sustainable terms holds a subjective appeal, which easily condenses most alternative growing methods into greenwashing campaigns (i.e. misleading promotions for green products that make any deliverable seem as a green product, consequently discrediting green labelling) (Delmas, 2011).

This was a large focus in much of the literature, as locality acted as a strong motivator for consumers, but lacked consistency in the rationalization as to why it is important. Of the
same sample mentioned above, 10 sources focused on local principles in their surveys. The obstacles were not dissimilar to the ones found alongside organic definitions, although there is much more room for working definitions as local hosts no legal precedence. Furthermore, the vacillation between local understandings can work as a benefit in this capacity, as many of the surveys want to investigate how the understanding is reflected between consumers, such as Grebitus et al.’s (2013) efforts to see how auction prices were influenced by local commodities.

Feldmann and Hamm (2015) conducted a literature review of consumer perceptions of local, and found that much of the literature involves working definitions of what it entails, based on consumer perceptions, which “ranged from distances (i.e. miles or kilometers), political boundaries, and specialty criteria, to more holistic approaches that also included emotional and/or ethical dimensions such as personal relations with or within the region.” This becomes advantageous to surveyors as it permits both quantitative and qualitative research methods and for open ended surveys that reflect various theories (such as Feldmann and Hamm (2015) looking at definitions of local through the Attitude-Behavior-Context (ABC) Theory) and gives opportunities to develop consumer driven surveys. Much of the literature involving “local” identities were very important, considering their contributions they offered to consumer understanding of subjective criterion.

Finally, locality often gets conjoined into a dimension of patronage, nationalism and ethics, which prevent a standardized approach to framing surveys due to the myriad of factors involved. Conner et al.’s (2010) work on attitudes towards locally grown food in the US emphasized this, where demographics played a pivotal role in consumer expectations and the obstacles to consuming were often prioritized from normative beliefs. Bond et al. (2009) coupled this with intrinsic and extrinsic drivers, whereas intrinsic looks at ethical values and personal affiliations whereas an extrinsic driver could be taken as market displays or actual distances from the venues.

With this comes the consideration of ethics, which will be discussed later in individualized theories. Naturally, any level of consumerism would have an ethical attachment
either inwardly or outwardly, and the focus on the ethical dimensions were mainly appropriated towards the theoretical models proposed. The literature review found that many of the works cited had avoided putting them as a keyword in the abstracts, even though they often were of high priority. Speculation would suggest that these terms are used more as accents to the above terms as well, and the literature often avoided making any preliminary distinctions. Some research, such as the work from Carrington et al. (2010), found ethical dimensions to be a poor indication of consumer habits, as the intention of the consumers rarely reflect the choices made, rendering the focus as a poor proxy. This was carried in an extensive study via Dowd and Burke (2013), where they adopted ethical consumerism in a 3-step model working with the Theory of Planned Behavior measuring ethical self-identity in relationship to ethical behaviorism; the study had reported similar findings to Carrington where self-identity was incongruent with actual habits.

These terms are by no means finite limitations of linguistic barriers, albeit the most-frequently repeated terms that came into play. Health, motivators, impulse and environment were also frequently cited, and will be brought into consideration alongside respective theories as well. WTP was frequently cited, although there was little variance in interpretation between studies. Any inherent discrepancies from the works work to the advantage of this review as it illuminates the wide range of theories and the difficulty in prescribing a standardized survey methodology.

1.3 Models Used for Measuring Consumer Behavior:

1.3.1 ABC Theory:

The Attitude-Behavior-Context (ABC) theory is the earliest of the studies that show consumer models for consumption. ABC Theory came from the New Ecological Paradigm (NEP) in the 1970’s as an attempt to study the human-environmental relationships and behaviors (2012). The model relied on scaled responses to 15 environmental questions focusing on the sociological aspects of environmentalism (Anderson, 2012). Guagano, Stern and Dietz (1995) developed the ABC Theory from this through a series of publications, namely The New
Ecological Paradigm in Social-Psychological Context (1995) and Influences on Attitude-Behavior Relationships: A Natural Experiment with Curbside Recycling (1995). What they had found was that the NEP “is indistinguishable from a scale of awareness of consequences (AC) of general environmental conditions, both psychometrically and in terms of its relations to behavioral intentions, but somewhat different in its relations to basic value orientations and sociodemographic variables.”

ABC Theory suggests that three external conditions, attitude (A), behavior (B), and context (C), shapes the way in which consumer’s view and ultimate act upon external conditions in regards to environmental decision making. This looks at behavior as the result of the interplay between attitude and context for the appropriate action. Figure 1.1 displays this relationship with regards to recycling showcasing the positive and negative outcomes that would produce a response in behavior (Guagnano, Stern, & Dietz, 1995).

![Figure 1.1: ABC Model Applied to Recycling (Guagnano, Stern, & Dietz,1995).](image)

Although the ABC was not designed specifically for fostering behavior in organic food purchases, it has been adapted and implemented in a variety of categories. As the authors put it, the “external conditions are conceived of broadly to include all external sources of support or opposition to behavior, whether physical, financial, legal or social. They can range from
extremely negative (unpleasant or barriers) to extremely positive (pleasant and supportive)” (Guagnano, stern & Dietz, 1995). This relates back initially to the consideration of ethics. Because there is not a divisive boundary on how ethics are implemented in these theories, the extent to which the ethical values are delivered in surveys is often obscure. This theory helps to divide consumer behavior and consumer perception into a context of ethical support (i.e. working towards eliciting a positive outcome) or ethical aversion (i.e. avoiding punishment or further harm).

Literary critic Slavoj Zizek alludes to this kind of consumer behavior with intent to purchase as guilt of consumption (Zizek, 2014). The idea being namely that many ethical drivers for consumption were a means of avoiding negative reinforcements, focusing instead upon a clearly finite endpoint. Carrington et al. (2010) critiques the model as it lacks a holistic approach which can be implemented under the same metrics as an intent to purchase as would be a desire to not shoplift. Elliot (2013) takes a different approach towards the ABC model, finding it not to be an ethical model and more of an indicator to help bridge the gap between attitude and behavior, as well as to fully incentivize consumers. Elliot’s (2013) work capitalizes on this model, where he suggests that presenting a level of education greatly increases the desirability of green consumption.

Ultimately, the ABC theory cannot exist alone, as it only works as a metric. This theory becomes pivotal in the preliminary research for assessing consumer behavior and intent to purchase; however, as it indicates the difficulty into framing proper questions necessary to address environmental concerns. With other variables at play, such as knowledge or information seeking, the theory cannot help to best assess consumer’s desirability to purchase certain produces as much as it can be a litmus test for finding how consumers respond to various external pressures. The theory works in line with what Nie and Zepeda (2011) refer to as a means-end chain, where consumers’ actions and values are directed at reflecting their own personal goals.
1.3.2 VBN Theory:

From the ABC Theory derived several tangential theories, of which many worked to address the limitations stated above. The Value-Belief-Normative theory (VBN theory), also developed by Stern (2000) basically works as a flow-chart that has taken all pre-millennial research that focuses on how values chain into beliefs to form action or non-action in regards to environment. Stern claims “the theory links value theory, norm-activation theory, and the New Environmental Paradigm (NEP) perspective through a causal chain of five variables leading to behavior: personal values (especially altruistic values), NEP, AC and AR beliefs about general conditions in the biophysical environment, and personal norms for proenvironmental action.”

Essentially the VBN theory explores the relationship between Values, now registered as varying degrees of external and internal conditions (including altruism, environmental and ego-driven behavior); beliefs, looking at the perceived and realized threats; and personal norms to assess the development of behaviors. Stern (2000) holds that this theory “links value theory to norm-activation theory by generalizing the latter,” and “postulates that the consequences that matter in activating personal norms are adverse consequences to whatever the individual values (AC).” The theory works to develop not only the external conditions, but the interpersonal conditions of individuals. Figure 1.2 works to illustrate the chain of events leading to behaviors under the VBN Theory.

![Figure 1.2: VBN Theory in Environmental Context (Stern, 2000).](image-url)
Whereas the VBN does provide a much more cohesive framework for developing the relationship between attitudes and behaviors, it lacks a succinct framework necessary for writing into surveys. This functions as the author intended to be a more sociologically-driven work and does not easily transition into quantifiable studies. Nevertheless, works such as Eide and Toft (2013) do note that the focus is in environmental efficacy and posits altruism as an immediate variable. Furthermore, they found that previous studies commonly used VBN alongside Ajzen’s Theory of Planned Behavior (TPB), rendering the most consistent results with a high range of predictability. Unfortunately, the predictability still failed to explain the gaps in attitude and intention and instead worked as a reflexive measure for consumer habits.

Eide and Toft (2013) suggests that three factors, health consciousness, brand quality, and trust in scientific evidence play a much more intimate role in the purchasing decisions, with organic regulations forcing cognitive overload in consumers and price barriers to be the highest dissuading factors. This echoes Nie and Zepeda’s (2011) conclusion that knowledge needed to be included in order to give a more holistic account. Farr-Wharton’s (2014) extensive look on VBN attributes in relation to food waste further developed this call, where consumers habitually showed low food literacy and supply knowledge. This also reiterates the vacillating ethical principles involved in the questionnaires, where consumers were posited between their personal goals (financial, contributitional, pro-environmental) and external conditions (supporting local developers, adhering to organic standards, mitigating waste).

1.3.3 The Theory of Planned Behavior & Theory of Reasoned Action:

The Theory of Planned Behavior (TPB) is one of the most important theories on consumer motivators to date, set by Iceck Ajzen (1991). It focuses on attitudes, subjective norms and perceived behavioral controls to form intentions, which in turn focus on the actualized behavior. This is an attributional theory which relies on expectations of the consumers, but produces relatively consistent results and shows the relative strength of the influencers. The TPB is very useful as a standalone measurement, and works well as a compliment to the earlier
theories as well. The theory was set forth between 1985-1987 and can work with expectancy and valuation for consumers.

The theory looks at the interplay between attitudes (intentions), behavioral controls (ability) and subjective personal norms (the perceived internal and external pressures) to predict behaviors. The distinguishing mark from previous theories is that this functions psychologically as opposed to sociologically, and permits a more demographically-oriented focus as well as offering the opportunities for knowledge-seeking behaviors and access to information to play a role in assessment for behaviors (Ajzen, 1991). In other words, it satisfies the gap from intention to behavior much more succinctly than previous models.

Both Ruiz de Maya et al. (2011) and Guido et al. (2009) utilized TPB as a complimentary model to other works to iron out earlier complications. Ruiz de Maya et al. had adopted Schwartz’s cultural dimensions as the cornerstone of their research, but uses TPB as it is considered very reliable and has been replicated often in European studies for identifying intention to purchase organic food (Ruiz de Maya et al., 2011). They find this model most palatable as (a) the attitudinal beliefs help to express how consumers evaluate products; (b) subjective norms help to contextualize societal pressures and expectations from the consumer; (c) perceived behavioral control looks at personal limitations, such as income or religious pressures; and (d) it allows a cross-cultural platform for studies between different locations. The TPB is “the basic theoretical framework used to explain the behavior of European consumers toward organic food products” because it can work with attitudes and offer proper context while giving clear indications of its limitations that can be amended with tangential applications of other behavior models.

Conversely, Guido et al. (2010) utilized TPB as a measure to reconcile discrepancies from internal and external ethical values. They believed that TPB works to distinguish “…moral norms, defined as a belief-based perception of what is right or wrong… and moral disengagement, described as the individual tendency to suspend personal moral standards in order to reduce self-censure” as “moral norms…can be considered the main motivator of
purchasing intention, and they are, in turn, affected by subjective norms and product personality traits of Naturalness and Authenticity.” Adding this measure has been instrumental in giving consistent and coherent moral/ethical dimensions to organic food purchase studies. Dowd and Burke (2013) readapted model of the TPB incorporating a 3-step model to account for ethical dimensions, which “explained 76% of the variance in intention to purchase sustainably sourced food.” Conversely, Arvola (2008) only gave partial support to TPB’s capacity to judge moral capacities, as a focus on ethical consumerism would overshadow the other variable (e.g. subjective norms and attitudes). Onel (2016) took a multidimensional approach to environmental habits along with TPB models to find that perceived behavioral control was a weak indicator of behavior-related intention.

The precursor to TPB, the Theory of Reasoned Action (TRA), was also developed by Ajzen and Fishbein (1977) and essentially states that “behavioral intentions, which are the immediate antecedents to behavior, are a function of salient information or beliefs about the likelihood that performing a specific behavior will lead to a specific outcome,” as illustrated in Figure 1.3. This theory works identically to TPB, except that it excludes perceived behavioral control as a factor. Although it is less comprehensive than TPB models, it is sometimes preferred in studies, as it looks at intentions as the best indicator to behavior, as was found in Onel (2016).

![Figure 1.3: A Model of the Theory of Reasoned Action (Madden, Ellen & Ajzen, 1992).](image)

This focus was capitalized on studies such as Smith and Paladino (2010) where the study was performed to focus on the attitude-behavior relationship of eating organic. The study had still incorporated TPB models, but used them as a paradigm to the survey results for
consistency, with the perceived behavioral control as outside the limits to the study (i.e. “my mom purchases my food for me” or “I am on a fixed diet set by my doctor”). The results showed subjective norms, environmental concern and organic knowledge to be strongly related to organic attitudes and familiarity hosted a strong relationship to organic purchase behavior.

Some interesting adaptations to TRA have also been used instead of directly switching to TPB, such as Vazifehdoust et al. (2013), where they incorporated personal and marketing aspects instead of perceived behavioral controls. This took multiple dimensions of attitude, environmental concern, green labelling, green purchasing behavior, intentions of purchasing green, knowledge, perceived innovation and quality to adapt a profile on consumers, which showed a high relationship between attitude and intention on purchasing organic products. This evaluation, however, was not able to adapt how knowledge was obtained or the reliability of information.

Consequently, TPB and TRA models have been up to this point the most consistent and accurate in studies that can measure a wide range of variables in purchasing intent with regards to organic purchasing behavior. They can account for multiple metrics and evaluate relationships between attitude and behavior, which can allot for ethical dimensions and permits extensive studies on organic purchasing motives. However, the missing elements of information seeking and knowledge are still at large, as the theories are not able to gauge the reliability or consistency in consumers’ knowledge; only their intent. Thus, a strong level of caution needs to be emphasized to avoid consumer biases.

1.3.4 Alphabet Theory:

The penultimate theory that was looked on was the Alphabet Theory, proposed by Zepeda and Deal (2009). This model works as a synthesis of prior investigations that seems to ultimately encompass most of the pressing variables in organic and environmental food purchasing. The theory suggests “…that organic food shoppers in particular are motivated by values, beliefs and the creation of norms…However, the interviews indicate that knowledge (K), information seeking (IS) and habit (H) are also important in understanding why consumers choose organic
and local foods…[thus] Incorporating demographics (D) as well, the resulting VBN-ABC-D-K-IS-H or ‘Alphabet Theory’ is presented as a new framework to explain organic and local food purchase behavior.” Because this theory engrosses the previous models, it could appear somewhat reflexive or redundant; however, Figure 1.4 accurately represents the feed of information presented in the model.

![Conceptual Framework of the Alphabet Theory](image.png)

**Figure 1.4: Conceptual Framework of the Alphabet Theory (Zepeda and Deal, 2009).**

The greatest strength of the Alphabet Theory is not in its complexity and overall breadth of previous ABC-VBN-TPB models, but that it also works across platforms and various survey methodologies and gives an account for *why* consumers make the purchases they do with a focus on *habits* and *rational* (Zepeda and Deal, 2009). Thus, what is left is a very open depiction of consumer models within a framework that utilizes a high degree of accuracy. Consequently, models for information seeking, intent and knowledge are applied via the background of the person and not put simply as a personal subjective norm. With regards to studies such as that performed by Conner et al. (2010) where demographics formed salient beliefs and attitudes, the Alphabet Theory utilizes the demographic information as part of a segmented “style” (i.e. Rational, Adventurous, Careless, Conservative Uninvolved).
Feldmann and Hamm (2015) found the framework to be satisfactory in rectifying many of the inherent problems in getting an accurate portrayal of attitudes and behaviors as seen in ABC and VBN theories; yet, they did stress that the term “habits” could become over-encompassing, even though it did offer a measure for information seeking and knowledge. Further research is certainly recommended, although utilizing this framework contains no disadvantages over the other models since it incorporates them into its model. Consequently, following the dynamic set forth by Zepeda et al. (2011) in the Alphabet Theory is not only the most pragmatic but also the most fulfilling for looking at organic and environmental motivators in purchasing decisions.

1.3.5 Schwartz Theory:

There are other parallel theories that did not follow the above trajectory and have been used either alongside the other models or used successfully on their own for framing consumer motivator surveys. The Schwartz theory was often alluded to as a complimentary aspect towards many of the theories that investigated the relationship between various “guiding principles in one’s life” (Schwartz, 2012). The categories included power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, tradition, conformity, and security. For the most part, these categories were cursory elements, although hedonism and universalism played a huge role in many of the literature frameworks.

Schwartz values were a curiosity as they suffice as proper elements for evaluating values and applying them to consumers; consequently, the criteria can be rather subjective and not particularly focused enough to be a standalone element in evaluation. Albeit this was rarely the case in many of the studies, and the particular values were used for cross-cultural references as well as identifying demographic information. For example, Thogersen et al. (2016) argues that cultural values act as problem solving cues along with acting as mediators for constructs and applying directly to behaviors, such as pro-environmentalism.

Modelling Schwartz values can work as a transitory model between behavioral actions and value-based judgements. Essentially, using the Schwartz values, the undefined relationship
in the value-attitude-behavior hierarchy can be smoothed out. From incorporating this, Thogersen’s results yielded “Universalism” as the strongest value indicator in purchasing organic produce (Thogersen et al., 2016). Universalism, as defined by Schwartz as the “understanding, appreciation, tolerance, and protection for the welfare of all people and for nature” was the only category to have an altering effect on the results (Schwartz, 2012 & Thogersen et al., 2016). However, the study did take on a three-year period and found various Western influences to change the scale of values.

This illustrates several key points; namely the significance of incorporating personal values into theoretical models, the difficulty of assessing vacillating terminologies, and the extent to which demographic influencers can skew a survey. The direct model between ethics-attitudes-behaviors-context-demographics-information seeking-knowledge-intuition etc. is not linear, and the Schwartz values act as a very good scale for appropriating surveys. Ruiz de Maya et al.’s work is very adept at looking at the cultural interplays of these values and can find a positive relationship between strong cultural values and stronger intention to purchase organic (Ruiz, 2011).

1.3.6 Other Considerations:

Despite these models quite accurately encompassing consumer habits and values, it is necessary to discuss how some of the variables are taken into effect in more detail. The review presented is by no means a display of the models used in their entirety; what this does reveal most importantly is that there are recurring motifs presented that are utilized in sourcing motivators for consumers. These nuances seem to encompass ideologically driven motivators and localized results based on a participant’s living conditions are not always able to be incorporated. Whether a person lives in a rural or urban environment will greatly alter the way a person prioritizes values, as Annunziata and Vecchio (2016) found in Italy, with rural participants being more concerned with health over environmental focus. This can be speculated as having more immediate access to perceived environmental qualities that would
discourage concern for environmental sourcing along with a smaller stream of information, as was seen with the attributes found in locality, as portrayed by Onel (2016).

The notion of promoting confidence in consumers and bolstering their esteem also plays a pressing role. This is somewhat different from subjective norms presented in TPB, where Clairborn and Sirgy (2015) depict the cause of the dependency of consumer behaviors on products where self-image congruity is related to self-esteem (social approval) and self-consistency (social consistency) motivations. Onozaka (2010) further elucidates this matter, where his research concluded “the confidence consumers associate with certain venues to achieve both private and public outcomes is affected by the opinion of peers, which often instills trust in a product or product attribute…this is also affected by their own beliefs regarding the effectiveness of their action.” In other words, social pressures are a very common factor that influence the way subjective (and perceived objective) beliefs are manifested.

This stems heavily from advertising pressures, in which consumers are often reflecting personal values and worth along with the brand. Hughner et al. (2007) stresses the paradoxes involved in organic stakeholders for the industry to grow. There are pressing health and price barriers to making choices juxtaposed against a weak market approach for bolstering education to rally new participants and help to incentivize the current contributors. He encourages the need of markets to “include information pertaining to production methods, environmental benefits, positive contributions to local economies, etc.” as “the industry has left consumers to figure it out on their own” (Hughner et al., 2007).

Hedonism was also another attribute that, although covered by Schwartz (2012), was consistently supported on its own in multiple surveys. Hausman (2000) illustrates this where shopping accompanied by impulse buying is typically used as a method to produce hedonistic rewards for their purchases. Marketing strategies that utilize heavy branding and strategic labelling practices are also influential, although a full analysis on their impact would begin to exceed the scope of the literary review. Regardless, this has been a tangential effect for many of the studies, considering the extent to which the models use of subjective norms were strongly
impacted by brand appeal. This is also important as incentivizing a consumer to buy through brand or discounting incentives often leads to repeat purchases from the consumer, as discovered by Gottschalk et al. (2013). Gleim et al. (2013) strongly encourages both small and large businesses to open more available information to consumers about organic products in order to build trust and develop more long-term purchasing relationships.

Trust was repeatedly cited as an important factor, and similarly encompassed many of the models used directly. Siriex et al. (2013) discovered that familiarity, trust and fit were important for garnering a positive reception towards a brand. In particular, this is important where many participants wanted to avoid greenwashing and were somewhat skeptical from brands haphazardly using terms such as “climate-change” in order to promote a seemingly organic product (Siriex et al., 2013). This is quite apparent in research done by Hjelmar (2011), who found reflexive practices started by health scares, having children, etc. to be apparent in ethically and politically-minded consumers.

Consequently, when being exposed to a reflexive event, consumers may react with a level of justification to preserve “cognitive dissonance” in their life and will augment their purchasing habits to fit the new information provided (Hjelmar, 2011). Satisfaction derived from purchasing decisions (via perceived value and perceived quality) will also help to derive customer loyalty and trust, providing a higher WTP and more long-term, sustained purchases for goods (Terblanche & Boshoff, 2010). This was seen again in Dias’ (2016) work, which found superiority to organic food, justified by “affection through…concern for the family, as well as through the sensations resulting from the consumption of this type of food, from the motivations related to personal welfare, and from benefits achieved by the relationship with the producer and by the trust on the acquired and consumed food.”

The ethical and political dimensions are often filtered through both virtue and vice categories as a means of justification. Van Doorn and Verhoef (2011) discussed this phenomenon where vice foods (“products that provide immediate pleasurable experience but contribute to negative long-term outcomes”) derive a higher WTP but contain a more
immediate reward for prosocial benefits, whereas virtues (or products that are “less gratifying and appealing in the short term but have less negative long-term consequences than vices and therefore are a more prudent choice”) made consumers weary on the benefits associated in relation to the premiums.

Lim et al. (2013) discuss the conflicting results in WTP for organic food based on virtue/vice categories, where justification for organic produce stems from their perceptions of the health benefits offered from organics. Pollard et al. (2002) suggests utilizing health-focused groups with similar values to promote the sales of organics can help sustain a more positive social outlook to individuals on the fence with such purchases. Zander and Hamm (2010) suggests, however, that adding in additional attributes for ethical dimensions, such as animal welfare or fair prices directly increases WTP.

1.4 Discussion:

Having looked at the various models, it becomes clear how different indicators are translated through various approaches to manage consumer intents and attitudes towards organics. Each has its own strengths and weaknesses, where the ABC model is a good start that can isolate attitudes and context, even in seemingly unrelated categories. The VBN model can further support behavioral tendencies to give a clear indication of environmental behavior and value-based claims. The TRA and TPB are widely used, malleable and efficient in looking at the relationships that form intent to purchase and behaviors accordingly. The Alphabet theory takes it one step further, with a fully comprehensive model that encapsulates demographics, knowledge and information seeking. Finally, with the additional input of Schwartz values, there is an even stronger relationship between individuals and the environment that can be seen through various dimensions. The basic overviews along with positive and negative attributes can be seen in Table 1.1.
Table 1.1: Models Assessed in the Literature Review with Positive and Negative Attributes.

<table>
<thead>
<tr>
<th>Model</th>
<th>Basic Overview</th>
<th>Positives</th>
<th>Negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC Theory</td>
<td>Behavior is a result of attitudinal beliefs and context.</td>
<td>Strong in areas with weak links; can be easily applied.</td>
<td>Excludes multiple variables; without additional support, relationships can be ad hoc.</td>
</tr>
<tr>
<td>VBN Theory</td>
<td>Support/behavior for environment is a result of values, beliefs and normative behavior</td>
<td>Adopts a streamlined approach to look at value-based approaches; Personal values are antecedents of enviro beliefs.</td>
<td>Difficult to adopt into quantitative studies; does not account for information seeking; Not ideal for standalone surveys.</td>
</tr>
<tr>
<td>TRA/TPB</td>
<td>Behavior is a resultant of intention, formed by attitudes, subjective norms and perceived behavioral control.</td>
<td>Widely used and acts as a strong standard; can be readapted into multiple studies; covers intent, social pressures and knowledge</td>
<td>Moral and normative influencers are easily overlooked; too much emphasis on cognitive or emotive beliefs.</td>
</tr>
<tr>
<td>Alphabet Theory</td>
<td>Utilizes constructs of ABC-VBN-TPB with addition of Information seeking, knowledge, habits and demographics.</td>
<td>Extremely extensive, takes in previous models and incorporates missing conditions; can work in various frameworks; good predictive model.</td>
<td>Can become over-encompassing; Needs to be supplemented in large-scale surveys or case studies to best work.</td>
</tr>
<tr>
<td>Schwartz Scale</td>
<td>Values can be divided among a specific set, working together to explain the relationships between one another.</td>
<td>Fits in a large range; can be used in various disciplines; excellent tool for cross-cultural studies; good indicator for both actions and beliefs.</td>
<td>Terms can be subjective; Does not work well as a standalone; many of the values on the scale are looked at in isolation or difficult to present all in one study.</td>
</tr>
</tbody>
</table>

The frameworks of these models are expandable and malleable enough to give good predictors on consumer behaviors towards organics with a strong level of confidence. The difficulty in implementing these lies in the different manners of adaptations and interpretation, where so many personal effects shape the way in which consumers respond to organic food (Hughner et al., 2007). The personal conditions, such as beliefs, education, information seeking, health motivators, etc. are weighed strongly against external conditions, of social pressure, branding, advertising, virtue/vice categories for ethical behaviors etc. Fortunately, each approach to isolating the variables to see consumer attitudes towards values and motivators all follow a similar trajectory.
This literary review shows many conditional applications for consumers, although it is unable to find a consistent rule. What is revealed, however, is that consumers have a strong intent to purchase organics, provided they can see the justification of their premiums in quality and ethical contributions. However, consumers are also convenience-driven and face financial and accessible limitations, which limits their willingness and ability to pay for organics. Furthermore, subjective norms greatly influence a consumer’s attitude, which is used to provide justification alongside current knowledge and information seeking. WTP was a great example of this, where the WTP was shown to be conditioned strongly on knowledge and association that the consumer had with organics to begin with. Demographic influences and information seeking often switched between being a driving force to shaping attitudes and being an agent to which the consumers would justify their beliefs.

Of the variables mentioned above, the five that seemed to typically recur were health, price, accessibility, quality, and environment. The effects of health (nutrition) were consistently shown to be instrumental in the decision making, as it was consistently cited as an important quality that could entice a consumer to immediately change their behavior; price was often seen as both a motivator and a barrier, which often depicted strong associations with organics and divided sentiments on their intrinsic value; accessibility (locality/availability) often had a subjective framework that tied directly into knowledge and information seeking, which produced strong responses towards intent to purchase; quality (aesthetics/value) was often cited as well, and tied directly into brand awareness and price justification; and finally environmental efficacy of organics was pivotal in many assessments, although conditioned in various ways.

The results from this literary review could be applied in many dimensions, starting with the immediate application for marketing and advertising. There is a responsibility for organic food proprietors to adopt a clearer level of transparency in their labelling practices and visibility of information with regards to the environmental efficacy in their production. Weak or vague practices are ultimately discouraging to the consumers and lower the perceived value of organic
products overall. In fact, from Janssen and Hamm (2012), Italy was the only country that showed confidence in product labelling.

Many consumers are often confused with the lose definitions of organic and find it interchangeable with other terms such as “green”, “sustainable”, “natural” and “ecological” (Pieniak et al., 2010). Because consumers contain a high level of confidence in subjective knowledge and often little objective foundations, labelling practices are typically provisional and used for justification of their purchases. Behavioral practices influence a level of confidence that needs to be assessed in terms of multiple products over varying regions to get a collective understanding of the proper definitions. Following suggestions by Kahl et al. (2012), making stronger indicators, “…should be through parameters, where parameters are described by methods” to facilitate a more streamlined approach that reflects a more definable qualitative aspect and gives a more balanced approach to labelling practices.

This literature provides clear indications to where the aquaponics industry can develop and help to optimize their strategies. One of the most common criticisms against aquaponics is that the cost of ventures and dual production fail to outweigh the efficiency of hydroponics. This is catered to different perspectives, where short-term and long-term goals and various attributes can weigh on different results, as seen by Yamamoto and Brock (2013). This review tells us that an ideal focus can be placed on the rewards given to consumers for purchasing an environmentally-focused, local and organic product.

The relationship the consumer feels with the production methods and sites can reinforce subjective norms and bolster personal values, where they become part of a narrative. This also justifies a higher WTP, where there are little inherent vices and purchases offer a contribution to a “natural” system. Aquaponics sales can profit from increasing trust and confidence in their selection, offering justification to their purchasing goals. It further satisfies a drive for a novel product and gives the consumer a unique experience.
1.5 Conclusion:

On the individual level, there is a drive to promote organics to benefit a lifestyle. Ultimately, when presented with a consumer it must be asked what advantage they are receiving by having this product. Why do organic produces hold any superiority - if any - to others and how do the metrics for ranging it get measured? Because of the frequency of greenwashing and conflicting lifestyle choices, it is hard to make an argument to promote organics that would appeal to more than select niche groups. Consequently, when framing a survey to find out how organics are prioritized by motivators, it is expectant to have biases emerge.

From the literature, it was determined that the main survey ought to incorporate the survey framework set forth in Nie and Zepeda (2011), as the model used in the Alphabet Theory had given strong, consistent results that heavily mitigate most of the biases. As the Alphabet Theory was the most thorough work produced, it can act as one of the main instruments to which the Chapter 4 survey was framed for both metrics and questions. However, going straight to the Alphabet Theory is not entirely necessitated if an accessory model is used to measure the determining factors in the consumers’ decision making more accurately. The results consistently displayed that consumers’ self-expectations are a strong indicator of behavior, and measuring this subjective principle can often be difficult.

This literature study has led the author to follow and setup a questionnaire with 5 indicators (health, price, environment, quality and availability) measured through 4 questions - both behavioral and belief-based - for each indicator. The literature review also led the author to find that having a series of open-ended questions at the beginning could facilitate in the study, where participants could have an opportunity to elaborate on their perception of the conditions in Iceland with regards to produce and offer insight into other peripheral problems or measures that are specific to the region.

Results from this study have been incorporated into Chapter 2, where the production capacities have been weighed against tourism numbers and local consumption habits. The effects of this development have been weighed along with TRA/TPB models to identify
consumer intent and behavioral responses to increased production. The indicators have also been applied to the aquaculture industry in Chapter 3, where the impact of product labelling and organic appeal to fish consumption has been assessed. This has become particularly important when looking at the division of age demographics to depict consumption appeal.

Of the results from the review, one of the strongest conclusions that can be drawn is that consumers’ intention does not always match their attitudes. This is drawn out through a multitude of narratives, but ultimately boils down to consumers having confidence and beliefs that they contain proper knowledge of the benefits offered through organics. Any survey that tries to gauge intentions on organic purchases needs to consider this appeal on the subjective level and how it translates into attitude-behavior paradigms.

With organic produce rapidly emerging in a changing environment, it is not unforeseeable to see reactions and standards continue to change in the near future. This means for advertisers to help bolster the industry by giving clear and well-presented information to consumers that allows them to formulate purchasing decisions and incentivizes purchases. Consumers, conversely, need to take a stronger level in participation and present a well-defined set of demands on what they want from organics to help manage means to achieving this in both the supply chain and prioritization of values that can be reflected in their products.

Understandably, with the already overwhelming level of demands presented in daily life, it is difficult to encourage another set of chores to consumers to study and intimately know the market and the niceties of organic produce. Regardless of whether it is the onus of businesses or consumers, this is an aspect of life that consumers are confronted with daily and needs to be confronted. The goal is to bring forth a stronger level of communication and participation between consumers and businesses, where the consumers can act as both stakeholders and participants by influencing the product selection and having a greater level of participation in the produce market. They can feed their input and product selection into dictating changes they would like to see in produce that can be applied along with the versatility of systems in aquaponics.


Chapter 2: Greenhouse Production and Competitiveness to Imported Produce

Abstract: Iceland’s climate and general population are not welcoming to many means of conventional agriculture, leading to a heavy reliance on imported produce. However, this process undermines the opportunities presented and resources available through use of the country’s abundant geothermal energy sources. Using the data available from Statistics Iceland, localized surveys, tourism surveys, data from the Icelandic Tourist Board, energy costs and existing case studies, this paper assesses the conditions of conventional farming system and feasibility of increased horticulture in greenhouses as an alternative in lieu of import-dependent structure. The research provides indications that domestic production can act as a successful alternative to many of the products currently being otherwise imported and local production can be more energy efficient with less inherent risks in select products. The market prefers local produce as it is believed to be produced in a sustainable way without the use antibiotics, pesticides and herbicides. This chapter estimates the viability of increased food production in Iceland based on direct use of sustainable geothermal energy. The aim is to identify the current status and future possibilities of greenhouse production and fish farming for domestic sales, including a survey on consumers need, a market study for local sales as well as future export of new sustainable technologies. This chapter presents how horticulture in Iceland can be increased based on year-round use of geothermal energy.

Keywords: Horticulture; Import Statistics; Tourism; Energy Costs;

2.1 Introduction:

With a population of 332,296 natives as of September 2016, of whom 64% are concentrated in the capital region, Iceland can certainly be considered a curiosity (Icelandic Population, 2016). The country hosts a total land area of 100,250 sq. km and only a current usage of 18.7% for agricultural use (1.2% arable land and 17.5% permanent pasture), provoking a high demand for importing most goods (The World Factbook, 2016). The World Factbook (2016) puts Iceland at a -48.8% GDP composition by end use as of 2015 with $4.577 billion in imports in 2015 and $4.954 billion in 2014. Despite having the distinct advantage of readily available land and resources for greenhouses using geothermal energy, the numbers of greenhouses are in decline. From 2001 to 2008 the number of greenhouses had dropped from 121 to 96 in operation (Butrico, 2013). Butrico adds that “…in 2001 there were 199,000m² of greenhouse area, which is only slightly more than the 192,000m² [as of 2013].” However, the overall space of the remaining operations has increased, suggesting larger infrastructure for more stream-lined production with the space of individual farmers increasing on average.
Due to this dynamic, much of the fruits and vegetables are imported as opposed to being capitalized upon through greenhouse distribution. One question that arises is whether the current methodology applied to greenhouse production is most efficient and how this could be improved upon. The greenhouse farms in Iceland are mostly small “family” companies based on a few thousand square meter production areas. Consideration should be given to enlarge the production area and use more effective technologies for the production. There are also the effects of efficiency, productivity and costs (labor and energy) in respect to conventional agriculture and greenhouse production currently achieved. In order to test the viability, the current import trends needed to be weighed against local production as a means of establishing a baseline and then comparing this to other localized trends to test how increased local production could be adapted into the market under a system of various procedures. Moreover, new technologies as e.g. aquaponics, the combination of greenhouse farming and aquaculture, emerge as the practice is often seen as a much more “natural” or “green” procedure that could work well in the current market.

Direct use of geothermal energy for food production and processing can act as a solution to the growing problems with food source, not only in import demand, but also in food security. Johannsson (2011) had found in his Masters studies over food security in Iceland that it is worrisome insofar as changing consumption habits have increased a reliance on imports and created a demand for a more diversified diet in an area where the food sustainability is not easy to facilitate due to Iceland’s coastal position and small population. In Iceland, there are many risks to food security and its isolated position makes it at risk for food scarcity in the time of an emergency. Carolan (2013) boasts Iceland to have a freshwater food-print index (the ratio of “food consumption per capita to what the country’s freshwater stores could were all its food domestically”) at 0.31 percent. This shows that consumption habits, ecological benefits and general resource allocation are not matching what can be produced locally. The astounding concentration of natural resources and opportunities for geothermal powered greenhouses as well as local production are falling second to imports. It shows that Iceland has production rates for food that is being consumed at only a fraction of the abundant freshwater resources.
available. In other words, Iceland can literally afford to produce more domestically and conceivably venture into produce exports, which are relatively quite low.

Demand for greenhouse production is particularly keen in Iceland where there is an abundance of natural resources and means to renewable energy. Iceland would fare well with increased greenhouse facilities as well due to abundance of natural resources and availability of cheap, renewable energy. The total geothermal use is roughly 40% for electricity, 43% for space heating, and only 2% on greenhouses (Orkustofnun, 2017). The breakdown of final heat usage in 2015 is illustrated in Figure 2.1 (Orkustofnun, 2015). As 9/10 houses are equipped with geothermal heating, it makes temperature regulations in greenhouse facilities easy to manage.

![Final heat use by utilization category 2015](image)

**Figure 2.1: Energy Costs and Final Heat Use in Iceland, 2015 (Orkustofnun, 2015).**

The National Energy Authority (NEA) guide has hydropower and geothermal power as the primary energy sources since 1974 and recent data has shown 18.798GWh of electricity produced in 2015. Of those, 13.78GWh was from hydropower and 5.003GWh from geothermal, because of the abundant access to geothermal power and hydropower at a low expense. The
aluminum industry uses 70% of the electricity produced, from which 29% comes from geothermal energy. The total production of electricity was reported to be roughly 19 TWh/year, with 80% of it going to aluminum producers and ferrosilicon industry, 15% for the Icelandic industry and 5% to the public (Gudmundsson, 2016).

Concerning local farmers and energy subsidies, there are subsidy incentives for tomato, cucumber, and paprika production in Iceland (Reglugerð 1234/2016, Article 1, 2016). Because the aluminum industry has negotiated special agreements which they are grandfathered into, they receive special pricing for electricity which is not otherwise offered, due to the incentive being far too low to match nationally. Greenhouse farmers may receive subsidies on electricity costs. Figure 2.2 shows the prices for heating houses in 2015.

![Energy Price for House Heating in September 2015](Orkustofnun Data Repository: OS-2016-T001-01)

**Figure 2.2: Energy Price for House Heating, Sept. 2015**

Per regulations set forth from Reglugerð um stuðning við garðyrkju (Regulation on support to greenhouse farmers), reg. 1234/2016, article 4 (2016), electricity is divided into concession markets (“power companies have patents on the distribution and transport of electricity, and competitive market where there are electricity vendors and manufacturers of electricity”). Through the regulation, Icelandic consumers, industries and households “can negotiate the purchase of power but can only choose a tariff regime of distribution and transport operators.” However, the latter is subsidies for greenhouses with “annual
consumption for lighting by more than 100 MWh per year,” per reg. 1234/2016, article 17 (Reglugerd, 2016).

The rewards for local production could outweigh the risk, due to a high demand from consumers and a large series of potential end users. With a growing tourism market that is seeking out local cuisine and cultural experiences, incorporating a stronger presence of food-tourism is an ideal market; the educational benefits of utilizing hands-on agricultural programs and innovative means of urban agriculture are instrumental for fostering growth and development in a community; and the composite benefits for producing healthy food locally at competitive prices are imperative in a climate such as Iceland’s. However, to proceed and evaluate the feasibility of increased horticulture production, the first step is to look at the current distribution of produce being imported to assess what markets are satisfied and where there is an opening for alternative and additional means of production.

Thus, this paper will focus on the ability to increase the local vegetable production. In Iceland, the advantage of vegetation will best be utilized within the availability of fresh, green, local produce that is offering products that are not meeting to demand. Furthermore, this will entail the novelty effects of new produce in the extent to which it influences consumers as well. It will further explore how the market can be supplemented by new produce and novel technologies and services, and how that strategy would be adopted. Ultimately, this is working to set the groundwork for future studies in the potential role direct use of energy can serve in the agricultural sector as well as fish farming and other novel food production and processing technologies.

2.2 Methodology:

The import trends are taken from Statistics Iceland (statice.is) and compiled under different countries and products. The product list utilizes HS #s 07011000-09109900. The HS numbers are set as a form of tariff nomenclature, used to classify products and each number represents a specific item (such as 07069001 representing fresh carrots). The range was chosen to avoid dairy, meat, and cereal grains while still including spices and herbs. After removing the
null data and redundant/empty fields, the information was sorted under various models and compiled into graphics using Tableau software. It is organized under a variety of analytical models. Secondary data came from other Statistic Iceland reports such as local production, Icelandic Tourism Board surveys and local surveys/databases. Email interviews yielded private data unavailable, and private industries were in general not willing to help supplement the information. The data was initially displayed with each entry as product (HS), country, weight (kg), and month. Data ranged from Jan. 2014 through Dec. 2015.

There was a difficulty in measuring the local production against the import statistics by category, as the HS numbers did not match by category (e.g. Icelandic production for potatoes was under the blanket category “potato” whereas imports contained numerous sub-categories) and is based on annual production, excluding month-by-month breakdowns. This was easily amended by grouping categories in HS numbers to match the categories. Notices on comparative data will be mentioned for each item, including what items were inclusive or exclusive in the evaluation and why some were omitted or considered.

2.3 Import Statistics:

The import statistics have been compiled by both country and kilograms for the period Jan. 2014- Dec. 2015 for each month, focusing on HS number, country of origin and amount imported. To begin, the top five highest imported items are fresh apples, (HS 08081000 at 7,924 tonnes); bananas, other than plantains (HS 08039000 at 7,260 tonnes); plantains (HS 08031000 at 5,928 tonnes); other new potatoes (HS 07019009 at 3,889 tonnes); and oranges (HS 08051000 at 3,781 tonnes).

In addition, the top five highest importing countries are Netherlands, at 15,678 tonnes; Spain at 14,442 tonnes; Ecuador at 10,340 tonnes; United States at 7,518 tonnes; and France at 5,374 tonnes. Figure 2.3 shows the overall trends in import by country and product from the given period via a treemap of the data.  

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1 The Figure takes an in-depth analysis of import trends from Jan. 2014- Dec. 2015. Each white box represents one country, with each individual box demonstrating a single product (organized by HS number) that is imported. The
Figure 2.3: Treemap of Icelandic Total Imports of Select Produce by Product and Country, Jan. 2014 - Dec. 2015 (Williams, 2016).

The size of each item is relative to the percent it contributes to that country’s imports and the darker shades represent kg imported, ranging from 1.6 to 31,874 kg (represented by Ecuador: 0.0639000). For an interactive map with rollover information, please visit https://public.tableau.com/profile/jonathon.meadows#!/vizhome/test1Imports/Sheet2.
The total amount of produce imported between January 2014 and December 2015 for the respective products was nearly 87,716 tonnes (43,563 tonnes in 2014; 44,153 tonnes in 2015). Table 2.1 shows the top five most-imported countries and their respective top five imported products, organized by total kg imported, with the respective 2014 and 2015 totals as well; this is displayed in Figure 2.4, which illustrates the frequency of products being imported. This shows the totals frequency of products in relation to their distribution, or simply put the total imports per product (as HS number) over the two-year period.

Even though the imports come from 114 countries, Ecuador, Spain and the Netherlands are the only fields supporting over 10% of the total, suggesting the dependency on a global market for various products. One aspect that becomes clear is even with products that are produced locally in high frequency there is still a dependency on imports to supplement the demand. Much of the imported fruits are understandable; however, products such as lettuce and onions seem to be questionable, given the local narrative of production, as will be explored in the following sections. Overall, these issues reflect a growing area of concern for various markets that can be capitalized on.

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2 Because of the large selection of produce, not all items are visible on this Figure. For an interactive map with rollover information, please visit https://public.tableau.com/profile/jonathon.meadows#!/vizhome/ImportTrendsreproductsnocountry/SHEET1
Figure 2.4: Import Frequencies by Product, Jan 2014- Dec. 2015 (Williams, 2016).
Table 2.1: Top Five Importing Countries and Respective Top 5 Imports.

<table>
<thead>
<tr>
<th>Country</th>
<th>Product Description</th>
<th>Total (kg)</th>
<th>2014 (kg)</th>
<th>2015 (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>07031001 - Fresh onions</td>
<td>2,288,182</td>
<td>1,201,505</td>
<td>1,086,677</td>
</tr>
<tr>
<td></td>
<td>08083000 - Fresh pears</td>
<td>1,983,293</td>
<td>1,019,919</td>
<td>963,374</td>
</tr>
<tr>
<td></td>
<td>08081000 - Fresh apples</td>
<td>1,723,998</td>
<td>811,470</td>
<td>912,528</td>
</tr>
<tr>
<td></td>
<td>07096004 - Other fresh peppers, imported/exported between 16 March and 31 Oct.</td>
<td>1,284,052</td>
<td>645,523</td>
<td>638,529</td>
</tr>
<tr>
<td></td>
<td>07051112 - Iceberg lettuce, imported/exported between 16 March and 31 Oct.</td>
<td>1,022,417</td>
<td>540,999</td>
<td>48,1418</td>
</tr>
<tr>
<td>Spain</td>
<td>Total</td>
<td>2,321,438</td>
<td>1,095,206</td>
<td>1,226,232</td>
</tr>
<tr>
<td></td>
<td>08051000 – Oranges</td>
<td>2,045,119</td>
<td>963,811</td>
<td>1,081,308</td>
</tr>
<tr>
<td></td>
<td>08052000 - Mandarins and other citrus hybrids</td>
<td>1,123,820</td>
<td>520,049</td>
<td>603,771</td>
</tr>
<tr>
<td></td>
<td>08071100 - Fresh watermelons</td>
<td>932,897</td>
<td>433,856</td>
<td>499,041</td>
</tr>
<tr>
<td></td>
<td>08055001 – Lemons</td>
<td>885,768</td>
<td>454,832</td>
<td>430,936</td>
</tr>
<tr>
<td>Ecuador</td>
<td>Total</td>
<td>6,131,874</td>
<td>3,009,584</td>
<td>3,122,290</td>
</tr>
<tr>
<td></td>
<td>08039000 - Bananas, other than plantains</td>
<td>4,145,030</td>
<td>2,088,662</td>
<td>2,056,368</td>
</tr>
<tr>
<td></td>
<td>08031000 – Plantains</td>
<td>50,020</td>
<td>37,702</td>
<td>12,318</td>
</tr>
<tr>
<td></td>
<td>08043000 - Fresh or dried pineapples</td>
<td>4,407</td>
<td>4,407</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>08071100 - Fresh watermelons</td>
<td>3,791</td>
<td>476</td>
<td>3,315</td>
</tr>
<tr>
<td>United States</td>
<td>Total</td>
<td>2,321,079</td>
<td>1,027,979</td>
<td>1,293,100</td>
</tr>
<tr>
<td></td>
<td>07142000 - Fresh, dried or frozen sweet potatoes</td>
<td>1,334,653</td>
<td>904,718</td>
<td>429,935</td>
</tr>
<tr>
<td></td>
<td>08081000 - Fresh apples</td>
<td>980,347</td>
<td>384,719</td>
<td>595,628</td>
</tr>
<tr>
<td></td>
<td>08061000 - Fresh grapes</td>
<td>812,081</td>
<td>391,576</td>
<td>420,505</td>
</tr>
<tr>
<td></td>
<td>07133100 - Dried beans</td>
<td>296,649</td>
<td>137,438</td>
<td>159,211</td>
</tr>
<tr>
<td>France</td>
<td>Total</td>
<td>2,558,622</td>
<td>1,095,066</td>
<td>1,463,556</td>
</tr>
<tr>
<td></td>
<td>08081000 - Fresh apples</td>
<td>1,397,213</td>
<td>829,518</td>
<td>567,695</td>
</tr>
<tr>
<td></td>
<td>07019001 - New baking potatoes =&gt; 65 mm</td>
<td>895,685</td>
<td>683,860</td>
<td>211,825</td>
</tr>
<tr>
<td></td>
<td>07019009 - Other new potatoes</td>
<td>191,373</td>
<td>93,723</td>
<td>97,650</td>
</tr>
<tr>
<td></td>
<td>07061000 - Fresh carrots and turnips</td>
<td>90,607</td>
<td>28</td>
<td>90,579</td>
</tr>
</tbody>
</table>
Monthly trends yielded January and October as the weakest months for imports, with June being the strongest in both 2014 and 2015. However, no strong correlation can be provided between months and import trends overall. Nevertheless, when taken into consideration the import trends by month reflected only by the products produced in Iceland, a much more visible pattern appears. This pattern can be illustrated in Figure 2.5 where the difference in import trends by month from Icelandic products as a whole against import trends for products focused on Icelandic-only production (e.g. looking at the composite imports vs the import trends of potatoes, turnips, carrots, tomatoes, cucumber, cauliflower, cabbage, peppers, and mushrooms) are displayed (Williams, 2016).

This illustrates rather low imports in the winter seasons, with the peaks in the summer. One reason to account for this is that products such as bananas and apples are imported constantly, whereas other products are contingent upon seasonal demand as a supplement to local greenhouse production. Also, the summer climate is more inviting towards outdoor activity and greens and vegetables are consumed higher in that period with a higher influx of tourists and promotional opportunities for purchases.
Figure 2.5: A Comparison of Monthly Import Trends by Month for All Produce (left) VS Monthly Import Trends for Produce Also Grown in Iceland (Right) (Williams, 2016).
Searching for product by country yields a total of 87,716 tonnes of produce imported between 2014-2015. HS descriptions provide certain quality-indicator words that are often repeated, such as 39,366 tonnes (44.88%) containing the word “fresh”, whereas 5,230 tonnes (5.96%) contained “dried”, “preserved”, or “frozen”. 3,406 tonnes (3.88%) had “fresh or frozen” in the description as well. In this regards it shows a higher demand for fresh produce over imported, with country of origin being of little concern (there is no correlative trend showing country of origin mitigating import frequencies by month).

Country of origin is quite important for designating taxes. According to Butrico (2013), “no taxes are applied to goods that cannot be produced within Iceland to ensure affordable food prices for Icelanders,” which “was slightly amended in 2007 to place a 10% tax on fresh vegetables supplied by countries outside of the European Union.” Although Butrico claims this to be insignificant, the frequency of which products are purchased from non-EU countries (37.8 tonnes – 43% of select imports from the selected period) would certainly make an impact on the costs delivered from taxation.

Also from the Icelandic statistics database is a series of statistics representing comparative price level of food, beverages and tobacco. Table 2.2 investigates price indexes to determine if a country has a high cost of living, organized under the following conditions:

“The Price level indices are obtained as the ratio between PPP and the exchange rate for each country. These indices provide a comparison of the countries Price Level with respect to the EU average: If the price level index is higher than 100, the country concerned is relatively expensive compared to the EU average.”

The following data stems from Icelandic figures from the years 2006-2015, looking at every three years. From this it shows that the price of food overall was in decline, with a recent surge in prices. Whereas the relative increase in prices for food is certainly not close to that of alcoholic beverages, there is an overall concern for the future prospect of prices for food within the

---

3 Base EU28=100
country. The financial crisis of 2008 accounts for the sudden drop since 2006, also showcasing the slow increase of prices back to pre-crash levels.

Table 2.2: Comparative Price Level of Food, Beverages and Tobacco to EU Countries (Thorkelsson et al., 2012).

<table>
<thead>
<tr>
<th>Category</th>
<th>2006</th>
<th>2009</th>
<th>2012</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and non-alcoholic beverages</td>
<td>164</td>
<td>104</td>
<td>117</td>
<td>130</td>
</tr>
<tr>
<td>Food</td>
<td>162</td>
<td>105</td>
<td>116</td>
<td>132</td>
</tr>
<tr>
<td>Bread and cereals</td>
<td>188</td>
<td>129</td>
<td>121</td>
<td>136</td>
</tr>
<tr>
<td>Meat</td>
<td>189</td>
<td>100</td>
<td>123</td>
<td>139</td>
</tr>
<tr>
<td>Fish</td>
<td>112</td>
<td>80</td>
<td>96</td>
<td>108</td>
</tr>
<tr>
<td>Milk, cheese and eggs</td>
<td>149</td>
<td>91</td>
<td>115</td>
<td>139</td>
</tr>
<tr>
<td>Oils and fats</td>
<td>140</td>
<td>89</td>
<td>92</td>
<td>102</td>
</tr>
<tr>
<td>Fruits, vegetables, potatoes</td>
<td>154</td>
<td>115</td>
<td>117</td>
<td>130</td>
</tr>
<tr>
<td>Other food</td>
<td>161</td>
<td>120</td>
<td>127</td>
<td>141</td>
</tr>
<tr>
<td>Non-alcoholic beverages</td>
<td>177</td>
<td>103</td>
<td>124</td>
<td>114</td>
</tr>
<tr>
<td>Alcoholic beverages and tobacco</td>
<td>193</td>
<td>137</td>
<td>158</td>
<td>173</td>
</tr>
<tr>
<td>Alcoholic beverages</td>
<td>223</td>
<td>168</td>
<td>212</td>
<td>226</td>
</tr>
<tr>
<td>Tobacco</td>
<td>176</td>
<td>116</td>
<td>131</td>
<td>147</td>
</tr>
</tbody>
</table>

What this shows is that the overall prices of goods are consistently considered well over expensive. Consequently, even with cost of living adjustments and purchasing power, higher wages and strengthened currencies still do not produce more accessible goods when the price barrier is still high. This chart does not register the variance of goods (i.e. with a high band of low prices to high prices, the average may seem skewed), but even if they were offset, it would only reiterate how high the price variance is and how difficult it is to obtain affordable goods. The food categories “other food”, “fruits, vegetables, potatoes”, “food” and “food and non-alcoholic beverages” are all ranged as expensive.

In light of political events such as Brexit, currency exchanges are wildly fluctuating daily, rendering uncertainty in 2017 cost of living adjustments. Data from Numbeo (2017) shows a breakdown of some of the goods and services mentioned through Table 2.3 as of March 2017 (displayed in USD for convenience). The cost of living in Iceland is 60.24% higher than that of the US on average and consumer Prices in Reykjavik are 48.09% higher than in London on average (Numbeo, 2017). Despite the price barriers, Gallup polls still dictate a high level of

<table>
<thead>
<tr>
<th>Restaurants</th>
<th>Avg.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal, Inexpensive Restaurant</td>
<td>20.46 $</td>
<td>15.81 - 26.73</td>
</tr>
<tr>
<td>Meal for 2 People, Mid-range Restaurant, Three-course</td>
<td>111.61 $</td>
<td>82.78 - 139.51</td>
</tr>
<tr>
<td>McMeal at McDonalds (or Equivalent Combo Meal)</td>
<td>14.88 $</td>
<td>13.02 - 18.80</td>
</tr>
<tr>
<td>Domestic Beer (0.5 liter draught)</td>
<td>10.23 $</td>
<td>9.30 - 11.16</td>
</tr>
<tr>
<td>Imported Beer (0.33 liter bottle)</td>
<td>9.30 $</td>
<td>6.98 - 11.16</td>
</tr>
<tr>
<td>Cappuccino (regular)</td>
<td>4.99 $</td>
<td>4.19 - 5.66</td>
</tr>
<tr>
<td>Coke/Pepsi (0.33 liter bottle)</td>
<td>2.73 $</td>
<td>1.67 - 3.72</td>
</tr>
<tr>
<td>Water (0.33 liter bottle)</td>
<td>1.94 $</td>
<td>1.11 - 2.79</td>
</tr>
</tbody>
</table>

Table 2.3: Numbeo Cost of Living Averages for Iceland, March 2017 (Numbeo, 2017).

<table>
<thead>
<tr>
<th>Markets</th>
<th>Avg.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk (regular), (1 liter)</td>
<td>1.39 $</td>
<td>1.15 - 1.56</td>
</tr>
<tr>
<td>Loaf of Fresh White Bread (500g)</td>
<td>2.89 $</td>
<td>2.21 - 3.72</td>
</tr>
<tr>
<td>Rice (white), (1kg)</td>
<td>3.43 $</td>
<td>2.42 - 5.58</td>
</tr>
<tr>
<td>Eggs (12)</td>
<td>5.76 $</td>
<td>4.19 - 6.51</td>
</tr>
<tr>
<td>Local Cheese (1kg)</td>
<td>14.53 $</td>
<td>11.16 - 16.74</td>
</tr>
<tr>
<td>Chicken Breasts (Boneless, Skinless), (1kg)</td>
<td>20.02 $</td>
<td>14.22 - 25.30</td>
</tr>
<tr>
<td>Beef Round (1kg) (or Equivalent Back Leg Red Meat)</td>
<td>26.64 $</td>
<td>17.67 - 36.27</td>
</tr>
<tr>
<td>Apples (1kg)</td>
<td>3.14 $</td>
<td>2.22 - 4.66</td>
</tr>
<tr>
<td>Banana (1kg)</td>
<td>3.04 $</td>
<td>2.41 - 4.60</td>
</tr>
<tr>
<td>Oranges (1kg)</td>
<td>3.11 $</td>
<td>2.23 - 3.72</td>
</tr>
<tr>
<td>Tomato (1kg)</td>
<td>4.39 $</td>
<td>2.60 - 6.51</td>
</tr>
<tr>
<td>Potato (1kg)</td>
<td>2.57 $</td>
<td>1.86 - 3.43</td>
</tr>
<tr>
<td>Onion (1kg)</td>
<td>1.88 $</td>
<td>1.01 - 2.79</td>
</tr>
<tr>
<td>Lettuce (1 head)</td>
<td>3.14 $</td>
<td>2.01 - 3.72</td>
</tr>
<tr>
<td>Water (1.5 liter bottle)</td>
<td>2.11 $</td>
<td>1.57 - 2.79</td>
</tr>
<tr>
<td>Bottle of Wine (Mid-Range)</td>
<td>20.93 $</td>
<td>18.60 - 27.89</td>
</tr>
<tr>
<td>Domestic Beer (0.5 liter bottle)</td>
<td>3.46 $</td>
<td>2.79 - 4.19</td>
</tr>
<tr>
<td>Imported Beer (0.33 liter bottle)</td>
<td>3.21 $</td>
<td>2.51 - 3.72</td>
</tr>
<tr>
<td>Pack of Cigarettes (Marlboro)</td>
<td>12.09 $</td>
<td>11.16 - 13.95</td>
</tr>
</tbody>
</table>

2.4 Icelandic Production:

Icelandic food production is believed to have a great potential by increasing the direct use of geothermal energy, not least in the agriculture sector. From Smaradottir et al. (2014), “with geothermal heat and almost 100% renewable and secure supply of energy, Iceland could potentially saturate the domestic market [in food production], promoting further food security and save large amount of currency with less external trade.” Thorkelsson et al. (2012) suggests that alongside the potential for greenhouse production that is sometimes undercapitalized upon, there is also an opportunity for secondary products “such as tomatoes in salsa sauces, horticulture value chain and storage methods”. Furthermore, according to early sources
between 2002-2005, there was a notice of correlative trends emerging amongst an influx of tourism putting pressure on more imported goods and a lessening demand domestic goods, despite increased potential for domestic production in greenhouses as well as also mention of uneven distribution of support relegated primarily to lamb and dairy industries (Sigurdardottir, 2005). This is most likely a result of a myriad of factors, including fear of startup failures, strict regulations, convenience and affordability of purchasing cheap-grade products abroad and pressures to maintain profits by satisfying tourists’ culinary desires.

As mentioned above, Iceland’s statistics for domestic products are slightly more difficult to ascertain and compare than the import trends. From Statistics Iceland, the only available recorded data was from 2012 to 2014 at the time of this study, making monthly comparisons unavailable. Table 2.4 shows the available data on production rates. An email correspondence had mentioned as well that strawberries are under the threshold and not large enough to be recorded, lettuces (salads) are confidential in regards to greenhouse production and few products are grown exclusively in greenhouses (Gudmundsson, 2016).

<table>
<thead>
<tr>
<th>Product</th>
<th>2012 tonnes</th>
<th>2013 tonnes</th>
<th>2014 tonnes</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potatoes, tonnes</td>
<td>9,700</td>
<td>6,000</td>
<td>8,260</td>
<td>23,960</td>
<td>7,987</td>
</tr>
<tr>
<td>Turnips, tonnes</td>
<td>1,265</td>
<td>670</td>
<td>1,070</td>
<td>3,005</td>
<td>1,002</td>
</tr>
<tr>
<td>Carrots, tonnes</td>
<td>682</td>
<td>360</td>
<td>780</td>
<td>1,822</td>
<td>607</td>
</tr>
<tr>
<td>Cereal grains, tonnes</td>
<td>16,170</td>
<td>5,890</td>
<td>6,227</td>
<td>28,287</td>
<td>9,429</td>
</tr>
<tr>
<td>Tomatoes, tonnes</td>
<td>1,716</td>
<td>1,560</td>
<td>1,516</td>
<td>4,792</td>
<td>1,597</td>
</tr>
<tr>
<td>Cucumber, tonnes</td>
<td>1,673</td>
<td>1,781</td>
<td>1,807</td>
<td>5,261</td>
<td>1,754</td>
</tr>
<tr>
<td>Cauliflower, tonnes</td>
<td>136</td>
<td>51</td>
<td>44</td>
<td>231</td>
<td>77</td>
</tr>
<tr>
<td>Cabbage, tonnes</td>
<td>408</td>
<td>158</td>
<td>135</td>
<td>701</td>
<td>234</td>
</tr>
<tr>
<td>Pepper, tonnes</td>
<td>261</td>
<td>243</td>
<td>223</td>
<td>727</td>
<td>242</td>
</tr>
<tr>
<td>Chinese cabbage, tonnes</td>
<td>196</td>
<td>71</td>
<td>84</td>
<td>351</td>
<td>117</td>
</tr>
<tr>
<td>Mushroom, tonnes</td>
<td>583</td>
<td>585</td>
<td>602</td>
<td>1,770</td>
<td>590</td>
</tr>
</tbody>
</table>

*Turnips and Carrots were sometimes labelled together under HS Import numbers (e.g. HS 07061000, “Turnips and Carrots”, rendering small issues in comparing the products directly.*
A visit to Lambhagi has given insight into the niceties of lettuces developments. The facility is one the biggest lettuce producer in Iceland, maintaining 60-70% of the local market share, at approximately 13,000 m² with a total staff of 25 individuals. They produce five varieties of lettuces, with a per annum yield of 300 tonnes. Salads are typically weighed in at 150 g/head, with larger salads (200g) used as part of the mixed blends. The company boasts never spraying insecticides and instead relies on organic protection, which has thus far been quite successful in maintaining strong growing conditions. They utilize recirculating water systems set up as NFT models and are highly automatized. The summer has roughly 20% more production due to increased lighting from direct sunlight, where the supplementary lighting fixtures require 150-160 Watts/m². The biggest competitor is imported lettuces, recorded at 1364.4 tonnes in 2014 and 1343.6 tonnes in 2015. With the assumption of the market shares, it can be assumed between 428-500 tonnes produced in Iceland overall, and between 3-4 times that being imported.

Table 2.4 shows that production focus has a series of fluctuations, with 2013 being lowered in all categories (aside from cucumbers) and 2014 slowly increasing in production numbers. The rationale behind these fluctuations are most likely from administrative standpoints, where producers are directed towards focusing on a certain crop or being offered incentives to cater towards a particular product or market. Cucumbers, tomatoes and paprika grown in greenhouses also gain government subsidies. The extent of these fluctuations can be elaborated below, which identifies opportunities and barriers presented in different products.

Many of the vegetables that are routinely produced outside, such as grains, potatoes and carrots are subject to volatile weather conditions and the summer of 2013 was particularly unseasonable, rendering a mitigated harvest. This sentiment was echoed by local carrot farmers, who depicted 2010 as “extremely good,” rendering 90 tons; 2011 as not as favorable, with a lingering winter that yielded 60 tons; 2012 stifled by Ranabjalla (a type of pest), producing only 20 tons; and 2013 as very unfavorable, with poor weather conditions only generating 20 tons. This also reiterates the significance of greenhouse production, where controlled environments can curtail crop failures, aside from the potential risks of infestation and diseases.
Potatoes are one area of immediate interest. Comparing the import results alongside local production, there is a collective total of 4,163 tonnes vs local production of 8,260 tonnes in 2014. The import number was the composite value of dried potatoes (HS 07129002), provisionally preserved potatoes (HS 07119001), frozen potatoes (HS 07101000), other new potatoes (HS 07019009), new baking potatoes (HS 07019001) and seed potatoes (HS 07011000). The Icelandic statistics did not specify the respective divisions for domestic production. Unfortunately, even with the immense levels of potato production, Iceland is still dependent on imports and lacks a variety in potato species. According to the National Potato Council world statistics (2016) Iceland does not register as a competing producer, falling short of the closest competitors by over 470,000 tonnes. Figure 2.6 shows a breakdown of available data in Iceland 2014 in regards to import of the same products, which shows the significant proportion of potatoes that are locally grown (Williams, 2016).

Figure 2.6: Icelandic Production Against Imports, 2014 (Blue= Iceland; Orange = Import) (Williams, 2016)
Cucumber production in Iceland was noticeably larger than the import values (1,807 tonnes locally produced vs 11 tonnes imported in 2014). Imports are derived from Denmark, Germany, Italy, Ireland, Netherlands, Poland, Spain, Thailand, UK and Vietnam, ranging in weights from less than 1kg up to 11,615kg in the two-year period. Although the sheer volume of cucumbers is strong, there shows promise for the potential of diversifying the current market with different varieties in cucumbers as well. The Farmers Association of Iceland (2012) had noted cucumber producers delivering a total yield of 1.582 thousand tonnes in 2011 along with benefits delivered from government subsidies.

Peppers, cabbages, and cauliflower are of a great curiosity. Locally produced figures for peppers are roughly 13% of what was imported in 2014, with cabbage at 30%, Chinese cabbage at 85% and cauliflower at 12%. There is no important distinction in peppers regarding country, with cabbage, red cabbage and Chinese cabbages coming primarily from Netherlands and secondarily from Spain. Of these three products, a comparative evaluation is once more difficult insofar as assessing results from various subdivisions (i.e. red peppers, chili peppers, bell peppers, fresh, frozen, etc.) against a single category (vis. “peppers”). These three products are of a strong interest as they are all suited to be maintained quite well in greenhouses settings and can be applied in various means of cultivation, such as hydroponic or aquaponics systems.

Table 2.5 illustrates the description of peppers by HS number as well as annual quantities imported and the highest producer. It is curious why more production is not being facilitated in Iceland, as peppers are an easy to cultivate and suitable crop for production. Potential disease or low import costs may be dissuading factors, although no available sources can confirm why production is at its current condition. They offer a stable market for local producers and distributors as well. For example, Wen (2011) had discovered that locally grown products generated more profit and a higher Willingness to Pay (WTP) for local and organic products. Curtisa et al. (2014) took this information further and revealed that consumers were overall more willing to pay additional premiums for products that displayed origin as well as organic labelling (on average $2.96/pound more for green peppers).
Table 2.5: Pepper Imports, by HS number, 2014-2015 Totals and Highest Imports.

<table>
<thead>
<tr>
<th>HS Number</th>
<th>Description</th>
<th>2014 Total</th>
<th>2015 Total</th>
<th>Highest Import</th>
</tr>
</thead>
<tbody>
<tr>
<td>07096002</td>
<td>Fresh peppers, imported/exported between 1 November and 15 March</td>
<td>495,344 kg</td>
<td>494,670 kg</td>
<td>Spain</td>
</tr>
<tr>
<td>07096003</td>
<td>Fresh green peppers, imported/exported between 16 March and 31 October</td>
<td>119,061 kg</td>
<td>127,815 kg</td>
<td>Netherlands</td>
</tr>
<tr>
<td>07096004</td>
<td>Other fresh peppers, imported/exported between 16 March and 31 October</td>
<td>711,698 kg</td>
<td>746,095 kg</td>
<td>Netherlands</td>
</tr>
<tr>
<td>07096009</td>
<td>Other fresh peppers (of the genus capsicum or pimenta)</td>
<td>25,954 kg</td>
<td>42,831 kg</td>
<td>Spain</td>
</tr>
<tr>
<td>07108001</td>
<td>Frozen peppers imported/exported between 1 November and 15 March</td>
<td>59,317 kg</td>
<td>40,143 kg</td>
<td>Belgium</td>
</tr>
<tr>
<td>07108002</td>
<td>Frozen peppers, imported/exported between 16 March and 31 October</td>
<td>259,770 kg</td>
<td>291,678 kg</td>
<td>Belgium</td>
</tr>
</tbody>
</table>

Table 2.5 reveals that the three contributing countries are Spain, Netherlands and Belgium, which offer a variety of peppers to the country. Most pepper categories received an increase in demand, with “other fresh peppers” having the highest increase. This is most likely an effort to diversify and appeal to a demand for increased varieties of fresh peppers. Despite the drop of frozen peppers in between November and March, the increase returned from March through October, signifying seasonal developments as well, which seems consistent with Figure 2.5. In recent years, novelty peppers known for their intensity, such as ghost chili peppers have been gaining in global popularity, where US harvesters are selling out due to the increased demand for the novelty products (Krause, 2017).

Regarding this shortage of production in Iceland, it is worth considering what the mitigating factors are for an increase in production of peppers. Weller (2010) states in his assessment on the Icelandic market that tomatoes, cucumbers and bell peppers are crops that ought to be driven to more attention and focused on in a market, as these are non-native crops that could be grown locally (thus eliminating import demand) and hold a premium in local markets. Halldorsdottir (2013) echoes this sentiment with bell peppers as a keen example, as “…Iceland is capable of producing more than is currently done and without more environmental impact than would come from imported food”. In other words, Iceland has the
potential to eliminate imported pepper supplies which would come at a lower cost than frequent imports and help create more market stability.

Cabbage and Chinese cabbage were odd in their frequencies. Between the HS numbers examined, only three types of cabbage were revealed; namely 07049001 - Fresh cabbage, 07049003 - Fresh Chinese cabbage, and 07049002 - Fresh red cabbage. As it only comes imported fresh, that leads one to assume whether the red cabbage sold at stores is either all produced locally, imported and then processed locally, or through some other means. What can be said is that this number seems to be smaller in comparison to what is expected.

Cabbages can be incorporated into alternative greenhouse production systems, and has been mentioned alongside broccoli, Brussel sprouts and romaine as a favorable crop (Rakocy et al., 2006). In his 2010 report, Johannesson (2010) makes note that cabbage grown in Iceland is produced outside and not in greenhouses. This creates a very small timeframe for an ideal growing season and potentially compromises the capacity for strong growing periods, due to wildly fluctuating weather conditions, seen in carrots. These products mainly hail from Netherlands, with the second-most imported countries to regard a proportionally lower capacity. Fresh cabbage arrives at 449 tonnes in 2014 and 485 tonnes in 2015. Red cabbage recorded 27.8 tonnes in 2014 and 18.8 tonnes in 2015. Finally, Chinese cabbage accumulated 97.9 tonnes in 2014 and 98.1 tonnes in 2015.

2.5 Expanded Production Selection and Tourism:

Iceland’s local production, however, is mainly satisfactory in several sectors. The one thing that becomes abundantly clear from this research is that there is a growing concern not only for import demand, but also from a lack of diversification in products and several products were otherwise not mentioned. For example, strawberries were mentioned to be under produced and vegetables such as kale, watercress, and Pak choy have a low presentation. This is naturally tempered against a limited demand with a niche outlet and seasonal peaks. Efforts to encourage farmers to consolidate their markets and collectively focus on novelty products
could help generate higher overall profits from a more open and diversified menu of food choices.

Naturally to go through a list of potential markets can be exhaustive and particularly subjective; therefore, to account for a more comprehensive snapshot on the potential market or products that are imported which could be facilitated locally, it is important to look at three standards namely (1) product diversity, (2) market demand, and (3) feasibility. For (1), product diversity refers to looking at the various species of a product that could be grown locally which are not represented. Thus, instead of looking at cucumbers or tomatoes as a whole, to instead look at it in various species to supplement the market. This can be critical as adding diversity to the market will help merit a richer scope of products that can be used to for seasonal demand and a more comprehensive local menu. As noted in the previous potato and cucumber fields, even with a high production capacity, there is little versatility and consequently still a reliance on importation. Factor (2) represents an increased awareness and study focused on dietary and consumption habits to help both consumers and providers identify key products they can produce locally. Factor (3) represents the ease of implementing said products.

The goal of increased greenhouse production would be supplementary in the national market and mitigate redundancies forming competitions against already-established farming practices. It would be difficult and unfeasible to put efforts into concessions that are already satisfied and at lower premiums than are already available, with the addition of government subsidies and aid. In direct competition with established farmers, it would be unmanageable to provide a competitive edge that would deem itself sufficient enough to cater to enough consumers to justify the expenses. For products such as lettuces, there is no additional incentive that promotes individuals to purchase a select brand over another in Iceland; even if it is organic. The third aspect is in large focused to the purpose of the research here, combining (1) and (2) to find the most feasible products that can be initiated into local production and then driven to new means of cultivation.
This is important insofar as it is a key component to facilitating the high influx of tourism while maintaining a cultural identity. The reason behind this follows the theory of planned behavior set forth by Icek Ajzen. Accordingly, perceived behavioral controls, subjective norms and attitude towards the behavior dictate behavior towards consumer habits (Ajzen, 1991). This is reflected in market research for consumer perception and habits regarding hydroponic and aquaponics produce. In Brazil, Dias et al. (2016) highlighted “beliefs related to health benefits and the environmental impact reduction as the key purchase and re-purchase motivations.” In Malaysia as well, aquaponics-generated produced was regarded as particularly high in favor to consumer index due to variety, environmental conscientiousness and health (Tamin et al., 2016). Finally, this has been again reiterated through Rex and Baumann (2007) who suggest that the consumer perception of ecolabels is wanting due to the schism between activists and alienated individuals who feel environmental practices to be a transient issue which could be rectified via the application of an empirical means for engaging the consumer and increasing their level of participation.

Thus, in applying the behavioral practices in purchasing habits alongside the areas wanting of production, an avenue that is not only applicable to facilitation by more diversified production, but a focus that guarantees growth appears. The lack of diversification may be negatively affecting the market value of products. In his 2015 study, Stefansson (2015) found an increasing demand for vegan products and restaurants in Iceland, a subset which he describes as an untapped regional market, and depicts the consumer habits as frequently purchasing high quality, low cost items that are currently not being satisfied by available resources. Furthermore, alongside niche groups such as the permaculture societies in Iceland who are already capitalizing on unique methodologies for urban agriculture, increasing avenues for various production that follows a ‘natural’ or ‘green’ techniques are very important.

### 2.5.1 Tourism:

Tourism also increases the demand for diversification and expansion of product varieties and localized production. From the Winter 2011/2012, Winter 2013/2014 and Summer
2014 tourism surveys, various trends amongst consumers emerge, reaffirming the previously-mentioned significance of awareness of behavioral practices. For example, in the ‘11 Summer season, tourists noted 16,950 ISK on average for groceries during their staid. In the ‘11/12 Winter season, this number dropped to 10,276 ISK on average. However, by Winter 2013-2014, the average spending rose to 15,528 ISK and scaled again 23,917 ISK in Summer ‘14.

This is not including the restaurant spending (grouped as “restaurants, bars, and cafés”), recorded at a mean spending of 29,265 ISK in ‘11 Summer and 24,800 ISK in Winter 2011-2012. The 2013-2014 Winter season registered 44,034 ISK and 50,262 ISK in Summer ‘14. The Icelandic Tourism Board states tourism spending has increased 15% from 2013-2014 with a 4.8% higher average per individual (Ferdamalastofa, 2010). This same source notes that the Winter season is more quality conscience and recommenced an increased focus in introduction to Icelandic cuisine (Ferdamalastofa, 2010).

As of the most recent data, 2016 had yielded 1,767,726 visitors to this country, a 40.1% increase from 2015. Table 2.6 provides the tourism numbers and increases between 2010 and 2016 as a means of exposing how much the tourism demand (and consequently, the consumption demand) has increased in the last six years and continues to grow (Ferdamalastofa, 2016). The estimated number for 2016 of 1.7 million was achieved and 2.8 million has been estimated for 2019.

Table 2.6: Annual Visitors and Increase in Tourism Growth in Iceland.

<table>
<thead>
<tr>
<th>Year</th>
<th># of Visitors</th>
<th>Year Period</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>488,600</td>
<td>2010-11</td>
<td>16.6%</td>
</tr>
<tr>
<td>2011</td>
<td>565,600</td>
<td>2011-12</td>
<td>18.9%</td>
</tr>
<tr>
<td>2012</td>
<td>672,900</td>
<td>2012-13</td>
<td>20.0%</td>
</tr>
<tr>
<td>2013</td>
<td>807,300</td>
<td>2013-14</td>
<td>23.6%</td>
</tr>
<tr>
<td>2014</td>
<td>998,600</td>
<td>2014-15</td>
<td>29.1%</td>
</tr>
<tr>
<td>2015</td>
<td>1,261,938</td>
<td>2015-16</td>
<td>21.6%</td>
</tr>
<tr>
<td>2016</td>
<td>1,767,726</td>
<td>2016-</td>
<td>40.1%</td>
</tr>
</tbody>
</table>

Although it is questionable as to whether the tourism industry could directly impact the selection of food or if they are following status quo and will purchase regardless of quality
standards, the collective evidence shows an emerging pressure on consumer standards and awareness in produce. Martin et al. (2013) expands on this in the 2013 case study for using local food as a means of creating a marketing advantage. Accordingly, Martin et al. note that although the quality and potential for local food is quite high, there is a lack in the execution to food tourism, lack of branding and the lack of leadership in promotion are dissuading consumers. Strengthening the narrative of local food production and offering increased opportunities for regional diversification were suggested as ways to increase market awareness and orientation.

The PKF Accountants and Business Advisers Board echoed these sentiments in the 2013 long term strategy to promote Iceland. They found that quality and variety were the main concerns regarding food, followed by cost (PKF, 2013). Food and gastronomy was placed as one of the niche demand segments that could be capitalized on, as it is qualitatively sound, but lacks marketing intelligence frameworks (PKF, 2013). As the direct use of geothermal energy and greenhouse production in Iceland is an integral part of the country’s history and development, linking the narrative of food with a more diversified menu would be a beneficial means to gaining support for positive eco-tourism and generating income back into local businesses. This also gives unique opportunities for the country to incorporate emerging trends and design into its market, enriching the value of tourism and strengthening the local identity and practices as well, as it accentuates the Nordic Kitchen values.

In 2011, the broad category of food and beverages were only recorded to take 9.1% of total import rates; however, this does not mitigate the need for new sources of locally-produced food (Ferdamalastofa, 2012). From 2008-2011 food and alcohol reached 746,000 ISK, or 14.1% of the average household income at the time (Ferdamalastofa, 2012). Additionally is the consideration on VAT. It is known that the VAT in Iceland for goods is very volatile. To date analysis shows that Iceland is the 4th most expensive country in the world to live in. With high cost and high prices, opportunities for startups are difficult to maintain and the overhead in producing affordable, quality goods is difficult to provide. Additionally, Tait (2011) notes that the VAT is not uniform, and explains the take fluctuating between 14% (now 7% and 11%) to
24.5% (now 24.0%). Although he made mention that it is for the betterment of families in regards to the political agenda, he also forebodes:

“Estimates of the size of tax expenditures due to lower VAT rates for food and food-related goods are not easily obtained. In a 2006 report, it is estimated that a reform of the VAT rates for food and food-related goods so that all such goods would be subject to a 14% VAT rate and not partly 24.5% and 14% would cost ISK 950 million. Now the income accruing to the public purse from goods subject to the higher rate is a third of the income accruing from goods subject to the lower rate. Assuming inelastic consumption, the income accruing to the government would have increased by 4 billion 2006-ISK if the VAT rate had been increased to 24.5% for all food and food-related items. As the VAT rate for many food groups was lowered from 24.5% to 14% and some further from 14% to 7%, it seems fair to assume that the range of tax-exemption related to multiple VAT rates on food-items is 4-5 billion 2006 ISK. That is 3-4% of total VAT-income that year. It must be emphasized, however, that the report cited is a bit outdated as the construction of the VAT-system has been changed” (Tait, 2011).

2.6 Discussion:

A point of consideration to maintain after is that looking at the values and sheer numbers it can be quite daunting. It is easy to forget the size and population density of Iceland, as well as the fact that there is a much more participatory involvement in the citizens with limited resources. None of the information is to be condemning by any means. Instead, this can be used as a point of focus of where the best sources of resource allocation and competition can be provided. It is difficult to compare Icelandic production to larger countries such as the US and China, although Iceland can be facilitated as a strong area to test pilot global studies as an excellent test market. Unfortunately, the scope of procedures required to make a complete template are quite vast, and it requires a series of studies to see the holistic value of increasing focus on greenhouse production over importation. To stand, this study shows the first steps in looking at vegetable production. There is an unbelievable amount of potential and a lot of unique innovations that could be facilitated with the current dynamic and resources at hand. There are countless novel implications that could be facilitated and could be a starting point for future use.

Thus, the question that must be addressed now is whether increased production can facilitate the main areas of concern. To begin, it ought to be mentioned that there is a large series of end-users available with a wide breadth of products. Due to community development
being an intrinsic part of the market strategy, considering a new series of end users could be advantageous for Icelandic producers. For example, instead of going directly to market distribution, considering zoos, hospitals, correction facilities, hotels and education are key consumers that could be recognized. Using agriculture for work release programs has proven to be immensely effective with poor communities and Dimitri et al. (2016) calculate 21% of urban agricultural mission statements to correlate to community, 19% to education, and 10% to establishing food security. Blidariu (2011) had quoted Kotovich in the potential markets, making note of various channels such as “farm direct (farm gate, farmer’s markets, agri-tourism); Hotel Restaurant, and Industrial (HRI) (white table cloth, local restaurant, restaurant chains, hospitals); specialty retail markets (health food, whole food, ethnic, organic); vegetable/herb wholesale and garden retail centers”.

The potential output is contingent not only based on the size of the operation, but also looking at the products available. The goal would be more in line with supplementing demand for herbs, peppers, tomatoes, miscellaneous items and tailor to high-end markets and local restaurants that could use a larger variety in their dishes as opposed to directly competing with products that are already maintained well, such as cucumbers. Were a facility to maintain peppers alone, it would reduce total imports by 3%, based on the import numbers above. Additionally, if the herbs and leafy vegetables that can be easily maintained in greenhouses were instead produced locally, it could mitigate total imports by at least 5%. On its own, this is not seemingly too significant, except that it is looking only in products that are already produced in Iceland. When adding in new products with low market visibility but moderate demand, it not only mitigates import demands, but gives an incentive to promote local flavors, as was deemed necessary in the tourism surveys and the PFK analysis. Because import demand is so heavy in Iceland, reducing multiple trips for numerous small-item deliveries could greatly reduce the country’s carbon footprint (which is already quite high due to imports). The end goal is expanding the market paradigm for a country with a low variety of produce available and high demand from a large array of cultural backgrounds and establishments.
Because Iceland has a small amount of arable land, greenhouse production is a much more feasible outlet. Although there is a decline in greenhouses, there is still a high degree of available space and increased sizes of established operations, with investors willing to work in a more cooperative setting focused on direct-sales and opportunities for government assistance as mentioned above. For example, several industries are looking for collaborative efforts with Saemrekt (www.samraekt.is) to increase agritourism via aquaponics. Chatani et al. (2015) held energy efficient, cost effectiveness, sustainability, maintainability, maximized production capacity, educational avenues, scalability, and fitting into the local market as the key considerations for stakeholder needs. The ability to place the consumers as stakeholders holds a unique advantage that also appeals to ensuring a unique product variety. Karl Stefansson has shown this to be true in his implementation of a compact facility where he works with local restaurants to sell microgreens and select produce directly to restaurants through the company Spretta (www.Spretta.is). Having key markets located alongside swimming pools and key tourist spots allows for cross-promotion and offers an outlet for partnerships in sales.

Iceland is still in early stages for offering foodbanks, community gardens and farmers markets. David Bustion (2015) has cited in his work on Urban Agriculture that per Beekmans and de Boer, “urban agriculture, especially organized in cooperative ways, has proven to be an instrument that can rebuild entire communities, not only through food production but also through education and social networking.” His analysis on the size and population density have found community-supported agricultural programs to be in high demand, but ultimately insufficient due to outlying positions and low exposure for community gardens in programs such as Laugargardur community garden (Bustion, 2015). The Master Plan of Reykjavik 2010 – 2030 specifically calls for an increase in urban agriculture and promotion of accessible, local and fresh produce as well as a focus on community-accessible gardens and cultivation opportunities for the citizens (Reykjavik Municipal Government, 2013).

There are numerous educational and agritourism benefits offered by greenhouse systems, with Icelandic facilities such as Fridheimar in South Iceland (www.fridheimar.is) showing measurable levels of success in the industry. Aquaponics and hydroponics use in
greenhouse designs are convertible enough to work with a range of ages, from early childhood education up to adult courses, as has been demonstrated by both Hart et al. (2013) and Lluardo et al. (2014), respectively. Rendering these facilities fulfils an appropriate response to the influx of tourism, while giving a quality experience and an experience that provokes future projects and investments.

Education is a great means of promoting passively, which offers an opportunity to create awareness and traffic to the industry. Education also gives stakeholders an outlet for brainstorming and hosting peripheral projects in the community. This also creates a larger support group to help navigate problems and creates a safety net for when products are low. For facilities that intend to utilize some level of CSA (Community-supported agriculture) or food-bank incentive program, the participants become laborers, investors and end users. In such a case, the demand is always satisfied and allows for a much more focused scaling effort. This also helps to support a food narrative and bolsters community knowledge on production as well as formulating ideological perspectives.

2.7 Conclusion:

Although there is a lot to take away, the first consideration that should be addressed is that there is a proportionally heavy distribution on imports that could otherwise be maintained through an increased domestic production in greenhouses. Considering the shortened growing periods and access to geothermal power, it is not out of the question to look at increased production as a means to supplementing the demand while also introducing a higher variety of produce as affordable alternatives. The results had shown that some categories are satisfied, such as potatoes, cucumbers and to an extent tomatoes; however, adding in ventures for cabbages, peppers, and strawberries could be a good start. Diversification and expansion of selection could help mitigate price barriers and generate a higher return in markets.

The trends had depicted an increased demand coupled with variable outdoor growing conditions, rendering most ventures in increased production a high risk, high cost venture for most startups. Greenhouse focuses are the optimal means to combatting this, with a cooperative
framework in sales via local distributors that could generate a long-term advantage over importation. There would be more accessible outlets and larger control on product quality and variety with decreased lead times before being put on the shelf. Local production is not at a point where agricultural focus is insufficient; however, Iceland could benefit from the increased focus with fewer risks.

Tourism has been growing rapidly in recent years and the increase in numbers is not expected to slow down. This opens new pressures, new opportunities and new demands in regards to produce. Although there are seemingly limitless possibilities as to what produce can be facilitated, much of the produce and characteristics are put on a case-by-case basis (additional insight and consumer perspectives in Iceland will be detailed in full by survey responses in Chapter 4). In truth, produce such as apples, bananas, and avocados will not be able to be produced at a rate which matches the import prices and quality of local ventures; however, this is to be expected and does not mean that increased domestic production in other products wouldn’t be to a strong advantage that will help to incentivize tourists for return visits to Iceland by diminishing price and cost barriers.

Finally, increased focus on greenhouses works systematically in line with distribution and availability of hot water resources and utilization of natural resources. This focus can be adapted into multiple setups and a large variety of different cultivation methods, which not only allows for more innovation and leadership in local and global food security, but also incorporates a strong environmental focus and promises for increased tourism outlets that perpetuate a local identity through branding. This can work in hydroponics, aquaponics or countless other designs. It also gives way to entrepreneurial ventures and an increased network of producers that can work in collaboration to tailor to the local demands.
REFERENCES


Chapter 3: Aquaculture in Iceland: An Overview of Developments and Future Prospects

Abstract: Iceland is a country that has developed around fishing, where it has become an integral part of the country’s identity, both historically and in present day. The present industry is still dominated by marine fishing, although there is a growing sector in the face of climate change and limitations in the marine market regulations to begin working in aquaculture. This paper investigates the state of aquacultures in Iceland from a historical development into present-day operations and looks at how the peculiarities of the region have shaped the industry. What was found is that the environment hosts a unique potential for development with many obstacles stemming from financial limitations and availability to attribute more focus to aquaculture developments, although there are many advancements in production and innovation, especially with species such as trout, salmon and char. Ultimately, the industry shows health with prospects for development over time, but needs to be managed into different strategies that utilize domestic as well as foreign market approaches in order to be optimal. Furthermore, continuing to incorporate sales of fish products over sole reliance on fish would help to maintain higher profit margins and new market strategies. The aquaculture industry continues to grow with a promising increase in fish production and a high level of exports. With the increase in species such as salmon and char alongside new developments, it is very important to continue new methodologies and outreach for more opportunities and environmentally healthy, sustainable production.

Keywords: Aquaculture, Fisheries, Iceland, Cultural Trends, Industrial Development, Tourism Development

3.1 Introduction:

The state of the fisheries (marine fishing and production) and aquaculture (fish farming; restricted cultivation) is of great importance in Iceland. The country itself is and has been a fishing nation, holding the significance of such to the point of satire in their very own sagas, referring to the country as a giant “fishing camp” (Kunz, 2001). The historical value is quite significant, as it has shaped the way that the country operates, promotes cultural significance and garnered financial support. The Central Intelligence Agency has counted the Icelandic fishing industry at “40% of merchandise export earnings, more than 12% of GDP, and employs nearly 5% of the work force” (The World Factbook, 2016). More importantly, this country at 101,826 KM², maintains a leading global position in fish trade and exports. These numbers are further bolstered by the impact of fish products, research and tourism, which stress sustainable methods in production and deliverables. The Organization for Economic Co-operation and
Development (OECD) report has found the fishing industry to still show growth in an environment where, aside from Iceland, all Nordic countries have suffered decline (OECD, 2015). Not only is this industry in a level of increased growth, but the standards utilized in fisheries and aquaculture farms are within proper environmental guidelines and helps to accent the country as a ‘green tourism’ destination (OECD, 2015).

Nevertheless, alongside this industry comes many risks that are outside of the nation’s control, the most obvious being climate change. Through acidification of oceans, destruction of natural habitats, and threatened ecological zones, it is imperative to not only uphold the conditions of the standing industries, but investigate new areas of production and sustainability. Fish farming naturally serves as a good alternative that maintains the practice and even expands it into new ventures for marketing. The fish farming industry has shown considerable growth in Iceland as well, hosting a large range of sizes and selection. Once again, the resource intensive environment and access to proper water resources and systems acts an incentive for these operations.

Thus, the goal of this research is to investigate the current condition of aquaculture industries and assess the potential that future operations can hold. This requires to look at the background information as a cursory means to getting the relative strength of aquaculture facilities in the country, a review of the production capabilities and figures and the production values and prices. This will provide a depiction of the future production potential and aid in strategies to optimize the efficiency in fish farming ventures of varying scales. Iceland’s localized population, abundance of natural resources and steady stream of tourism positions the country as a more concentrated case study that can act as a global template for future ventures accordingly as well. Finally, this study will conclude by taking the data presented and applying it into the potential for ventures in production and research, to see the extent to which the venture can satisfy demand and operate under conditions that could provide a fair source of competition.
3.2 Background

3.2.1 Fish Farming in Iceland

Fish farming in Iceland is quite popular, although ultimately dwarfed by the marine fishing industry. Fish farming began to develop in the middle 1980’s, but did not take off until 1992 after issues on collapse and system failures were reconciled (National Energy Authority of Iceland, 2016). This industry has since been strong and somewhat resilient to the economic collapse. The Ministry of Fisheries and Aquaculture (Gunnarsson, 2016) elaborates on this narrative, showing early work in fish farming as early as the 1900’s through the 1950’s, although the practice did not formally progress until 1985, where large salmon rearing farms were started (of which many of them went bankrupt due to stagnation in the 90’s). The practice is mainly stifled by heavy licensing fees and regulatory practices as well as high startup costs for entrepreneurship compared to other countries, as seen in the OECD 2015 Economic Survey for Iceland which iterated that a combination of low competition and multiple restrictive regulatory practices mitigate the potential for market ventures (OECD, 2016).

This aspect is both a strongly positive feature and a difficult obstacle. Insofar as the benefits are concerned, these regulations are put in place to ensure the sincerest care to environmental wellbeing, both for the practice of preservation and maintaining the pristine sense of wilderness that attracts tourism. This delicate attention to detail adds in extensive environmental impact assessments and a large volume of bureaucratic work to ensure a successful operation. Furthermore, Iceland has adopted EU directive EC 2009/28, which “…guarantees…the [specific] energy source from which electricity is produced…[serving] to enable users of electricity to demonstrate that the electricity they buy is produced from renewable energy sources” (Matis [B], 2016).

Conversely, opposite to the benefits are considerations of stable employment in the industry, where employment is not as easy to maintain and a decreased labor force is often implemented. It is important to understand Icelandic aquaculture health in relation to the fisheries, which dominates a much stronger presence. This is explained via the Food and
Agriculture Organization (FAO) 2016 world fisheries report as the technological advancements and “increased efficiencies” contribute to the decline, although it is even more prominent in marine fishing, where the decline in employees dropped by 2400 from 1995-2014 (FAO [A], 2016). This is accounted as well in practice as increased globalization encourages a new paradigm, where “…fish can be produced in one country, processed in a second and consumed in a third… [which is] also linked to the increasing outsourcing of processing to countries where comparatively low wages and production costs provide a competitive advantage” (FAO [A], 2016).

Neil Einarsson, from the University of Akureyri, gave a thorough narrative of the conditions of the fishing industry in 2009. As he explained it, much of the cowboy dynamic was compromised by the more pragmatic institutionalization of procedures coupled with eco-tourism in industries such as whale watching. He cites one example of ITQ (individual transferable quota) systems that lead to more fish in fewer hands, where people would regard a more communal approach to resource allocation. The ITQ systems were essentially a means to putting limits on catches in regards to species and seasons. The systems required a heavier government presence in fishing, but also allowed for more sustainable fishing practices and registration of vessels. This allows for a more market-driven and economically-focused model, which transitioned with a deal of difficulty into the Icelandic paradigm. As Einarsson (2009) explains it,

“The ITQ system privatized the fisheries common property resources, and closed the formerly open-access fishing stocks in the exclusive economic zone. The transferability of quotas meant that smaller fishing operators sold out to bigger ones, or to those who saw advantages in increasing their own quotas. The economic rationale behind the new system was that more efficient units would buy out the less efficient ones, leading to an overall rationalization of the management system and economies of scale” (Einarsson. 2009).

Many of the fears associated in this body of work encompass fears of privatization and advantage taken by corporations, who have priority to resource allocations. However, the restrictions on fisheries through catchment quotas presented more avenues for the aquaculture industry to take a much more demanding presence with a conceivably more feasible outlet for rearing and producing fish.
Landssamband Fiskeldisstöðva, the Icelandic Aquaculture Association, shows 24 facilities working in fish farming in Iceland, although the January 2017 MAST (the Icelandic Food and Veterinary Society) public records of open businesses indicates 62 working businesses (56 aquaculture sites and 6 carriers) (MAST, 2017). Notably, some of these operations are under the guidance of a single parent company in several subsidiaries; nevertheless, these industries span throughout the island’s coast, with a focus mainly on char and salmon. Appendix A details a full breakdown of companies and their output from the MAST database (MAST, 2017). The exact niceties of this and its impact will be expanded in the later sections. Many of the companies represented confidently boast on their capacities to support environmentally-friendly and green production, with parent companies such as Samherji putting a heavy focus in the absence of any growth hormones or alternative genetic modifications, rearing a completely natural product.

Many facilities also hinge their reputations on the access to geothermal water, which allows for an almost negligible carbon footprint. Paisley et al. (2010) explains that “[since] there is no lack of cold groundwater and geothermal sources are found at many locations, [there is a] possibility to accelerate the growth of fish” with an appeal to natural (pathogen-free) groundwater and access to filtered seawater from bore holes. The facilities have varying sizes, with a strong divide between actual space and the requested expansions still under deliberation. For example, Ice Fish Farm (Fiskeldi Austfjarda) was established in 2012 and holds 11,000 tonnes license, but is under review for a request for 43,000 tonnes. The farms can be divided between land operations and sea operations, where smolts are produced on land and rearing maintained in sea. The Ministry of Fisheries and Agriculture (2016) cited 50 registered farms in 2008, which had 30 producing juveniles, 4 for marine species, 12 sea cage farms, 15 mussel farms, 4 research operations and additional 30 operations in mostly salmonid.

The licensing process is thorough, with an appeal for certification following environmental impact assessments. The licensing procedure has evolved to maintain control against fish diseases (started in 1957) and have been under regulatory fish surveillance in 1985 and EU standards regulations were adopted in 1993 (Paisley, 2010). Jonsson (2000) explained
the procedure, in that aquaculture facilities request licenses from the Ministry for the Environment and the Ministry of Agriculture, with monitoring issued from the Environmental and Food Agency or the local Health Inspection Authority. The *rekstrarleyfi* license is given through MAST, whereas the *starfsleyfi* license is delivered through UST (the Environment Agency of Iceland). Slaughtering and production requires permission from the Veterinary Officer for Fish Diseases and the Directorate of Fisheries. Stipulations for aquaculture operations are laid out in several legislations, most importantly in the Aquaculture Law, Act No. 71/2008.

Furthermore, the size of the aquaculture operations can dictate the requirements for specific licensing and procedures, rendering appeals for expansion to be somewhat difficult in many cases. Since June of 2000, if production exceeds 200 tons and/or wastewater is emptied into freshwater (with an excess of 20 tons of annual production), then an extensive report is required from the National Planning Agency (http://www.skipulag.is). Petitions for organic certification can be provided through the company TUN (www.tun.is), who have stated that currently there are no organically certified aquaculture facilities (although there are several seaweed producers who have been certified), with only Dyrfiskur (currently Arctic Sea Farms) listed as partly in-organic conversion, but no longer holding that certification.

The farming operations were quick to switch hands in the late 90’s, with a high rate of turnover due to environmental hazards, gaps in technology, high competition from neighboring countries, global currency exchanges, fish price indexing and sudden shifts in market prices (in particular a large spike dropping in the 90’s) (Aquaculture, 2016). Although the production is growing now, growth takes a long time to maintain with costs in relation to the labor force and startup costs.

Currently, the operations are much more stable and show capacity for growth. Iceland has a very high reputation in both trade and distribution of fish products, which promises the industry some security. In fact, the FAO’s Fish Price index report has placed Iceland in the highest ratio of exports and imports to fish consumption, with a ratio of 39.9 that completely
overshadows the closest competitor at 26 (Tveteraas et al., 2012). This means that nearly 40 times the amount of fish consumed domestic is exported abroad. Figure 3.1 demonstrates the world leaders, with the exemption of Iceland, Faroe Islands and Falklands to maintain scale. Were the three to be in the Figure, the volume would be so high in these three leaders that the scale would become unreadable. This scale is still even more staggering as Iceland additionally maintains a high level of fish and meat consumption with variable ratios. Although it was in decline, the annual fish consumption per head was at 44-47kg in 2010 with increased awareness, promotion and availability (FAO, 2016). However, there is a high gap between reported consumption rates, due to different methods of weighing the relationships, per capita relationships, population densities and the extent to which select fish products ought to be measured in the consumption; regardless, the consensus amongst most credible sources seem to suggest a low level of consumption considering the regional availability for fish and fish products. Even though Iceland has a lower level of consumption, the relative weight of Iceland to the global market remains astounding.

![Figure 3.1: Seafood trade-to-consumption ratio; Iceland, Faroe Islands and Falklands exempt (Tveteraas, 2012).](image)
Nevertheless, Iceland holds a longstanding tradition in fisheries with a large fluctuation between strengths and areas for improvement in fish farming. Although the farms are going between fewer hands, there is still a high level of growth and an increased level of focus and funding. The historical and cultural significance keep a large opening for growth and new innovations, especially in transitions into more aquaculture production, provided these opportunities can be capitalized upon.

3.2.2 Domestic Sales:

Domestic sales are of an important concern, as mentioned before that Iceland’s fish consumption is not as high as it could be, given the availability and resources. One point of opportunity lies in the demand amongst tourists for the perceived value and abundance of locally caught and produced fish in the market. Many proponents of gastronomic tourism seek out culturally specific delicacies, such as Hákarl (fermented shark fin). The reason that tourism becomes so important is that with marine industries remaining either stable or in slow decline, a movement away from fisheries catchment could be supplemented by fish farming to drive domestic sales to tourists. Huijbens et al. (2014) depicts the relationship of declining fisheries to the tourism industry, where the tourism holds as a good supplement to bolstering economic development, especially outside of the capital region. This can be further supplemented with the aquaculture industry giving a new outlet for tourism development and adaptation to the changing environment in an eco-friendlier approach.

The Icelandic R&D company Matis has done extensive research into the domestic consumption with interesting results. In 2011, 525 Icelanders took part in a survey used to measure fish consumption habits and trends by varying age groups, particularly 18-to-26-year-olds. The study found that there is a great variance amongst age groups with consumption, where older generations were more focused on health, more price conscience and had a higher perceived value alongside a higher willingness to pay whereas younger demographics were influenced more by variety and high levels of information and awareness (Sveinsdotir et al., 2011). A traditional and cultural element came into play as well, with gender identities
correlating to behaviors and an overall focus on eating fish (on average twice a week) vs. consuming fish oil (on average 4 times a week, with 50% claiming daily consumption) (Sveinsdottir et al., 2011).

This was later followed up in tangent with a compilation of Nordic studies by the Nordic Innovation Center which generated findings in line with what has already been mentioned. They have found that stakeholders show a strong confidence in the industry for consumption levels, regardless of source as the most pressing limiting factors are price, planning and variety (Luten, 2010). A more diversified approach to fish needs to be utilized with more innovative practices that reflect consumer ideologies to increase consumption and promote industry growth (Luten, 2010).

This leads to an important rational for fish farming and urban agriculture in general: namely tailoring the appeal of fish accordingly. From Matis [A] (2016) evaluation on consumers, they determined “…since more emphasis was on taste and freshness rather than wholesomeness it is important that people know how to determine fish freshness.” Younger demographics were deterred by aesthetic qualities, such as 30% finding the odor too unpleasant and 40% not having the knowledge to determine freshness, although 91% were influenced by taste and 81% of the participants studied were influenced by freshness (Matis [A], 2016). Framing this alongside the previous narrative given, it is easy to see how different varieties and presentation methods could appeal to younger crowds, especially when given options for sushi and sashimi as an alternative presentation.

The 2012 Iceland Seafood Report, presented by Islandsbanki, give a comprehensive report that follows similar trends as mentioned, with a larger variance in statistical representation regarding consumption. For consumption per capita, they had found Iceland to be the highest in the world, at 88 kg per person (of ungutted fish) as of 2009 (Islandsbanki, 2012). They found obstacles in prices where the overall prices acted as a deterrent towards willingness to pay for fish or fish products and mentioned the decline of consumption, with an extended focus on attributional models, such as fish feed in farms and fish products
(Islandsbanki, 2012). The models presented shared the same trends as FAO price indexes, which will be presented in the following chapters.

With the rapidly expanding tourism growth is also an increase in domestic consumption and a wider range of availability, especially in the Reykjavik area. Gunnar Tomasson, director of the fisheries company Thorbjorn (Grindavik), explained this relationship as an increased level of awareness, which not only bolstered exports through global demand but also accompanied higher market value and more localized flavors that people were willing to taste (Gislason, 2016). Although this may go against the local perspective of price being a barrier, the two strategies are not mutually exclusive and a diversification would not work against the producers. The reason that tourism is so important to consider alongside fish sales and consumption is that fisheries, tourism and aluminum production have been considered the three pillars of the economy in Iceland. As recent as 2013, the tourism has surpassed fisheries in revenue provided (as seen in Figure 3.2), which opens a series of opportunities in regards to new strategies, especially in fish farming for overtaking the gaps in fisheries and tailoring the experiences to tourists. Whereas fish farming is a fair means to providing an alternative source of income for domestic ventures and providing a sustainable and consistent stock to match demand, there is a question on how the future development of industries will take place.

![Figure 3.2: Iceland: Composition of export earnings 2009-2013 (%) (Gylfason & Wijkman, 2015).](image)
3.2.3 Development From 2007 Onwards:

In 2008, Iceland had suffered a devastating market crash, tipping the rather delicate economic balance at hand. The country has since stabilized, where the general purchasing power and cost of living is reaching back to pre-crash levels. The fishing industry, (referred to here as both in fisheries and aquaculture), was a very instrumental aspect in this recovery, and due to the nature to which the culture is tied to fishing, many of the scientific and anecdotal lines are often blended, giving a holistic account through the narrative as well as through bodies of research. This is due to fishing being an intimate aspect of many peoples’ lives, where the cultural impact is almost taken at face-value. The analysis would hardly come as surprising, provided the information set in previous chapters, and much of the information would be attributional to both aquaculture and fishery influence.

If nothing else, the market crash had showcased the dependency of fish and the resiliency of the industry. Skarphedinsson speaks of the Icelandic economy as a foundation supported by three pillars mentioned earlier, namely “heavy industries” (aluminum production), “fisheries” (as fish sales through aquaculture and marine fishing; not restricted to just fisheries) and “tourism” (Johannesson et al., 2015). Although mostly independent, these three industries are in flux, with the strengths and weaknesses of each influencing future growth of the economy. The reason that these industries are significant is due to the account of the relative strength to export power and consequentially GDP growth. With the influx of tourism comes a higher diversification of labor outlets, although these three pillars remain pivotal to the country’s economic paradigm.

Gylfason and Wijkman (2015) give a particularly interesting account for this interplay by comparing levels and composition of exports (i.e. “the share of fish exports in merchandise exports times the share of the exports of goods in total exports of goods and services”) and the composition of export earnings, as can be seen via Figures 3.2 and 3.3 and sourced from Statistics Iceland. These figures outline three key points mentioned before, namely that the regulatory practices (such as ITQ standards and stricter regulations/catch quotas) sharply
dropped the exports of fisheries and required a more diversified approach to maintaining a local economic balance; the market crash of 2008 demanded a staunch increase in exports; and finally the expansion of tourism helped contribute to stabilized growth in all sectors and gave way for other practices, including fish farming over marine fishing, to improve their efficiency.

![Figure 3.3: Level and Composition of Exports 1957-2012 (%)](image)

Thus, when looking at the effects the market crash held on aquaculture and fisheries development, a higher range of stability can be seen as opposed to other industries. Even though this was in large part due to the contributions put forth from fisheries, it increased the reliability and confidence in aquaculture as fish sales were deemed more financially viable. Early papers, such as Knutsson’s work in 2006 concerning the fishing industry, proposed that despite doubts- including some mentioned earlier- concerning the impact of fish farming, that the industry continued to show a leading global position with an increased state of growth in shares annually thanks to salmon and trout contributions (Knutsson, 2006). This significantly
mitigated the damage caused by the market crash and provided ample support despite
devaluation of the krona.\footnote{This is very difficult, as the crash devalued the Krona, although the success of fish exports helped to maintain the income stream. Consequently, the exports of fish in a stabilized global market helped to balance out the devalued currency, as trades were still maintained at a reasonable price margin.}

Several factors come into play as to why this stability occurred, as stated by the central bank of Iceland: first, Iceland’s gross value from fisheries and farming from 2000-2009 registered at 7%, compared to a global average of 2%; second, the level of investment for said industries at the time was at 7%- even in the face of uncertainty from global investors; and finally, the fishing quotas imposed on a regulated (fishing) market prevented sharp spikes and declines in the industry with high diversity and low volatility (Thorgeirsson, 2013). The regulations on commercial fishing did provide a window for aquaculture to demand a higher presence.

Clark and Jones (2012) remarks insofar as the relationships between fisheries, aquaculture and fish sales were effected post-crash, the struggle focused around a shifting government, remodeled practices and legislative boundaries that were uncooperative with what locals called the ‘Icelandic way’ of development via internal and external struggles. This caused conflicts in the investments mentioned through Thorgeirsson, although, there was a strong confidence in the industry to help support fishing industries in both marine and farming capacities. Wade and Sigurgeirsdottir (2012) illuminate this narrative by discussing the rather self-contained level of statehood that Iceland maintained pre-crash, which was later faced strong changes under the corporatism of the nation. They conclude that despite obstacles to growth after the crash, natural resource industries could continue to develop, albeit “at a low base”.

Einarsson (2011) reports that one bittersweet result of the 2008 crisis was a forced position of a globalized presence, where the country was coerced to readapt their cultural identity and find a means to relating to the outside world. This, coming at a time still where participation in the European Economic Area (EEA)and staunch opposition to joining the EU as
well as ITQ standards had caused a great deal of political uncertainty within the country, structured fish and fish products as an anchor of sorts that grounded the country in the face of change. Because of this deregulation and focus on the country, not only was there an increase in tourism, but also in immigration, reaching 8.6% in 2008 (as opposed to 1.8% in 1995) (Loftsdottir, 2010). With increased tourism and immigration into Iceland delivered an increase in demand and production. This sentiment once again looks at new means for innovation and changing the social dynamics, while still trying to remain independent and culturally connected.

Vaiman et al. discuss this shift in relationship to weak (or perhaps more fitting would be less-structured) business practices with a unique cultural identity. They explain that despite the heavy concentration in the capital region, there is a strong identifying feature with fish and the fishing industry; this, coupled with an analysis on Hofstede’s cultural indexes, posits Iceland with a PDI (Power Distance Index) of 25–30, a UAI (Uncertainty Avoidance Index) of 40, a MAS (Masculinity index) at 10, and IDV (Individualism Index) at about 70 (Vaiman et al., 2011). This essentially describes the country as one that acknowledges power distributions and requires independent thinking/problem solving, more risk taking and openness to other cultures as well as gender and lifestyle equality and a high level of familial ties. Bearing this, the position on fishing and aquaculture as a key industry and its relationship to the crisis becomes quite evident.

3.3 Development:

3.3.1 Production Numbers in a Globalized Context:

Thanks to resources such as Statistics Iceland and a highly concentrated and small population, gathering statistical information regarding Iceland’s aquaculture industry is easily attainable and detailed. This is somewhat barred by private industries reluctance to share information, although speculation does result in reasonable assertions. Ultimately, some of the figures are difficult to distinguish, as fish sales and production may be tied intrinsically to both fisheries and aquaculture, which shall be noted accordingly.
Currently, the fish farming practice is dominated by salmon, although it is not the sole means of income source. From, Table 3.1 shows the fish that are farmed and annual tonnes from 2006 into 2017 projections (Landssamband Fiskeldisstodva, 2016). Whereas the focus is on salmon is high, Iceland is the leading contributor to global char production (Matis [B], 2016). Salmon contributes to the largest share of exports, and is expected only to grow. Whereas there is a focus on hatcheries and smolts, the focus remains primarily in salmon, as investment costs are high along with global market demand.

Prior to 2006, there was opportunity for cod to raise its sales significantly higher than it is today; however, it has merely proven itself to be unsuccessful and unable to manage costs in relation to the global fish price index, which can be seen from Figure 3.4 (Johannesson, 2010). Turbot and halibut were also abandoned, although as early as 2010 there was optimism in reports that production would have a heavy resurgence, with salmon tapering off (Paisley, 2010). Rainbow trout has gathered some popularity, although it will be conditional as to whether it will plateau in demand or continue to grow as the weather conditions make it susceptible to disease and stock decline. Sole is likely to increase, as it uses a unique method for growing conditions via geothermal water runoff from Reykjanes power plant, although the impact it will make is still uncertain.

### Table 3.1: Fish Farmed and Annual Yields 2006-2017⁶ (Landssamband Fiskeldisstodva, 2016).

<table>
<thead>
<tr>
<th>Fish</th>
<th>Year &amp; Annual Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lax (Atlantic Salmon)</td>
<td>6.894</td>
</tr>
<tr>
<td>Blaðska (Arctic Char)</td>
<td>1.426</td>
</tr>
<tr>
<td>Regnbogi (Rainbow Trout)</td>
<td>10</td>
</tr>
<tr>
<td>Heklað (Tilapia)</td>
<td>0</td>
</tr>
<tr>
<td>Forskuri (Cod)</td>
<td>1.412</td>
</tr>
<tr>
<td>Lúða (Halibut)</td>
<td>111</td>
</tr>
<tr>
<td>Sandherfa (Turbot)</td>
<td>47</td>
</tr>
<tr>
<td>Senegal flura (Senegal Sole)</td>
<td>0</td>
</tr>
</tbody>
</table>

⁶ 2017 projections are based on expected projections from [www.lf.is](http://www.lf.is)
Appendix A provides the total number of operations and production, which can be synthesized in the Table 3.2 (MAST, 2017). This provides a total output of 17,503 tons per year. This also depicts a good picture of the distribution of operations throughout the country, with the South having the highest densities and the West providing the most output (albeit largely in part from Arnarlax, who contributes 8000 tons per year alone). What this also demonstrates is that 16 operations (29%) are quite small with an annual output of less than 5 tons. Between hatching at rearing together, the most prominent was Char, with Salmon second most prominent and rainbow trout third most frequent. Naturally, having a higher representation does not correlate to a higher output, as salmon is the highest-produced species of fish (MAST, 2017).

### Table 3.2: Aquaculture Operations in Iceland Divided by Region and Annual Production.

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Operations</th>
<th>Total number of Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUSTURUMD/EMI (East)</td>
<td>5</td>
<td>1527</td>
</tr>
<tr>
<td>SUDURUMD/EMI (South)</td>
<td>17</td>
<td>937</td>
</tr>
<tr>
<td>NORDVESTURUMD/EMI (Northwest)</td>
<td>4</td>
<td>95</td>
</tr>
<tr>
<td>NORDAUSTURUMD/EMI (North District)</td>
<td>9</td>
<td>1689</td>
</tr>
<tr>
<td>VESTURUMD/EMI (West)</td>
<td>11</td>
<td>9695</td>
</tr>
<tr>
<td>SUDVESTURUMD/EMI (Southwest)</td>
<td>10</td>
<td>3560</td>
</tr>
</tbody>
</table>
The brunt of statistics is heavily derived from FAO statbooks and Eurostat reviews. Following the general statistics and guidelines maintained earlier are additional information that may elucidate upon the condition of individual fish and values. One of the most immediate points to be recognized is that despite a declining amount of fish caught in marine settings with a declining price valuation, the aquaculture industry “more than compensated for stagnating supply from capture fisheries, enough to make per capita consumption of seafood to continue to increase, reaching a record level of 17 kg per capita in 2008” (FAO, 2010). Figure 3.5 reveals the fish price index moving to a point where it is nearly inimical to marine fishing alongside Figure 3.6 which reinforces this on a contribution model.

![Fish Price Index Between Aquaculture and Fishery Contribution](image1)

![Relative Contribution of Aquaculture and Capture Fisheries to Fish For Human Consumption](image2)

**Figure 3.5:** Fish Price Index Between Aquaculture and Fishery Contribution (Aquaculture, 2016) & **Figure 3.6:** Relative Contribution of Aquaculture and Capture Fisheries to Fish For Human Consumption (Matis [A], 2016).
For Iceland, this shows a great deal of promise maintaining the status quo and state of fisheries without compromising the stability of industry and the supply while also allowing for new outlets to be utilized in production. Furthermore, the fish holding to the highest value in terms of production are only strengthened by this pattern. However, there is mixed reception towards aquaculture where “for some, aquaculture is regarded as a highly promising food production technology that is already fulfilling some of its potential... [whereas] for others, aquaculture is regarded as an environmentally degrading production technology increasing production using unsustainable practices with clear limits to how much can be produced” (Tveteraas, 2012). This does act as a major barrier to development in the aquaculture industry and investment viability due to the uncertainty of the industry.

Thus, moving onto the focus of Iceland’s relationship and potential for aquaculture production, the main point of consideration is reconciling the obstacles presented earlier alongside the production capacity to see the extent to which this production properly assimilates (or fails to do so) in the current framework. Currently the leading global markets for fish exports and production in the global market are in Asia and the Americas, whereas the European market is primarily a regulatory body and outlet for trade. Thus, investment strategies and government subsidies are harder to come by, rendering the general cost of startup and maintaining an aquaculture facility difficult.

The interplay in investment opportunities to obstacles was discussed in part through Allison (2011), where she maintained that the focus on generating wealth and sectoral economic efficiency could overshadow opportunities for increasing welfare and poverty reduction, as well as access rights obfuscating industry growth while placing too heavy an emphasis on ecological protection. In Iceland, this is particularly poignant where the barriers to entrepreneurship are harder to overcome than in other countries. Curiously, this shift requires a rather staunch change in outlook and strategies, avoiding similar incidents to the ITQ systems funneling funds into the hands of a few individuals.
With aquaculture growing at a rate of 8% annually, increasing access and a higher demand for goods, there is an incentive to strategize on not only direct sales but also to incorporate fish and fish products into a dietary regime, which Iceland is doing quite well. This is emphasized where the price indexes for fish is scaling past meat, and FAO projections register the average for caught fish at a 39% increase by 2020 and 43% for farmed fish and their prices (Islandsbanki, 2012). This is mainly from the increased demand for fish oil and fish products (fishmeal), which assisted in the 12% rise in fish prices in 2010 with extended annual growth (Islandsbanki, 2012 & Merino et al., 2012). Iceland hails as one of the top 12 nations for fishmeal production, which collectively accounts for over 80% of the total global sales (Merino et al., 2012).

### 3.3.2 Market Characteristics:

Next is the consideration of how aquaculture manages in regards to price points and relative market strength, specifically with the strongest fish in the Icelandic market. As mentioned earlier, the overall strength of aquaculture is on the rise (along with fish in general) and quickly accelerating past meat in terms of price/kg and in overall value. One advantage Iceland has in the markets is that it is very hard for many areas to compete with Iceland in regards to its abundance and richness of fish available. Lindkvist (2015), in his report on the Norwegian-Spanish seafood trade value chain production, considered Iceland to have a better level of personal integration and higher perceived values of quality in fish products that can’t be matched while competing against Iceland’s more efficient pricing.

Iceland strategizes many of its value chains similarly from aquaculture to a marine model, which does allow for an extended efficiency (Knutsson et al., 2016). The value chains focus on a much closer relationship from fishers/harvesters to producers, allowing success in aquaculture to streamline the distribution of fish and in a less restrictive market. Although the PPI (Producer Price Index) is in slow decline along with marine products, its relative strength is still very high to other countries because of the industry strength in the country, as shown in Figure 3.7 (Statistics Iceland, 2016). Because the Icelandic market is supported on pillars of
tourism, industry and fisheries, the transition into aquaculture sustainability is quite natural. Thus, despite overall trends of PPI dropping, the producers keep consistent earnings.

![Figure 3.7: PPI in Iceland Jan. 2008 - Oct. 2016, Against Marine Products and Food Production Indexes (Statistics Iceland, 2016).](image)

Recent trends from 2016 activity have caused strong fluctuations in the price points and trade dynamics, which were available from the FAO. In particular, the European trade market had suffered from uncertainty due to Brexit, Russian trade embargos and lowered catch rates resulting from global warming and unseasonable variances (FAO, 2017). Fortunately for aquaculture, this has facilitated a 5% total volume increase and a focus on increased consumption in urbanized environment (FAO, 2017). This is fortunate for the Icelandic aquaculture industry as well, as Norwegian fisheries are slowly overtaking the export divisions, where they are benefiting strongest from the currency valuation exchanges.

As of April, 2016, the Fish Price Index reached 142, which is one of the highest levels it has ever shown to date. The main contributor to this growth is ultimately salmon, which is once again fortunate for Icelandic aquaculture and shows little to no indications of slowing. Norway does hold a higher market presence, due to the above reasoning alongside more technical outlets for higher return on fish that Iceland has not invested into yet. The FAO October 2016 price report determined a sale price of US$ 7.15/kg by week 40, and the final week of the NASDAQ Salmon Price Index registered prices ranging from US$ 6.31/kg for weight class 1-2
and US$ 7.62/kg for weight class 2-3, which are typically farmed in aquaculture systems. The FAO holds positive speculations for European markets, which ought to be capitalized by new ventures as the only limiting factor is maintaining consistent production costs.

Tilapia, conversely, has a lot of potential for domestic growth, but little success in the European Market as well as the global market. For the most part, tilapia is so resilient and hardy that the cost of production can rarely outweigh the cost of shipment. Furthermore, this fish is so readily available in Asian producers, leaving little incentive for local purchases when the location does not add any inherent value to the product. Engle et al. (2016) noted in their 2016 work on aquaculture that Nile Tilapia has risen to the 6th most valued aquaculture product in 2012 (from the 15th in 2002), valuing roughly $4,000,000 per annum. Nevertheless, it should be noted in addition that these market values deviate from the real prices, as it is not considerate of the fish products and oils (Engle et al., 2016).

Technology has also played a major role recently in tilapia farming. Advancements have allowed for more specialization on the fish, focusing on “diffusion of genetically improved farm tilapia”, producing higher-quality fish with more adept spawn rates and less contraction of diseases (Kumar & Engle, 2016). Sex-reversal technology has also played a pivotal role in increasing yields, reducing labor significantly, although this has come upon backlash in the US due to the growth hormones methyltestosterone used in the process (Engle et al., 2016). The ability to control populations have led to a much more focused domestic venture on tilapia worldwide with more global exports at an extended farm-gate value (Dalsgaard et al., 2013).

Moura et al. (2016) had found the economic incentives from Tilapia to be desirable, and caged rearing works well on a fiscal level due to the high density of fingerlings that can be stocked in a single space; however, environmental and social dimensions had led operations to only be potentially sustainable. The input of feed is a large consideration of tilapia, which have a wide diet available, although for commercial viability a high-protein feed is warranted, mitigating the net returns on the fish. Because tilapia is so resilient and easy to produce with a
high return, a domestic venture would be viable, with the largest obstacle being environmental and ethical concerns in the rearing which could potentially obfuscate the potential for earnings.

It has been noted by Dalsgaard et al. (2013) that RAS production of tilapia produces a relatively lower yield, albeit with high market prices and a cost of feed “approximately half that of salmonids.” ROI in tilapia farming has been studied extensively in various countries, with similar findings across the board. Although there has been fewer studies performed in Nordic countries, similar attributes could be assumed with the notable differences being cheaper capital for startup with more feasible energy costs and a higher premium in local markets. Compared with similar species such as bass, findings had discovered tilapia gives similar (or in some cases slower with a latent return) spawning rates, with a higher net income for fish (Gammanpila & Singappuli, 2014).

Although a complete list of every species would be exhaustive and each comes with their own peculiarities in regards to a proper investment return, some key considerations for Icelandic aquaculture seem to reappear each time, namely (i) generating startup costs, (ii) promoting interest in various fish species, (iii) having sufficient regulations and policies met, (iv) obtaining proper space for rearing and meeting demand, and (v) tailoring to the wellbeing of fish species. Most changes brought forth in individual farms are quite expensive and time consuming, where few businesses can afford these measures overall. Below are some of the set characteristics from key species:

A) Lax (Salmon): Salmon currently dominates the Icelandic fishing industry, with projections for even higher production numbers and increased sales. Extensive studies are conducted to maintain compliance with salmon in regards to EU standards, and species are monitored intensely with little to no diseases present. Lumpfish has been used with the species to control outbreaks of lice as well. Because salmon comprises 30-50% of the European market share with so few players (Chavanne et al., 2016), many facilities are forwarding the momentum from salmon sales to increase size of operations. Salmon production in aquaculture facilities
Iceland has more than doubled from 2015-2016, and 2017 projections indicate around 28% increase in production as well. Currently, there are 15 salmon producing facilities (11 hatcheries, 4 rearing) and 7 aquaculture facilities that hatch wild salmon, per the 2017 MAST figures.

B) **Senegalflúra (Senegal sole):** Stolt Sea Farm is the only company currently hatching and rearing sole, as the introduction of this species in Iceland is novel, utilizing new technologies to optimize living conditions. The process works from taking sea water from a nearby power plant, which is fed in at 35 degrees and mixed into the water to reach 21 degrees, creating an optimal environment for the fish (Ragnarsson, 2014). The project is still growing and showing promising signs of success, as the fish is in high demand, but difficult to satisfy in European markets due to the rates of overfishing.

C) **Bleikja (Char):** Iceland is very reputable for char production and is a global leader in production and sales. Char is so successful because it thrives in Icelandic conditions, with very little risk to complications and diseases. The 2013 Monterey Bay Seafood Report, a system that evaluates the ecological sustainability of various species presented in the US market, had put Icelandic char as a “best choice” product, with a score of 6.78/10 (mitigated mainly through the lack of available information from government agencies and public resources in English) (Ethier, 2013). Aside from its adaptability, char also has maintained a promising reputation alongside Icelandic producers and can easily satisfy production gaps. Saether et al.’s (2013) analysis of arctic Charr (*Salvelinus alpinus*) shows that although a good standard is maintained well in the industry with regards to minor incidents that could afford improvement, the farms could utilize improvements on water quality and feed to help secure a larger return on investment. MAST 2017 reports 27 facilities hatching and rearing char.

D) **Styrja (Sturgeon):** Sturgeon is a noteworthy curiosity in Iceland, where this species is more famously prominent in Finland for production. Sturgeon production is
typically not very high in size to meat yield, and consequently, deemed unfavorable for meat and fish product production; instead, it is mainly sought out for caviar. Stolt Sea Farm is the only recognized producer of sturgeon, in small quantities.

E) **Regnbogasilungur (Rainbow trout):** Rainbow trout has shown a steady increase in recent years with regards to production, although it has since plateaued. Rainbow trout does maintain a large size with moderate grow times and manageable stocks; however, the Nordic conditions have made production difficult, where the cold weather and susceptibility to diseases have limited the favorability in cultivation. The January 2017 MAST report indicated 10 facilities producing rainbow trout.

F) **Sæeyra (Abalone):** Abalone is only reared and hatched at Sæbýli, with a total production per year of under 5 tonnes. Abalone is a mollusk species that feeds on kelp and algae, native to California. While still in trial periods in Iceland and Ireland, it faces some difficulties due to the sensitive nature of this species. In California, the species are susceptible to many threats, most resulting in withering syndrome, which is an infection caused by bacterium *Candidatus Xenohaliotis californiensis*, causing the species to consume its own body mass and eventually lose its ability to retain footing or feed. Some infected species transported from California have spread this disease to Chile, China, Taiwan, Iceland, Ireland, Israel, Spain, Thailand and Japan, threatening species (*Crosson et al., 2014*). However, the industry for farmed abalone is consider sustainable, with high premiums on the product.

G) **Porskur (Cod):** Cod is another species in Iceland that has since tapered off to very low production numbers, due the product failing to prove itself as viable. Many facilities have slowly transitioned facilities into the more-profitable salmon ventures, as aquaculture cod could not compete with fishery numbers and prices. MAST reports Tilraunaeldisstöð Hafró hatching cod in < 5 tonnes annually, with Sjávareldi and Porskeldi rearing the species. Porskeldi manages 20 tonnes annually as of the latest report (see Appendix A). Cod was prominent in Iceland and expected to be
the prominent species for aquaculture production around 2009-2010, and has since been replaced by expectations from salmon (Paisley, 2010).

H) **Sandhverfa (Turbot):** Only hatched at Tilraunaeldisstöð Hafró, Turbot has failed to take off in Iceland and has since been almost entirely abandoned due to susceptibility to the pathogen *Aeromonas salmonicida*, a disease endemic to Icelandic waters (Bjornsdottir et al., 2005). Vaccine attempts had been attempted, as the heat exchange from geothermal waters forms favorable conditions for production and growing; unfortunately, due to the presence of diseases and problems in healthy rearing of the fish in environmentally sound conditions, it seems unlikely that turbot would be able to take on commercial levels of sales.

I) **Hrognkelsi (Lumpfish):** Lumpfish falls into a similar disposition to sturgeon, where the return for meat on the fish is not at high as another fish species. They are easy to maintain and resilient for the climate, with their caviar (sold as lumpfish roe) being a desirable alternative to sturgeon caviar. MAST reported the only lumpfish facilities to be hatcheries from Tilraunaeldisstöð Hafró and Stofnfiskur. Lumpfish is considered a favorable fish to share in aquaculture facilities as they efficiently control lice in salmon facilities and are considered more environmentally friendly with regards to fish and fish products (Imsland et al., 2014). Their population has been increasing as a lice deterrent in salmons.

J) **Other considerations:** Although there are limitless other considerations and many opportunities, few species make it past the pilot studies. Le Francois et al. (2010) mentioned the attempts at cultivating wolf fish species in Iceland and Canada in addition to Paisley (2010) mentioning trials with spotted catfish and freshwater shrimp. Many facilities focused in research and development are often looking for new species to adapt into the market, and previous accounts on tilapia production have showcased the potential for the product as an affordable domestic product. Very few authors have been shown interest in facilities for producing sea bass, sea
bream or carp, although the allocation of geothermal resources would certainly not be unfriendly to the species.

### 3.3.3 Regional Nuances:

Finally, looking at various regional nuances gives some insight into future prospects of the industry. Additional peculiarities come from the terrain development and access to fresh water and natural resources. The facilities are strategically positioned regionally, where the North and Southwest has the most access to geothermal heat. The facilities in the North and Southwest are land-based operations, with Reykjanes in the southwest and Akureyri in the North focusing most on char. Salmon based cages is only permissible in the East and Northwest, as they are the only areas that contain fjords for such operations. However, Akureyri facilities in the north are applying for permission, due to favorable rivers for salmon rearing. The Southwest is land-based mainly due to rivers being underground, and the South and North provide the most riverways.

Geothermal energy plays a pivotal role in fisheries, where the National Energy Authority of Iceland estimates 1,600 TJ used annually in fisheries from geothermal energy, although Ragnarsson estimated in 2015 2,230 TJ annually for fish farming (Ragnarsson, 2005). Fish farming accounts for a total of 7% of the final heat use from 2015, which is incidentally the same amount used for fisheries (Energy Statistics in Iceland, 2015). Ragnarsson (2014) estimates that of the 70 fish farms in 2013, between 15-20 utilized geothermal water, primarily used to heat water in heat exchanger. The main use of geothermal energy is attributed to salmon and char, although post-smolt rearing has also taken advantage of the accessibility (Ragnarsson, 2014). Of his many contributions to this discussion, Ragnarsson also notes of the fish farms in Iceland, 15-20 use geothermal water (boasting an increase in efficiency for growth between 50-100%). Although he does add that fish farming is a slowly growing market, companies such as Silfurstjarnan reported salmon grown and sold for over 2 USD more than current US market price (Ragnarsson, 2014).
Many efforts are maintained to diversify and increase species of fish are well-received due to the advantages of geothermal water and resource efficiency, but are obfuscated by the legislative and financial boundaries. Einarsson (2009) makes note of this in his report on incentives from the municipalities in Húsavik to strongly consider alligator farming in a geothermal pond near the village, “feeding from offal from the local slaughterhouse and fish processing industry.” This plan was abandoned, however, when the veterinary authorities refused licensing. Despite obstacles for licensing, there are many interesting developments in fish farming in Iceland. As mentioned earlier, Stolt Sea Farms has successfully started a Senegalese sole fish farming plant, which takes strong advantage of geothermal energy. The 22,500 m², 100 MWe plant produces roughly 500 tons/year in the first stage, with planned levels of about 2,000 tons/year by the final stages (Energy Statistics in Iceland, 2015).

Overall, the aquaculture sector does show a significant level of promise for development and growth. Iceland has a relatively high Gross National Income per capita on a global scale, although the level is significantly lower than other Nordic countries, suggesting a high influx of income weighed against a still-weakened labor market (OECD, 2015). The FAO has commended Iceland on innovation in several sectors where developments in halibut juveniles and selective breeding of salmon has been quite successful (Fishery and Aquaculture Country Profiles: The Republic of Iceland, 2017). Restructuring industry to help embrace technological developments that could be used alongside the abundance of natural resources and energy would be ideal, provided the funding could match research and development.

3.4 Conclusion:

3.4.1 Future Development:

Thus far, that the largest deterrent to more production outlets is that framing a new operation within set regulations and practices offers skeptical returns on investment; in other words, the costs and risks involved in experimenting with aquaculture facilities are high. However, this does not imply that any venture would be a failed opportunity. There are plenty of innovations occurring and developments that would ideal. In fact, thus far this paper has
shown several key movements into new projects and potential for even more fruitful businesses. The research would suggest that a strong strategy be placed in several key aspects, namely (1) incentivizing consumers to diversify their option and providing adequate justification for price margins, (2) focus on both fish and fish products, and (3) encourage an environmental focus that can work along with tourism.

Incentivizing has been proven to be a sine que non for both domestic and international sales in the industry. Consumers are well aware of the health benefits of fish, although often misguided in their beliefs. Many have partial understandings of the health benefits, but slightly inaccurate or misguided information about the holistic accounts (Verbeke, 2005). Pieniak et al. (2010) suggests that compliance cannot be implemented solely on increasing consumption alone, as there is a strong subjective element that forms beliefs and attitudes. Thus, following the Matis survey (Sveinsdotir et al., 20110, locally fish consumption and overall sales can be worked on by educating and increasing a positive attitude and additional benefits. Although Verbeke’s work seems to focus on consumers who have loose understandings of fish health benefits with absent information on attributes such as Omega-3 fatty acids, Icelandic consumers know of the local health benefits (Verbeke, 2005). Consequently, forming that attitude into something more accessible with fewer perceived detriments would generate higher sales and provide justification to increased premiums.

This can be best achieved in an environment with a more overt presence of fish and fish sales. With the influx of tourism and heavy focus on fish, catering to this demand in new ways would help to increase the range of available demographics and create passive, sustained sales. Work done by Lähteenmäki et al. (2010) on perceptions of health, taste, attraction and naturalness found that Icelanders surveyed “perceived products with health-related claims as slightly more healthy, attractive and natural when compared to products without a health-related claim.” This was backed up by Sveinsdóttir’s research in fish perceptions, as demographic, motives/barriers and overall preferences, which created a very curious caricature of Iceland. Her results stated that familiarity warranted a more confident and familiar attitude with price not seeming as such an issue and a diminished level of consumption (Sveinsdottir et
al., 2009). A suggested strategy on educating consumers of how easy fish preparation and cooking can be was strongly suggested and an ideal way to increase positive attitudes and sales among youth.

An Icelandic study has also found that contrary to previous beliefs, encouraging heavy fish consumption at a young age does provide positive attitudes and higher consumption rates in the future (Thorsdottir et al., 2012). As such, younger demographics would be a more optimal target for marketing strategies and garnering sales. However, this can be expanded upon by helping to utilize the historical relationship Iceland has with fish and capitalizing upon a local identity through various supply chains. Marketing as a niche product or specialty product in different packaging displays would offer little increase to labor and bolster direct sales to both tourists and locals. Various suggestions include having more environmentally-conscious packaging, having prepared fish fillets with suggested recipes and cooking instructions, offering visible labelling for environmental and health qualities of the product or reflecting the benefits of the products to various lifestyle enthusiasts. Also, creating visibility to production facilities or management process can help to sustain interest and a positive relationship along with the product.

Aquaponics can naturally play a huge role in this effort, as the process would satisfy avenues where fish sales are lacking. It permits for higher diversity in fish species and a closer relationship to the rearing and processing of fish. It can help produce work with the youth in education and give a strong presence in agritourism. There is also the benefit of dual production of aquatic species and produce, which can be sold together to help build confidence and familiarity with cooking without the burden of purchasing additional materials. An aquaponics model can also vary in scale and utilize species such as tilapia for domestic sales at a reasonable premium.

A venture in aquaponics would also sustain an easy eROI (energy return on investments), where heated water can be exchanged in RAS systems, limiting the risks. This can also be implemented in various strategies such as rearing fries or juveniles over direct sales. It can also
be used in areas with a scarcity of arable land (of which, Iceland only has 1.2% of its country) or in junction with greenhouse operations. This implementation can facilitate a higher subjective value and increase a more positive attitude towards fish sales and consumption. It would also accent the pro-environmental appeal, giving further indirect rewards. This also bolsters food security, as the 2008 Greenpeace report (Allsop et al., 2008) had placed this as a key concern that could be rectified through increased production in the challenges the aquaculture industry faces.

In both fish and fishmeal production, it has been remarked consistently that countries such as Iceland are instrumental for aquaculture production and would benefit most from increased aquaculture focus. High latitude countries would benefit the most from aquaculture focusing, according to Merino et al. (2012) and that Iceland was ranked as one of the top twelve most important fish meal producers in dissuading ecological collapse.

3.4.2 Final Remarks:

The Icelandic aquaculture industry is consistently showing growth. As fish sales act as one of the three pillars for industry in Iceland, it continues to evolve despite the growing diversification of industries. In fact, the changing economic environment has opened new avenues for businesses and slowly is adapting into new revenue streams in a seemingly-restricted market. Aquaculture can find its way as an emerging practice that can work alongside marine fishing and implement the rich resource and regional attributes into a more developed framework.

Globally, the demand and profitability for fish has never been higher. Looking at opportunities through education and attitude formation can help to direct a more confident return on investment and generate higher sales margins overall. Aquaculture success depends highly on consumers having access to information and growing in confidence for their purchasing decisions as well as modes of preparation. Iceland holds more than enough of an abundance for resources in maintaining access and diversification in fish selection, but is stifled by price barriers and legislative boundaries.
There are increasing opportunities for advancements and introduction to new species, as well as a strengthening the production for salmon, char and trout as the three most prominent species. Tilapia holds potential as a domestic venture that could easily transition into less-familiar consumers and help to overcome the high price margins. Efforts can also be maintained to continue distribution and utilization of geothermal waters for maintaining temperate conditions. Whereas other species can be explored, it should remain cautionary to entrepreneurs to first discover the licensing fees and maintain a guaranteed outlet for sales before starting a venture.

Aquaculture facilities have shown to vary wildly in output and can be customized not only to output but also facilitating research and development as well as hosting environmental tourism. Iceland has the distinct advantage of being a country notorious for its fish, which helps to draw in an immediate brand appeal. Finally, tailoring not only to fish but also to fish products such as fish oils is very viable with the growing popularity and high profits for distinct products. Technology is allowing for higher production with more pronounced characteristics at more considerate price margins. The aquaculture industry has all the necessary tools for thriving in Iceland with a promising future in its capacity to grow.
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7 Tons are produced per annum. This is “compared to production / biomass, but not Operating Licenses”.
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Additionally, below are the following carriers/licensed transporters in Iceland with regards to aquaculture:
Chapter 4: Motivators for Organic Produce Purchases in Iceland: Consumer Surveys

Abstract: Consumers are subject to a high degree of cognitive overload when approaching organic purchases. Many of their purchases are colored by biases and impulses, which leads to different purchasing behaviors. In Iceland, where premiums for produce in general is very high and the country relies on imports, consumers desire to purchase organic produce but are limited by accessibility and price. This survey frames factors of price, availability, quality, health and environmental efficacy to determine the relationship between these motivators and behaviors. The study focused on a core sample of University students to derive a quantitative analysis on how the relationships could be measured. What was determined is that price is a barrier to increased purchases, with quality and availability being the strongest indicators of final purchases. Environmental efficacy is a considerably important factor, but is only used in justification to purchases that would otherwise be made, as consumers are convenience-driven. Factor analysis reveals a hidden indicator of trust to be a prevalent, discrete motivator which influences purchasing decisions. Results divided between Icelandic consumers and non-natives indicate that taste and quality are more important to natives, with brand appeal being the lowest consideration. Other factors such as environmental packaging, local produce and energy allocation are deemed equally significant. These results can be applied to a commercial aquaponics program in attempts to foster a local product with high quality that is bolstered by the relationship shared to the producer. Consumers desire a high-quality, affordable product.

Keywords: Quantitative Survey, Local, Organic, Motivators, Iceland, Lifestyle Segmentation

4.1 Introduction:

Food is an essential construct that not only acts as an evident basis for survival, but is also an agent through which narratives are structured and cultural identities are formed. The choices consumers make or refuse to make with food give light to a personal identity through what is consumed, what is abstained from and how it is obtain. Organic food is no different in this regard, and one of the more controversial aspects that can be encountered in consumption habits. Because of the high diversity in organic labelling criteria and the personal appeal it holds to individuals, consumers are often baseless in their justifications for their purchases or are generally convenience-driven instead of quality-driven.

Organic consumption is a difficult metric to measure, as it entails multiple dimensions. Rarely would a consumer ever be opposed to organics, per se, although finding an approach to make organics appealing enough for a consumer to justify increased premiums can be difficult. Semantic boundaries add in additional uncertainty towards confidence levels and having proper knowledge can be a pressing obstacle. In Iceland, it is particularly interesting where an environment with such a focus on greenhouse production and abundant geothermal resources
is often perceived as a comparatively more environmentally progressive country on a global scale. Consequently, it is important to find out how organics realistically are perceived in Iceland and towards what ends.

There has been a large array of previous studies conducted in Iceland that look at consumer trends, falling in different categories such as food planning and security, shelf displays and advertising and consumption habits. The R & D company Matis has been particularly instrumental in conducting research in this field, with assignments focused in “analysis and consulting; biotechnology and biomolecules; food safety, environment and genetics; and resources and products” (Matis, 2017). Along with ongoing research conducted in Iceland by the Farmers Association and governmental departments such as the Ministries of Fisheries and Agriculture and the Ministry of Environment, there is an abundance of instruments and tools that compliment a large body of available research. Studies focused in Iceland can be more discrete and harder to find, although they are readily available. One particular study of interest is research performed by Thorhildur Osk Halldorsdottir in Lund University, 2013, which worked at “Identifying Behavioural Barriers to Change Towards Increased Production and Consumption” (Halldorsdottir, 2013). Her research incorporated behavioral barriers into divisions of structural, cultural and personal barriers, of which personal barriers and cultural barriers can be assessed with regards to this research.

The goal of this research is to identify key values in organic purchases and determine the relationship between the metrics of price, health, environmental efficacy, accessibility, and quality. The survey has been modelled after a litany of sources in consumer perceptions of organics, most importantly Nie and Zepeda (2011), of whom several research questions are reintroduced and adapted to this survey. It is the hope that the characteristics taken in this study can be replicated in large-scale models that would best benefit the country in identifying the opportunities and limitations in organic production as well as giving a template that could best facilitate new technologies and niche productions.
4.2 Methodology:

To frame the survey accordingly, the first step was to investigate which dimensions would be assessed and where the barriers would be. Prospective categories for evaluation were modeled from the literature review, aquaculture and agriculture assessments provided in Chapters 1, 2 and 3. The categories for *price, environment, health, quality,* and *accessibility* were decided based on recurring motifs in previous surveys and conditioned around an Icelandic context. Other considerations for factors to evaluate included confidence levels, willingness to pay, safety, cultural obstacles, knowledge, and awareness. The additional factors were not overlooked and rather were decided that they were better incorporated into the final questions, which could accurately map the conditions qualitatively when evaluating the results. The samples were designated by a first presurvey group, represented through an online sample; a second presurvey group from Icelandic businesses; and a final sample through undergraduate students attending Icelandic Universities. Appendix A shows the final survey and individual metrics that were assessed.

The survey was conducted in three sets, with two rounds of pretesting, following a final round focused on the main demographic. The first two sets were presurveys, where participants were 30 individuals or less. Presurveys were conducted twice: once through a global convenience sample (adjusted for global regions and not Iceland-specific) distributed through several popular forums and then a second time to Icelandic businesses in an opportunity sampling. The first sample is used to measure consistency in responses whereas the second sample acts as a counterpoint to the University demographics.

The initial presurvey (Presurvey 1) was conducted from Nov. 11, 2016 through Dec. 28, 2016 and was built using [www.esurveypro.com](http://www.esurveypro.com). The survey was distributed through various online channels, including [www.reddit.com/r/samplesize](http://www.reddit.com/r/samplesize), [www.monsterfishkeepers.com](http://www.monsterfishkeepers.com), [www.backyardaquaponics.com](http://www.backyardaquaponics.com), Facebook and other social media outlets. As the sampling methodology was based on a convenience sampling and the survey was distributed as-needed
to fulfil a minimum quota of thirty individuals, the option for participants to answer where they accessed the survey from was omitted.

The major changes between Presurvey 1 and the business survey (Presurvey 2) are changing the matrixes from a 6-point Likert scale to a 5-point Likert scale. The original justification for a 6-point scale favored Goetzke et al.’s explorative approach, to force participants to pick a level of agreement/disagreement and avoid reverting to neutral options (Goetzke et al., 2014). The options changed from “strongly disagree”, “disagree”, “slightly disagree”, “slightly agree”, “agree”, and “strongly agree” to “completely disagree”, “disagree”, “neither agree/disagree”, “agree”, “completely agree”. Feedback from participants revealed that the original layout was difficult to keep track of and made the survey slightly overwhelming. The question models were reorganized and changed to fit better semantic qualities, with several major alterations to questions to fit the final categories. Results were organized and graphed based on responses to ensure variance in response selections.

Presurvey 2 was conducted through the website En Klik Anketa (1 Click Surveys: www.1ka.si). The model is made identical to the final survey, minus a few sentence augmentations to accommodate business reflections. The survey opened from February 22 through April 5, 2017. It was initially distributed to businesses in Sjavarklasinn (Icelandic Ocean Cluster in Reykjavik), and then through the MAST database of aquaculture proprietors. It was later redistributed to select interest groups, NGO’s and various operations through email. Later distribution was sent to multiple restaurants and hotels, contacted through email. Additionally, personal invitations were set out to select businesses. A total of 93 participants invited entered the introduction, with 65 (70%) reaching the first page, 36 (39%) started responding, 26 (28%) partially completing the survey and 23 (25%) fully completing the survey. The introductory letter incentivized participants with the promise of an executive summary of results and access to consumer responses to help businesses with market strategies.

The results from Presurvey 2 were also analyzed qualitatively, as there were not enough respondents to offer a statistically significant quantitative analysis. The input did give insight
into key differences in interpretation of motivators between consumers and businesses and offered input which can be later readapted into future studies, provide that there are sufficient resources for reaching out to businesses. Responses were measured on frequencies, mean, median, mode and standard deviation as well as open responses, but no factor analysis was provided between subsets of businesses and individual variables. No major changes were offered between Presurvey 2 and the final survey.

The final survey was released on February 17 and closed on April 03, 2017. It contained a total number of 100 complete, valid responses. It was initially dispersed to undergraduate students at the University of Iceland through services provided by the registrar’s office. The service offers to send the survey out to all undergraduate students (n=7,509) and was sent on February 22, 2017.

The survey was later sent out to other Icelandic institutions as well, delivered to the same demographics. The University of Akureyi had distributed the survey on March 6th and the Iceland Academy of the Arts had sent out the survey on March 9th, 2017. Reykjavik University declined participation and other Icelandic Universities did not respond. 455 participants entered the introduction, with 351 (77%) entering the first page, 111 (24%) starting to respond and 100 (22%) completely responding. Although the participants were not separated by individual university, a total of 343 participants entered the survey introduction prior to March 6, rendering roughly 75% of the completed participants in that period to be from the University of Iceland. Of those, 82 participants had at least partially completed the survey, giving around 82% of the full respondents to be from the University of Iceland as well.

The response rates and sampling faced difficulties in which can be explained in local dynamics. Per Félagsvísinðastofnun, the Icelandic Social science department, the response rate in Iceland for surveys is 50-80% response rate in telephone surveys (50% is common) and online polls can be much lower, around 5-10% (Thamar, 2017). For the purposes of this study, online was chosen over telephone responses, as the focus group (University undergraduates) was already decided and the survey could most reasonably be delivered from an online source.
Attempts for a telephone survey have proven to be too expensive. With regards to the final survey, many students opt to have emails sent to a different mail folder that they less frequently check, ignore emails entirely or hold off indefinitely in responding to emails the high volume of survey requests and the regular flow of emails/requests that come from the registrar’s office.

Icelanders face frequent survey requests over multiple categories, and the population offers itself as an interesting pilot study for many fields with its population size. There is a heavy influx of surveys coming from efforts to maintain the high quality of the natural environment and generating a unique perspective to encourage responses is highly labor-intensive. Research companies such as Matis have a larger array of instruments for survey distribution and tools for collecting respondents than do most university students.

4.3 Methodology: Category Breakdown:

Price was the immediate concern, although a willingness to pay survey was discouraged, as the high premiums in Iceland lead to an already strong bias in what consumers are willing to pay, and would not give a clear indication of the climate. However, from Chapter 1, price is consistently cited as a barrier to organic purchasing and in Iceland, where premiums on produce are extremely high, it seems to be most important to initially consider. To satisfy the conditions for price, it is broken down as (1) the extent to which it is perceived as fair, (2) price as a positive motivator and (3) as trust in business and (4) government setting price regulations. The conditions for prices are drawn on several different studies, but shaped in the parameters of assessment based on the FAO responses to organic agriculture inquiry on why organic food is more expensive (FAO, 2017).

Environmental efficacy is chosen as organic appeal and satisfaction seem to correlate with perceived environmental standards. This is particularly important as environment carried over several different dimensions and could equally exist as a standalone study. This issue with finding the upper and lower boundaries for environment metrics is that it is tangentially related to the other categories and framing questions can be particularly difficult. Consequently, the final survey utilizes Q7, taken and modelled after Nie and Zepeda (2011) to act as a secondary
measure for environmental concerns, whereas Q9 works as the primary source for environmental measures. There are additional allotments for an “other” category to see if there are any overlooked categories stemming from local environmental concerns, which are later elaborated on. Q9 accents different impressions of (1) environmental labelling, (2) environmental awareness; (3) environmental safety and (4) sustainability.

This study defines quality as inherent properties in the products that increase an appeal, both objective and subjective. With regards to food supply chains, there is not only a consideration of source and quality, but also in social constructs, lifestyle segmentation and biases that compliment political and ethical ideologies (Renting et al., 2003). Lifestyle segmentation is also placed in Q6, readapted from Nie and Zepeda (2011), to investigate how various lifestyles and habits are reflected in perceived qualities. Questions Q10 examines quality in regards to (1) reputation, (2) overall characteristics of produce, (3) with the aid of visual indicators for justification (Piqueras-Fiszman & Spence, 2015), and (4) as aesthetic appeal contributes to preformed beliefs.

Health metrics often overlap with qualitative metrics and tie to lifestyle segmentation analysis as well. The literature review has shown that health is often correlated to environmental concerns (i.e. health concerns factoring into the standards for production or environmental efficacy, with regards to contamination) and nutritional factors (whereas health is the overall benefits and nutrition is the content that encompasses diets/nutrients). However, health-behavior with organic food and the environment as well as health-behavior with organic food and price is only conditionally supported in the literature reviews, where contributions such as Kriwy and Mecking (2012) did not support the low-cost hypothesis and stated “income does not influence the purchase of organic food but that it does affect expenditure on organic food significantly.” To correct the rather large breadth of health-related issues and organics, Q11 investigates health with regards to (1) price, (2) knowledge, (3) avoidance of vices and (4) nutrition.
Accessibility is not measured solely on the perceived availability of products simply because with select produce (especially that which is seasonal), many people may have simply not looked hard enough. Instead, accessibility encompassed in this study the (1) source- tied to the nutritional content, (2) local-vs-imported products, (3) producer (regional and/or local) availability, and (4) ease of finding select products. This was further bolstered by Q1-Q5, which gives concessions for open responses on different attitudes towards various select products’ availabilities, which are also taken into consideration in the discussion.

The research has provided a very detailed and thorough set of relationships to be assessed in the quantitative study. The results were analyzed in SPSS using basic frequencies, such as standard deviations, mean, median and modes. From there, skewness and kurtosis are evaluated, which translate the results into predictive models and regression analyses. Results are also interpreted via crosstab analyses for significant chi-squared values and relationships between Icelandic interpretations to locals. Because the survey contains 16 to 17 variables with multiple conditions, there is an overwhelming level of data available and only the key findings are displayed in the results for clarity.

The final survey was limited in certain factor analysis due to a disproportional response rate. Females (n=72/100) are much more likely to respond, which can be attributed to interests and cultural norms discussed in section 5. Citizenship options available are native, or Icelandic by heritage; Resident on Visa, as in a non-Icelander who is living under a visa permit; Nationalized citizen, as in a non-Native that has since gained citizenship; tourists, which were not expected to be part of the survey, but included as a means of filtering out results that did not apply to the sample; and other, which included responses such as people holding dual citizenship/raised abroad, EU students (who therefore do not require a visa) or participants that misunderstood the categories. Almost half (n=59/100) of the participants identified as native Icelanders, which offered a strong foundation for analysis.
4.4 Results

4.4.1 Presurvey 1:

Presurvey 1 delivers very comprehensive qualitative results. Most importantly, the open-ended responses give clear indications of desired products and unique insight into where divisions could leverage for improvement. The term “variety” was most often cited in the open responses (over 75%), with the words “quality”, “price” and “cheaper” recurring 22% of the time. Variety appears to be the largest indicator of dissatisfaction, where even when participants understand why there is a lack of increased variety, they find it hard to obtain markets supplying niche products. Many participants are curious regarding local markets and production scales, where they believe it is difficult to find open markets where buyers could purchase directly from the local farmers.

Respondents who pushed for increased visible production also note that they believe opening local markets would provide cheaper and healthier options for produce. One notable pattern happened to be that participants from countries on Northern latitudes perceived food variety and accessibility acceptable due to the means of production available, whereas others from Southern latitudes were more critical on variety and accessibility under the same conditions.

Questions 1 and 2 focuses on what products were lacking (Q1) and which products were completely absent in respective regions (Q2). Because of regional variations and particularities regarding consumer preferences, the responses are best organized by broad categories and recurring motifs in the product desires. What does stand out is that participants claim fruits to be much more difficult to obtain over vegetables, and desire more tropical varieties of fruits in local markets. Provincial food is considered difficult to obtain, and variety, price and quality are the main attributes deemed absent. One responder describes the situation where he desires “seasonal foods at larger providers, other than bulk sales at mid- and end-of-season”, which he admitted is available through an electronic guide, but difficult to plan for. Other respondents
find it curious that they must buy products in small quantities (such as dried mushrooms) from China, instead of through a local vendor.

Question 3, which asks participants what changes they would like to see, follows a similar vein with a focus on variety, price and quality. As the questions are open-ended, participants tend to give multiple criterion they would like to see changed. 43% found quality to be an issue, in terms of taste, appeal and freshness. 33% are concerned about pricing issues, and observe premiums to be unacceptable. As one participant notes, it is difficult to educate on the value of buying healthy produce when compared to large fast-food chains, the products are more affordable and in larger quantities. Variety is noted 24% of the time, as is a driver for more local food. There is a repeated correlation in responses where consumers who request an increase in local production tend to feel antagonistic towards mass producers and prefer an outlet with increased variety in smaller quantities over similar products in too large of quantities. Some participants wanted more novelty products, such as organic eggs, vegan products and specialty shops. Other interesting responses involve an increase in government efficiency and policy to help facilitate distribution.

Question 4, regarding satisfaction over fish purchases elicit only 20% of the respondents as satisfied, 33% do not know or do not consume fish, and 37% are not satisfied or cannot afford fish. Positive respondents recognize the abundance of fish supply in various regions and the “supply and demand reflecting prices”; although respondents who are positive also recognize a need for better sourcing for food. None of the participants believe the taste and quality of fish to be a problem, although one participant living in Reykjavik 101 lamented that finding fresh fish to bring for home use is difficult to find.

Questions were originally recorded at random, with varying metrics throughout the survey. Using the 6-point Likert scale allowed for a more variant response rate, which helped to identify skew and distribution. The questions are framed somewhat differently from the final survey, as seem below in Table 4.1. Key findings from this set show, mixed responses in Q6b with regards to the effect of food price to purchasing intent, a varied level of trust in practices
from Q6c and Q6d. Q6e showcases a normal distribution, with moderate desire to pay for “organic” or “green” labelled food. These results can be seen in Figure 4.1. Questions were later altered to reflect a wider range of variables and focus questions with multiple factors such as “fair and competitive”.

Table 4.1: Original Questions 6a-6e

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel that the current prices for produce here are fair and competitive.</td>
<td></td>
</tr>
<tr>
<td>The price of food greatly effects my choices for purchasing food.</td>
<td></td>
</tr>
<tr>
<td>I have trust in the governmental policies regarding produce availability and prices.</td>
<td></td>
</tr>
<tr>
<td>I have trust in businesses regarding produce availability and prices.</td>
<td></td>
</tr>
<tr>
<td>Produce that is labelled as “green” or “organic” makes me more willing to purchase it.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.1: Presurvey 1 Responses for Q6a-Q6e.

Questions 7a-7e illuminate more concentrated responses, despite previous predictions. Table 4.2 shows the original questions presented for Presurvey 1. Q7a shows most respondents either agreeing or somewhat agreeing that environmental efficacy is a strong influencer to purchasing. Environmental safety in Q7b has produced a normal distribution of responses, revealing a mixed concern for safety, which can correlate back to trust in governmental procedures. Q7c shows a heavy skew to the left in strong disagreement and was later changed to give a clearer indication on consumer beliefs. Q7d has a strong skew right, providing a strong
confidence level in consumers’ purchasing decisions as justified by understanding. Q7e also shows a heavy skew right, which details consumers’ seeking quality products, as was indicated in the open responses. Results for Q7a-Q7e can be seen in Figure 4.2.

<table>
<thead>
<tr>
<th>Table 4.2: Original Questions for Q7a-Q7e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental awareness influences what produce I decide to purchase.</td>
</tr>
<tr>
<td>I am more willing to purchase produce that I know is environmentally safe.</td>
</tr>
<tr>
<td>Produce can only be grown in the soil to be truly organic.</td>
</tr>
<tr>
<td>I believe that my purchasing decisions for produce are grounded in facts.</td>
</tr>
<tr>
<td>Produce quality is a main factor in my purchasing decisions</td>
</tr>
</tbody>
</table>

![Figure 4.2: Presurvey Responses for Questions 7a-7e.](image)

The original questions for Q8a-Q8e can be seen in Table 4.3, although many of the questions have gone through several revisions. Q8a shows general agreement that seeing the production site would increase appeal, and responses generated a platykurtic kurtosis. Q8b has a fairly normal distribution, which seems to be in line with open responses focusing on quality, freshness and taste over aesthetics. Q8c was significantly altered to isolate only one variable (as opposed to nutrition and health) and shows almost all participants in agreement. Q8d is skewed left with varied responses in price to health relationship. Q8e was altered significantly due to the implications of GMO foods, although the normal distribution shows interesting response variances. Responses can be seen in Figure 4.3.
Table 3: Original Questions for Q8a-Q8e

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeing the production sites or food would influence my appeal towards consuming it</td>
<td></td>
</tr>
<tr>
<td>The appearance of food greatly effects my purchasing decisions.</td>
<td></td>
</tr>
<tr>
<td>Nutrition and health are factors that influence my purchasing decisions.</td>
<td></td>
</tr>
<tr>
<td>Higher prices typically give a healthier product.</td>
<td></td>
</tr>
<tr>
<td>GMO foods are safe and reliable.</td>
<td></td>
</tr>
</tbody>
</table>

Questions Q9a-Q9e were restructured for increased clarity in their wording to maintain more accurate responses. The original questions can be seen in Table 4.4. Q9a shows avoidance towards unhealthy products. Q9b has a moderate to high disagreement of product source relating back to nutrition. Q9c echoes a drive for more local food, with respondents in disagreement that they wouldn’t mind imported over local food. Q9d reveals participants in agreement over accessibility to food as important to the decision process. Q9e indicates varied levels of satisfaction with regards to their produce demands. This likely stems from respondents feeling strongly about the availability of certain produces, and availability (or lack thereof) could influence a more determined response. The results for Q9a-Q9e can be seen on Figure 4.4.
Results for Presurvey 1 indicated several interesting results. Namely, it appears as though the avenues to which consumers felt needed more representation was in mitigating price barriers, having more outlets for a varied selection of produce and receiving a price to match the quality. The consumers tended to align strongly with pro-environmental behavior and were driven for quality and health. Many of the participants wanted a more accessible local market to make their purchases under the pretenses of local food being more environmentally sustainable and healthy. Despite high demands for quality, price did not appear to be related to quality, and the premiums were based more on administrative barriers over an increase in health.

4.4.2 Presurvey 2:

Presurvey 2 was structured identical to Appendix A, with only minor alterations to accommodate the sample as businesses instead of individual consumers. Participants were asked to divide themselves by their industry, which resulted in 4% of the respondents from agriculture & services, 17% in aquaculture, 22% in education, 13% in fisheries, 9% in health and health services, 9% in NGO divisions, and 26% in the “other” field, not pertaining to any available options. Other options were available to which no representatives participated. All
participants for Presurvey 2 live in Iceland. There was a notable difference in responses from Presurvey 1 and a staunch difference to the final surveys in motivators and sentiments.

Concerning Q1 and Q2 on what produce is difficult to obtain and what is absent, respectively, 40% state in both questions that nothing is absent or missing, or at least nothing that they could think of. Characteristics of produce that are cited are most often fresher variants of vegetables already available (i.e. peas, broccoli, asparagus that is not canned) or specialty herbs. As opposed to Presurvey 1, there was only 2-3 responses concerning exotic fruits. The results indicate a high demand for a large variety of leafy, herbaceous vegetables.

With Q3, depicting changes the participants would hope to see, over 50% stated they want “more” or an “increase” in some aspect. This ranged from organics and local produce to a higher reiteration of “greens”, “herbs” and “leafy salads”. Roughly 17% of the respondents demand better quality or freshness from the produce selection. There is an equal drive for more local products, or at least that local products have a higher representation. As opposed to Presurvey 1, only one comment presents pricing issues and a very mitigated focus on fruits.

When asking the participants whether they were satisfied with the current fish prices and availability, and what changes they would like to see, 50% are satisfied, with minimal exceptions such as more variety, lower prices or outlets for fishmonger sales over supermarkets. 1/3 of the participants lament prices being too high, with the condition that lower prices still maintain reasonable quality, variety and access to information. Several participants note that quality between different fish species is indistinguishable and the expenses for routine fish consumption has drawn off younger generations for eating, as there are little to no affordable outlets. There is also a mention of regional variances, where price and accessibility issues differ greatly between small towns and the main city.

Additional comments only focus on not seeking prices of produce and rather for acceptable quality, which is characterized as hard to find in Iceland. One respondent finds that having an open market for produce would be ideal in Iceland, which probably would be for
supplementing local produce and farmers. Presurvey 2 reveals a much more satisfied
demographic with clear indications of produce that they desired.

On average, the samples spend 27.8% of their grocery expenses on fruits and vegetables,
with a minimum of 5% and maximum of 60%. Fish comprises 22% of their spending on average,
with a minimum of 10% and maximum of 50%. As many of the participants were tied in some
way to the fish industry, it would not be surprising to presume that they are more inclined
towards fish and fish products, and are most likely in a better financial position to feel that price
is less of a barrier, as was indicated in the open responses. With regards to Presurvey 1, there is
less of a focus on price, except in fish, with a very particular set of demands for produce. Both
presurveys warranted an increase in local production and higher quality food.

Replicating the study from Nie and Zepeda (2011), Presurvey 2 gives a unique
segmentation. The areas with lowest concentration are brand, source and organic, with heaviest
focus on taste, safety and health, as demonstrated in Figure 4.5, where 1= very important, 2= moderate, and 3= unimportant. The most mediated categories are cost, environmental focus,
convenience and organics. This depicts a consumer who is mainly concerned with the returns
given by food, supported second to cost and production conditions.

Figure 4.5: Lifestyle Segmentation from Presurvey 2. (1= Very Important, 2= Somewhat Important, 3= Not at All)
Following Nie and Zepeda’s environmental analysis, the area of heaviest focus becomes personal or family health, followed by water contamination and then wildlife preservation. Energy/resource conservation was the most moderated category, followed by animal welfare and then wildlife preservation again. Very few categories were deemed as not important. The fill-ins for “other” included sustainability and Co2 emissions. It was interesting to see family health taking priority over wildlife preservation, with consideration to the extent that wilderness preservation is considered important in Iceland. The results can be seen through Figure 4.6.

![Figure 4.6: Vertical Bar Graph for Presurvey 2 Environmental Indicators.](image)

Responses for Q8-12 can be seen in Appendix B. Price is very moderated for this group, with most participants as neutral on subjects for pricing. Environmental conditions, however were met with overall positive receptions and the participants displayed a strong agreement over all environmental conditions except for Iceland’s sustainability, which was seen on average as neutral. Quality indicators are all seen as strong, with the average for each indicator scoring over 4 (agree); this is consistent with open responses. Health indicators depict areas with most agreement in vice avoidance and nutrition, and low-neutral responses for knowledge and with regards to price. Accessibility indicators are highest with regards to producer availability and neutral in ease of finding; source to nutrition and local sourcing were consistent with open responses and are reiterated as important indicators.
Presurvey 2 demonstrates that the sample is very conscientious, quality driven and has strong support for local food. They have a very focused set of wants and are concerned with health and safety delivered from food. The base has a strong level of confidence and knowledge with regards to food and purchasing habits are tailored accordingly. The group showed heaviest support within environmental and are most neutral in regards to pricing barriers.

4.4.3 Final Survey:

The final survey yields strong results which followed similar results to Presurvey 1 and Presurvey 2. The respondents divide almost equally between Native Icelanders (n=59) and non-natives (n=41), which gave excellent grounds for comparing the different behaviors. The respondents give clear indication of Quality being the strongest indicator of their purchases, followed by Accessibility. The respondents are more environmentally driven and more outspoken on packaging issues. There is also a larger call in this sample for local produce, and price acts as the strongest barrier to purchasing more organic produce. Relationships were strong between trust, price, green purchasing, quality and sustainability. The open responses provided a much higher willingness to purchase environmental products than their results yielded.

Missing and absent produces follow responses closer to Presurvey 1 than Presurvey 2. Q1 reveals consumers to believe that vegetables are mainly difficult to find, mainly in pumpkins/squashes, kale, eggplant, leafy greens, peppers and select root vegetables, such as horseradish. Demand for exotic fruits is lower in Q1 than it is in Q2; however, an equal demand for fresh produce also exists. For Q2, produce that is absent from the market, consumers find a lack of fresh varieties of certain produce and an emphasis on root vegetables and exotic fruits. The results are closer to Presurvey 1, where respondents want more exotics and niche items. There was a call for leafy vegetables as seen in Presurvey 2, such as kale, different lettuce varieties, Pak choy and endive. Respondents reiterate a demand for better packaged products. 16% were satisfied and could not find anything that was entirely absent.
Question 3, regarding changes consumers would hope to see, can be grouped into 6 primary categories; namely, Price (24%), Variety/Access (19%), Organics (12%), Local (31%), Quality (18%), and Packaging (12%), with overlap. Price is considered too high, especially for local products. Consumers want to see a higher amount of variety and access to different goods, with an emphasis on seasonal variants and berries. Local varieties were deemed important, as many participants demand a reduction in imports and heavier greenhouse production. Quality typically entails freshness and being less prone to rot. Curiously, packaging is often cited as a large issue here, where labelling practices are considered irrelevant/meaningless, and consumers are very dissatisfied with the heavy use of abundant plastics to wrap produce. They believe that it defeats the purpose of having an environmental product when it is weighed against so much packaging waste.

After consolidating the responses for Q4, satisfaction for fish and fish products follow key indicators of “price”, “freshness”, “sustainability”, “variety”, and “locality”. 45% of the responses mentioned that the price was too high, even if they were satisfied (18%). This was typically accented with an additional caveat that there are not enough outlets for variety (20%) and it is difficult to support local production due to price barriers and restricted access. Many of the participants do not want to go to a fishmonger directly and find the supermarket chains to be lacking in available fresh fish in a wide variety (20%). 8% of the respondents do not eat fish and an additional 5% are vegan/vegetarian, abstaining from eating fish in general. Participants found it “hard to believe” that a fishing country has “too much frozen fish”.

Q5 reveals very telling insight into problems that consumers felt are not represented well. Multiple respondents encounter difficulty in buying fruits and vegetables, when the relative cost of candy is vastly cheaper. Various responses detail the government regulations and import taxes to curtail a lot of opportunities for future development and access to local goods. This was backed up with multiple entries for better labelling practices and visibility, as respondents believe that food from Icelandic chains spoils measurably quicker than in other nations. They had found a lack of information and expiration dates to be exhausting in their food choices, where “the food quality is too low for the costs.” The most-frequent comments for
Q5 petition for more organic farming and products, especially in berries/strawberries. They believe that there is a surprising lack of berries in a country where they grow organically, and would prefer to buy local as opposed to imported varieties.

Participants report that spending for fruits and vegetables per Q16 averages 45.9%, with a minimum of 6% and maximum of 100%. Wider barriers are most likely due to convenience and pricing in addition to lifestyle choices (veganism, etc.). Spending on fish and fish products per Q17 averages 12.4%, with a minimum of 1% and maximum of 75%. This coincides with younger generations not being able to afford fish, elicited in the open responses. Nearly 50% of the respondents selected less than 10% of their spending was on fish and fish products.

Presenting the same questions to the respondents from Presurvey 2 showed a lifestyle segmentation that was most focused on taste and health, and least by brand and sourcing. Lifestyle choices, convenience and organics were moderately important. The segmentation shows the biggest focus on high-quality products at affordable rates, regardless of sources. The results indicate similarities to Presurvey 1, with a more extreme focus in taste and healthiness and a higher emphasis on costs. The results can be viewed from Figure 4.7.

![Figure 4.7: Lifestyle Segmentation for Consumers (1= Very Important, 2= Somewhat Important, 3= Not at All).](image)

The environmental indicators presented the most important concerns to be water contamination and animal welfare, followed by wildlife preservation. Personal and family
health was considered less important than Presurvey 2 indicated, most likely due to the younger age of the participants, of whom many have not yet set up a family and are in relatively healthy conditions. Animal welfare is much higher than Presurvey 2 provided, as well as energy and resource conservation. The results can be seen in Figure 4.8. Responses for “other” surrounded “animal-free products”, “fair trade”, “place of origin/shipping distances”, and several responses for “better packaging”.

![Figure 4.8: Environmental Indicators for Consumers.](image)

Detailed qualitative results for Q8-Q12 are provided in Appendix B. Respondents are most likely to disagree that the prices are fair, and tend to choose disagreement or strong disagreement as opposed to Presurvey 2’s neutral position. Half of the respondents responded that price effects their purchasing decision as well. Participants are also less likely to trust business or government practices for regulating prices, with only a small margin in agreement, as opposed to Presurvey 2’s neutral position on the subject.

Participants show a high level of environmental focus in all environmental categories, although their responses are collectively less in agreement than Presurvey 2 within each question. Oddly, the respondents gave high results on Nie and Zepeda’s environmental indicators and provide much more thorough feedback with demands for organics and clearer packaging. This can most likely be explained as Presurvey 2 has a smaller sample and that
participants in the final survey are more likely to err on the side of neutral in these categories. This may also result from a higher level of skepticism in environmental labels and practices effectiveness.

Quality indicators reveal the sample to be in strong support reputation and overall quality, although they are less likely to strongly agree as Presurvey 2. They show less of a concern for aesthetics where they are more likely to agree or stay neutral. Site influence is less important than in Presuvery 2, although it is still significant at influencing purchase decisions. The responses are in line with lifestyle segmentation, although it could be assumed that these categories would also be higher to match their open responses. This shows an equal level of quality-conscientiousness that takes on a more subjective level of approval.

Health indicators show radically different responses from Presurvey 2, which matches with lifestyle segmentation and environmental indicators earlier. Participants are likely to disagree or completely disagree that price indicates a healthier product, with very few respondents as neutral. Most the responses disagree or strongly disagree that they research products beforehand. They provide much more agreement towards health avoidance, with 42% in agreement and 34% neutral. Nutrition importance registered the majority in agreement, second to neutral regards. This reemphasizes the sample as more impulsive and convenient based, with less levels of planning, albeit a high level of efficacy.

Descriptive analyses generate different responses patterns between lifestyle segmentation studies and Nie and Zepeda’s environmental influencers, due to structuring differences in questions frameworks and in general expectations to outcome. In the initial presurveys, most participants often leaned towards agreement over neutral positions, as seen above, which produced a lower variance in response rates. The descriptive results for Q8-Q12, however, produce a different skew and distribution, which can be reviewed in Appendix C.

Factor analysis using a principal component matrix between Q6 and Q7 reveals 4 components with communalities, which suggests an overlaying factor. A full breakdown of the matrix can be seen in Appendix C, where the total percentages of variances for the 4 extracted
factors are also displayed. As the factors are so integrally tied, the relationships dwelled on positive reception and not aversion, which can be seen via all factors except for brand and source, which entail few quantifiable relationships. Using the same analysis on Q8-Q12 reveals 8 components, with a relationship between price, trust, green buying and quality + sustainability. The same results are available in Appendix C, which further detail that there is a relationship between negative reception to price and health attributes in food, similarities in trust to pricing, consistent quality conscientiousness as both a motivator and a mediating factor and a strong pull towards environmental efficacy.

A chi-squared test between Icelanders and other participants for Q6 and Q7 provides no statistically significant relationships between Icelandic status and responses, with the closest depiction coming from Q6g, where P=.059. However, crosstab analysis reveals closer relationships between nationalities and responses. The crosstabs analyzed each demographic for relationship strengths in responses and weighed the response strengths. This gives indications of where the positive and negative relationships are for each demographic to motivators.

With regards to Q6 Native Icelanders show moderate relationships from taste (1=very important) and moderate negative relationships to taste (3= not important). This pattern is repeated in convenience and safety. A strong negative relationship is made between organics and option 1, although only a moderate positive relationship exists for the same metric and response 3. A moderate negative relationship exists between source and option 1, with a moderate positive relationship between source and option 3. Curiously, nationalized citizens are most likely to show strong relationships, with taste and option 3 depicting a strong negative relationship. Brand fostered a strong negative relationship for this demographic and option 1, albeit only with a moderate positive relationship between brand and option 3.

As for Q7, only one strong relationship exists for residents on visa for option 2 and energy resource and conservation and only few moderate relationships. Residents on a visa warrant a moderate negative relationship between option 2 and purchasing due to personal or
family health problems. There exists a moderate positive relationship between option 1 and energy conservation for residents on visa. Both native Icelanders and naturalized citizens show a moderate negative relationship towards animal welfare and option 2, where residents on Visa show a moderate positive relationship between animal welfare and option 2. Naturalized citizens indicate a moderate positive relationship between option 3 and animal welfare.

4.5. Discussion:

Nie and Zepeda’s (2011) lifestyle segmentation analysis factors her results into groupings of rational, adventurous, careless and concerned uninvolved consumers. This series of groupings is made in consideration of the food-related lifestyle models, which is not implemented in this study. To translate the results to this study, it is best to look at a chi-square analysis between the different nationalities and then through the implicated results. Most of the participants could be labelled as rational consumers (high investment, but practical on their purchases), followed by careless (uninvolved) and conservative (invested, but restricted) due to circumstances. The results from this study extend Nie and Zepeda’s results into a unique sample that is actively seeking out more alternatives for food, but is limited by price and sourcing issues. Trust is a factor that is hard to establish and limited availability curtails efforts for more adventurous cooking.

When comparing results with Halldorsdottir (2013) where applicable, her cultural and personal barriers can be compared or extended upon. Structural barriers are inapplicable for this chapter, and developed in Chapter 2. Halldorsdottir notes a significant loss in variety were local production to be facilitated, which would “be least for dairy, meat and fish if food supply would be entirely from domestic sources. Vegetable, sugar, and oil variety would decrease by half, and the decrease would be two thirds for alcoholic beverages. Variety loss would be complete for fruit, cereals, beans and non-alcoholic beverages as those food categories are currently not produced domestically” (Halldorsdottir, 2013). This goes against the petitions of many of the samples, who most likely harbor good intentions with an entirely local production. A synthesis between both groups can be made, where Halldorsdottir’s methodology was based
solely on FAO data and “more than is probably called for in [her] results,” although an entirely local production center would be financially unfeasible and redundant.

The participants interest in the health and safety for local food correlates back to Halldorsdottir’s results, confirming consistency in positive health-based beliefs. Similarly, her results are in line with consumers’ perceptions of convenience and packaging practices with regards to local foods. The price and convenience barriers can be overcome with an increased range of access to consumers and wider varieties of vegetables already being produced (different types of lettuces, cucumbers, etc.). Overall, the results in regards to consumer sentiments towards local food is in line with Halldorsdottir’s results and the results from this survey expand her findings further. The similar barriers lead to suggest similar solutions for mediation and improvement.

Key findings from this survey show qualitative demands for Icelandic produce with lower prices, more local sustainability and increased variety. The sample is convenience-driven, with a focus on environmental efficacy and more cohesive branding. Increased outlets with more fresher varieties are important factors. Taste is important, although aesthetic factors are not so much. Curiously, an increase in organic produce would, according to this study, work if the product was promoted as a local entity with a low reliance on the labels. It would most likely be effectively promoted word-of-mouth. One consideration for availability response frequencies can be noted that gourmet stores favor novelty products and unique selections, although price barriers and the locations of the shops may prove to be strong deterrents from consumers discovering the selection opportunities available.

From the factor analysis, the revelation of “trust’ as a discrete factor is very important, as it shows a prevalent motif that underlies many of the purchasing decisions. Low levels of trust seem to create a higher level of skepticism towards brands and providers, which in turn lower the effectiveness of labels and promotions. Trust is revealed to be a permeating factor which dictates many of the purchasing decisions and can prevent adventurous purchases, as a low level of trust in price regulations, market values and the value of labels. This low level of trust
diminishes credibility from other producers and stifles opportunities for information seeking from the consumers.

Environmental characteristics are a key point of interest as they act as a moderating factor. Whereas consumers provide strong sentiments for environmental characteristics and provide a positive attitude towards environmental products, they are not more inclined to purchase environmental products when price is a barrier. In turn, environmental efficacy posits itself as an additional reward/bonus, but not a primary factor in influencing the purchases.

This has a high degree of overlap with the foundations of trust. If there is a low level of trust in the consumers, then the environmental claims of produce are mitigated, where they no longer feel that their purchases are meaningful towards the environment. A high level of trust provides a strong commitment to the brand; however, with the low confidence in brand appeal, producers may struggle to provide a strategy emphasizing the environmental quality of their products that would be highly regarded to all consumers. This positions environmental quality as a feature that has less of a positive or negative attribute to purchase motivation and instead is used as additional quality of a product after the purchase.

The demographic relationships seen in this study can be explained through several narratives. The difference between native Icelanders and other participants can be attributed to expectations, where visitors filter their expectations against previous living conditions. Icelanders deal with a high influx of tourism and development, with a growing cost of living that may soften the “sticker shock” that they are exposed to. This, along with a lower level of food planning and security (Johannsson, 2011) details food purchasing to be more of a hope than a force of habit.

Retail surveys in the Nordic studies are typically asterisked by the fact that the respective countries have a high concentration of individuals and respective markets in a capital region with low customer satisfaction (Einarsson, 2008). This is driven by high premiums overall, and opportunities for alternative ecommerce practices are driven by convenience,
which can easily become unsustainable and take away from local distributors (Óskarsdóttir, 2016).

Icelanders differentiate mainly in that the final survey showed the only statistically significant factor between responses to be in taste, where it was higher for Icelanders. Price was equally regarded, but more than likely under different premises. Non-Natives find price to be comparatively too high to their country of origin and not justified in their premiums, whereas Icelandic citizens, who are more accustomed to living conditions and prices, are more deterred by prices in terms of conveniences. This would mean that a strategy for organics consumption would be able to take on a similar strategy to any consumer subset, as the motivators remain the same, but are just expressed differently.

With regards to aquaponics production, the results illuminate a fitting relationship that can be achieved between the consumer ideals and aquaponics principles. The petitions for “organic” and “local” as defined by the consumers are encapsulated by aquaponics fish and produce, which also holds the same quality standards. The produce and fish can be made at a high quality, and are not deterred by their source. Giving consumers the ability to see the production sites and look at the systems also increases perceived quality and appeal towards aquaponics produce.

The production methods for aquaponics entail the environmental standards consumers identified, especially with regards to water quality and waste mitigation. The systems can be emphasized by the appeal it holds to a community and are healthier product options. Because it holds a wide selection of products that can be maintained in a system, aquaponics can satisfy many consumer demands. Furthermore, with the proper selection of fish, consumers have access to more economically-conscientious selections with a reliable source. If a commercial system were to be integrated into a local community, it could provide a conceivably environmentally friendly, local, organic product.
4.6 Conclusion:

A low-cost, high quality, local, environmentally-friendly product is certainly possible, especially through alternative means of production. Iceland has the tools necessary to implement this and begin to offer new food choices. The results reveal pricing barriers to making more environmentally-driven purchases and a demographic that desires high quality food with a good taste. This appeal works to all demographics explored and is a condition that is echoed in all samples. Consumers are not concerned with brand appeal and require a high degree of trust in order to carry out more sustained purchases as well as to venture out into new produce experiences.

Consumers want to try more exotic varieties of foods at reasonable costs and are particularly driven towards products that are considered “organic” or “local”. Increasing outlets to providing this while maintaining environmental efficacy is very important for consumers. Although there are some differences between native Icelanders and non-natives, the biggest statistical difference is a more-focused concern for taste. The reasoning behind various motivations for price and environment may differentiate, although it ultimately leads into a similar result.

This study shows that it is very important to find ways to appeal to consumers that can maintain continuous, sustained purchases for fish and produce. Introducing a new product into the market would require a very delicate strategy that needs to hold to consumer appeal as well as market an innovative product that is not too steep on pricing. Some of the demands may appear to be contradictory, and there are limitations to satisfying everything; however, this study showcases how important trust, quality and health are in products that rely on environmentally safe and community-driven practices. With a limited access to many food varieties coupled with opportunities for increased development, there are many ideal points of focus for increasing quality and efficiency in produce selection in Iceland.
REFERENCES


### Appendix A: Final Survey and Metrics

<table>
<thead>
<tr>
<th>Question Bracket</th>
<th>Question</th>
<th>Question Type</th>
<th>Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Response 1</td>
<td>What produce (grænmeti) do you feel is lacking (i.e. hard to find) in Iceland?</td>
<td>Open Text; Qualitative</td>
<td>Measure for extended responses in produce options</td>
</tr>
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<td>Open Response 2</td>
<td>What produce do you feel is absent (i.e. cannot be found at all) in Iceland?</td>
<td>Open Text; Qualitative</td>
<td>Measure against open response 1: completely unavailable</td>
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<tr>
<td>Open Response 3</td>
<td>What changes would you hope to see regarding produce in Iceland?</td>
<td>Open Text; Qualitative</td>
<td>Opportunity for extended response: opportunities in Iceland</td>
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<tr>
<td>Open Response 4</td>
<td>Are you currently satisfied with the prices and availability of fish for consumption in Iceland? If not, what would you hope to see changed?</td>
<td>Open Text; Qualitative</td>
<td>Extended responses: sentiments with regards to fish.</td>
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<tr>
<td>Open Response 5</td>
<td>Any additional comments?</td>
<td>Open text; qualitative</td>
<td>Additional available insight.</td>
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<td>Importance:</td>
<td>Please select the importance to which the following influence you in your purchasing decisions for produce:</td>
<td>3-point Likert scale; 10 categories (lifestyle) Q6a-Q6j</td>
<td>Lifestyle segmentation. Relative weight between individual responses to categories</td>
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<td>purchasing decisions</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>by broad category</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Importance:</td>
<td>Please select the extent to which the specific environmental concerns are important to you with regards to purchasing produce:</td>
<td>3-point Likert scale; 5 categories (specific environment), 1 open response Q7a-Q7f</td>
<td>Environmental significance weighted between individual responses to categories. Opportunity for open response for additional concerns.</td>
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<td>purchasing decisions</td>
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<tr>
<td>by specific</td>
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<tr>
<td>category</td>
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<tr>
<td>Price Indicators</td>
<td>Please read the following sentences and select the option that best describes your opinion regarding the following statements.</td>
<td>5-Point Likert scale; 4 indicators (price). Q8a-Q8d</td>
<td>Price (is just); Price (positive motivator); price (re: trust in govt); price (re: trust in businesses)</td>
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<tr>
<td>Q8a. I feel that the</td>
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<td>current prices for</td>
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<td></td>
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<tr>
<td>produce here are fair.</td>
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<td></td>
<td></td>
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<tr>
<td>Q8b. The price of food greatly effects my choices for purchasing food.</td>
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<td></td>
<td></td>
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<tr>
<td>Q8c. I have trust in the governmental policies regarding produce prices.</td>
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<td></td>
<td></td>
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<tr>
<td>Q8d. I have trust in businesses regarding produce prices.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Please read the following sentences and select the option that best describes your opinion regarding the following statements.</td>
<td>5-Point Likert scale; 4 indicators (environmental efficacy). Q9a-Q9d</td>
<td>Environment (labelling to WTP); Environment (awareness to confidence); Environment (safety and standards); environment (local sustainability)</td>
</tr>
<tr>
<td>Indicators</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Q9a. Produce that is labelled as “green” or “organic” makes me more willing to purchase it.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Q9b. Environmental awareness is important in the products that I purchase.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Q9c. I am more willing to purchase produce that I know is environmentally safe.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Q9d. Produce in Iceland is typically produced in a sustainable manner.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Quality Indicators</td>
<td>Please read the following sentences and select the option that best describes your opinion regarding the following statements.</td>
<td>5-Point Likert scale; 4 indicators (quality). Q10a-Q10d</td>
<td>Quality (via reputation to WTP); Quality (of produce); Quality (visual indicators for justification); Quality (aesthetic)</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>------------------------------------------------------</td>
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<tr>
<td>Q10a. The reputation of the producer of the produce increases my willingness to purchase it.</td>
<td>Q10b. Produce quality is a main factor in my purchasing decisions.</td>
<td>Q10c. Seeing the production sites or food would influence my appeal towards consuming it.</td>
<td>Q10d. The appearance of food greatly effects my purchasing decisions.</td>
</tr>
<tr>
<td>Health Indicators</td>
<td>Please read the following sentences and select the option that best describes your opinion regarding the following statements.</td>
<td>5-point Likert scale; 4 indicators (health). Q11a-Q11d.</td>
<td>Health (re: price); Health (knowledge and info seeking); Health (avoidance of vices); Health (Nutrition)</td>
</tr>
<tr>
<td>Q11a. Higher prices typically give a healthier product.</td>
<td>Q11b. I research my produce source before I purchase items from it.</td>
<td>Q11c. I avoid produce believed to be less healthy.</td>
<td>Q11d. Nutrition is a factor important to my purchasing decisions.</td>
</tr>
<tr>
<td>Accessibility Indicators</td>
<td>Please read the following sentences and select the option that best describes your opinion regarding the following statements.</td>
<td>5-point Likert scale; 4 indicators (accessibility). Q12a-Q12d.</td>
<td>Access (Source-Nutrition); Access (Local-Import); Access (producer availability); Access (Easy to find)</td>
</tr>
<tr>
<td>Q12a. I feel that the source of produce does not affect its nutritional value.</td>
<td>Q12b. I prefer buying imported over locally grown products.</td>
<td>Q12c. I have certain products that I always purchase from a specific producer.</td>
<td>Q12d. I believe that all of my produce demands are easy to find.</td>
</tr>
<tr>
<td>Gender</td>
<td>Male, Female, refuse to respond.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age group</td>
<td>In which age group do you belong?</td>
<td>Up to 20; 21-40; 41-60; Over 60</td>
<td>Age segmentation decided in wide range due to smaller sample size and more concentrated demographics.</td>
</tr>
<tr>
<td>Citizenship status</td>
<td>What is your current status in Iceland?</td>
<td>Native; Resident on Visa; Nationalized Citizen; Tourist; Other</td>
<td>Segmentation based on citizenship to identify demographic distribution</td>
</tr>
<tr>
<td>Spending Habits</td>
<td>Please select what percent of your grocery spending is spent on fruits and vegetables.</td>
<td>Sliding scale 0-100</td>
<td>Weighing habits of spending against perceived values</td>
</tr>
<tr>
<td>Spending Habits</td>
<td>Please select what percent of your grocery spending is spent on fish and fish products:</td>
<td>Sliding scale 0-100</td>
<td>Weighing habits of spending against perceived values</td>
</tr>
</tbody>
</table>
Appendix B: Responses for Presurvey 2 and Final Survey by Indicator Group

Presurvey 2:

1. I feel that the current prices for produce here are fair.
   - 38% Agree
   - 38% Neither Agree/Disagree
   - 13% Disagree
   - 1% Completely Agree
   - 14% Completely Disagree
   - 9% Don't know

2. The price of food greatly affects my choices for purchasing food.
   - 33% Agree
   - 38% Neither Agree/Disagree
   - 29% Disagree
   - 14% Completely Agree
   - 10% Completely Disagree
   - 9% Don't know

3. I have trust in the governmental policies regarding produce prices.
   - 33% Agree
   - 38% Neither Agree/Disagree
   - 29% Disagree
   - 14% Completely Agree
   - 10% Completely Disagree
   - 9% Don't know

4. I have trust in other businesses regarding produce prices.
   - 38% Agree
   - 27% Neither Agree/Disagree
   - 27% Disagree
   - 18% Completely Agree
   - 9% Completely Disagree
   - 9% Don't know

---

Produce that is labelled as "green" or "organic" makes me more willing to purchase it.

- 53% Agree
- 52% Neither Agree/Disagree
- 30% Disagree
- 13% Completely Agree
- 10% Completely Disagree
- 9% Don't know

Environmental awareness is important in the products that I purchase.

- 73% Agree
- 71% Neither Agree/Disagree
- 24% Disagree
- 9% Completely Agree
- 9% Completely Disagree
- 9% Don't know

I am more willing to purchase produce that I know is environmentally safe.

- 36% Agree
- 41% Neither Agree/Disagree
- 18% Disagree
- 13% Completely Agree
- 10% Completely Disagree
- 9% Don't know

Produce in Ireland is typically produced in a sustainable manner.

- 36% Agree
- 41% Neither Agree/Disagree
- 18% Disagree
- 13% Completely Agree
- 10% Completely Disagree
- 9% Don't know

---

The reputation of the producer of the produce increases my willingness to purchase it.

- 61% Agree
- 55% Neither Agree/Disagree
- 35% Disagree
- 9% Completely Agree
- 9% Completely Disagree
- 9% Don't know

Produce quality is a main factor in my purchasing decisions.

- 35% Agree
- 45% Neither Agree/Disagree
- 18% Disagree
- 9% Completely Agree
- 9% Completely Disagree
- 9% Don't know

Seeing the production sites or food would influence my appeal towards consuming it.

- 50% Agree
- 27% Neither Agree/Disagree
- 23% Disagree
- 9% Completely Agree
- 9% Completely Disagree
- 9% Don't know

The appearance of food greatly effects my purchasing decisions.

- 35% Agree
- 55% Neither Agree/Disagree
- 9% Disagree
- 9% Completely Agree
- 9% Completely Disagree
- 9% Don't know
Final Survey:

- Higher prices typically give a healthier product: 38% Agree, 41% Disagree, 18% Neither Agree/Disagree
- I research my produce source before I purchase items from it: 30% Agree, 41% Disagree, 18% Neither Agree/Disagree
- I avoid produce believed to be less healthy: 5% Agree, 38% Disagree, 19% Neither Agree/Disagree
- Nutrition is a factor important to my purchasing decisions: 9% Agree, 88% Disagree, 18% Neither Agree/Disagree

- I feel that the source of produce does not affect its nutritional value: 13% Agree, 22% Disagree, 18% Neither Agree/Disagree
- I prefer buying imported over locally grown products: 46% Agree, 10% Disagree, 6% Neither Agree/Disagree
- I have certain products that I always purchase from a specific producer: 15% Agree, 33% Disagree, 30% Neither Agree/Disagree
- I believe that all of my produce demands are easy to find: 41% Agree, 18% Disagree, 23% Neither Agree/Disagree

- I feel that the current prices for produce here are fair: 17% Agree, 18% Disagree, 40% Neither Agree/Disagree
- The price of food greatly affects my choices for purchasing food: 26% Agree, 11% Disagree, 10% Neither Agree/Disagree
- I have trust in the governmental policies regarding produce prices: 19% Agree, 33% Disagree, 20% Neither Agree/Disagree
- I have trust in businesses regarding produce prices: 21% Agree, 30% Disagree, 35% Neither Agree/Disagree
Appendix C: Principal Component Matrixes

Descriptive Results for Q8-Q12

|   | 8a | 8b | 8c | 8d | 9a | 9b | 9c | 9d | 10a | 10b | 10c | 10d | 11a | 11b | 11c | 11d | 12a | 12b | 12c | 12d |
|---|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Mean | 2.51 | 3.8 | 2.4 | 2.2 | 3.31 | 3.89 | 4.22 | 3.32 | 3.88 | 4.03 | 3.9 | 3.79 | 2.39 | 2.4 | 3.3 | 3.8 | 2.51 | 1.8 | 3.46 | 2.87 |
| Median | 2.00 | 4.0 | 2.0 | 2.0 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.0 | 4.0 | 2.00 | 2.0 | 3.0 | 4.0 | 2.00 | 2.0 | 2.0 | 4.00 | 3.00 |
| Mode | 2 | 4 | 3 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 4 | 4 | 2 | 1 | 4 | 2 |
| Std. Deviation | 1.08 | .98 | .97 | .93 | 1.16 | .912 | .768 | 1.07 | .819 | .767 | .86 | 1.05 | 1.04 | .95 | .88 | .87 | 1.03 | .88 | .12 | 1.02 |
| Skewness | .357 | - .13 | .31 | - .542 | -.946 | -.675 | - .813 | 1.12 | 1.52 | .76 | 6 | -.644 | .423 | .51 | - | .41 | .93 | - .14 | .88 | -.640 | .212 |
| Kurtosis | -.856 | .53 | - | - | -.542 | 1.12 | 2.52 | - .134 | 3.85 | 1.74 | .73 | - .262 | -.784 | - | .20 | .18 | .83 | -.312 | .54 | -.574 | -.870 |
Principal Component Matrix, Q6-Q7

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<thead>
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<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>Q6a</td>
<td>.238</td>
<td>.763</td>
<td>-.386</td>
<td>.283</td>
</tr>
<tr>
<td>Q6b</td>
<td>.842</td>
<td>-.342</td>
<td>-.249</td>
<td>.310</td>
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<td>Q6c</td>
<td>.971</td>
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<td>Q6d</td>
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<td>Q6e</td>
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<td>.191</td>
<td>.323</td>
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<td>Q6f</td>
<td>.127</td>
<td>-.178</td>
<td>.721</td>
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<td>Q6g</td>
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<td>Q6i</td>
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<td>Q7b</td>
<td>.528</td>
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<td>Q7f</td>
<td>.603</td>
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Principal Component Matrix and Variance for Q6 and Q7.

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<th>Component</th>
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<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
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<td>% of Variance</td>
<td>Cumulative %</td>
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<tr>
<td>4</td>
<td>1,983</td>
<td>12,392</td>
<td>95,399</td>
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</table>

Frequency tables from the responses show the lifestyle segmentation with a more compact range of responses, where the average standard deviation between questions is 0.62. The standard deviations range from .4 (taste) to .75 (lifestyle choices). The average standard deviation for environmental attributes in Q7 reveal an average also at 0.62 in standard deviation, with a range .38 (Other) to .77 (personal or health problems).
## Principal Component Matrix, Q8-Q12

<table>
<thead>
<tr>
<th>Question</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>-0.408</td>
<td>0.085</td>
<td><strong>0.561</strong></td>
<td>0.261</td>
<td>0.197</td>
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Chapter 5: Concluding Results- The Viability of Aquaponics in Iceland

5.1 Introduction:

When assessing the viability of aquaponics in Iceland, the question is not simply whether or not it is viable, but to what extent it is viable, and where and to whom would it be most applicable. This is because the viability can certainly be achieved, but the extent to which aquaponics can be maintained as a sustainable practice and how that practice can most efficiently be implemented is important. Thus, the viability assessment is implicit in how the practice could most effectively function. Consequently, considerations from this chapter manage a variety of factors, drawing from the previous chapters into a synthesized picture of aquaponics that looks at ideal points of entry for a business through demographics, market characteristics, returns on investment and energy costs, previous case studies, policy and limitations and extended research opportunities.

From the previous chapters, several considerations become apparent. To begin, consumer attitudes and behaviors are conditioned on a myriad of factors, and they need to sustain a connection to the products in to provide a stronger willingness to purchase products. With organics, there is a drive for health promotions, along with quality and environmental efficacy. However, from the consumer survey, it becomes apparent that the rewards offered are limited by price barriers. In Iceland, where there is a heavy increase in tourism and high prices for produce, managing an outlet for increased production and local produce is invaluable, although taste and accessibility remain prominent, along with trust in the producers. Forging a relationship with the producer helps to increase credibility, which needs to be bolstered by the facility’s narrative.

Consumers need to take on a position where they feel their input can help dictate the product selection and characteristics. The country depends on imports, of which several varieties are not necessarily adept to the environment, even with increased greenhouse focus. For the products that are viable, an increase in production must either outweigh the current prices or provide a fitting incentive to purchase produce with high premiums. Product selection
should appeal to a wide enough demographic to justify the production or be focused on an increase in product varieties.

Fish and fish products are increasing in the aquaculture sector and slowly extending past fishery development. However, finding the right fish species in an aquaponics system that could maintain proper stocking densities and out-compete already established operations will still take time and research. There are many opportunities for sales with species of tilapia, and series of lesser-explored fish species, such as bass, sea bream and wolf fish for introduction into the market. With the research from Matis, we can see a need to appeal to younger generations, who are consuming less (Matis, 2016). The features of aquaponics allow for consumers to generate a connection to the fish and allow for increased confidence and knowledge in their purchases.

Many of the consumer demands for organic products can be satisfied through aquaponics. The produce holds to the local appeal that is desired, with an environmental focus, mitigated water waste, access to a wide variety of produces and fish. It permits a more tactile approach, developing an increased level of trust between consumers and producers and gives the consumer an outlet for dictating product selection and quality standards. The consumers can rely on the facilities for justification for their product requirements which are not dependent on brand claims or labels and it enhances trust between the consumers and the businesses. The practice appeals to Icelanders and Non-natives alike, conjuring a myriad of opportunities for sustained tourism and promotion.

5.2 Market Points of Entry

The key consideration to a market strategy is finding out what points of entry an aquaponics facility could manage in the Icelandic market. This comes under considerations of the proper end users, system scaling, key demographics, produce and fish selection, market characteristics, community drivers, and incentives/rewards for promoting sustained purchases. Aquaponics is still in developmental stages, where scaling is determined on regional and administrative factors and not fit into a consistent framework, as the systems still have heavy
data gaps (Love, 2015). Nevertheless, this thesis offers insight into ideal strategies that can be utilized for aquaponics systems.

With regards to tailoring to end-users in Iceland, there are opportunities for direct sales, business-to-business (B2B) outlets, selling secondary products, selling food source as feed, community-supported agriculture (CSA) programs, educational outlets and sales to restaurants. Previous chapters suggest that although restaurants and B2B models are ideal candidates, that targeting these end-users disconnects consumers from the aquaponics facilities, and as a standalone strategy would disassociate the positive benefits from seeing the production sites and showcasing the production cycles, which in turn would diminish the opportunities supported in aquaponics production. Secondary products would fall under the same impediments in the sales provided, unless proper promotion and advertising opportunities can justify the premiums.

Although no end user is mutually exclusive to other groups, the initial setup would ideally focus on an outlet that reaches out to the highest number of individuals with the widest demographic distribution to generate the most exposure and awareness of aquaponics principles. As aquaponics is still relatively unknown in Iceland and consumers have a lower understanding of the practice, it would be ideal to target a market schema that initially relies on exposure to aquaponics, showcasing its potential and outputs. Lapere (2010) expresses a similar situation in South Africa, where the need to incorporate diversified income streams, offer niche products and manage agritourism are key to starting up a local aquaponics facility, as it would initially generate the most interest that can be later readopted into new market outlets. Dehling’s (2013) work on crowdfunding mentions aquaponics as a specialty project that merits opportunities for additional crowd-generated funding due to its unique nature.

An ideal facility would manage a high number of touchpoints (opportunities for the consumer to interact with the business) and an operation that allows for variable product and fish selection as well as educational benefits in the early stages. An operation would manage well if it were developed in tandem with pre-existing facilities to aid in brand recognition,
which would mutually benefit both companies. The Ohio State University’s food educational resource guide expresses that with sustainable models, such as aquaponics systems, they derive value, which is “redistributed along the food supply chain and creates opportunities for entrepreneurship in specialty and value-added products that incorporate feedback loops between consumers and those businesses” (Fox et al., 2016).

Aquaponics sales are conditioned on the question of “why ought I purchase this specific product over another?” An aquaponics industry must ask itself how they can justify higher premiums with the product selection it offers over other produce. Despite indications from consumer surveys and research detailed in Chapter 1 indicating that the qualities of “local”, “organic”, “trust”, “availability”, “quality” and “health” attributes being satisfied, the price barriers and limited knowledge of consumers may stifle opportunities for sales. This goes in line with results from Eide and Toft (2014) and Hughner et al. (2007).

This thesis indicates that there is a high level of competition in Iceland, not only between producers but also against the price of imports. The conditions warrant a need to find the most available entry point into the market, where product selection has a higher level of play after the market entry. A CSA model can act as a good entry point into the market, where even if prices cannot compete well enough with current providers, modelling a community-supported program can generate interest and lead into more stable developments.

This was elaborated on by Crews (2016), who determine that despite market characteristics that would be ideal for the highest sales margins, the “aquaponic greenhouse cannot create enough produce for an anchor institution” in its initial stages and instead would have to rely on a co-op CSA model until they could generate enough income to expand into further programs and expand their systems. They found that the fish could not maintain high enough sales for profit and that product selection could not compete with local distributors, which realized a CSA model as the most fitting solution until product recognition and a stable clientele basis can be established (Crews, 2016).
5.3 Return on Investment:

There are few reports on the return of investments (ROI) given by aquaponic systems, as there are a multitude of setups available geared towards different end-users in tandem with relatively few commercial facilities. In turn, the ROI is based on speculation and regionally exclusive. Nevertheless, several results can be established from previous reports given. Iceland’s available heating and energy allotments provide an ideal eROI for a commercial aquaponics system. Although eROI calculations were not detailed, the results from Ragnarsson (2014) and Goddek et al. (2015) mentioned in Chapter 3 can facilitate as a starting point to finding how proper energy incorporations and utilizations can be implemented in an Icelandic aquaponics system.

Aquaponics have been proven to be quite successful in market ventures as well, provided they have suitable preliminary research prior to operations. Returns on aquaponics systems are variable, and once again contingent on size and the market. Based on the research from the UVI, a 20-year projection on the internal rate of return (IRR) and net present value (NPV) given a 20% discount rate yielded a projected IRR 11.1% for 6-system farms, 17.9% for 12-system farms and 21.7% for 24-system farms; the NPV was given for these systems at $(127,655), $(60,208), and $116,508 respectively. This study found the total costs for the 6-system farm to be $154,589 annually, with the returns to risk and mgt. at $(52,255); 12-system costs were placed at $266,678, with returns at $(62,010); the 24-system facility faced costs at $518,355 and returns at $(109,019) (Bailey et al., 1997).

English’s (2015) introductory work on the economic feasibility of aquaponics find the systems to be most profitable in temperate climates, where hydroponics is a more fitting alternative otherwise. This is not in consideration of Iceland’s climate and energy resources, which may give a better advantage to fish rearing and investment returns. A closer investigation was offered by Soppela (2016) on special requirements for aquaponics in Finland. His findings determined that the natural resources available in Finland could promote a
successful operation, although the energy requirements in Finland would require long-term investment to maintain a successful ROI. Scaled to Iceland, this problem can be easily overcome.

Olukunle’s (2014) research into horticulture-aquaculture integrated systems not done strictly aquaponically “fetched about 6-27% higher returns compared to aquaculture alone, besides generating employment opportunity around the year”. The hybridization offers an increase in opportunities with a system that mitigates losses on both ends of the system. This does require more technical prowess, but receives higher long-term rewards. In approaching aquaponics, considerations of the return on investments need to be tailored to long-term rewards and offerings derived from both the agriculture and aquaculture facets.

5.4 Policy:

Policy considerations are of great importance, where despite a properly structured market approach with a solidified consumer group, legislative boundaries can completely unravel a project. This extends not only to licensing and operational standards, but also to auditing processes, labeling practices, and certification. There are few outlets for hydroponics and aquaponics to obtain organic certifications, as they fail to fit within the proper guidelines and utilizing the combination of fish sales and agriculture in a soilless medium increases the difficulty even further. Furthermore, misunderstandings about the potential for transmission of diseases through the water circulation can impede on maintaining an optimally working system.

Organic policy demands an immediate overhaul, with standards recognizing the global market and changing demands brought forth by technological advancements. The policies have become a huge barrier to consumers, as it creates arbitrary dimensions that confuse and dissuade them, fostering a weakened level of trust. Many truly organic crops do not correspond to typical aesthetic dimensions set forth for gradation purposes (e.g. curvature of cucumber, robustness qualities, weight) and the “desire for attractive and homogenous appearance” outweigh efforts towards pest resistance and quality of food (Bellon & Penvern, 2014). The bombardment of technical terms and legislative loopholes obfuscate the goals of new producers
and consumers, leaving an apathy as “the consumer is left to act passively, meaning that the individual must assume the information provided is adherent with his/her socially and political ideologies” as opposed to utilizing the information (Bingen, 2015).

Many products that are otherwise organic fail to meet criteria for organic certification and regulatory practices bar certain products from becoming certified due to the legislative focus being placed on nonconvertible products. Regulation on this is very problematic as “few good models exist …inspection bodies do not collect and/or release data…organic is not separately identified in trade statistics…and businesses are highly sensitive to confidentiality issues” (Willer et al., 2011). Aquaponics suffers significantly from receiving organic certification, where most famously, European Council regulation EC 834/2007 bars aquaponics and hydroponics from being considered organic (EC, 2007). Despite offerings to revisit the definition in the future, there has yet to be any restructuring for the organic qualifications in hydroponics and aquaponics.

The licensing, certification and auditing practices can also be hindered depending on the way an aquaponics facility is tailored. Whereas education and agricultural tourism would not be burdened by the legislative boundaries, a direct sales approach or a B2B model would lose a portion of their net income traded for the security offered from a consistent stream of sales. The certification practices outlined in Chapter 3 also present further difficulties for operating fish sales with regards to the space and condition requirements for fish production to match sales and production numbers that could be obtained. A large-scale facility could accommodate more room for fish production; however, it would be mitigated by the extent to which a low-cost fish option would not be able to meet sales demands and remain in compliance with stocking densities and environmental regulations.

Because aquaponics goes through various iterations of setups with varying degrees of filtration and can even be achieved through desalination, appropriating aquaponic models to a blanket category can be less effective for regulations. This is opined in Sander’s (2013) evaluation of EC Regulations, where EC definitions are considered unclear and vacillate
between regions, tailored to specific purposes that need re-evaluations. Kahl et al. (2012) discusses how the “concepts and definitions are changing in development”, and are tailored to specific farming techniques and not to the conditions of organic production.

In regards to plant contamination to humans, it is infeasible and particularly uncommon for any issues to occur. For example, Graber states that “microbiological contamination of the target plants is not a problem discussed in aquaponics literature, as the harvested crops have only contact with the fish water by their root systems,” evidencing that properly running systems could not warrant any pathogenic issues (Graber et al., 2009). The Leopold Center also produced extensive research in this capacity and failed to find any traces of human pathogens (E. coli or Salmonella spp.) present; in fact, the aquaponics water circulating process further reduced potential for contamination over soil-based propagation (Patillo, 2016). Chalmers (2004) found contamination “quite rare…from the perspective of food safety in aquaponics systems, there seems to be much less likelihood of contamination of vegetable and other aquaponics crops, and fish, with pathogenic bacteria of domestic animal origin, and with microscopic parasites such as Cyclospora sp. of human origin, and Cryptosporidium sp. of domestic animal origin, in aquaponic systems, especially in indoor systems, compared with the potential of such contamination in the traditional field methods of growing such crops.”

The legislative barriers can be overcome with creative outlets for sales in small scale systems, but are dwarfed when a commercial facility operates. In Iceland, this mitigates cooperative practices and can staunch the growth on systems that are not designed to fit within this regulatory schema. From Chapter 2, the demand is evidenced where the costs of purchasing domestic are stifled by the ease of importing produce and the current agricultural regimes are not as open to an aquaponics facility, which cannot compete with the opportunities offered from standard greenhouse operations available. Compliancy could best be achieved with partnerships from already-established operations in supplementing produce that offers organic and environmental values, although maintaining proper certification for these specific criteria are questionable.
5.5 Case Studies

The scope of aquaponics is still in development and consequently tailoring research to case studies is still developing and not yet perfectly systematic. Nevertheless, there are a series of viable case studies that will be briefly reviewed and viewed in respect to Iceland. Case studies show several factors that vary, such as products, system setups, scale, regional characteristics, and time. The following case studies produced in Alberta (Savidov & Brooks, 2004), Puerto Rico (Granger, 2013), and Virgin Islands can give insight into development that has occurred and adapt the results to an Icelandic context. This is important as a penultimate area of consideration before the conclusion, as the results from the studies can be incorporated and balanced against the previous chapters, to further identify how Iceland can act in the aquaponics market.

5.5.1 Alberta:

The research presented in Alberta, Canada was presented by Savidov and Brooks in August, 2004. Focusing on various systems and their capacities, they had found several instrumental findings. The primary concern in many of the facilities was proper rotation of crops to prevent nutrient spikes and tailoring the systems to resulting in appropriate yields (Savidov & Brooks, 2004). The system was found to be efficient in maintaining pest control and the fact that the system yielded no pesticides and was more conceivably clean and organic helped to promote business and achieve a higher reception amongst the community.

The Alberta facility capitalized on consumers’ WTP for premium products, which worked out quite well. There were no direct figures on profitability, but the evaluation showed that aquaponics marketing could absolutely abate apprehensions regarding greenwashing, cultural predispositions against tilapia (i.e. why purchase tilapia over local fish), concerns over the general workings of aquaponics and health and safety debates. The authors demonstrated a SWOT analysis, which characterizes most of the threats and weaknesses in the regional market to be surrounding climate-related issues, administrative and legislative practices and a concern
for a novelty practice emerging and maintaining strength in the market (Savidov & Brooks, 2004).

The study looked at several different groupings of plants in regards to commercial significance and tolerance/mineralization of the different vegetables. Group 1 consisted of “High CF (conductivity factor)” vegetable, namely tomatoes and eggplants; group 2 was a “medium CF”, relying on basil, chives, spinach, parsley, lettuce and cucumber; and group 3 was focused on “low CF” watercress (Savidov & Brooks, 2004). This method demonstrates how sectioning off different plants can contribute to more efficient growth and mineralization, while still tailoring to market demands and rotating crops. The study was very thorough on the spikes and dips in chemical compositions, which is a common occurrence especially around feeding times.

<table>
<thead>
<tr>
<th>Market Size*</th>
<th>Consumer age</th>
<th>Income</th>
<th>Spending Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>36- over 65</td>
<td>$10,000-$25,000</td>
<td>Up to 20$</td>
</tr>
<tr>
<td>Medium</td>
<td>36-55</td>
<td>$40,000-$55,000</td>
<td>$11-$30</td>
</tr>
<tr>
<td>Large</td>
<td>36-55</td>
<td>$65,000-$80,000</td>
<td>$21-$30 OR over $50</td>
</tr>
</tbody>
</table>

* Small markets: less than 25 vendors; medium markets: 25-100 vendors; large markets: over 100 vendors

One of the most striking effects of this study was the amount of market research that was conducted and the extent to which market demands and scaling shifted along with the clientele. Savidov demonstrated one farmers’ market in Table 5.1, which reflects spending habits and key demographics of consumers in relation to their incomes. This reflects a different key demographic to the indicated Icelandic market, where despite consumers between 35-65 being more apt to shop at farmers’ markets frequently with more disposable income, it would be less likely to incentivize them locally to purchase aquaponics produce, although it could still be maintained as a secondary consideration. Because Iceland also maintains a smaller representation of farmers’ markets, such a strategy would be less appealing to a large target audience.
5.5.2 Puerto Rico:

The Puerto Rico report was conducted by Granger (2013) as part of an academic paper for the Worcester Polytechnic Institute. The report focuses on market interest, potential for market success and the value of aquaponics-based education. Puerto Rico shares with Iceland in regards to dedication to conventional agriculture and dependency on imports, although it has much more arable land. Much of the obstacles face in aquaponics viability in Puerto Rico surrounds educating consumers and bringing awareness as well as surveying reception to aquaponics. The key areas they presented for investigation were the following:

“[1] What is the community’s knowledge of organic and GMO-free foods?
[2] What is the market’s willingness to buy organic and GMO-free foods?
[3] Where is the strongest market interest in products grown in aquaponics systems (organic and GMO-free)?
[4] Are restaurants interested in a small-scale aquaponic system for their business?” (Granger, 2013)

The most intriguing aspects of this study were strong correlations between consumer knowledge of organic produce/GMO produce and WTP for products. The study shows a vested interest in the practical feasibility of restaurant owned/support aquaponics systems for produce, but relatively high uncertainty for execution or long-term benefits. Concerns over consumer perceptions were combatted in Puerto Rico through very overt marketing and branding strategies as a means of promoting the product as well as its benefits and narrative. This strategy works well in curtailing disinterest and helping to promote sustained commitment from the consumers from their relationship maintained with the products.

The market findings from this study were interesting, as it showed a lot of detailed market behavior. Age distribution seemed to have no dominance and the demographic was localized to a Hispanic market. Over 70% agreed to having basic knowledge of organic and GMO-related food options with no significant correlation between food purchasing options (i.e. most remained neutral) (Granger, 2013). In regards to consumer purchases at stores, lettuce and tomatoes were in the highest demand of aquaponically produced produce, carrying health and
taste as the highest priority, and availability and quality as the lowest priority issue (Granger, 2013). It seems that most restaurants had locally been dissuaded by price point issues among restaurateurs as well.

The educational aspect of this study yielded spectacular results, with almost univocal agreement on the effectiveness of the program and its ability to translate the results, although much of the participants were already enthusiasts. The authors make a good point in utilizing Facebook, Instagram and other social media to attracting new attendees and expanding the business model. Iceland can learn from the research that restaurants and consumers both have a very strong desire to choose healthy food source alternatives that offer an environmentally friendly option. This is not dissimilar from the Chapter 4 study, which emphasized taste as a marketing point with environmental efficacy as a moderating agent.

Consumers have, according to this study, a very obscure view of proper organic production and what is constituted as a green market. The WTP is often based on governing bodies regulating standards and not on actual knowledge of the products (Janssen & Hamm, 2012). This is also apparent, as many consumers implicit and explicit motives are used in formulating the decision-making process for organic produce (Yu et al., 2014). Having a familiarity with product choices, benefits and nuances in organic/green food choices gives consumers a better foundation in their purchasing habits. In accordance with this, the Puerto Rico case studied finds that providing education and fostering confidence in the individual can potentially mitigate the cognitive load associated with purchasing decisions, making the purchasing patterns more natural, as it strengthens previous held preconceptions. This gives a distinct opportunity for aquaponics production, as it posits itself as interactive as much as it is functional.

As a final note, Iceland can benefit from having a means to looking at consumer preconceptions that influence purchasing habits and identifying key industries and end users for tailoring aquaponics produce. Under-produced, niche items in high demand are of great importance locally, and working in tandem with the restaurant industry can prove itself to be
invaluable. If the study is true insofar as there is no statistical evidence favoring a restaurant type hosting organic produce, then the opportunities for production and distribution are highly favorable and reveal an increased number of end users to be explored for a variety of purposes.

5.5.3 Virgin Islands:

The Virgin Islands act as a poster child of sorts for commercial aquaponics facilities. The fish are put on a 24-week growing cycle, and the return is roughly 11,000 lbs. of basil or 1,400 crates of lettuce annually as of 2011 (Rakocy et al., 2011). The operation is overall quite successful and aquaponics has been considered a fitting avenue in the Virgin Islands due to its environment. Because there is such a heavy amount of literature already established on the UVI (University of Virgin Islands) system, this case study instead focuses on some brief takeaways in regards to the current Icelandic climate.

Choice products are relegated mainly to leafy vegetables and tilapia as the fish of choice, as both are most resilient and stable in a growing environment. Table 5.2, taken from Rakocy et al. (2011) lays out the production parameters and income levels for vegetables in the system. Cunningham (2015) makes mention that prices for production were higher than market average, although they did outproduce other markets. The strategy is considered successful and relies heavily on continuous production and a fair knowledge of the common market prices and practices. The UVI system has the distinct advantage of having over 30 years of committed research and one of the most thorough series of documentation available.

Table 5.2: Production Parameters and Income Levels for Vegetables Grown in the Commercial-Scale UVI Aquaponics System (Rakocy et al., 2011).

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Plant density (#/m²)</th>
<th>Production Cycle (weeks)</th>
<th>Sales Price (US $)</th>
<th>Annual Income (US$/m²)</th>
<th>Annual System Income (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf Lettuce</td>
<td>20</td>
<td>4</td>
<td>1.50/each</td>
<td>292</td>
<td>62,595</td>
</tr>
<tr>
<td>Romain Lettuce</td>
<td>16</td>
<td>4</td>
<td>1.50/each</td>
<td>234</td>
<td>50,076</td>
</tr>
<tr>
<td>Basil</td>
<td>16</td>
<td>4</td>
<td>26.40/kg</td>
<td>515</td>
<td>110,210</td>
</tr>
<tr>
<td>Okra</td>
<td>3.7</td>
<td>12</td>
<td>1.10/kg</td>
<td>15</td>
<td>3,210</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>.67</td>
<td>13</td>
<td>2.99/kg</td>
<td>46</td>
<td>9,884</td>
</tr>
<tr>
<td>Chives</td>
<td>80.7</td>
<td>6</td>
<td>1.00/bunch</td>
<td>700</td>
<td>149,800</td>
</tr>
</tbody>
</table>
The immediate consideration that needs to be taken is the planning and research associated with this system. Led by Dr. Rakocy (2011), this system is very good at giving an ideal reference point for operations as well as maintaining a standard for many aquaponics principles. Many aquaponics websites and forums where enthusiasts had wanted to pursue commercial aquaponics have noted that the biggest failure stems from having an ill-equipped market outlook and a treatment to the sales procedure in a mirrored fashion to conventional agriculture. Studies have shown that direct sales at farmer’s markets leads to wasted crops and higher break-even prices. Following that, fish are meant typically to be a net return, and that the focus on plant sales is a much more viable procedure. The successes and obstacles outlined by the UVI systems helps give a very clear path of how to optimize system efficiency and growth, or at least a point of reference for adapting and developing new strategies. The UVI systems have been successful at maintaining sales despite having higher-than-average market prices.

The UVI systems facilitate an environment of exploration and innovation, which allows for new avenues of research and development. The systems have yielded, per Goodman (2011), “productivity levels of basil and okra in the aquaponics system to be 18 times and 3 times higher, respectively, then in the field system.” Bailey et al. (1997) echoes this sentiment, under an economic analysis that proved to be profitable with cost for production exceeding the investment. Because of the low energy costs and high degree of traffic, Iceland can mirror these practices with an extended field of research and development. The size of the country offers a very ideal test region for pilot studies, with a high influx of different demographics and continuous traffic of tourists as well.

5.6 Discussion, Limitations and Extended Research:

5.6.1 Discussion:

With regards to aquaponics, the viability of a commercial system is only a small fraction in an even smaller subset of agricultural and aquaculture practices. It is not a universal solution, nor does it at its current state hold the capacity to completely overhaul agricultural paradigms. What it does offer is a new means of production that can offer a novelty product to a large
selection of demographics with considerable opportunities for product variety and quality. The core principles in aquaponics are reflected by consumer values, with a multitude of touchpoints for systems that could integrate in the Icelandic climate with a high success rate and mitigated energy costs.

This revisits the question of if the advantage aquaponics holds over hydroponics operations or soil-based agriculture. The answer relies on different conditions for the operations and can be tailored to various purposes. Aquaponics production has been proven to outperform and give better yields than conventional agriculture under set conditions. For example, Yamamoto and Brock (2013) compared the efficiency of hydroponic, aquaponics and soil based agriculture for cultivation of beans, tomatoes and peas. Their results yielded hydroponics to be significantly stronger in immediate uptake of vegetable, with aquaponics having a better quality of plant in regards to aesthetics and nitrate uptake, influencing more long-term value on the crops. Furthermore, Shanbhag et al. (2014) and Graber et al. (2009) both found that multistar variety cucumbers produced 18.25% more yield, with a lower mortality rate for crops over time and a higher capacity of fruit flowering and better nutrient recycling rate. However, further studies need to address all specific criterion for evaluation to determine the relationships between market strategies in aquaponics, hydroponics and soil-based agriculture.

In relation to the raw data of imports and the agricultural climate, aquaponics holds a distinct advantage of being malleable to consumer values and motivators while also hosting a large array of products. Whereas hydroponics may statistically show identical in output and easier in maintenance, aquaponics could work as a more fitting transitory means into exploring urban agriculture that would appeal to a more localized view of cultural values. In many permaculture societies in Iceland, for example, the personal biases towards hydroponics is far less palatable, and many consumers that are neutral or slightly unfamiliar with hydroponics production have found that the soilless production has warranted a bland taste and somewhat watered-down texture in produce, despite scientific studies stating otherwise (Matthew et al., 2011).
An aquaponics system would be most fitting if it were to allow a frontend display that provided recreational, aesthetic and novelty values with a backend production site. This also allows for many of the lower-quantity, niche imported items to be experimented in the frontend display whereas the backend manages market production. Because of the high prices for produce, consumers are often skeptical to explore different options, although the appeal would work quite well in areas catered to high tourist traffic. Research on consumer values on organic produce has proven through Eide and Toft (2013) and Gleim et al. (2013) that price is an extensive barrier to adopting more environmental and ‘green’ purchasing habits in produce. However, several authors, such as Dowd and Burke have discovered interesting relationships with subjective norms and ethical behaviors that influence willingness to purchase, with health and environmental efficacy being the primary agents to transcending those barriers (Dowd & Burk, 2013). This is further bolstered in the consumer survey from Chapter 4 which dictates the principles of aquaponics fitting into a market schema.

This does give a distinct advantage to an aquaponics model, as it would act as a good foot in door, allowing consumers to begin investigating and adopting a wider range of affordable and accessible produce. There is a specified niche in aquaponics that would work alongside the current produce demand and give an acceptable amount of risk while still guaranteeing a return on investment, mitigate import requirements and satisfy both local and tourist demands. As aquaponics entails a large novelty factor, production sites can offer unique tourism opportunities tailored to both tourists and locals that can generate community-driven programs which eventually can branch off and generate more small-scale operations hosted under a single organization. Of the various implementations for aquaponics facilities, future studies can encompass:

- **Market Research**: Looking at the market for available points of entry into the market and secured end users.
- **Scaling**: Investigating proper scale and production cycles to establish a fair break-even price that would reach out to the highest level of consumers.
- **Consumer surveys**: Produced to look at key demographics and most fitting opportunities for aquaponics produce and under what conditions to market it.
- **Technical research**: Assessing the benefits and limiting features of the various systems and their applications in regards to different products.
- **Comparative research**: Taking the above case studies as well as other applicable commercial systems and comparing the research and strategies to find a uniform, streamlined approach at commercial aquaponics systems locally and abroad.
- **Environmental impact assessments**: Looking at the composite energy costs and environmental impact to properly assess the different advantages and disadvantages to conventional agriculture. Life cycle analyses can also be implemented.
- **Alternative means of urban agriculture**: Comparing yields on aquaponics system and inherent challenges against hydroponics and aeroponic systems.
- **Education**: Looking at the educational application stemming from aquaponics systems and the relationship to immersion education.
- **Food Mapping**: Developing a food ontology that can assist in further exploring regional characteristics and opportunities for various product opportunities.

This is not an exhaustive list and there is a myriad of extensive measures for research and applications, especially in the hands-on field. The authors intend to follow this study in future publications with further development and expansion of current pilot aquaponics systems at greenhouse farms in Iceland and with market research, as well as extending the extrapolated results from the current study. Aquaponics research is still in a juvenile stage, and more scholarly research in this field is greatly encouraged from a multidisciplinary approach. This is important not only in the scope of the incredible yield aquaponics, but also in communicating a distinction between enthusiasts/hobbyists and scholarly applications. This compliments varying approaches and designs, which would work well in educational settings.

### 5.6.2 Limitations:

As this paper covers a large series of topics that explore different dimensions of aquaponics, each chapter has a series of limitations in their approach that can be expanded upon. This research did not cover technical aspects for production and different strengths and weaknesses involved in various system designs. It also only lightly touched upon the differences between aquaponics and hydroponics. Legislative boundaries are also only lightly brushed upon, and can be expanded in future research. Although the paper does designate when specific regions in Iceland are being discussed (i.e. in Reykjavik, etc.), further studies can be provided for full research in one specific area.
Chapter 1 was limited to the discussed theories of behavior, which indicates a strong profile for consumer habits towards consumptions. It can best be strengthened with the addition of other theories and an increase in EU-centered studies to offer extended research on how localized models are effected with regards to tourism habits and changing environments. Future studies could afford to look at only quantitative or qualitative studies and utilize preexisting surveys to determine new categories that consumers can be broken down into. This chapter could have benefited from the inclusion of more Icelandic papers to enhance the profile of local organic purchase motivators.

The methodology and approach in Chapter 2 focuses on a large body of data. Finding new methods for analyzing and expressing this data could be invaluable, beginning with the exclusion of the fruits and vegetables examined that would not be feasibly viable for commercial production in Iceland, such as bananas. This would allot for only the marketable produce that can be measured against their profits maintained from local production against import costs. An extended study on price points, yield times, and returns would become invaluable for a full assessment on the key products that would be most fitting for increased focus in Iceland.

Chapter 3 would equally benefit in future research from a more detailed breakdown of price points, international and domestic sales and local case studies involving the farms mentioned from the MAST database to provide a more intimate picture of where aquaculture development stands. This can be coupled with farm sizes and stocking densities in relationship to price margins, which would allow for studies in commercial aquaponics facilities to assess whether they could feasibly compete with local producers. A continuation on the breakdown of fish species would be ideal in future studies, as this could also incorporate the potential for new species to be adopted into the market.

The consumer survey in Chapter 4 acts as a fitting indicator for consumer habits, where University students host a wide range of backgrounds and demographics with varying conditions and beliefs concerning organic produce. They entail a wide scope of knowledge and
are more likely to have strong opinions in this topic. Future studies can develop this further with larger sample sizes that extend to a larger distribution of genders and age groupings from different backgrounds. The analysis can be extended to a higher business sample to frame a gap analysis, and the value indicators could reach out to more subgroupings. The study can be readapted into willingness-to-pay models and future studies can also further the research with a study on consumers’ knowledge on the topics of organics to weigh against their responses.

Due to multidisciplinary aspects of aquaponics, the research opportunities are quite vast. The most important aspect that needs to be maintained in the studies, however, is adopting this research into practice. Studies have laid sufficient groundwork for a variety of theories that could be presented in both research-oriented and sales-driven studies, and the next steps for aquaponics comes in implementation to foster a better understanding and presence of the practice in Iceland. Additionally, future studies on the educational benefits of children working with aquaponics models in Iceland can be a beneficial addition to the current body of research. Partnerships with restaurants and food purveyors can allow for a mixture between research and avenues for increased sales.

5.7 Conclusion:

When considering the viability of aquaponics, the point of focus is not simply whether or not it works. Any project can feasibly work, by some standards. What is more apt is whether the practice is sustainable, can be implemented further and permits new avenues for innovation. The practice of aquaponics certainly holds potential for economic viability, provided the operations are tailored accordingly, consumers can maintain a sustained level of interest in the products and new incentives can be offered to increasing the appeal of the fish and produce.

The efforts to maintain a commercial aquaponics system is not allocated to a single individual; rather, it is contingent upon a community that is willing to actively seek out and promote new products. Offering personal rewards to reflect lifestyles and incorporate outlets for education and community sharing are instrumental in strengthening cultural values and
developing a narrative around food. Aquaponics offers an opportunity for consumers’ voice to be heard, increase a vested interest in produce and allows for a stronger familiarity with fish. This opens multiple dimensions for exploration and can become accessible to both hobbyists and research-oriented positions.

The multidisciplinary nature of aquaponics provides robustness to various marketing ventures. Were it to be unsuccessful in direct sales or not generate a sustained interest to enough consumers, the educational and community-driven outlets are equally welcome to integrating in the community. Whereas each aquaponics producer has a specific ambition to the practice, a continued presence and awareness will manifest more outlets for achieving these goals. This practice can outreach and communicate to non-aquaponics producers, encouraging further opportunities for partnerships and localized production in fish and produce sales.

The future of aquaponics still rests on a multitude of factors. It is showing promising development in the US and EU alike, where both commercial operations and hobbyists are contributing to new and innovative systems offering produce and fish to communities. Aquaponics communities are providing invaluable research and incredible insight into food production systems. Whether the ambitions are market driven, eradicating hunger or simply maintaining a system, what must be said is that the future for the aquaponics industry shows potential for incredible development where the industry in both research and practice will continue to grow. The increase in market presence will offer a new paradigm with a wider variety of fish and produce not only in Iceland, but across the globe.
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