Shaping market conditions for air protein companies

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Preface

As a student at Aeres University of Applied Science and Dalhousie University, I am writing my Bachelor Thesis. The thesis examines market conditions for novel food products made out of Air Protein and suggests the need for further research and development. Working on the research proposal provided new industry insights and made me realize the interconnection between the classes that I took in my last year of studies. Mr. Taco Medema helped me during the writing process with guidance and valuable feedback on my work. I am thankful for his support and open-mindedness for my ideas in our meetings.

The research deviated slightly from the original search words and the research strategy for question two was adapted.
Question two only provided four responses from sending e-mails out. During the research on the companies, some valuable sources were found that added relevant information to the research question. These are YouTube videos of interviews with the CEOs of companies that have not responded as well as one-time online events. In the third question, the search term “how to create consumer awareness on new foods” was adapted to “how to create consumer awareness on novel foods” to find more specific information for the research topic. Through governmental websites, links to related topics such as the Horizon 2020 program were accessed to receive more information for question one and three.

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Summary

The sustainable provision of enough nutritious food for a growing world population is pushing the food system towards finding new approaches to agriculture (Ockenden, et al., 2017). While the demand of animal products is rising (Armanda, Guinée, & Tukker, 2019), the negative effect on the climate, soil, and biodiversity it is predicted that there will be frequent extreme weather events, resulting in the loss of agricultural productivity (Strom, Hu, Haarith, Chen, & Bushley, 2020). As innovative solutions for the future of food are needed for fighting climate change, Air Protein companies have the potential to take a share in sustainably transitioning the food system (Specht & Crosser, 2020). Air Protein companies are producing novel food products with a superior nutritional content than plant-based products by using biomass fermentation. The production process emits a lower environmental footprint than raising livestock or plant-based alternatives such as peas or soy (Air Protein, 2019a). Therefore, biomass fermentation companies are tapping into the realm of fermentation technologies that aim to revolutionize the food system (Solar Foods, 2020). This research is aiming to find how market conditions can be shaped to successfully introduce Air Protein products in the markets of the European Union and United States of America.

In terms of legislation, the EU and U.S. are open for novel foods based on fungi and microorganisms, which are the main components of air proteins (European Parliament; European Counil, 2021) (FDA, 2018). However, the process for receiving a novel food permit is more challenging in the EU than in the United States (Pitkänen, 2021) (U.S. Department of Health and Human Services Food and Drug Administration, 2017). Both governments provide financial aid, have a strong focus on Research and Development, and are shifting towards more sustainable practices in the agricultural and food industry (European Commission, 2020b) (U.S. Departement of Agriculture, 2019). Yet, when looking more specifically at the protein fermentation industry, a letter from the Good Food Institute brings to light that the U.S. is hesitant to invest in Air Proteins (Good Food Institute, 2021a). The EU has recently announced to channel more funding to alternative proteins and focus on shaping market conditions positively through the Food2030 policy (European Commission, 2020a). Moreover, communication with consumers is an important tool, which requires careful wording to avoid creating resistance against the novelty of the products (Siegrist & Hartmann, 2020). As consumers are behaving differently in each market, the companies are responsible for analysing purchasing behaviours and adapting their communication style accordingly (J. Bobo, personal communication, 31.05.2021). Social media, packaging, nongovernmental organizations and scientists can help shape perceptions (Siegrist & Hartmann, 2020). Overall, the findings suggest that more research and development as well as additional governmental support could accelerate the process of scaling the new method of sustainable protein production.

1. Introduction

Since the Neolithic era the human population has been growing exponentially (United Nations, n.d.). It is assumed that by 2050 there will be more than 9 billion humans on earth, which is two billion more than today (United Nations, n.d.). Urbanization is causing more humans to live in cities than in rural areas which brings an imbalance in food needs (Qiu, Li, Tang, Chen, & Berry, 2020). Almost 80% of food produced is consumed by urban dwellers (EAT Forum, n.d.). However only 5.9% of cropland was part of urban areas in 2014 (Nicholls, Ely, Birkin, Parthiba, & Goulson, 2020). This is triggering a disconnection between food and the place of production (Nicholls, Ely, Birkin, Parthiba, & Goulson, 2020). Globalization and more financial stability led to more demand for animal products, whilst overall inputs increased with it (Armanda, Guinée, & Tukker, 2019). Consequently, it is expected that in 2050, 50% percent more food will be needed than in the year 2012 (Armanda, Guinée, & Tukker, 2019). As the production of animals require high inputs of land, water and feed, all will have to increase to provide the demanded meat products (Mekonnen & Hoekstra, 2010). This fosters the concern of having to feed the world population in the years to come. Thus, humanity has reached a point where new diets and more efficient production methods should be considered (Fanzo, 2019). If conditions for reaching climate neutrality in CO2 intensive sectors are set right today, it can be part of forming a future in prosperity (O'Sullivan, 2020).

What are the risks that climate change brings?

Climate change is a threat to the livelihood of the planet for future generations (UNICEF, 2019). It involves processes that accelerate each other in the context of global warming (Shi, et al., 2021). While temperature fluctuations have always occurred, global warming is unusual as it happens because of the influence of human activity (Shi, et al., 2021). Global warming is affecting the rise of sea levels, more extreme weather conditions, and mass extinction of essential species, which is predicted to ultimately result in an imbalance of the ecosystem (Easterling, et al., 2000). The European Commission claims that the food system accounts for 20% of greenhouse gas emissions, contributing to global warming (European Commission, 2019a). Animal-based food products add an especially high amount of greenhouse gas emissions to the atmosphere. For instance, ruminants contribute around 90% of direct greenhouse gases of the food sector (Henderson, et al.). Furthermore, valuable forests are cleared to plant feed for livestock production, destroying natural air filter systems and habitats for many species (WWF, 2016). This is a driver for climate change that is indirectly connected to food production (WWF, 2016). In exchange for the forests, highly intensive monocultures are introduced (WWF, 2016). Soy is one of the leading crops that is planted in these regions of which 75% is turned into feed for livestock production (WWF, 2016). Another problem arises with soil exploitation and weather conditions that cause nutrient deficiencies and unfavourable conditions for farming (Strom, Hu, Haarith, Chen, & Bushley, 2020). During the last years, temperatures have been rising in various regions in all seasons, shifting the world of agriculture irreversibly (Panagos, et al., 2015). Extreme weather such as droughts have impacted soil health that resulted in harvest losses (Panagos, et al., 2015). Financial losses because of extreme weather conditions will rise with every year if there is no adjustment in production methods (Grillakis, 2019). The European Environment Agency

investigated the soil loss rates in European arable lands. It showed that fertile countries like Italy have been experiencing more drought than usual, and that this has started to spread into colder regions, such as Sweden (European Environment Agency, 2012). This development already has far-reaching impacts on an economic, social and environmental level. An estimate of 7.4€-14.2€ Billion will be lost yearly due to droughts (Cammalleri, et al., 2020). Agriculture accounts for 39% to 60% of these losses, and will require higher inputs of water or drilling new wells to revive the dried landscapes (Cammalleri, et al., 2020). Moreover, extreme weathers such as wildfires, hurricanes and flooding are becoming more frequent in many parts of the United States (Center for Climate and Energy solutions, n.d.). Extreme weather events such as hurricane Harvey in 2017 are costing billions of Dollars for restauration, business interruptions, health care, and more (Center for Climate and Energy solutions, n.d.). Besides this, the changes in climate trigger an increasing amount of illnesses and ultimately resulting in more deaths (Melillo, Richmond, & Yohe, 2014). For example, several coastal areas are expected to disappear before 2100 due to rising sea levels, putting more than five million Americans at risk of losing their homes (Melillo, Richmond, & Yohe, 2014). These statistics prove that most parts of the world, including Europe and the U.S. are affected by climate change and food production is one of the most central fields that require adaption to be prepared for different scenarios emerging with global warming (Johns Hopkins University, n.d.).

Health implications for humans

Not only is the environmental footprint of certain food products reason for concern but also the health implications for people. Humans require protein as a source of energy, and traditionally use animals as the carrier of this everyday need (Clayton, Specht, Welch, & Berke, 2019). However, livestock production and consumption is producing health issues on many levels. Antimicrobial resistance is one of the most impactful concerns (Clifford, et al., 2018). In livestock production, antimicrobial drugs are used for curing common bacterial, viral, and other types of infections or for enhanced growth of animals (O'Neill, 2016). Some of the medicine given to animals are also used as treatment for humans (O'Neill, 2016). Being helpful at first, these drugs continuously decrease in effectiveness, as mutations from the original infection form (WHO, 2020). This is relevant for humans, as these diseases sometimes are part of the animal products that are consumed (WHO, 2020). Consequently, humans can be infected with diseases that are resistant to modern antimicrobial medicine (WHO, 2020). Additionally, common infections for which humans have found cures, are becoming drug resistant and therefore deadly once again. Agriculture accounts for 70% of worldwide antimicrobial drug use (O'Neill, 2016). Beyond this, human pandemics are more likely to occur in shorter intervals with intensified livestock systems and a decrease in biodiversity (IPBES Bureau and Multidisciplinary Expert Panel, 2020). Another health impact that scientists found is a direct link between cancer and the consumption of red meat (González, Marquès, Nadal, & Domingo, 2020). Moreover, the type of feed provided to livestock influences the nutritional composition of the products (Mann N. J., 2018). Neil J. Mann (2018) claims that the heavy usage of grain feed negatively impacts the nutritional value of meat compared to pasture fed animals. The decrease of nutritional value in many highly processed products leads to another health problem, which is obesity (Gladek, et al., 2017). This is part of a

structural problem that is shaped by an imbalance of food supply and an insufficient nutritional provision (Gladek, et al., 2017).

Food waste

A main driver for food insecurity is food waste. Thirty percent of food is lost from farm to fork, due to technological inefficiencies, adverse weather conditions and the lack of financial means (FAO, IFAD, UNICEF, WFP and WHO, 2020). The "FAO estimates that annually between 20 to 40 percent of global crop production are lost to pests" (FAO, 2019). Globalization is providing a stage for pests to spread from one country to another (FAO, 2019). An estimation shows that in 2020 around 80 billion pounds (36bn kg) of food was thrown away in the United States (Wunder, 2019). In the EU, approximately 53% of waste comes from end-consumers with a tendency of wasting more in high-income countries (Wunder, 2019). While the input used in production is lost, food waste that end up in landfills cause further problems. As food in landfills lead to nitrogen pollution, by-products such as algae bloom and dead zones develop (Recycle Track System, 2021). Algae bloom puts an additional strain on water quality and the survival of ecosystems as it is the most common form of eutrophication (Kukreja, 2019). If food waste and loss would be fully eliminated all undernourished people could be fed twice over (WFP USA, 2020) and the environmental impact of the food sector could be reduced (Move For Hunger, n.d.).

Transitions in agriculture

The structural problem of the unbalanced provision of nutrition and the connection to high greenhouse gas emissions and environmental impact within the food system can only be solved if agricultural practices are questioned and re-established (Ockenden, et al., 2017). Current practices are becoming ineffective. Thus, the food system is undergoing changes in various parts of the supply chain, such as a shift toward plant-based products, circular farming and the use of new technologies (Klerkx & Rose, 2020). Two main directions for an agricultural transition have been identified (Mann C. C., 2019). Firstly, transitioning through a change in consumer behaviour by shifting from a meat intensive diet, to a diet which contains more vegetables and fruits (Mann C. C., 2019). This means cutting down consumption of certain products that have a negative impact on the environment (Mann C. C., 2019). Secondly, technological advancements is the key to a more sustainable food system by intensifying production in several ways (Mann C. C., 2019). In recent years, the need to join these two forces and bring both strategies together has been pointed out (Mann C. C., 2019). Dyball (2015) identified that the food system is undergoing a shift from an "industrial" to a "biosensitive" paradigm. Biosensitive means "to recognize, and positively support, the fundamental role that food plays in the physical health of the consumer as well as the psychosocial health of producers" (Dyball, 2015). This is only possible if the ecosystem is supported as well (Dyball, 2015).

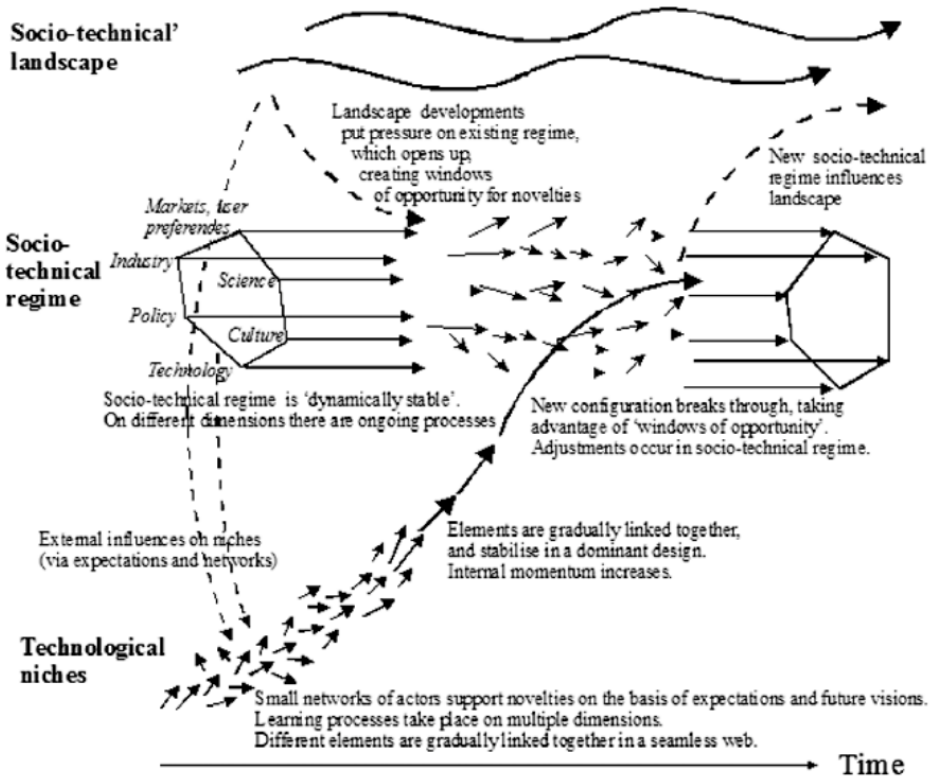

Figure 1 Multi-Level Perspective on transitions (Spaargaren, Oosterveer, & Loeber, 2012)

Transitions can therefore be enabled by different actors and their corresponding activities (Dyball, 2015). Figure 1 shows the Multi-Level Perspective on transitions. On the left side, the socio-technical regime is in a locked state, which includes policies, culture, industry, technology and markets (Spaargaren, Oosterveer, & Loeber, 2012). These need to be loosened by different developments to reform into a completely new regime (Spaargaren, Oosterveer, & Loeber, 2012). Accordingly, a transition is not a small modification. Instead, it means a fundamental change in mindsets, beliefs, policies, and other factors (Galli, et al., 2020). Initially, the formation of niche markets that bring innovations are enabling the transition because new options are formed for consumers and the marketplace is starting to experience a shift (Galli, et al., 2020). Gradually, these firms form a network, which is the basis for accelerated growth (Spaargaren, Oosterveer, & Loeber, 2012). During this development, the Socio-technical landscape and Socio-technical regime put pressure on the niche market, which pushes innovation (Spaargaren, Oosterveer, & Loeber, 2012). Two dynamics are identified as forming the present Socio-technical landscape, that being sustainable development and the ecological dimension (Spaargaren, Oosterveer, & Loeber, 2012). These dynamics influence many parts of the Socio-technical regime and produce the need for adapting to the new Socio-technical landscape (Spaargaren, Oosterveer, & Loeber, 2012). An important driver in the Socio-technical landscape are consumers (Panizzut, et al., 2021). Each purchase shows the marketplace what consumer needs are, so trends can be derived (Panizzut, et al., 2021). Consumers are becoming increasingly aware of their freedom of choice to avoid products that negatively affect the protection of nature and the environment (Panizzut, et al., 2021). Thus, more products are purchased that have a lower

environmental footprint and promote a healthy diet (Wiederkehr & Liebenberg, n.d.). For instance, the sales value of plant-based food between 2018 and 2020 has increased by 49% in Europe (The Smart Protein project, 2021). Another part of the Socio-technical regime are policies (Spaargaren, Oosterveer, & Loeber, 2012). Policies can create a framework that enhances transitions and lays the foundation for new companies to enter the market (Spaargaren, Oosterveer, & Loeber, 2012). Currently, the EU is using 60 Million Euros for meat marketing campaigns (Boffey, 2020). This money comes from tax payers and promotes food that is likely to have adverse effects on the health of consumers and the climate (Boffey, 2020). When refocusing these marketing campaigns on more sustainable companies, this would lay the groundwork for deep changes in the Socio-technical regime (Elmqvist, et al., 2013).

The idea of air proteins

A niche market of companies is developing, which is innovating so-called air protein (Specht & Crosser, 2020). It is part of the movement to develop technological innovations in the food sector (Specht & Crosser, 2020). These proteins are cultivated by fermenting a chosen microbe or plant, which is called biomass fermentation (Specht & Crosser, 2020). It is one out of three types of protein fermentation (Specht & Crosser, 2020). The production of Air Proteins is defined as:

> *"In biomass fermentation, cell culture processes, such as fermentation, capitalize on the fundamental biological property of exponential growth, meaning that every growth cycle can double the available biomass. When performed at the scale of hundreds of thousands of liters, these processes generate tens of metric tons of biomass every hour"* (Takefuji, 2020).

Proteins from biomass fermentation are made out of a few ingredients, including elements from the air like carbon dioxide, oxygen, nitrogen and a variety of other natural ingredients (Air Protein, 2019b). This gives the products their name of air proteins (Air Protein, 2019b). Shifting to fermented protein production means to disconnect from agriculture as it is known (Specht & Crosser, 2020). Each company has a slightly different approach for production. For example, Solar Foods claims that the fermentation technology needs 500 times less water compared to beef production (Solar Foods, 2019) and Air Protein claims that it can be even more efficient, needing 15,000 times less water than beef production (Air Protein, 2019a). Moreover, air proteins require less electricity and land to be farmed (Nature's Fynd, n.d.). These advantages are not only competing with animal products, but also with current foods that make up a vegetarian or vegan diet (Nature's Fynd, n.d.). The production process can be done everywhere without exploiting the ecosystem, as inputs are minimal compared to conventional food production (Air Protein, 2019a). Furthermore, the production does not require high educational backgrounds and little labour is needed (The Protein Brewery, 2019a). The fermented proteins are taste- and odourless and versatile in its application (The Protein Brewery, 2019b). Therefore, the proteins can be used for adding value to many types of products, including meat replacements, plant-based egg-whites, or bread for bringing solutions to multiple dietary needs of the end-customer (The Protein Brewery, 2019b). It also carries all nine essential amino acids that are needed in a human diet, plus it is high in vitamins and minerals, such as B12 and Thiamine (Air Protein, 2019a). The company Nature's Fynd states: "Fy yields 3.6 times more protein per acre of land than animal and plant sources" (Nature's Fynd, n.d.). Heavy dependence on inputs such as wheat or soy and

various animal products could diminish, which could have a positive impact on the rainforest, dry soils and potentially ripples down to setting a new stage for fighting against climate change (Solar Foods, 2020). The Good Food Institute drew the conclusion that without the use of alternative proteins, including air proteins, the future population of around 10 billion will not be able to be fed sustainably (Specht & Crosser, 2020). Thus, investment in 2020 has peaked at almost $1billion for alternative proteins (Bitter, 2020).

Barriers for trade

Products from biomass fermentation are starting to enter the market, but most are still in development. Therefore, the question arises if biomass fermentation is likely to be successful when being commercialized. Porter has developed a model for analysing industry attractiveness before entering a market (Leeman, 2017). There are five drivers to be studied as a powerful tool to assess market conditions (Leeman, 2017).

The threat of substitution is small when looking at the very specific ingredient of air proteins (Specht & Crosser, 2020). However, the products in which the proteins can be used are manifold and oftentimes replicate traditional animal products (The Protein Brewery, 2019b). Thus, the threat of substitution is high (Leeman, 2017). For instance, the global dairy industry was worth an estimated 673.8 billion U.S. dollars in 2019 (Shahbandeh, 2020a). North America and the EU together account for 50% of the dairy market value (Shahbandeh, 2020b).

Rivalry is another part of Porter's model (Leeman, 2017). The rivalry between players such as the meat industry and vegan companies is very high (Bromwich & Yar, 2019). It goes as far as formulating an Amendment for blocking the growth of vegan or vegetarian brands (European Alliance for Plant-based Foods, 2020).

The third driver is supplier power (Leeman, 2017). There is not much information available about the suppliers for the air-protein companies. It is known that Nature's Fynd collaborates with Yellowstone Park for accessing the main ingredient, the microbe *Fusarium strain flavolapis* (Nature's Fynd, n.d.). Since the microbe is continually reproducing, once a starter culture is taken from the park, it can be reused infinitely (Nature's Fynd, n.d.). Other ingredients are simple sugars, nitrogen as well as acidic water to start the fermentation process (Nature's Fynd, n.d.). Similar ingredients are needed for the various air-protein companies.

Porter's five forces additionally analyses the bargaining power of customers (Leeman, 2017). Air-protein products are highly differentiated with a strong advantage in sustainability on many levels (Air Protein, 2019a). Prices could become competitive with those of animal products and their current replacements (Pitkänen, 2021). These two factors point in the direction of low customer bargaining power (Leeman, 2017). However, when looking at the bigger picture, the buyer has many options of choosing other brands that are traditionally embedded in the respective culture (Reddy & van Damb, 2020). Thus, bargaining power of customers is at a medium level and has potential to become lower with price changes (Lockwood, 2021). Lastly,

new entrants could become a threat if technologies get more advanced and can outperform air-proteins (Leeman, 2017).

After summarizing these findings, the knowledge gap around air proteins is formed. It is not known how the market will accept the new protein ingredients and the final products that will be created. Consumers might be hesitant to buy products that include these proteins as it is processed with the intensive use of technologies. Likewise, it is not known if there are policies that inhibit, ban or even encourage the production of the new proteins. Moreover, the competition with animal products or current plant-based alternatives is likely to be strong. But, it is not known if air protein companies have competitive advantages in price at the time of market entry. Therefore, this thesis investigates the common barriers which might influence the success of the upcoming air protein companies. More specifically, companies and the corresponding markets in the EU and the U.S. are examined.

This research is focusing on the readiness of markets for the entries of these fermentation protein companies. Primarily, the investigation is useful for arising food-tech start-ups but also for politicians who have influence on the food system in the European and U.S. American markets. Moreover, investors might be willing to devote their money to new business ideas. As the chosen companies have the potential to scale up rapidly, these concepts may be lucrative for investments. Retailers could be inspired to know about new companies for building partnerships to stand out with new and innovative products. Generally, every citizen that is willing to make a change and lead the way towards a more sustainable future can find valuable information in this research. The topic is relevant because it investigates a novel ingredient with potential to revolutionize the way humans produce food and may be part of the solution to a sustainable food system transition. It is important to understand the market and be prepared for various situations when introducing such a fundamental new innovation.

Therefore, the main question is formulated as follows:

How can market conditions be shaped for air proteins, to enter the market successfully?

Sub-questions:

1. **What are the current legislations for the cell-based Air Proteins in the European Union vs United States?**

2. **What are present barriers for the companies innovating new proteins to enter the market?**

3. **What are the tools available to help shape conditions in the marketplace for Air Protein companies to enter the market?**

2. Proposed Material and Methods

The proposed materials and methods describe how research on the thesis questions was conducted. For answering the questions, qualitative research was used.

1. **What are the current legislations for the cell-based air proteins in the European Union vs United States?**

The first sub-question entailed qualitative research resulting in an overview of current policies that relate to the production, consumption or trade of cell-based proteins. The sources were be provided by the European Union, the FDA or comparable governmental webpages. Investigation did not need to be continued by contacting corresponding legislators.

The specific words that were searched for each geographical region, the EU and U.S. respectively, have been "novel food legislation", "biomass fermentation legislation", "new proteins", "agricultural transition", on the official governmental websites "agricultural policies" can be examined. The specific parts for novel food start-ups, novel foods and the more specific biomass fermentation was searched within the agricultural policy documents. The research on government webpages was chosen because it provides unbiased information about the current state of policies. The aim was to give a neutral overview of the framework of policies and regulations that surround Air Protein companies when entering the market.

2. **What are present barriers for the companies innovating new proteins to enter the market?**

To answer the second sub-question, e-mails were sent to the known companies that exist in the markets covered by this research paper. The e-mail can be found in Appendix 2. Since many companies could not share information through this medium and did not respond to phone calls, research was adapted by finding interviews and articles which provided some deeper insights into the barriers of the companies. "Air Protein", "Natures Fynd", "Arbiom" and "Afineur" are companies from the North American market. The European market of air protein consist of "Solar Foods", "Mycorena", "Mushlabs", "Pura", and "The Protein Brewery". Links to the corresponding websites can be found in the first Appendix. It was decided to reach out to the Air Protein companies personally to be able to understand the perspective of the market conditions that Air Proteins have so that unknown issues could be exposed. The research method was supposed to paint an honest picture of market conditions, which can be best obtained from the people who have experience in the sector.

3. **What are the tools available to help shape conditions in the marketplace for air protein companies to enter the market?**

On different levels there are tools to influence the success of companies when entering the market. For the political level, changes in policy to leverage innovation were found. This was done with qualitative research.

The search terms for the EU and U.S. respectively were "tools for agricultural transition", "start-ups government programs", "bodies for accelerating transition", "help for startups". For consumers, the tools for improving awareness were explored with the terms "brand awareness",

“how to create consumer awareness on novel foods”, “how to build trust in consumers”, “how to successfully introduce novel products to consumers”. Within the food supply chain, no tools were found for this specific research topic. There was not enough information and uniformity of business models (B2B or B2C) to conduct further research. The method of desk research was used because it is providing the opportunity to collect many different types of tools within the different markets which then can be described more in detail than it might have been possible through interviews. Additionally, it is likely that tools beyond the knowledge of Air Protein companies can be found with this method (SIS International Marketing Research, 2021).

3. Results

In this chapter, answers to the three sub-questions are collected. The first question focuses on sources from the government websites of the EU and U.S. to provide an overview of the legislations that surround air proteins. During the research of the second sub-question, problems with the collection of data arose. Consequently, the research method was broadened by finding information on the websites of the companies or from interviews in which the founders of the companies are presenting relevant information about the companies. For the third sub-question, research concentrated on tools like financial aid or customer communication strategies that are available for air protein companies as support for entering the market.

1. What are the current legislations for the cell-based air proteins in the European Union vs United States?

European Union

Novel Foods

In the EU, novel foods are defined as „food that has not been consumed to a significant degree by humans in the EU before 15 May 1997“ (European Commission, n.d.-a). It includes innovative food or food that is produced with new technologies and production processes (European Commission, n.d.-a).

Main principles

For novel foods to be allowed to enter the market, three main principles have to be met (European Commission, n.d.-a). Firstly, it has to be safe for consumers. Food safety includes biological and chemical safety (Directorate-General for Health and Food Safety, n.d.-a). Examples for biological hazards are bacteria, viruses or parasites (Directorate-General for Health and Food Safety, n.d.-b). All food and feed companies need to be prepared for the occurrence of a biological hazard through prevention practices and management plans (Directorate-General for Health and Food Safety, n.d.-b). Chemical contaminants include nitrates, metals, mycotoxins, and other substrates for which the European Commission has set maximum acceptable levels in food products (Directorate-General for Health and Food Safety, n.d.-c). If an unacceptable amount of a contaminant is identified in a food product, the company is not allowed to place the product on the market (Directorate-General for Health and Food Safety, n.d.-a). Secondly, labelling needs to be done properly to not mislead customers (European Commission, n.d.-a). Binding labelling rules that apply for air proteins are nutrition labelling, providing the name of the food, net quantity, the date of minimum durability, the quantification of an ingredient in percent, and a list of ingredients in which allergens are highlighted (European Commission, n.d.-b). Air proteins itself are low-risk allergens (Nature's Fynd, 2021a), but if any other ingredient that is considered an allergen is used in the end-product, it must be “emphasized through a typeset that clearly distinguishes it from the rest of the list of ingredients” (EUR-Lex, 2011a). Additionally, special storage conditions or usage have to be mentioned (European Commission, n.d.-a). The labelling

also contains the name and address of the business operator (European Commission, n.d.-b). A nutrition declaration is required in form of a table, in which the quantity of elements like energy, fat, and proteins are given per 100g (EUR-Lex, 2011b). Thirdly, if intended to replace other food products, there must not be a disadvantage in nutrition for the consumer (European Commission, n.d.-a). Since Air Proteins are created to add nutritional value to products, it is unlikely that the last principle is applicable (Air Protein, 2019a). As the novel food requires authorization by the European Food Safety Authority (EFSA), all these principles have to be met before application (European Commission, n.d.-a).

Eight Features and Improvements

In 2018, a new regulation was adapted specifically for novel foods (European Parliament; European Council, 2015). It states that new technologies and innovations in food production should be encouraged and investment can be protected for stimulating research and development (European Parliament; European Council, 2015).

Table 1 Novel Foods Regulation Features and Improvement (European Parliament; European Council, 2015)

NR.	FEATURES/ IMPROVEMENTS
1	Expanded categories of Novel Foods
2	Generic authorisations of Novel Foods
3	Establishment of a Union list of authorised Novel Foods
4	A simplified, centralised authorisation procedure
5	Centralised, safety evaluation of the Novel Foods
6	Efficiency and transparency
7	A faster and structured notification system for traditional foods from third countries
8	Promotion of innovation

The regulation consists of eight features and improvements that aim at easing the launch of innovative foods. Table 1 shows the eight features and improvements.

Under the first point, the definition of novel foods is expanded: “various situations of foods originating from plants, animals, microorganisms, cell cultures, minerals, etc., specific categories of foods (…), foods resulting from production processes and practices, and state of the art technologies (e.g. intentionally modified or new molecular structure, nanomaterials), which were not produced or used before 1997 and thus may be considered to be as novel foods” (European

Parliament; European Council, 2015). Therefore, the definition promotes a more specified field in which innovations can occur (European Commission, n.d.-a). In 2021, a description was added that defined some areas that are considered novel food in more detail (European Parliament; European Council, 2015). “Food consisting of, isolated from or produced from microorganisms, fungi or algae (…)” are specifically mentioned (European Parliament; European Counil, 2021). As air protein companies use microorganisms and fungi, this is a notable addition (Specht & Crosser, 2020). No research could be found to what extent this change has an effect on bringing Air Proteins through the approval process.

The second point highlights that authorization moved from needing a specific application purpose to generic authorization (European Parliament; European Council, 2015). Hence, restrictions are relaxed for food businesses to authorize new products (European Parliament; European Council, 2015).

Third, the EU incorporated the creation of a list including authorized novel foods (European Parliament; European Council, 2015). After a novel food is added to this list, it can be brought to the European Union market (European Parliament; European Council, 2015). On this list, none of the ingredient names from the air protein companies can be found, yet (European Commission, n.d.-c).

Fourth, the authorization process is managed through a simplified online application system (European Parliament; European Council, 2015).

This is connected with the fifth point. The safety evaluation is taken over by the European Food Safety Authority (EFSA), which is in contact with the European Commission to present conclusions of the evaluation of novel food products (European Commission, n.d.-d). Any specific administrative, technical or scientific requirements need to be included in the application (EFSA, 2016). For instance, this includes a cover letter, a technical dossier with a summary, information about the manufacturer (European Commission, 2017). EFSA offers guidance documents for applications to clarify all necessary steps (EFSA, 2016).

Sixth, efficiency and transparency is improved by set deadlines for the assessment and authorization procedures (European Parliament; European Council, 2015). This strategy reduces the time needed for getting approvals (European Parliament; European Council, 2015).

Seventh, for novel products that have been used in third world countries a faster and structured notification system is implemented for receiving the novel food permit (European Parliament; European Council, 2015).

Lastly, innovation is promoted by protecting data for five years to bring the novel food to the market (European Commission, n.d.-a). After this time period, protection is lifted and every European citizen has access to it (European Commission, n.d.-a). Before starting with this process, the food business operator is obligated to first identify if the product can be considered a novel food (European Commission, n.d.-a). If this is unclear, the respective EU country authority can be

notified for help (European Commission, n.d.-a). After concluding that the food product is considered novel, all information will be published on the Commission's website (European Commission, n.d.-a).

Alternative proteins in the European legislation

When looking at the broader picture, the legal background on novel foods encourages new technologies and innovations in food production (European Commission, 2020a). Through the Food2030 policy, the EU targets various topics for transforming the food system (European Commission, 2020a). Within this policy, 10 pathways are named to achieve food and nutrition goals (European Commission, 2020a). "Alternative proteins and dietary shift" are on the fourth place to initiate this change (European Commission, 2020a). The importance of changing dietary habits and including alternative proteins is highlighted in this part of the policy (European Commission, 2020a). Several issues are pointed out that need to be adapted for accelerating the introduction of alternative proteins (European Commission, 2020a). Consumer preferences could be influenced through behavior-oriented pricing and a greater extent of public communication on the benefits of alternative proteins (European Commission, 2020a). Direct and indirect agricultural subsidies are mentioned as enablers for overcoming barriers of alternative proteins (European Commission, 2020a). The policy also recognizes the need for more research and innovation in many subjects related to consumer trust, safety and nutritional quality as well as redefining the roles that actors of the supply chain play in this transition (European Commission, 2020a). This policy might lay the foundation for an important shift in perception of policy makers and consumers to understand the need for alternative proteins such as Air Proteins in transitioning the food system.

CAP specific objectives

In the Common Agricultural policy (CAP) of the European Union, CAP specific objectives include areas for change that are relevant for biomass fermentation methods (European Commission, n.d.-e). First and foremost, biomass fermentation technologies are improving the productivity of food production (European Commission, n.d.-e). Once scaled for commercialization, more produce can be generated on less land and with less resources than meat or meat substitute products (Nature's Fynd, n.d.). This can be indirectly connected to the specific objectives "biodiversity", "soil", and "agriculture and climate mitigation" (European Commission, n.d.-f). Through the new technological application that Air Protein companies are developing, space that is used for livestock or crop production is freed for reviving natural ecosystems and improve soil health (Nature's Fynd, n.d.). Agriculture and climate mitigation are targeted with the comparable small amount of inputs to produce the air proteins (Air Protein, 2019a). Also, the production releases less Carbon Dioxide than livestock production (Nature's Fynd, n.d.). These specific objectives were created to frame the Common Agricultural Policy and guide towards sustainable agriculture (European Commission, n.d.-f). Though the CAP specific practices are not a binding regulation, their guidance could indicate that Air Proteins may be recognized by policymakers as a promising solution to touch on many of the objectives (European Commission, n.d.-f).

USA

Novel Foods

In the United States, there is no definition of novel foods given by the FDA (U.S. Department of Health and Human Services Food and Drug Administration, 2017). The focus for introducing a new ingredient or food to the market is on its safety rather than on its novelty (U.S. Department of Health and Human Services Food and Drug Administration, 2017). The Air Proteins have to be "Generally Recognized as Safe" (GRAS) by the FDA (FDA, 2018). GRAS occurs when there is consensus about the safety of the food among qualified experts outside of government (FDA, 2018). Nature's Fynd has received a letter from the FDA that approved their protein ingredient as GRAS (FDA, 2021a). The company specified the intended use, including the types of products and the maximum amounts of the Fusarium protein dry mass in these products (FDA, 2021a). Moreover, an analysis of the safety is given, which presents the outcomes of examinations in toxicity, allergic responses, and adverse gastronomical effects. None of the studies suggested safety concerns (FDA, 2021a). Therefore, the ingredient was recognized as safe (FDA, 2021a).

Food Safety

General food safety in the U.S. is recognized under the Food Safety Modernization Act (FSMA), comprising a set of rules of which three relate to biomass fermentation companies (FDA, 2021b). First, the rule for preventive controls for Human Food is a requirement for food facilities to have food safety plans prepared, including a hazard analysis and risk-based preventive controls to prevent identified hazards (FDA, 2020). Second, if a European company decides to export to the U.S., the products need to undergo the Foreign Supplier Verification Program (FDA, 2021c). With this program, the FDA is ensuring that the food delivers the same standards of public health protection as within the U.S. (FDA, 2021c). Third, the rule of Food Traceability is not required by the types of food products that Air Proteins are part of, but its implementation is encouraged (FDA, 2021d). Food traceability contains the record keeping of Key Data Elements (KDE) that are identified through Critical Tracking Events (CTE) (FDA, 2021d). Thus, for each company the necessary Data Elements have to be identified case by case (FDA, 2021d).

Labelling

In terms of labelling, the General Food Labelling Requirements have to be followed. The name of the product or statement of identity as well as the net quantity (in grams and ounces) of the product have to be visible on the front side of the package, which faces the consumer (U.S. Departement of Health and Human Services, 2013). The information panel is required to be placed on the right-hand side next to the front (U.S. Departement of Health and Human Services, 2013). Here, the name and address of the manufacturer, the ingredient list, nutrition labelling and allergy labelling are placed (U.S. Departement of Health and Human Services, 2013). Nutrition claims may be added if the requirements for the specific claims are met (U.S. Departement of Health and Human Services, 2013). As there are many different types of claims, the individual examples of conditions can be found in the Food Labelling Guide provided by the FDA (U.S. Departement of Health and Human Services, 2013). On the packaging of the end

product in which the air proteins will be used, the protein has to be mentioned in the ingredient list and its effect on health can be highlighted with a nutrition claim, like “high in protein”, if applicable (U.S. Departement of Health and Human Services, 2013).

Agriculture improvement Act of 2018

In the U.S., the Agriculture improvement Act of 2018 highlights the advanced research and development needed for tackling challenges in the agricultural and food sector (Authenticated U.S. Goverment Information, 2018). Subsequently, the Agriculture Advanced Research and Development Authority (AGARDA) pilot was formed as part of the Department of Agriculture (Authenticated U.S. Goverment Information, 2018). Novel and early stage innovative agricultural research are accelerated through this Authority as it focuses on R&D that private industry does not embark on (Authenticated U.S. Goverment Information, 2018). The pilot also addresses the development of products, agricultural technologies, and innovative research tools (Authenticated U.S. Goverment Information, 2018). This can be supported through “prototype testing, preclinical development, (…), assessing and assisting with product approval, clearance, or need for a license under an applicable law, (…) or manufacturing and commercialization of a product” (Authenticated U.S. Goverment Information, 2018). The goals of AGARDA are to overcome barriers of creating new agricultural technologies, research, and products with the background of being competitive on the economic world stage (Authenticated U.S. Goverment Information, 2018). AGARDA has the responsibility to communicate between entities (Authenticated U.S. Goverment Information, 2018). Furthermore, grants and cooperation can be given out for leveraging innovations and research (Authenticated U.S. Goverment Information, 2018). Companies have the option to consult the Urban Agriculture and Innovative Production Advisory Committee, which assists on acquiring a grant for research or activities such as developing emerging agricultural production (Authenticated U.S. Goverment Information, 2018). For example, this might include new technologies that minimize energy, water, and other inputs for increased food production (Authenticated U.S. Goverment Information, 2018).

Agriculture Innovation Mission

The U.S. is working on an Agriculture Innovation Mission (AIM) that has the goal to “increase and accelerate global innovation research and development on agriculture and food systems in support of climate action” (USDA Press, 2021). This new program is directing more investment into R&D for agricultural practices and innovation (USDA Press, 2021). With this fund, the speed in transitioning the agriculture and food sector will be likely to increase (USDA Press, 2021). This mission could potentially move more funds into scaling the production of Air Protein companies (USDA Press, 2021). Next to the U.S., countries like the United Arab Emirates, Israel, and more are aiming at establishing a commitment between countries, outlining a framework for innovation as well as identifying key scientists that have insight into agricultural R&D and the relation to climate change for communication between the countries (USDA Press, 2021). Three channels will be coordinated and gain investments via the AIM program, including scientific breakthroughs in agricultural research, applied innovations, and the development and arrangement of practical and actionable research and data (USDA Press, 2021). If this idea is put into practice, it could give the biomass fermentation technologies a stage for growth and

interconnect research and development between different countries. The AIM program only mentions technologies and innovation in the food system in general (USDA Press, 2021). But it is probable that Air Protein companies may take part in this innovative program because of the variety of issues that it has the potential to solve, such as fighting climate change.

2. What are present barriers for the companies innovating new proteins to enter the market?

Of the nine companies four have responded by mail and one by phone. The e-mails and the transcription of the interview can be found in Appendix 3. Two additional responses were generated by joining webinars with representatives of the companies Solar Foods and Arbiom and asking about present barriers in the Q&A chat. More answers could be found by listening to interviews that were recorded and shared by the companies.

The three companies, Pura (Italy), the Protein Brewery (the Netherlands) and Nature's Fynd (U.S.) replied by mail, but had no capacities to respond to the question or could not provide information due to confidentiality reasons. No additional information could be found for the companies the Protein Brewery and Pura.

However, for Nature's Fynd some valuable information could be found in an interview with on YouTube. The main barrier for the company is reaching price parity. Beating offers of the food products that the company is simulating, like chicken, is essential for success according to CEO, Thomas Jonas (Jonas, 2020).

The German company Mushlab responded by mail and revealed that the greatest bottlenecks for the company are regulatory approval and finding skilled scientists (See Appendix 3).

The person that was interviewed by phone wished to stay anonymous. The present barrier for this company is scaling. Though the demand is there, the volume cannot be produced, yet. Another detail was revealed in this call. The company did not need to apply for the European novel food permit. This created the advantage that the company was able launch products more quickly than others in the field. Moreover, it was claimed that consumers in their market are generally interested in trying new things and have some knowledge about fungi and fermentations already.

For the Finnish start-up Solar Foods, an interview was found on YouTube with Pasi Vainikka. This revealed that one of the barriers that the company has to overcome is to apply for the novel foods permit approval for FDA & EFSA (Vainikka, 2020). Additionally, an information webinar was joined where collecting data for the dossier of the Novel Food regulation in the EU was named as a great barrier (Pitkänen, 2021).

Lastly, for the company Arbiom (U.S. & France) an article brought some information to light and an information webinar was joined for more insight. Arbiom is mentioned in an article by Sally Ho (2021). In an interview with the author, the CEO Marc Chevrel, states: "Our long-lasting relationship with BBEPP has been a key factor contributing to the success of Arbiom's Demonstration Program (…). We want to thank the BBEPP team for their dedication and support to Arbiom's successful technology scale-up initiatives to reach full commercialisation." (Sally Ho, 2021). Arbiom has finished the demonstration program of the company's proof-of-concept. In a next step, regulatory hurdles need to be overcome to launch the products in the U.S. and

European markets (Sally Ho, 2021). The BioBase Europe Pilot Plant project (BBEPP) is described in the next sub-question, under the European Innovation Partnership.
Moreover, the company hosted an online webinar where the question about bottlenecks for launching the product was asked. The Project Director of Arbiom responded that the certification of the ingredient and the quantities needed for the feeding trials are posing the greatest difficulties. Product development of Arbiom currently focuses on applications in the feed sector, which is not the main focus of the research. However, the response is in line with the statements of other companies (Nicolas, 2021).

3. What are the tools available to help shape conditions in the marketplace for air protein companies to enter the market?

Governmental programs

European Union

The European Green Deal Investment Plan

The European Union is in the process of constructing a new framework for transitioning into a carbon-neutral industry until 2050 (European Commission, 2020b). The European Green Deal Investment Plan warrants €1 trillion for becoming sustainable and carbon neutral over the next decade (European Commission, 2020b). The Just Transition Fund is one part of facilitating change in all countries within the European Union (European Parliament, 2020). €17.5 billion are allocated to this fund and is distributed to regions where it is most needed (European Parliament, 2020). These include regions that have the highest gas emissions and use of fossil fuels. Agriculture plays a role in waste prevention, resource efficiency, and circular economy (European Parliament, 2020). Though this tool mostly focuses on the transition of the energy sector, a small part is dedicated to agriculture (European Parliament, 2020).

European Innovation Partnership

Research and Innovation at EU level is supported by the agricultural European Innovation Partnership (EIP-AGRI), which contains two sources of funding (European Commission, 2018). These are Horizon Europe and Rural Development Programs (European Commission, 2018). Horizon Europe is promoting a combination of research and innovation. Between 2021 and 2027, €95.5 billion will be accessible through the Horizon program (European Commission, n.d.-g). While providing help through funding to innovative companies, another important factor is visibility. Getting investment from the EU means a higher likelihood to be discovered, have more breakthroughs and to quickly bring ideas to reality (European Commission, n.d.-g). Biomass fermentation companies fit into the funding area of biotechnology, which is an umbrella for innovative industrial products and processes in food, feed, and many more (European Commission, n.d.-h). Key focus is on the impact companies can have on the reduction in CO_2 emissions (European Commission, n.d.-h). The Horizon Program for the years 2021 until 2027 build on three pillars. Excellent Science forms the first pillar (European Commission, 2019b). It targets the science base that is present in the European Union and aims at reinforcing and extending excellence in this field (European Commission, 2019b). The Marie Skłodowska-Curie actions are part of this pillar, which “equip researchers with the necessary skills and international experience for a successful career (…)” (European Commission, 2021). Training, co-founding of programs, Individual fellowships, as well as international and inter-sectoral cooperation are the building blocks of the Marie Skłodowska-Curie actions (European Commission, 2021). The second pillar is called “Global Challenges and European Industrial Competitiveness” (European Commission, 2019b). Through 6 clusters, this pillar supports research exploring societal challenges and strengthens technological and industrial capacities (Universidad del País Vasco,

2021). Biomass fermentation methods can be categorized in the “Food, Bioeconomy, Natural Resources, Agriculture and Environment” cluster (Universidad del País Vasco, 2021). Through this cluster, €30 Million of the funding is allocated toward alternative proteins (European Commission, 2021b). On request of the Good Food Institute the EU will distribute money specifically to alternative proteins, including air proteins (European Commission, 2021b). The Good Food Institute (GFI) is an international nonprofit organization that believes in the disruptive change that alternative proteins and meats can have in the food system (Good Food Institute, 2021b). With the development of a roadmap for protein supply, the organization is aiming to make alternative proteins the default choice (Good Food Institute, 2021b). Moreover, the GFI is sharing all data and research openly to support the alternative protein development and works closely together with the private and public sector (Good Food Institute, 2021b). The last pillar “Innovative Europe” is supporting the development of new products, processes and technologies (Bundesministerium für Bildung und Forschung, n.d.). The three entities “European Innovation Council”, “European Innovative Ecosystems”, and “European Institute of Innovation and Technology” create a synergy by finding, promoting, and scaling innovative technologies (European Commission, n.d.-i). European Innovative Ecosystems is an actor that combines the two other entities and other funding programs that the EU supports for enhanced innovation (European Commission, n.d.-i). The European Innovation Council encourages breakthrough, deeptech and disruptive innovation that has potential to scale (European Commission, n.d.-j).
The European Institute of Innovation and Technology is a Community that connects businesses with research centers and universities (EIT Europe, 2021). Innovation is thus enhanced and information flow between the bodies guaranteed (EIT Europe, 2021). Moreover, these communities are ground for dynamic European partnerships that strengthen new entrepreneurs to enter the market (EIT Europe, 2021). There is a specific Innovation Community that focuses on food (EIT Europe, 2021). If Air Protein companies could become part of this innovation platform, R&D and scaling of production plants may experience a boost through the networks and aid provided (EIT Europe, 2021). The EIT has introduced the company the Protein Brewery into the “EIT Food’s Rising Food Stars Association” (EIT Europe, 2021). This association is guiding start-ups through scaling up production from industry leaders (EIT Europe, 2021). The network can also help with gaining more investments (EIT Europe, 2021). Moreover, Arbiom is in the BioBase Europe Pilot Plant project (BBEPP) funded by the EU that provides necessary equipment for testing and scaling production (Bio Base Europe, n.d.). This project is part of the Horizon 2020 program. As two of the European Air Protein companies are already part of programs from the EU it is likely to have a positive effect on the scaling process.

USA

Government grants

In the Agriculture Improvement Act of 2018, around $18 million spending is flowing into research and extension (U.S. Departement of Agriculture, 2019). Most programs under this act focus solely on supporting farmers (U.S. Departement of Agriculture, 2019). During the Covid-19 pandemic, the U.S. created a stimulus bill offering $1,9 trillion to businesses and individuals as tax credits, loans, and grants (Pramuk, 2021). Government grants are plentiful for companies with all kinds

of backgrounds (Pramuk, 2021). Companies that fit into the description of multiple funding opportunities may be eligible to receive more than one program (Pramuk, 2021). Several programs are likely to be applicable for air protein companies, including the "Small Business Innovation Research Program" (SBIR) and "Small Business Technology Transfer Program" (STTR) (U.S. Chamber of Commerce, 2021). SBIR provides grants to small businesses that can become part of federal research and development, aiming at commercialization (U.S. Chamber of Commerce, 2021). STTR requires small businesses to collaborate with a research institution already and the fund is targeted at research in the R&D area (U.S. Small Business Administration, 2020). In the 115th Congress bill from 2018, the Competitive, Special, and Facilities Research Grant Act is described (Authenticated U.S. Goverment Information, 2018). This act provides details about a grant with the purpose to push progress in research and development in the agricultural sector (Authenticated U.S. Goverment Information, 2018). The grant includes "(…) practices, techniques, methods, and technologies using digital or other novel platforms" (Authenticated U.S. Goverment Information, 2018). $700 Billion was prepared to be spend between the years 2008 and 2023 (Agricultural Senate, 2018).

Moreover, centers of excellence are set up at U.S. American institutions (Authenticated U.S. Goverment Information, 2018). The priority of these centers is global food security and defense which bring international partners together as well as doing collaborative research on animal and plant pests and diseases (Authenticated U.S. Goverment Information, 2018). The excellence center for natural resources, energy and environment is established for protecting and managing domestic natural resources so food and agricultural production is secured for present and future generations (Authenticated U.S. Goverment Information, 2018). Emerging technologies are supported by focusing among others on the development of technologies that may bring solutions for increased agricultural productivity (Authenticated U.S. Goverment Information, 2018). Biomass fermentation is a new technology which is predicted to have a positive impact on agricultural productivity and protects the environment by needing less resources than livestock production or meat alternatives like pea or soy (Air Protein, 2019a). Besides, global food security could be increased, because the production of air proteins can be scaled anywhere, without the need for specific environmental conditions (Nature's Fynd, n.d.).

Comment Letter from the Good Food Institute

A comment from the Good Food Institute revealed that the U.S. Department of Agriculture is hesitant towards investing in alternative proteins (Good Food Institute, 2021a). In a letter, recommendations are made to "(…) advance open-access alternative research to help achieve President Biden's climate goals and create a more equitable food system" (Good Food Institute, 2021a). GFI recommends funding and implementing research on alternative proteins, highlighting the importance of the USDA's Agricultural Research Service (ARS) and the National Institute of Food and Agriculture (NIFA) (Good Food Institute, 2021a). The ARS is the research agency of the department of Agriculture in the United States (ARS, 2021). Through a variety of research projects innovative scientific tools are created for the full supply chain of the Agricultural sector (ARS, 2021). The ARS has the power of prioritizing projects, which according to the GFI should be used more intensively for alternative protein research and funding to stay competitive in the agricultural sector (ARS, 2021). NIFA is investing in projects that work on

agriculture-related sciences (NIFA, 2021). The SBIR and STTR programs, already mentioned in the description of government grants, are part of NIFAs work (NIFA, 2021). However, only around 50% of all applicants receive a grant through the SBIR program (NIFA, 2021). This might be one reason why the GFI is pressuring for more funding to be channeled specifically to alternative proteins. Moreover, the Institute asks for pursuing an "interagency initiative with the National Science Foundation (NSF) to research alternative proteins" (Good Food Institute, 2021a). The NSF is a federal agency that supports most fields in pushing fundamental new discoveries and also selects projects that are high-risk (NSF, n.d.). This synergy could enable new technologies, and specifically biomass fermentation, to be implemented quickly and make the innovative products available at a competitive price for American citizens (Good Food Institute, 2021a). The comment can be underlined by the fact that companies from the EU, like Mycorena (Weishaupt & Johansson, 2020), Arbiom (the French part) (Arbiom, 2021), and Solar Foods (Solar Foods, 2021) have gotten funding and/or other support from the European Union. Whereas, such support could not be found for the U.S.-based companies. Biomass fermentation companies from the U.S. are more likely to receive investments from private investors, such as Breakthrough Energy Ventures that invested in Nature's Fynd (Crunchbase, 2021) or Google Ventures that invested in Air Protein (Yates, 2021). These investment are usually significantly higher than what is offered from the government programs (Specht & Crosser, 2020). As an example, SBIR allocated up to $650.000 to applicants (NIFA, 2021), while Nature's Fynd received $158 million from private investors (Crunchbase, 2021).

Consumer perception

Consumer acceptance

Consumers are key in the success of air protein companies. In terms of consumer acceptance, there are several tools, mostly of psychological nature, that can be used to create more trust (Siegrist & Hartmann, 2020). The article "Consumer acceptance of novel food technologies" suggests that nongovernmental organizations, scientists and the media play an important role in shaping perceptions (Siegrist & Hartmann, 2020). Consumers often see technological applications in the food sector as negative features (Siegrist & Hartmann, 2020). Novel foods are perceived as unnatural and therefore as highly processed (Siegrist & Hartmann, 2020). However, the process is not much different than brewing beer or making yoghurt (Dyson, 2020). Some of the differences are the ingredients, which are Co2 instead of sugars and a microbe (Every company chose their own) instead of the starter culture when producing yoghurt (Dyson, 2020). Limited knowledge about nutrition and misleading ideas of the impact of food products and production can become challenging when entering the market with a novel product (Siegrist & Hartmann, 2020). Consequently, consumer perception and acceptance of air protein products need to be carefully framed with selected information (Siegrist & Hartmann, 2020). Tools like packaging, marketing or the public debate can have an impact on the understanding of products (Siegrist & Hartmann, 2020). If this is done at an early stage, consumers already have built trust in the new technologies when the products enter the market (Siegrist & Hartmann, 2020). Social media is an important tool for creating awareness and trust (Green, 2018). New food ingredients like spirulina or turmeric have been successfully introduced by using Instagram to spread awareness

(Green, 2018). Social engagement in the company through social media platforms makes it more likely that consumers can identify with the company culture (Green, 2018). Only four of the Air Protein companies have an active Instagram page through with news are communicated. These include Nature's Fynd (Nature's Fynd, 2021b), Air Protein (Air Protein, 2021), which are both from the U.S.; and Mushlabs (Mushlabs, 2021), and Mycorena (Mycorena, 2021a), which are from the EU. The ingredients and technologies used are explained in various posts on these pages and in all cases, except for Nature's Fynd, the team is introduced with pictures and short descriptions (Nature's Fynd, 2021b). Nature's Fynd has a different approach by posting pictures of the end-products and having the well-known scientist, Hank Green, as a trusted personality to explain the process behind making the protein ingredients and end-products (Nature's Fynd, 2021b).

An interview with the founder of Air Protein, Lisa Dyson, underlines that there are some aversions against the combination of food and tech. The interviewer, Brian O'Keefe says: "A lot of people feel differently about creating tech that you hold outside your body than something that you ultimately put into your body (…). People just feel a little different about (…) digesting it" (Kowitt, Dyson, & Murray, 2021). This quote reflects that people who are new to the field of food technology and alternative proteins perceive it as unnatural. Educating people on the naturalness, nutritional superiority to meat as well as competitiveness in price and taste, is important to make consumers understand the benefits of the new products. The interview is held by Americans of which several people from the alternative meat sector speak about the upcoming changes in the food industry. Therefore, this observation can only be made for the American market (Kowitt, Dyson, & Murray, 2021).

Law of Diffusion of Innovation

In his book "Why Smart People make Bad Food Choices", Jack Bobo touched on how companies should talk about alternative proteins (Bobo, 2021). He highlighted that most food tech companies try to sway meat eaters for trying the new products rather than vegans or vegetarians (Bobo, 2021). However, by pointing the finger at the livestock industry for being responsible for a broken food system, resistance evolves in some potential customer groups (Bobo, 2021). Instead of buying the alternative proteins, these groups intentionally work against the new products and boycott the brands (Bobo, 2021). Moreover, Jack Bobo puts emphasis on the "Law of Diffusion of Innovation" model, which suggests that brands need to communicate differently with each group of consumers (J. Bobo, personal communication, 31.05.2021). As can be seen in figure 2, a newly introduced product first attracts innovators when entering the market (J. Bobo, personal communication, 31.05.2021). These consumers have deep knowledge about the brand and its products and are keen for trying the innovation (J. Bobo, personal communication, 31.05.2021). The early adopters have a very different point of view; therefore, marketing efforts need to be adapted once the audience broadens (J. Bobo, personal communication, 31.05.2021). These two phases are critical for introducing new food products (J. Bobo, personal communication, 31.05.2021). If both groups are convinced of the products and the early majority is targeted, the tipping point is reached (J. Bobo, personal communication, 31.05.2021). This model is a powerful tool for novel food companies to reevaluate continuously who is targeted with the marketing strategy so that research can reveal what the specific group is looking for in

the product (J. Bobo, personal communication, 31.05.2021). People who are afraid of the change that novel foods bring (of which some fall under early adaptors), require subtle messaging and do not appreciate the novelty to be obvious, unlike innovators (J. Bobo, personal communication, 31.05.2021)

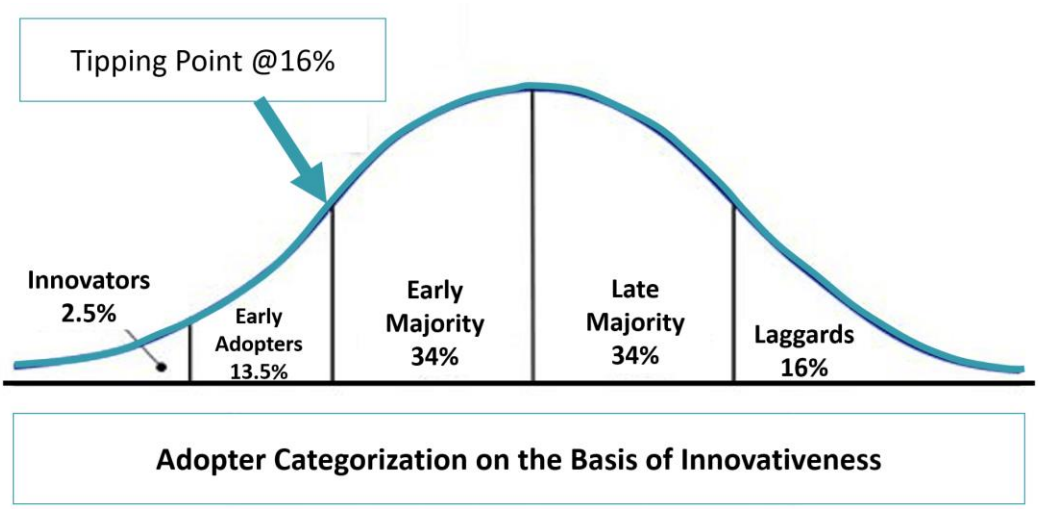

Figure 2 Law of Diffusion of Innovation (Abo Saad Blog, 2020)

Figure 3 Mycorena Promyc-Nuggets front (Mycorena, 2021b)

Figure 4 Mycorena Promyc-Nuggets back (Mycorena, 2021c)

Two of the companies that are being researched have launched their first products within the last year. The packaging of Mycorena (EU-based) and Nature's Fynd (U.S.-based) are displayed in the figures 3 to 6. As can be seen, these designs do not include a picture of the technologies used, nor of the new protein being included. However, all have a small added logo of the specific strain used in the product. For Nature's Fynd, it says "Made with Fy", and Mycorena added a small logo with the name of their protein, called "ProMyc". In the ingredient list on the back, Promyc can be found as the first ingredient with the description "a fungal protein".

On the packaging of the chicken nuggets (Figure 3), the name of the protein is also included in the name of the final product. This is not done with the other products. Another detail to note is that the Promyc-Nuggets have the ICA logo on the packaging. ICA is one of the main supermarket chains in Sweden, so Mycorena is selling this product as a home brand of ICA. One of the reasons for this decision might be that Swedish consumers trust ICA as a well-known company. Therefore, a collaboration with this brand creates more trust of consumers from the beginning. Moreover, the validation of the product being everything that it claims to be, is more likely to happen with this partnership. On the backside of the Nuggets (Figure 4), the partnership is introduced with a short text that can be translated to: „Promyc is a protein developed by mycorena. A Swedish startup with the ambition to create products that both taste good and do well. The product is a first test in collaboration between ICA and Mycorena and we hope that you will like the product very much!" (Mycorena, 2021b). The test products were sold in selected ICA shops and sold out

within a few days (Mycorena, 2021d). The collaboration between the two companies is established under the umbrella of the program ICA Växa, which brings innovation forth that help reduce the carbon footprint of customer's purchases (Mycorena, 2021d). Through this program, consumer trends will be analysed by gaining insight in buying behaviours (Mycorena, 2021d). This can help Mycorena to successfully introduce their products to the market by understanding which products have the highest market potential (Mycorena, 2021d).

Figure 5 Mycorena Swedish Vego Balls (Mycorena, 2020)

Figure 5 shows Swedish Vego balls that are also sold by Mycorena, but the packaging design is different compared to the Promyc-Nuggets. This product is not backed by ICA. Instead, there is a green circle, which says "Let's go local". Next to it, a woman drawn in cartoon style is pointing at the message. Although there is no official description on the female image on the packaging, it could be a reference to the cartoon figure "Popeye" which portrayed gaining strength from eating spinach. Evidence that the cartoon refers to Popeye are the anchor tattoo on the forearm, the strong arms, as well as the winking eye (Popeye, 2021). Underneath, the message "Redefining tradition – With mycoprotein" is stated. With the connection to a well-known, traditional cartoon, this redefinition of food for strength and health is likely to create trust in age groups that are familiar with Popeye. Moreover, another message is: "Got the balls to try the new? Forget about soy and pea…It's time to move on!" This clearly sets the product apart from other options that are available in the plant-based sector so far. However, it does not convey the idea that a fully new technology is used for producing the ingredients for making this product.

Overall, there is a naturalness to both products, as they are wrapped in carton packaging rather than plastic. A picture of the Promyc-Nuggets as well as all information is placed on a separate label and glued on the packaging. As this product was only produced for a small test run, this packaging is probably not the final design. The Vego balls have a small peephole through which the product is visible and the rest of the information is part of the carton box.

Figure 6 Products Nature's Fynd (Vegconomist, 2021)

The products sold by Nature's Fynd are only available for pre-order (Watson, 2021). On the back, the protein ingredient is called "Fy Protein (nutritional Fungi Protein)" (Watson, 2021). In figure 6 the Breakfast Patties and Cream Cheese can be seen. The packaging of the breakfast patties is colored orange and blue, which might not only resemble the colors of the patties (orange), but also the volcanic geyser of Yellowstone Park, where the microbe for this protein originates from. It is a very subtle but recognizable messaging. The thin, wavy lines might also represent the movement within the geyser. The lines as well as the wavy shape in the middle of the packaging are part of the design of both products, but different colours are applied. Additionally, both packages display a picture of the product. The cream cheese is designed with lighter colours, such as white and light blue. Overall, the look of the packaging is very lean and does not show anything technological that could remind the consumer of anything unnatural. Only if consumers read the ingredients and feel unsure about the Fy Protein, resistance for buying the product might develop.

4. Discussion of results

The discussion of results presents what has been discovered through research and provides an interpretation in context with the information given in the introduction. The objective of this research was to figure out how market conditions need to be adapted for Air Protein companies to launch their products successfully in the U.S. and EU.

4.1 Reflection of research method

Limitations of the research methods were revealed in the second and third sub-questions. For question one, overall information was satisfactory for describing the current legislations. Governmental sources gave a broad overview of innovations in agriculture and food, but there is no specific insight into regulations on air proteins that this research was aiming to discover.

The second sub-question brought up the problem that three companies that replied by mail did not want to participate in the research and most of the other companies did not respond. By mail and phone interview, just two companies provided useful feedback. Since protein fermentation includes more techniques than only biomass fermentation, this research could have included companies from the entire segment, so more responses might have been generated. However, after adapting the research method to finding interviews with the founders of Air Proteins and joining webinars, it was possible to gain more information for responding to the second sub-question. Also, the research method was limited because the companies that were contacted are in a development stage where time is very limited and sharing information about the problems that one's company is facing might feel uncomfortably revealing.

Additionally, the third sub-question could have spanned more topics. As suggested in the Materials & Methods, research on the supply chain was supposed to be included. However, information regarding this topic was not found to be suitable for this research. There was not enough insight given for the specific situations of Air Protein companies regarding supply chains. Furthermore, there were rapid developments happening during the final stages of writing this research, and updates were coming in weekly. This is a good sign for the companies, but unfortunately not all news could be covered in this thesis as it would have required constant updating.

Overall, the research generated interesting and comprehensive insights in the current legislative frameworks of the U.S. and EU and could identify many different types of programs for advancing innovations such as Air Proteins. Responses from the second sub-question formed a deeper understanding of the actual situation that the Air Protein companies find themselves in when facing these regulations.

4.2 Discussion of results

1. What are the current legislations for the cell-based air proteins in the European Union vs United States?

For deriving an answer to the main question, the regulations that effect Air Proteins need to be known. In the first sub-question, the legal framework was found to be open for Air Protein products to enter the market.

In chapter one, policies were stated as a potential barrier for introducing Air Proteins in the market. This hypothesis applies partly, as there are no restrictions to enter the two markets if all necessary precautions are met. In the EU, a novel food permit needs to be acquired and in the U.S. the ingredient has to be claimed GRAS to enter the market. The EU has updated the novel food application for easing the launch of innovative foods. In both markets the safety of the product has to be identified and labelling adheres to specific rules. The EU and U.S. underpin the urgency of innovations in the agricultural and food sector. The EU is moving towards introducing alternative proteins, of which Air Proteins are a part of, into the legal framework. With the Food2030 policy, alternative proteins gain attention and strategic plans are laid out for furthering the innovation, commercialization, and consumer awareness about alternative proteins. AGARDA is a R&D authority pilot that aims to intensify the research and development of innovations in the United States. However, there is no specific information about Air Proteins and if the companies benefit from this pilot. Moreover, the Agriculture Innovation Mission might be an important development for U.S. based air protein companies, as this program brings funding to innovations that provide solutions for agriculture and climate change. The laws and regulations as well as tools are most likely to be applicable to other type of protein fermentation companies, too.

2. What are present barriers for the companies innovating new proteins to enter the market?

The second sub-question revealed that the novel food permit is easier to obtain in the U.S. than in the European Union. The novel food permit might inhibit more companies to form and was found to slow down processes and also requires a great amount of funding. One company pointed out that the dossier the most time consuming part of the application. The company that did not need to apply for the novel food permit in the EU had the advantage to focus directly on the development, production and testing of the first product while all other companies in the EU have to overcome the barrier of receiving the permit first. Moreover, finding skilled scientists is also an issue because a specific field of knowledge is required. It is unknown whether this applies for both the U.S. and EU, as the information was only provided by a European company. Extended research might help to understand why there is a lack of skilled scientists and the EU could include a project under the Excellent Science pillar for creating awareness for the need of skilled scientists. Furthermore, it was found that price parity needs to be reached for consumer acceptance. In the knowledge gap, competitive advantage in prices of Air Protein products compared to meat products was stated as unknown. In this question, it was revealed that

competitive advantage over meat has not been reached yet. But, the Air Protein companies are aiming at such. Overall, financial needs for scaling up production is the greatest barrier. Funding is essential for reaching price parity as well as collecting data for receiving the permits for commercialization. Lastly, financial means are necessary for building fermentation farms that are big enough for large-scale implementation.

3. What are the tools available to help shape conditions in the marketplace for air protein companies enter the market?

In the last part, tools were researched that could enable the Air Protein companies to enter the market successfully. Plenty of governmental programs were presented that invest in sustainable R&D in the agricultural sector. The EU allocates 30 Million Euros of funding specifically to alternative proteins due to pressures from the GFI (European Commission, 2021b). When comparing the funding opportunities in the two markets, the EU was proven more favorably in governmental aid. In the EU, the infrastructure for research and innovation is aligned and shows more synergy under the umbrella “Innovative Europe”. According to the Good Food Institute, the U.S. could be more open to partnering with the biomass fermentation companies and is in need of creating a synergy similar to what was found in the EU (Good Food Institute, 2021a). Moreover, several communication tools to enhance consumer awareness on the naturalness, health and environmental benefits of air proteins were found. In the introduction, consumer acceptance of the intensive use of technologies for protein production was claimed unknown. This research revealed that through marketing, social media, and a public debate, consumer acceptance can be build. It is important to communicate the naturalness of the products and not highlight the use of technologies when introducing the products to a broad audience. Three products were presented as examples, but it cannot be analyzed which product will be the most successful as they are still in the test phase.

4. Main question: How can market conditions be shaped for air proteins, to enter the market successfully?

The three afore discussed questions can help formulate an answer to the main question of this research. Overall, there is no law that bans the use of biomass fermentation proteins in the U.S. or EU. However, there are barriers in the process of introducing Air Protein products to the market. The outcomes of this research show that launching Air Protein products could happen more successfully by adapting parts of the legislation to enable the entrance to the market more efficiently. Thus, the novel food permit in the EU could be improved. The dossier requires the collection of much data, which takes time and money. Of course, ensuring the safety of each product is central, but there might be a more efficient application process for the novel food permit. The Food2030 policy is likely to be a helpful driver for shaping market conditions for Air proteins to be introduced successfully. The U.S. has no specific policy or funding that touches on the need of Air Proteins, or alternative proteins. These may be subjects where a foundation for Air Proteins to successfully enter the market could be shaped by political decisions. Open-access research is one example, given by the GFI that would be a first step in improving market

conditions. Next to this, consumer awareness has to be increased. The companies themselves take a share in creating marketing campaigns and presenting the products on social media. But, if scientists and trusted public figures would start a debate, consumer awareness and acceptance most likely increases. Also, governmental efforts could be focused more on supporting companies that have cutting-edge innovations like biomass fermentation. Projects like the BBEPP or Rising Food Stars Association have been identified to have a positive impact on the development of Air Protein companies. These projects were only found under the flagship of the European Union, so the U.S. could build projects based on these ideas.

5. Conclusion and recommendations

5.1 Conclusion

As the food system is contributing significantly to climate change, a transition into a less environmentally damaging system has to happen. This research focused on the market conditions for Air Protein companies to enter the market. Air Proteins are protein ingredients that need much less inputs compared to traditional sources of protein in the Western diet (Specht & Crosser, 2020). The proteins are produced with biomass fermentation (Takefuji, 2020) and applied in various plant-based products (The Protein Brewery, 2019b). As most companies are in the development phase or have launched recently, the question on how market conditions should be shaped for these products to enter the market successfully was investigated. The research focused on the European Union and United States of America as target markets.

In terms of legislation, the EU has created a process for novel foods that is easier to go through than before. It claims that processes are faster and that more foods are approved. Still, this is a barrier that biomass fermentation companies in the EU have to cross. The fact that the EU refined the definition of novel foods and the biomass fermentation ingredients are part of it, makes it more likely that the companies will get a novel food permit and might reduce time needed for receiving it. But, the system is not yet as accessible compared to receiving a permit in the United States. Next to this, the EU and U.S. have comparable regulations for food safety and product labelling. Any product needs to adhere to these standards to get permission for entering the market. Through the Food2030 policy, the EU is promoting the introduction of alternative proteins, including Air Proteins, in the European market (European Commission, 2020a). In the U.S., it is unknown if the programs for research in agriculture have an impact on the Air Protein companies. The government is working on an Agriculture Innovation Mission, which might have a stronger focus on alternative proteins because of the increasing the efforts put into the transition of the agricultural sector. However, this will take time to be implemented and to be able to draw a conclusion over its impact on Air Proteins.

Barriers for Air Proteins to enter the market are the application for the novel food permit in the EU, finding skilled scientists for the development of products as well as funding for scaling production. For the U.S., reaching price parity is the only barrier that could be found.

Tools for shaping the conditions in the market place were divided in government programs and consumer perception. The government of the United States has many tools in place to aid research and development for innovation in agriculture and food, but it is not applied on the biomass fermentation companies. The EU has developed different tools to leverage the transition of the current, unsustainable system, to a more technological advanced system. Money, research, training and collaboration are all part of the incentives for sustainable development. The tools suggest that Air protein companies have many opportunities to get help in different ways from the European Union. It was also found that most companies from the EU are backed by European programs like Horizon 2020, while U.S.-based companies rely more on private

investment. Letters from the Good Food Institute point out that the U.S. and EU should increase efforts in research and investment in alternative proteins. Consequently, the EU channeled funding specifically to alternative proteins. Yet, there was no information found if the U.S. reacted to the demands of the GFI. Regarding consumer perception, an interview with the CEO of the company Air Protein revealed that consumers are developing a misunderstanding of the technology. Educating people on the naturalness, nutritional superiority to meat as well as competitiveness in price and taste, is important. The law of diffusion of innovation was presented as a tool to show that Air Protein companies have to analyze which customer group is targeted in which development stage and that marketing needs to be adapted accordingly. Two companies have released products that are limited in their availability. With the trial runs, information about consumer perception can be generated and implemented in further launches.

The answer to the main research question can be dilute out of the foregoing conclusions. Market conditions can be shaped by providing more financial aid to Air Protein companies from governments. The EU could make the application for a novel food permit, more specifically writing the dossier less time consuming. Additionally, the U.S. government could make aid in R&D more accessible for Air Protein companies. It is not known why U.S. based companies receive no aid from the government and if any company tried, yet. So, it would have to be figured out how government funding could be adapted for Air Protein companies. Lastly, creating more awareness about the products by also highlighting the naturalness of the biomass fermentation process is necessary for success. For drawing a conclusion in terms of differences between EU and U.S. based companies, more information is needed from U.S. American companies. The majority of respondents are seated in the EU and the additional information provided through extended research did not add much evidence for U.S. based companies.

During the research, the source that gave most insights into the protein fermentation sector was the Good Food Institute. Barriers that were identified in the second sub-question are reflected in the work of the GFI. The institute is pressuring the European Union and the U.S. to channel more money into the protein fermentation sector. As the alternative protein sector is still very young and the branch of fermentation has only started to take on shape recently, research is very limited. The viewpoint of the Good Food Institute is that much more funding in this emerging sector could bring an increase in scaling and thus the intended effect on sustainability that the Air Protein companies are aiming to have. This research was particularly turning the attention on biomass protein companies and their products. However, most findings, like the laws or the tools for successfully bringing the products to the markets, did not specify on biomass fermentation. Therefore, this research is most likely also applicable and can be of value for other types of protein fermentation companies and novel food companies that direct their efforts towards replicating animal products with plant-based alternatives.

5.2 Recommendations

In this part of the chapter, recommendations are given to the target groups that were identified earlier in the research. The target group includes arising primarily food start-ups in the Air Protein field, politicians, but also investors, and retailers. If the recommendation were to be followed,

Air Protein companies could enter to the market in less time and would most likely be accepted by consumers. Most importantly, it could cause a shift in the food sector with a positive impact on biodiversity, soil health, and agricultural productivity and a decrease in global warming.

In the short-term, politicians of the EU should loosen the permit restrictions and application process for novel foods. Politicians of the U.S. should create a synergy between several agencies such as the European "Innovative Europe" and through open-access research. Also, the U.S. might go a step further and draw up a policy like the Food2030 policy of the EU. This would create a pathway for becoming more sustainable. In both markets, governments have to bring forth more funding as well as research and development in the field of Air Proteins. Arising food start-ups with biomass fermentation technologies should continuously monitor consumer behaviour and understand how to derive successful marketing campaigns based on the findings. This thesis is laying the groundwork for more research on the reason why novel technologies like biomass fermentation are perceived as unnatural even though the production process is comparable to products that are already widely accepted, like beer. Based on this, more research could find how to successfully communicate the novelty of products with different target groups. The collaboration between ICA and Mycorena might be a good example of how retailers can help formulating marketing strategies by using the abundance of data that can be collected by each purchase. It would be favourable for more forward-thinking retailers to start strategic relationships like this.

In the long-term, awareness on the positive effects of Air Proteins need to be raised. Politicians, the Air Protein start-ups, but also citizens who already know about Air Proteins can broadcast information about the needs and developments of the technology. On the governmental level, networks for skilled scientists should be built to share knowledge and create solutions together. Moreover, throughout the following years, the effects of the Food2030 policy should be measured continuously and improved if needed.

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Appendices

Appendix 1: Air Protein companies

Companies from different countries

https://solarfoods.fi - Finland

https://www.airprotein.com – U.S. (California)

https://www.naturesfynd.com/fy-protein - U.S. (Illinois)

https://arbiom.com/ - U.S. (North Carolina)/ France

https://mycorena.com - Sweden

https://www.afineur.com - U.S. (New York)

https://www.mushlabs.com - Germany

http://pura.mogu.bio - Italy

https://www.theproteinbrewery.nl - The Netherlands

Appendix 2: E-Mail to companies

Dear (Name),

As part of my thesis research, I am reaching out to you for information about market conditions for air protein products to successfully enter the market. In the first part I am looking into the legal barriers that might inhibit or even forbid the entrance of air protein products in European (Eu-27) countries and the United States. The second part is based on your responses and is designed to show hardships that you are going through or are prepared to face in the near future. If you have information beyond what my questions suggest, please feel free to describe the situation.

Thank you very much in advance!

My main question to you is:

What are the biggest problems that you are facing before entering the market/that you have faced during the launch?
Examples could be consumer awareness, specific laws, competition, financial barriers etc.

Kind regards,

Merit Vogt
Aeres Univerity of Applied Sciences
Dalhousie University

Appendix 3: Responses

Mogu – Pura

Dear Merit,

thanks for your kind communication, for your interest in Mogu and more specifically in our R&D Business Unit, Pura.

We are glad to learn about your ongoing thesis research. However, unfortunately at this moment we cannot provide the information you request.
This, for multiple reasons, including the fact that we are currently in a pivotal development phase.

Certain of your understanding, we'd like to wish you the best of luck with your investigation and we look forward to keeping in touch in the future.

Kind regards,
Giulia

Nature's Fynd

Hi Merit,

Thank you so much for reaching out and for your interest in Nature's Fynd! It sounds like your interests line up well with what we're all about. Unfortunately, our team members aren't available for consulting or interviews but we wish you luck with your research and encourage you to follow your curiosity. Please continue to check our website or social media where we regularly post updates.

The Nature's Fynd Team

Mushlabs

Hi Merit,

To answer your question the bottleneck in Europe is regulatory approval. The US and Asian countries are much more open to alternative foods/alternative ways of production. In general, it is also difficult to find people with experience in the sector because it is such a new sector. Thankfully our founders are both scientists and can train up other scientists but it still difficult to find more experienced talent.

Let me know if you have any further questions. I have added my email to the chain.

Best,

Mariana

The Protein Brewery

Dear Merit,

Thank you for reaching out to us with your research question. Unfortunately, due to confidentiality reasons, we are not able to participate in your research.

We wish you all the best for the future and in finishing your thesis. Have a good day!

Met vriendelijke groet | Kind Regards,

Pien de Laat

Anonymous Phone call

What are the greatest bottlenecks that you are facing with your company?

> The scaling is the biggest problem. It would have to happen very fast to meet the demand. The volume to satisfy the demand is just not there, yet.

I saw that your company does not need to apply for a novel food permit. Is that an advantage?

> Yes. The launch of first products for validation happened quickly. Most other companies in the field are still in the process of applying for the permit, but we did not have to do that.

Do consumers perceive the product as unnatural?

> No, many consumers in our market are interested in trying new things. People know about fungi and fermentation, but are not completely sure how it works.

Appendix 4: Structure