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An analysis of Plant-based Meat Consumption Trends and the State of the Industry

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Introduction

In the next decades, food systems will face many challenges due to changes in macro forces, such as population growth and increase in urbanization. Moreover, their equilibrium will be threatened by the effects of climate change that are reshaping natural ecosystems. Then, food systems will have to face these challenges and strategically adapt to these changes, trying to increase food security and developing more resilient agricultural methods. To do so, food systems must adopt sustainable development measures defined as *"giving equal consideration to the social, environmental, and economic impacts of a choice or product, from a global level down to the level of individuals*" (Vinnari & Vinnari, 2020). The contemporary economic paradigm of the food sector, therefore, needs to evolve. Reaching sustainable development would need the implementation of both mitigation and adaptation strategies to reduce and better manage the effects of climate change. These strategies are complementary and consider the co-benefits, adverse side effects, and risks that could arise (IPCC , 2014). Reaching this new equilibrium would allow for the long-term sustainability of the food systems environment.

However, global food consumptions patterns have an influence on allowing this switch toward sustainable development. In the last decades, globalized food habits had led to an increase in meat and convenience food consumption. Therefore, more sustainable dietary patterns that include major consumption of low environmental impact food products are required to enhance food systems resiliency.

Simultaneously, a new trend of food sectors that has emerged is the interest toward sustainable diets which the FAO defines as "*dietary patterns that promote all dimensions of individual health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable. They aim to achieve optimal growth and development for all individuals of present and future generations, contribute to prevent all forms of malnutrition and support the preservation of biodiversity and planetary health*" (FAO, 2019). Then, there has been an increasing interest in the origin, naturalness, composition, and environmental impact of food.

These reasons, together with ethical motivations led to sustainable dietary patterns such as vegan, vegetarian, and flexitarian dietary habits steadily rising.

Due to these new food trends, many companies in the food sector decided to produce some plant-based meat alternative products. In the last years, the supply of this food category has significantly expanded and new innovative plant-based meat alternatives, such as Plant-based meat and cell meat, have been developed. Plant-based meat is a product that is only made by plant-based raw ingredients and which aim is to reproduce traditional meat in its aspect, smell, and texture. The main benefits linked to this product regard its capability to reproduce meat features but with a lower environmental production impact. Then, from a consumers' behaviour perspective, this product category could help on the shift toward more sustainable diets cutting back on meat consumption. However, Plant-based meat is a very innovative product that has just been introduced at the mass market and is still considered a niche product. Nevertheless, thanks to the rising interest in a plant-based diet, this new market could give new opportunities to both meat and meat alternatives producers.

Taking into consideration this framework, this thesis aims to study which are the main motivations that lead to the adoption of a plant-based diet, the main perceived barrier to the embracement of these sustainable dietary patterns, and which are the main attitudes, opinions, and intentions toward Plant-based meat products. Then the thesis is structured as follows.

The first chapter assesses the challenges that food systems will face in the next decades and understands how they will need to integrate a more sustainable approach to be resilient and sustainable in the long term. Then, it is accessed its environmental impact and how it is affected by environmental changes. It concludes with an analysis of the main food consumption trends and consequent shifts in dietary patterns with a look at which are the new and innovative food products that will be part of individuals' dietary patterns in the future.

The second chapter overlooks the global meat industry dynamics looking at its evolution and development. It also accesses the environmental impact of meat supply

chains and analyses how meat consumption patterns changed in the last decades and how they are projected to evolve.

The third chapter is a review of the theoretical framework aimed at studying the cognitive drivers of reducing meat consumption. Then the personal, social, and contextual factors that determine and affect this behavior are accessed.

The fourth chapter analyses the evolution of the plant-based meat alternative products and presents the Plant-based meat understanding how the market of this innovative product is evolving, its environmental impact, and its market acceptance levels. Moreover, a focus on the innovative product of cell meat was also addressed.

The fifth chapter is dedicated to the experimental analysis of this study which involved the use of an online addressed survey and a one-to-one semi-structured interview, aimed at understanding which are the main drivers toward the adoption of a plant-based diet, the main motivations, and perceived barriers of it, and the attitudes, opinions, intentions toward the innovative product of Plant-based meat.

The final aim of this research would be the investigation of consumers' target to which the Plant-based meat should be addressed, assuming that companies that produce Plant-based meat should well know their potential consumers' features to engage with them and deliver the appropriate communication messages, especially considering that this product has been recently introduced to the market.

1. Feeding the Future: an assessment of food systems dynamics

1.1 Population Trends

The next thirty years will be crucial for global food and agricultural systems adaption to increase in population, urbanization levels, and income that will drive up the demand for food and will change dietary patterns. Food systems must face a huge challenge: how to feed almost 10 billion people providing enough food and meet changing global demands while trying to reach the world's climate goals.

Even if global food production increased in the last few years, there are growing issues about inequalities and food security.

The following part is an overview of population forecasts and general trends that are shaping the food system and an analysis of the food security phenomenon and possible actions to mitigate it.

1.1.1: Population forecasts for 2050

The global population is expected to reach 9.8 billion by 2050, from 7 billion in 2010, and therefore the demand for food products will increase by more than 50%, while the demand for meat and dairy products will grow by 70% (World resource institute , 2018). The UN projects there will be 10.8 billion people by 2080 and it will keep growing till 11.2 billion by 2100, the period in which it should start becoming stable. Population growth will take place in a heterogeneous way. In fact, in high-income countries, it will stay constant until 2100, while other regions like Near East and Sub-Saharan Africa will increase exponentially doubling their inhabitants, and the South Asian region and the Latin American ones are expected to continue growing too (FAO, 2018). Changes in global food demand also depend on other variables: urbanizations, migrations, income growth, and diets composition. It is expected that by 2050 almost two-third of the whole population will live in urban areas and the number of cities will grow by 75 percent, particularly fast in Africa and Asia. Furthermore, in high-income countries (HIC) elderly people will represent most of the population while in low- and middle-income countries (LMIC) the number of young people will increase a lot, and these phenomena will affect the dietary patterns. As the population is growing even migrations are and will continue to. In 2020, 55 million people were living in internal displacement (IDMC, s.d.). Major causes of these human flows are conflicts and natural

disasters, which because of climate-change are more and more frequent. Asia and Africa are the world's regions that are mostly affected by the migration phenomenon with respectively 30 million and 10 million people that migrated between 2010 and 2015 (FAO, 2019). Migrants often move from places in which food systems have low capacity and production searching for better lives conditions.

Changes in average per capita annual income are a variable that strongly affects food demands. It is expected that incomes will grow worldwide, even if, unfortunately, poverty and inequalities will still be high. In Africa and Asia, a new middle class is on the rise and the annual growth income rate is higher concerning the rest of the world. However, strong regional differences will remain, with an actual global income that is almost USD 11.000 per year, in which HIC have a USD 43.000 per year compared to the USD 3.900 in LMIC (FAO, 2018).

Food production is driven by these trends and now is at the highest level it has ever reached. The increase in food production is going faster than the one in population and it produces a higher level of global average caloric needs.

The socio-economic trends mentioned above generate a shift in diets composition that significantly changes global food demands. By 2030, the calories intake of six people in seven will be almost 3.000 kcal (FAO, 2018). This nutrition transition is characterized by a higher request for meat, dairy products, and fish, an increase in sugar, processed foods, vegetable oils, and fast foods. On the other hand, the demand for cereals, tubers, and roots is projected to slow down, and national markets are showing the tendency to commoditize these products. Changes in dietary patterns are shifting toward the HIC model that is rich in energies, added sugar, salt, and more in general fats. Shifts to this nutritional pattern show health and sustainability issues. Overweight and obesity are huge problems, especially in Europe and the USA, where 28 percent of adults and more than 15% of children are obese (FAO 2017). Other health-related problems linked to this diet model concern some type of non-communicable diseases like diabetes, cardiovascular problems, and certain types of cancers.

Unfortunately, these speed nutritional transitions will not even solve the problem of undernourishment, and right now there are not the socio-political conditions to allow for great access and affordability of nutrient-rich food.

1.1.2: Food Security

Undernourishment is a battle that the UN is struggling with, and even if there have been some improvements, the goals set seem to be too far to be reached. From 2014 hunger slowly started to rise and it is estimated that in 2019, almost 750 million people experienced high levels of food insecurity while 1.25 billion experienced it at moderate levels and 690 million people were hungry (WFP, 2020). Possible reasons for this increase could be found in a high number of conflicts and climate changes issues like biodiversity loss, water crises, and a higher level of carbon dioxide that lower nutrients in some type of food as staples (WEF, 2020). Furthermore, the effects of Covid-19, which are still uncertain, could even worsen the situation.

In the case in which this trend will continue to move in this direction, the world will fail on achieving many of the SDGs[1] set by 2030, including the SDG 2 Zero Hunger.

However, the global food system would be able to produce sufficient food for the whole population, but many people do have not the purchasing power to get enough food. Hunger is not just a problem of insufficient supply but a distribution, both local and global, matter. This is one of the food and nutrition paradoxes: *food excess and access*. It is a paradox because in the world, for every undernourished person there are two that are obese or overweighted, and every year 36 million people still die from starvation while 29 million dies because of health problems caused by obesity. Asia is the world region with the highest number of undernourished people, 381 million in 2019, but it is expected a reduction to 329 million by 2030, however, despite the improvements the outcome would not be enough to reach global sustainable goals. On the other hand, forecasts for Africa are expected to get worse becoming the place with the highest percentage of undernourished people, 51 percent of the total, that means almost 435 million, and its level of PoU (prevalence of undernourishment) is expected to reach 25.7 percent by 2030, so this region is off-track to achieve the Zero Hunger goal. Also, Latin American and the Caribbean will see an increase in hunger being the

[1] The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership. Source: (UN, 2021)

region in which food insecurity is growing at the fastest level: 31.7 percent in 2019. By 2030 there will be a different distribution of hunger, but the number of starving people will reach 841 million from almost 690 million in 2019 (FAO, 2020). We are moving toward a scenario in which inequalities will become deeper, and the cross-country Gini Index[2] calculated between 1970 and 2000, which result is above 0.70, clearly demonstrates it, considering that its maximum level (1.0) represents the highest level of global income inequality.

Food security is positively related to diets quality. In fact, in LMIC people who experienced at least moderate levels of food insecurity had to modify their diets increasing the consumption of food that is cheaper on per calories basis (as staples, for example) and reducing consumption of more expensive foods (livestock products, for example). This phenomenon generates issues linked to the nutritional matter of these diets that lack macro components of some food groups. An affordability analysis showed that most poor people can afford a sufficient caloric intake but not a nutrient or healthy diet (WFP,2020). Therefore, an important step to take to reach food security would be to make affordable healthy diets worldwide. Today, healthy and complete diets cost almost 60 percent more than diets that only comprehend essential and basic nutrients, and the cost of a healthy diet is above the poverty line that is set at USD 1.90 purchasing power parity per day (WFP, 2020). Unfortunately, more than 3 billion people do not get to this threshold.

Shifting to complete and nutritive diets require an analysis of the contribution costs of various food groups that let healthy diets be unaffordable for many people, especially in the low- and middle-income countries. Studies made by WFP and FAO showed that higher food contribution costs are associated with high nutrition food groups that are mostly included in the categories of dairy products, vegetables, and high protein food (both from animal and plant-based sources) (FAO, 2020).

[2] The Gini coefficient is based on the comparison of cumulative proportions of the population against cumulative proportions of income they receive, and it ranges between 0 in the case of perfect equality and 1 in the case of perfect inequality. Source: (OECD, Income inequality 2020) available at: https://data.oecd.org/inequality/income-inequality.htm

Many variables affect the cost of nutritious food; from food production to the wider supply chain, climate-changing conditions, consumers demand, and food policies adopted by governments.

Insufficient levels of technology and investments in food production determine low productivity and tackling this issue could be a solution to have a higher supply of nutritious food, enhancing the average income and affordability of certain food products. Especially in low and middle-income countries, keeping having a low diversification of food production generates problems not only related to health but also economic ones, as the capacity of the population to react to food price shocks. The capability to innovate and sustain the growth of a more diversified food production would be fundamental to increase diet quality and reducing food prices.

Among the different variables, food losses are the biggest issue that affects nutritious food supply chains. At the global level, one-third of the total food produced, a huge percentage, gets lost or wasted. Globally, every person wastes 121 kilograms of food per year on average, and 61 percent of food waste is caused by final consumers. However, in LMIC this phenomenon mainly affects the earliest stage of the food chain because of a lack of efficiency, insufficient levels of technology, and agricultural government policies. Reducing the entity of FWL (food waste and loss) could help with the higher availability of nutritious food and on reducing its cost while working on more sustainable food systems. The main causes of food losses are driven by adverse or extreme weather conditions, worsen by climate change, while others are connected to storage conditions. High technology levels are often fundamental to keeping good storage conditions and prevent products' deterioration. Therefore, even logistics and market infrastructures need to be efficient to allow for a "long shelf product life".

Consumers' demand has an important impact on nutritious food production; social changes as urbanization, family size, and working conditions led to shifts in consumers' preferences and food habits. The opportunity cost of having a healthy diet seems to be too high because consumers have to pay higher prices for nutritious food and add on top time and efforts costs related to healthy meal preparation. Consequently, consumers worldwide are asking for convenience food that most of the time is high in sugar, salt, and fat and not particularly nutritious.

Apart from all these variables mentioned above, the most important role in helping a structural change in diet composition is up to government policies. The cost of food is directly driven by food and agricultural policies made by institutions that comprehend a wide set of actions that shift from fiscal policies and farmers' subsidization to the regulation of food marketing and promotion of healthy food programs. Particularly important to be on track to reach the SDG2 is the so-called *twin-track* approach (FAO, 2018), which encompass both investments in social protection as cash transfer programs, food distributions, school feeding programs to extremely poor and pro-poor investments aimed at increasing the production activities and raise their purchasing power.

Other fundamental policies should be addressed to nutritious food price reduction, which, considering the diversity of food systems, should be context-specific and a high level of coordination among the operating actors should be reached. The first step to take would be to readdress agricultural priorities trying to shift toward the production of nutritious food like legumes, fruits, and vegetables. The increase in subsidy actions to small farmers, especially in LMIC, would be fundamental to rethink the agricultural system. On the other hand, taxation of highly nutritious food should be completely avoided. Furthermore, investments in Research and development would help small producers to keep a sufficient technological level in order to be competitive and profitable (FAO, 2020). Recently, in food value chains many resources have been addressed on the production of highly processed foods. Today, in order to get to sustainable development and move toward food security, government policies have to redesign more nutrition-sensitive value chain food systems; investments in technologies to improve storage conditions and infrastructures are fundamental to do it. Other types of policies should work on food loss reduction identifying the more critical steps in the food chain that determine food loss.

Together with actions that directly affect and promote nutritious food, there’s a set of complementary policy actions that can be implemented to get to a healthier diet regime. Actions aimed at raising awareness on the benefits of healthy food could have a positive effect on consumer choices influencing their behavior; promotional programs of healthy food environment could be an example. Other complementary actions could be the taxation of minimal nutritional value food, as many types of

convenience food and soft drinks, and the regulation of the food industry through the introduction of limitations on the use of sugar, salt, and fats (FAO, 2020). Regulation in marketing activities and promotion of the support on nutrition education would also be important actions to take.

1.2 Sustainability in food systems

Nowadays, climate change is the biggest challenge the world has to face and that is defining people's conditions of life and availability of natural resources. The last thirty years have been the warmest that human life has ever experienced, and the equilibrium of the Holocene is going to disappear irreversibly. Greenhouse gas emissions, since the preindustrial era, are the main cause of temperature increase and climate change, and even if international agreements regulate and limit the emissions, population growth, and economic activities are boosting them. The atmospheric concentration of methane, carbon dioxide, and nitrous oxide are at their highest level and fossil fuel combustion contributes about 78 percent of the total GHG emissions (IPCC , 2014). Food systems are great contributors to emissions, and it's estimated that their share is between 19 and 29 percent of total GHG emissions (CIRAD, 2019). Food systems both trigger climate change and are jeopardized by it. There are many interdependent links among the negative effects of the food sector on the natural and social capital, and global risks driven by climate change. As an example, the food sector contributes to biodiversity loss and land degradation, and at the same time is affected by the consequences of these global changes. One of the biggest risks for food systems is that climate change directly threatens crops and could significantly reduce them in the long term (FAO, 2018). Other issues are caused by the increasing level of Co2 in the environment that is lowering nutritious in many staples like soybeans, wheat, and rice. Biodiversity loss can drastically increase food insecurity and generate involuntary migrations and social instabilities. On the other hand, food systems contribute to the increase of many issues that drive climate change. Methane emissions, as an example, are largely generated by global livestock, while deforestation and land degradation are due to agriculture expansion that is running fast.

Sustainability is defined as “giving equal consideration to the social, environmental and economic impacts of a choice or product, from a global level down to the level of individuals” (Vinnari & Vinnari, 2020). It is the contemporary economic paradigm of the business environment and the food sector, as the others, needs to evolve. To reach sustainable development, both mitigation and adaptation strategies must be implemented in order to reduce and better manage the effects of climate change. These strategies are complementary and consider the co-benefits, adverse side effects, and risks that could arise (IPCC , 2014).

1.2.1: Climate change effects on food systems: challenges

Several climate change effects may threaten food security and let hunger rise worldwide. This phenomenon happens in different measures across countries and has different impacts. For sure, low- and medium-income countries, which dispose of few economical resources, have more difficulties with respect to the high-income ones on fixing consequences generated by climate change, as extreme weather events and their relative food price shocks for example.

The vast number of risks could affect both directly or indirectly food systems and it’s fundamental to underscore that all these risks are linked in a more or not strictly way. Variables that drive climate change and affect food production can be categorized as modal climate change, seasonal changes, extreme events, and atmospheric conditions (IPCC, 2016). Among the various effects, there are some riskier than others, as the threatening of crop yields.

The impact of these risks on crop production is starting to be dangerous. Some studies have identified a strong relation between warming temperatures and the productivity of crop yields. Globally, in the period between 1980 and 2010, the reduction of yields of wheat, soybeans, and maize have been almost 5 percent (IPCC, 2016). Globally, approximately USD 280 billion have been lost due to reductions in crops and livestock production between 2008 and 2018 (FAO, 2021).

In Australia, for example, the increase in temperature, extreme weather events, and rainfalls led to a decrease of more than 20 percent of the water available for crop irrigation determining a negative effect on yield productions. While in some parts of

Africa, farmers are trying to adapt to climate change modifying their agricultural techniques and using crop rotation.

In general, in the next years, as temperatures will continue rising, crops production will constantly decrease leading to food insecurity, livelihood, migration, and social instability issues. Furthermore, LMIC may not be able to tackle the climate change effect while supplying a higher demand for food due to population increase.

Natural disasters have already become systematic events and have long-term negative effects on food systems. They have become more and more frequent and intense, and food systems must systematically tackle these issues. From the 2000s the overall level of extreme weather events drastically increases, with a number 440 per year while in the 1980s they were about 100, including geophysical disasters, climate, and weather disasters (FAO, 2021). These events have a great impact on global economies that have to use an enormous number of resources to remedy these damaging effects; between 2011 and 2017 an average of USD 300 billion per year has been used to cover these consequences. The agricultural sector is particularly vulnerable to extreme events and the multitude of heat waves, pests, floods, droughts, wildfires, storms, and many others are challenging the equilibrium of ecosystems that guarantee agriculture its productivity.

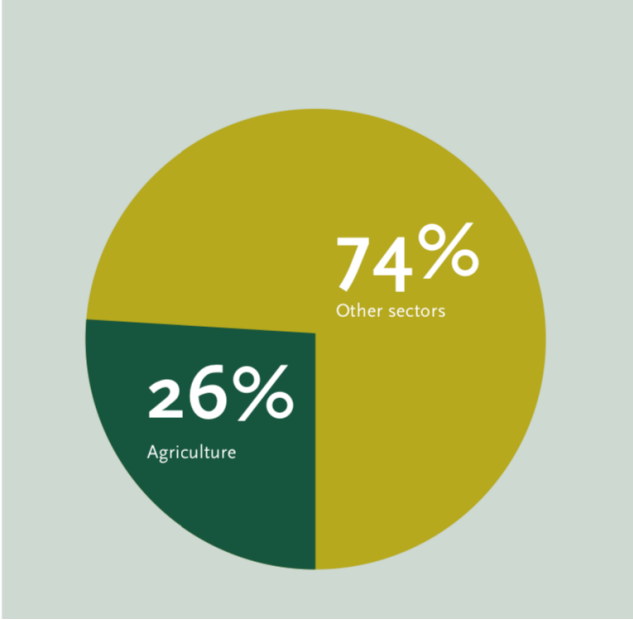

Figure 1.1: Damages and loss in agriculture as share of natural disasters total damage and loss in all sectors, 20008–2018; Source: FAO, 2021

As the figure 1.1 shows, 26 percent of total natural disaster damaging effects have been absorbed by agriculture; and in 2019, the global economic loss due to extreme weather events has been USD 122 billion (FAO, 2021).

Worldwide, extreme events have different frequency and differently affects countries and regions. Among the disasters, drought, storms, and floods have the most negative impact on agricultural systems. The first one is the main cause of crop production reduction in the whole world, and just in Africa, it accounts for economic losses of almost USD 14 billion in the last 10 years. Africa is also hit by waves of locusts' swarms that in normal conditions can destroy the amount of food that 35.000 people would consume in just one day. However, Asia is the continent that is paying the highest cost of climate change with economic losses of about USD 50 billion in the last decade.
Besides the direct effects that impact food productions, there are also indirect ones. As mentioned above, climate change threatens food systems and food security in all its pillars: food availability, access, utilization, and stability. A decrease in crop yields leads countries to increase their imports and decrease exports due to domestic loss.
The next parts will address the effects of food systems on the environment and adaptation and mitigation measures that should be taken.

1.2.2: Food systems contribution toward climate change

Food systems, as mentioned above, are a major driver of climate change, changes in land use, depletion and pollution of terrestrial and aquatic ecosystems, biodiversity loss, and many other environmental effects. These settings are going toward levels that are beyond planetary boundaries, overcoming the world's biocapacity. An increase in population and incomes and shifts toward HIC dietary patterns will stress food systems together with climate change.
It's estimated that, if there will be no structural changes in technologies used in the food market or mitigation policies, by 2050 the negative effects on the environment may rise by a percentage between 50 and 90 percent (Marco Springmann et al., 2018).
Food systems have to tackle various natural resources management challenges; the most impactful effects of food production are listed below:

1) Anthropogenic GHG emissions

GHG emissions are the main cause of temperature increase and biodiversity loss, therefore of climate change. As mentioned above, food systems contribute between 19 and 29 percent of total anthropogenic GHG emissions (CIRAD, 2019). Some studies state that in 2010 food systems emitted 5.2 billion tons of emissions in the form of carbon dioxide, methane, and nitrous oxide (Marco Springmann et al., 2018). The main source of GHG in the food sector is agriculture, mainly because of livestock agricultural emissions followed by deforestation and soil management. The Agriculture, Forestry and Other Land-Use sectors (AFOLU) according to the OECD accounts for 23 percent of net global GHG emissions. In the case in which mitigating actions, international policies, and a carbon tax would be taken the whole AFOLU sector could reduce its emissions to 89 percent with a consequent decrease of total global emissions by 12 percent (OECD, 2020). However, if on the contrary, the business-as-usual scenario will continue to be the major one, the food system emissions would increase by more than 80 percent and the demand for croplands may rise by almost 40 percent (IPCC, 2016).

Food loss is a phenomenon that contributes to generating emissions; in high-income countries, it's linked to overproduction and overconsumption and mainly affects the last stages of the supply chain, while in the low- and middle-income countries it is due to early production steps. Food loss contributes to GHG emissions through waste management activities and the core activities of the supply chain (from production to consumption). Just in 2007, food loss and waste (FLW) has emitted 3.3 Gigatons of carbon dioxide and the FAO estimated that if FLW would represent a country it would have been the third top emitters in the world after China and the USA (FAO, 2013).

GHG emissions are a complex issue to deal with, but many mitigation activities have been developed and could be applied to reduce the impact of the food systems on natural capital.

2) Biodiversity loss

Biodiversity loss is one of the most dangerous risks that is already affecting our planet, it drives the natural functioning of ecosystems and is at the base of agriculture's natural cycle. "*Humans are the 0,01 of all living creatures but determined the extinction of 83 percent of wild mammals and half of the plants"* (WEF, 2020).

Agriculture is the first sector that threatens biodiversity because its expansion led to changes in 75 percent of the world surface, and the loss of 85 percent of wetlands while affecting 66 percent of ocean areas (WEF, 2020). Methods of productions used in food systems are a damaging source of biodiversity loss. With the advent of industrialization, new fertilizers and pesticides, and mechanization methods that rely on fossil fuels have come. Furthermore, urbanization and population growth led to the increase of intensive and extensive crops that endanger biodiversity.

The vast types of pesticide used are jeopardizing the existence of insects, and more specifically of pollinators like bees that pollinate most food crops. Furthermore, fertilizers are reducing oceans' life because of water acidification. For example, the huge use of herbicides in the middle USA plants determined the acidification of the Atlantic Ocean in the Mexican Gulf where now there is not any form of life. Genetic diversity is another factor that helps to keep biodiversity, but intensive crop yields are contributing to reducing it and favor the possible diffusion of pests and viruses.

Biodiversity is a driving force for food systems and there are feedback loops in which one jeopardizes the other. To reduce the negative effects some mitigating solutions should be applied. Diversifying crop species would both protect biodiversity and production itself, while the regulation on the use of pesticides would protect many species both terrestrial and marine and the population would gain benefits on the health. Anyway, a structural change in the food system is needed because, apart from productivity, nutrition and environmental footprint must be considered (CIRAD, 2019).

3) Land Degradation

Land degradation has been an unavoidable consequence of agriculture since ever. Humans have always changed the aspects of parts of the land surface to address it to agriculture. However, since the advent of modern times, the levels of land degradation have become critical. The FAO estimates that 33 percent of global land is already degraded due to overexploitation, use of chemicals, erosion, salinization, and acidification (FAO, 2015). Agriculture is the main driver of land degradation, and intensive crops and non-sustainable agriculture methods speed up this phenomenon. Soil degradation of lands addressed to agriculture is estimated to have lost between 20 and 60 percent of its organic carbon content (IPCC, 2016). Furthermore, the problem of intensification of soil degradation is even more severe if we consider that in many

parts of the world there is low or no possibility to expand agricultural areas (CIRAD, 2019). Also, deforestation processes are great contributors to land degradation. Forests are potentially arable lands, and some studies state that agriculture is responsible for 80 percent of deforestation (Hosonuma et al., 2012).

Land degradation generates many problems linked to climate change, as biodiversity loss, ocean acidification, and drought. Agriculture keeps put land pressure and contribute to climate change while, at the same time, land degradation jeopardizes its activity.

4) Water scarcity

An increase in temperatures and emissions are causing many problems of drought. Therefore, water is going to become a precious asset that needs to be efficiently managed. Agriculture uses on average 70% of freshwater withdrawals globally (THE WORLD BANK, 2020); The increase in population and urbanization will probably enhance these levels. However, many issues limit the efficient management of available water. International food markets are shaping a new pattern of natural resource investments and land acquisitions. Unfortunately, many phenomena of corruption and speculation are linked with these trends. There are conflicts of interest among powerful investors and local farmers and users. In many cases, investors are capable to get to water acquisitions damaging local communities and threatening their food production and access. These events mainly happen in low- and middle-income countries, as in Chile where many international producers steeled entire regions' water resources in order to irrigate their crops addressed to international markets and let local communities starve. Also in Africa, whose many regions are affected by drought problems, many lands have been allocated to large investors that are overexploiting water sources.

Natural limits and hydrological realities must be taken into consideration in order to limit problems of water scarcity. International policies should regulate the whole sector of water management to create resilient water systems through incentives for innovation, reforms, and accountability (THE WORLD BANK, 2020).

1.2.3: Food systems' sustainable development

Sustainability is a challenging goal for food systems, and it involves the consideration of many different issues. The fundamental challenge to be addressed is how to feed almost 10 billion people by 2050 while fighting poverty, meet global climate goals and reduce pressure on the environment (World resource institute , 2018). To get to sustainable development, some gaps have to be filled: food gap, land gap, and GHG mitigation gap (World resource institute , 2018). Closing these gaps imply the adoption of mitigation strategies on both the demand and supply sides.

The food gap is defined as the difference in food amount produced in 2010 and the projected food demand in 2050; and the difference is about 56 percent, driven mostly by population increase and shift in dietary patterns, as mentioned above. Reducing this difference would involve both actions aimed at decreasing the unnecessary demand and at raising the food supply. Filling the gap would help food systems meet the future global population needs and reduce the sustainability challenge. Increasing the land dedicated to agriculture, as said in previous parts, would be a short-term and not sustainable strategy because it would contribute to land degradation and the increase of the so-called land gap. The land gap is the difference in the amount of land needed in 2010 by agriculture and the projected area of agricultural land needed to meet the global food demand in 2050, and it is estimated to be above 590 million hectares. To avoid agriculture expansion, an increase in crop yields is needed. The FAO estimates that crop productivity will grow at a similar rate that it had from the 1960s to 2010. However, these growth levels are insufficient to stop agricultural expansion and its negative effects. In order to fill the land gap, the yield growth must go faster (World resource institute , 2018).

The third gap is the greenhouse mitigation one and it is defined as the difference between the GHG agricultural-related emissions' projections for 2050 and the global target levels of GHG emissions for all sectors for 2050. In business-as-usual conditions, the amount of agricultural-related emissions would be 15 gigatons in 2050. However, modelled strategies aimed at reaching the climate warming global target of 2°C require a maximum amount of 21 gigatons for all sectors. Therefore, just the agricultural sector alone would emit more than 70 percent of the target quantity set, and stay within the 2°C thresholds would not be feasible. The GHG gap is estimated at 11 Gt

because to respect the target, emissions due to agriculture-related activities may stay into 4Gt. Actions to take to close these gaps should be implemented in time and different actors, from the private to public sector, need to be involved. Many of these mitigation measures are aimed at increasing the efficiency of resources (supply-side solutions) or at changing food demand patterns (demand-side solutions). Reducing food demand would at first require food loss and waste limitation methods. In high-income countries, nudging policies that incentivize people to reduce their waste may be effective. Also, retailers have a central role in wasting, efficient inventory management, and precise purchasing agreement which help suppliers better planning their activity could contribute to waste reduction. On the other hand, technological developments are fundamental to prevent and slow food degradation at every step of the food chain, especially in low- and middle-income countries where food loss happens due to poor access to technological resources. Preventing food loss and waste need governments worldwide to set a precise target that complies with sustainable development goals, actors in the supply chain to measure the entity of the food loss and waste problem to identify critical steps, and investments in innovation to develop new technologies. Moreover, shifting of food consumption patterns toward more plant-based diets would have positive effects on the global food demand reducing both GHG emissions and resources needed; this topic will be discussed in the next parts.

Other mitigation measures are addressed at reducing the cropland expansion. Zero-net expansion seems to be an unrealistic goal, but if complementary actions are taken, it would not be impossible to close the land gap. To increase crop yields, improvements in soil and water management are the baseline to start from. Revitalization of degraded soils may increase productivity, especially in dryland like Africa. International and local institutions may incentivize farmers on the adoption of agricultural methods that prevent soil exploitation as conservation agriculture, that is based on the principles of minimum soil disturbance and permanent soil cover, combined with appropriate crop rotation (IPCC, 2016). Climate-smart agriculture is a technique that prevents soil degradation and tackles both food security and climate change challenges; its objectives are increasing productivity and incomes, enhancing the resilience of ecosystems, and reducing emissions (IPCC, 2016).

Smart agriculture is an integrated approach that could help nations identify solutions that can maximize benefits and improve soil management practices.

Agroforestry is another successful method that thanks to regenerative trees increase the soil capacity to hold water and needs few quantities of pesticides.

Agroforestry helps with GHG emissions reduction because it improves the soil carbon sequestration and the soil structure itself. This mitigation method contributes to economic, social, and environmental stability thanks to the diversification of species and soil preservation (IPCC, 2016).

Protection of natural ecosystems is a way to boost crop yields. The adoption of protective environmental policies has shown a positive effect on crop profitability gains in some parts of South America for example (World resource institute , 2018). Linkages between productivity gains and ecosystems protection can attract investments interested in both. Governments have the power to create and make explicit the relation among forests protection laws and support for agricultural improvement in existing crops; institutions may favourite investments that openly disclose their interests in sustainable agriculture and ecosystems protection (World resource institute , 2018). Agricultural loans are another incentive that protects native inhabitants because of agricultural improvements. To build these strong links between crop yields and natural environment protection, international agencies and institutions may support the government in developing specific land use plans.

Other mitigation strategies would be reforestation and the conservation of peatlands. Reforestation is considered as a measure that can help reducing land degradation but, according to some studies, it is sometimes overestimated considering that this process is not able to completely restore destroyed natural environment and reach its previous levels of biodiversity and to get significant results, reforestation processes should involve many lands already addressed to agriculture (World resource institute , 2018).

Reducing GHG emissions and close the emission gap is a big challenge for food systems. One of the main sources of this problem is emissions due to livestock, but this topic will be deeply discussed in the next chapter. Other fundamental mitigation measures that could be adopted regarding the shift of fertilizers used, conversion to green energies, improved rice cultivation management methods, and sequestering carbon in the soil.

Nitrogen-based pesticides are widely used because of their low prices. However, changes in agronomic methods and a decrease in the use of nitrogen may largely contribute to a reduction in agricultural emissions, precisely in the condition of nitrogen use efficiency about 600 million tons of GHG emission would be cut. These actions must be supported by incentives toward fertilizers companies to produce more sustainable products and investment in research for biological nitrification inhibition.

Switching to non-fossil energy sources is a step to take by 2050. On-farm energy uses deeply rely on fossil fuels and mitigating this status requires governments to provide incentives to farmers and producers on switching to sustainable energies, and the integration of low carbon energies into the development efforts of farmers and suppliers. Moreover, regulation and threshold setting on GHG emissions are powerful measures that governments may take to faster the shift toward sustainable energy sources.

Soil may have an active role in mitigating GHG emissions. However, practices on improving its potential are at their early stages. Improvements in soil management methods can reduce emissions through carbon sequestration, which is a strategy that can be applied worldwide and at a relatively low cost (Keith Paustian et al., 2016). Carbon sequestration could be obtained through an increase in organic inputs or reduction in decomposition residues. Also, agroforestry methods build above-ground carbon and allow for its retention. Wild forests often have undisturbed soils that can better retain carbon stocks; therefore, the preservation of natural ecosystems is fundamental in trying to fill the GHG emission gap.

Sustainable development in food systems is a hard but not utopic challenge, however achieving this goal requires complementary efforts of many mitigation measures in which governments, the private sector, and civil society are strongly involved.

1.3 Food consumption trends

Food systems are changing worldwide driven by many megatrends that influence their whole value chains from production to consumption. Population growth, urbanization, diet patterns shifts, and technological improvements are creating a completely new food industry that in the next 10 years will change more than in the past 50 years (ACCENTURE, 2017). Food design, growth methods, and people consumption habits

will disrupt the food industry which, in order to adapt, will innovate business models. New competing forces will shape the market and firms will provide new and different value propositions to their consumers.

However, even though food consumption trends will see an increase in average calories intake, in many countries poverty will continue to increase leading to the problem of food access and security and representing a paradox about food and nutrition.

1.3.1 Shifts in consumers' needs

Today, post-modern societies look like information societies, in which people and goods are no more the economic centres while communication networks are the tool through which information is conveyed. The modern service economy is based on information transmission and the internet has a central role in it, becoming a tool that defines relations, codifies information, and eliminates the concept of space. Stability and duration are concepts that do not find anymore their space in society. Speed is the main feature of the modern age and modern relations, and it leads to a growing sense of uncertainty, risks, and anxiety state (Bauman, 2002). All these trends influence people eating behaviours; speed and changing life rhythm led to an exponential demand increase of convenience food that is more practical and shorter the average time of a meal; rising stress levels and growing desires to maximize leisure time let people consider cooking as a waste of time.

Convenience food is also the expression of the technological improvements that occurred in the food industry (Barilla center for food and nutrition, 2012). However, in many countries, these types of food contribute to increasing health problems considering that, usually, they are poor in nutrition and high in calories.

On the opposite side of convenience food, there are some consumption trends related to healthy and sustainable food. Awareness about the benefits of healthy food is increasing among the society and consumers are more and more interested in "functional food", which are types of food that have relevant benefits on one or many bodily functions that can improve health or reduce the risk of diseases and are consumed on a dietary basis (Barilla center for food and nutrition, 2012). In 2016 "Food with a function" has been in the top five of food-related internet search in the

USA (ACCENTURE, 2017), and the most three searched words in this category have been turmeric, apple cider vinegar, and jackfruit (Google Trends, 2016). The interest in healthy food is not completely new, but in recent times it gained attention due to changes in lifestyle and the find out of relations between food and non-communicable diseases. Consumers seem to be willing to pay a higher price for healthy food and the market of healthy food products is estimated to value more than $ 1 trillion (ACCENTURE, 2017). Consumers are also willing to pay higher prices for products provided by companies that make efforts on sustainable development and that are transparent in disclosing information about their activities. Many firms are investing in technologies that help on traceability of food from production to consumption. However, even if food sustainability is a growing trend, the category of people that are indifferent to environmental issues is still the most common one, but the positive news is that new generations as millennials and generation z are more sensitive and aware of these issues respect to previous generations, a study reveals that almost 75 percent of these two categories are willing to pay higher prices for sustainable products (marketing charts, 2015). This attitude creates a good basis for developing and marketing sustainable products. Consumers have a fundamental role in the evolution of the food chain toward sustainability, they have the power to reward sustainable products and punish not sustainable ones (Grunert, 2010).

Forecasts cannot predict if dietary patterns will radically change to get sustainable, but climate change will require irreversible adaptations of the food industry for sure.

Technology is a significant macro trend that is shaping features of new consumers' demand, and the digital transformation is fundamental in the food industry. Rapid improvements in technology enhance consumers' expectations that want to be satisfied in real-time (ACCENTURE, 2017). In the next years, retailers will increasingly interact with the digital self instead of the physical person. This process is leading retailers to the creation of omnichannel strategies that increase purchasing occasions and offer new and fast experiences to customers. Artificial intelligence personal assistant will become normal, and the video and voice technology techniques will allow for the conversational commerce in which the voice integration support will have a central role in responding precisely to customers' needs and getting many insights about them (ACCENTURE, 2017).

1.3.2 Changes in the food industry

New consumer needs are changing the food industry's economic environment. There are new competitive forces that are shaping this industry, which is already under economic pressure, to meet new requests (ACCENTURE, 2017). Food systems must be able to supply accessible and practical solutions driven by environmental sustainability. This process needs the whole system to be rethought. The various step of the chain will change; product design will use new materials for food, technology will help on reducing distances among different steps and increase the production system's efficiency, and completely new food sources will be widely used. Technology is already helping on facing business ecosystems challenges through methods that efficiently manage resources, smart agriculture is an example.

Another important trend that will strongly impact the food industry is the digitalization of food. It is starting to be used to measure, calculate and store the optimal micro-needs of plants in digital tools to better manage productions and monitor crop yields (ACCENTURE, 2017). This method, through automatization of functions, can both leverage crop yields and let food production be more flexible on defining where and how to produce food.

In the next years, food retailers' setup will be completely disrupted by new consumers' needs and technology. Even though this sector survived the prior e-commerce age, now it is threatened by digital platforms. The digital allows firms to directly interact with customers and then cut the supply chain through a direct consumers model. Even small and local producers can take advantage of digital networks to enlarge their audience. Delivery companies are a new, but already well-known, actor in the business environment that well respond to current consumers' needs and redefine competitive forces in the market. To still be competitive, retailers must shift from usual business to new digital formats able to provide fast access to customers' desired goods and design new customers' experiences. Therefore, fulfilment platforms of the food industry are completely changing, and retailers will innovate their business models to acquire customers at many different steps of their customer journey and deliver value propositions based on providing food-related services. Creating an easy way to

interact with customers will be fundamental and modernization of the supply chain and technology will be the key to adapting to these new rising trends.

1.3.3: Innovative food products

Population trends will force food systems to adapt to climate change and develop new efficient and sustainable production methods, as discussed above. A complementary solution to these issues will be searching for new food sources, both humans developed and already available in nature. These new sources should be chosen strategically; high nutritional value, low environmental impact, accessibility, and affordability are the criteria that the FAO use to define sustainable diets and that these new types of food should have to be considered as a valid integration and alternatives to already existing foods (KNORR; WWF, 2019). Today, 75 percent of the global food consumed comes from 12 types of plants and 5 animal species (KNORR; WWF, 2019), and the FAO enumerates between 250 000 and 300 000 edible plant species, of which just almost 200 are consumed by humans (FAO, s.d.). Even though many people, especially in high-income countries, have a sufficient calories intake, diets are too narrow in terms of products' range and exclude many potential sources of nutrition that already exist. This phenomenon contributes on threatening of biodiversity because diet monotony led to a fast expansion of intensive monoculture that caused a drop in plant species. Adopting more diversified diets could both benefit health and agrobiodiversity. There's an urgent need to increase the consumption of food that has high energy efficiency ratio, so an optimal proportion of the energy that the system consumes to produce food output (Bajan, 2020), and meat and dairy products are among food types that have a low-efficiency ratio. Many existing foods have a lower impact compared to animal-based products and are highly nutritious too. Algae, for example, are a great potential meat substitute, because they are rich in proteins, and probably one of the food types that in the next decade will be used daily.

Other types of food that may be widely consumed are cacti. They are already part of the Mexican culinary tradition and are cultivated in many parts of Africa, Central, and South America. Succulents are rich in vitamins and fibre; they have high water storing potential and grow in drought conditions.

Mushrooms are foods that have a low environmental impact considering that they can grow on by-products recycled from other crops (KNORR; WWF, 2019). There are more than 2000 edible varieties of mushrooms, and their texture makes them a valid and sustainable substitute to meat.

The UN elected insects as the food of the future (Will Italia, 2021), because they are cheap, highly available, and nutritious. Edible insects are rich in protein, vitamins, and minerals. A beetle that weighs 100 grams, for example, contains 200 calories and 20 grams of proteins (Will Italia, 2021). In the world, mainly in low- and middle-income countries, almost 1900 species of insects are eaten by humans (IPCC, 2016). Insects have a low impact on the environment; some of them can grow in organic side streams and enrich organic wastes with high protein components, and they would result low in greenhouse emissions to conventional livestock (A. van Huis*, 2015). However, insects can make a difference in food systems and dietary patterns only if they are mass-produced. They can be considered as a meat alternative food, but their consumption in many high-income countries depends on their acceptability levels; price, food safety, nutritional and environmental benefits together with the cultural dimension are drivers of markets acceptability. Educating western cultures to have a positive attitude toward these types of food would be a great step toward acceptability (A. van Huis*, 2015).

Furthermore, there's also a new category of food products which is on the rise: the new generation of meat alternatives. This category is made by two different product types which almost have the same aim. The first one is the category of plant-based meat, a product which reproduce traditional meat in its features but is only made with vegetable raw ingredients. Plant-based meat is considered to be an innovative and disrupting food products that could change the equilibrium of meat markets considering its fast diffusion in mass markets. Moreover, another greatest challenge of contemporary food systems is cellular agriculture. This technology works on the laboratory growing of muscle tissue animal cells from animal staminal cells. Cellular agriculture could be used to produce many animals derivative products, from milk to eggs, but the most potentially valuable is cultured meat, also called synthetic meat. A lifecycle assessment conducted by a study, states that cultured meat may need less than 60 percent of energy use and just 1 percent of land use of beef production,

generating, therefore, lower GHG emissions (IPCC, 2016). In the next ten years, the synthetic meat value market is expected to reach $140 billion (Will Italia, 2021), even though now, the consumption of these products is still not economically feasible. The assessment of plant-based meat industry and cell-meat will be discussed in following parts.

2. The meat industry

2.1 An overlook of the global meat market

In history, meat has always been a luxury food product not accessible for most of the population. However, from the 1950s, meat production and consumption started to steadily rise, changing the global dietary pattern. It is estimated that from the second post-war period till now, meat consumption increased by around 500 percent, reaching 325 million tons, and it is expected to get to 400 million tons by 2050 (Will Italia, 2021). The increase in meat consumption has not been a constant phenomenon in every world region and has been driven by population and income growth; Western countries saw a sharp rise in meat consumption, while some others did not. The USA is still the country that eats the most meat, with an annual per capita level of meat consumption that is around 100 kg, while in India the average meat consumption is 4 kg per person (STATISTA, 2018).

The aim of this part is to analyse the structure of the global meat industry with a highlight of the Italian one, understanding how it will be influenced by population megatrends, climate change, and new consumption patterns.

2.1.1 The Global Meat Industry

Meat prices

The value of the global meat sector was estimated to be USD 945.7 billion in 2018 and is forecast to reach USD 1142.9 billion by 2023 (Statista, 2019).

International meat prices decreased by 4.5 percent in 2020 compared to the previous year, reflecting an excess of exports and curtailments on imports (FAO, 2021). The main reasons for meat price decline are due to the Covid-19 effects; economic

downturn, transportation issues, and tourism limitations led to export incomes shrinking and to increases in domestic goods availability that generated lower meat purchases. However, total global meat imports saw a rise, mostly driven by the Chinese market request, in which meat imports rose by 62 percent (FAO, 2021). The African Swine Fever that outbreaks in Asia caused a pig meat deficit, therefore China, which production of pig meat decreased by 21 percent, has been forced to increase its meat imports. Worldwide, poultry meat price is the one that fell the most (around -10 percent), followed by the ovine meat (-6 percent), pig meat (-3.6 percent), and bovine meat (-1.4 percent) (FAO, 2021). Real meat prices are expected to continue having a downwards trend in the next years because of slower growth in meat consumption and a larger meat supply (OECD, 2020).

Meat production and trade

In 2020, meat production was estimated to have reached almost 325 million tons, with just a small 2 percent reduction from the previous year (Heinrich Böll Stiftung, 2021). This small contraction is mainly attributable to the African Swine Fever that hit the pig meat market in Asia and to the Covid-19 lockdown effects. Especially in China, the African Swine Fever caused a 10 percent reduction in meat production and 20 percent less pig meat output (Heinrich Böll Stiftung, 2021). Global meat production is expected to keep growing, reaching 366 million tons by 2029 (OECD, 2020). This increase in production will be attributed for 80 percent to world developing regions which demand meat is growing. However, by 2029, the USA, China, Brazil, and Europe are projected to continue being the main meat producers accounting for 60 percent of the global meat output (OECD, 2020).

During the 1990s, China overtook the meat production of other countries becoming the biggest one worldwide producing 88 million tons of meat per year (Heinrich Böll Stiftung, 2021). Production in Africa has also exponentially grown in the last 50 years quadrupling its meat output reaching 20 million tons per year (Heinrich Böll Stiftung, 2021).

Beef meat production in 2020 has been 71.4 million tons, with a downward of 1.4 percent with respect to 2019. It had a decline in India, Australia, Brazil, and the European Union, while it had a moderate expansion in Mexico, China, and Argentina

(FAO, 2021). As figure 2.1 shows, the US is the country producing the most bovine meat by some margin with respect to other countries. Brazil is expanding its meat production thanks to the abundant natural resources it disposes to but creating many

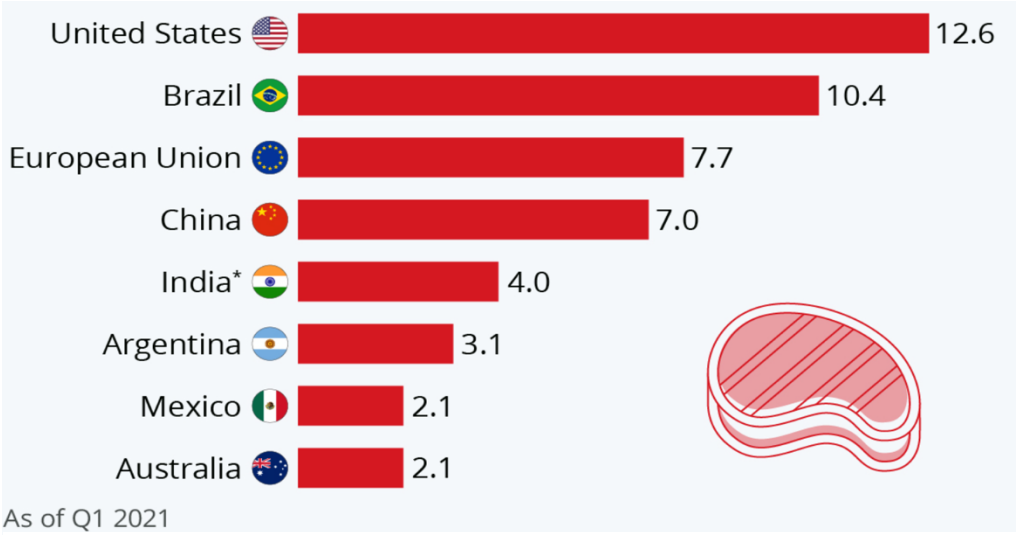

Figure 2.1: The biggest producers of beef in the world in 2021 (in million metric tons). Source: Statista 2021

environmental issues as soil exploitation and deforestation.

Europe and USA have very different meat industry structures, in fact, in Europe the industry is more diversified and localized, the 80 percent of meat companies have fewer than 20 employees (University of Florida, 2014). While in the USA, the percentage of meat processors with less than 20 employees is much lower and the intensive farming model is much more diffused.

The US meat industry is characterized by a high vertical integration. The CAFO[3], a farming model born in the USA, accounts for most of the livestock production. In 2016, more than 19.000 CAFOs were active in the USA and this model is today spreading in other countries as China and Brazil for example, where it is replacing traditional farming methods. However, the intensive meat production method is expanding also in Europe; in fact biggest companies of the meat market, thanks to their market power, use mergers and acquisitions to incorporate small and medium firms to settle

[3] Concentrated Animal Feeding Operation (CAFO) is an agricultural enterprise where animals are kept and raised in confined situations. A CAFO is an AFO with more than 1000 animal units (an animal unit is defined as an animal equivalent of 1000 pounds live weight and equates to 1000 head of beef cattle, 700 dairy cows, 2500 swine weighing more than 55 lbs, 125 thousand broiler chickens, or 82 thousand laying hens or pullets) confined on site for more than 45 days during the year. (USDA, s.d.)

their market power and reduce competition (Heinrich Böll Stiftung, 2021). Therefore, in Europe the CAFO model is expanding; the biggest one in the UK accounts for more than 1 million chickens, 23.000 pigs, and 3.000 other livestock species (Watson, 2020). The UN stated that CAFOs provide 72 percent of chicken meat, 42 percent of eggs, and 55 percent of pig meat of the total global production (Watson, 2020).

At the global level, the dominant meat production type is poultry that is having a fast growth, in fact, today it accounts for 35 percent of total meat production while 50 years ago it just reached 12 percent (Heinrich Böll Stiftung, 2021). Poultry production is followed by pig and bovine meat production (H. Ritchie, 2019). Many factors contribute to making poultry meat the preferred one for both producers and consumers worldwide; low production costs, short production process, and low product prices are the drivers of the huge amount of produced poultry meat that in 2020, worldwide, reached 133 million tons (FAO, 2021). The short production process of poultry is an important driver of its high production levels, in fact, if in the USA the average time of red meat processing from slaughter to consumption is almost 14 days, for poultry meat is much faster considering that this type of meat is processed within the same day (University of Florida, 2014). Pig meat is the second most produced one and in 2020 it accounted for nearly 109 million tons (FAO, 2021). Despite pig meat production having a production contraction in 2020, it is expected to steadily grow in the next years mostly driven by the Chinese domestic market demand.

While the global meat production almost remained stable, the meat world trade expanded by 4 percent in 2020, with lower growth compared to the increase of 6.9 percent in 2019 (European Food Agency, 2020). This was due to the negative impact of the pandemic that caused import restrictions and economic recession. However, the global meat trade is expected to rise by 2029 and grow by around 12 percent (OECD, 2020). Global meat trade had significant growth in the last 50 years. During the 1960s international meat trade was almost null considering that the traditional local farming model was the most common one worldwide. Today, 11 percent of the annual global production is traded internationally, meaning that 38 million tons of meat are traded across national borders every year (Heinrich Böll Stiftung, 2021). Meat trade saw growth thanks to the reduction of international tariffs and quotas. However, many

countries still use tariffs in order to protect their own national meat production. Another factor that threatens international trade is livestock diseases; They undermine international trade flow because in a very short time period diseases can lead to the market collapse, as it happened in the UK during the 1990s when the BSE started spreading. Therefore, strict sanitary policies made to prevent diseases' spreading will keep being the main limit to international trade growth.

Rising imports will mainly regard poultry and pig meat whose demand will be higher in Africa and Asia. Developing countries will rise their imports considering that their growing demand will outstand their domestic supply and the limited capability of small producers to compete with cheap imports (Heinrich Böll Stiftung, 2021). Asia alone will account for 53 percent of meat global trade by 2029, with China alone absorbing 30 percent of total meat exports (OECD, 2020) (European Food Agency, 2020). Brazil, the USA, and Europe are projected to keep being the main meat exporters. Meat consumption in most developed countries is already at its peak, and this is the motivation why USA's and Europe's meat production will increasingly focus on the export market (Heinrich Böll Stiftung, 2021).

Meat consumption

Meat consumption, as mentioned above, is projected to reach 400 million tons by 2050, while in 2018 it got to 320 million tons (Heinrich Böll Stiftung, 2021). This trend is positively related to growth in population and rising incomes, so meat demand

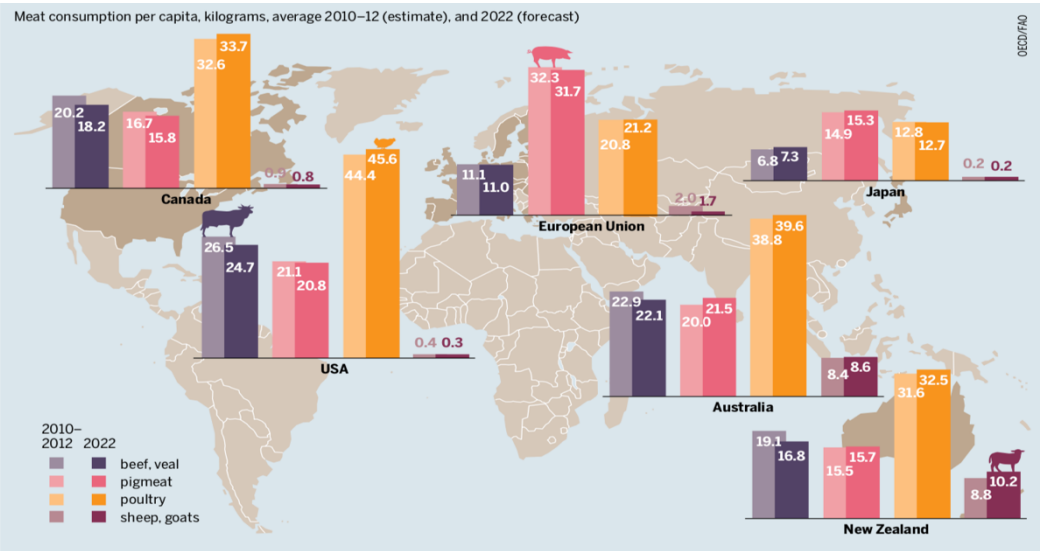

Figure 2.2: Meat consumption per capita, kilograms, average 2010–12 (estimate), and 2022 (forecast) in the rich world (Meat Atlas, 2014)

increases as revenues continue to grow. In fact, developing countries, which are expected to have an increase in per capita income, will see a growth in volumes of meat consumption five times higher than developed countries (OECD, 2020).

As figure 2.2 shows, in high-income countries, meat consumption levels are at their saturation points, and trends are moving toward meat consumption reduction for both consumers' environmental and health concerns. Furthermore, people worry about food safety and past years' scandals of the industry reinforced doubts on meat consumption. In the US, for example, meat consumption dropped by 9 percent between 2007 and 2012 (Heinrich Böll Foundation, 2014).

On the other hand, as figure 2.3 shows, big developing countries will keep asking for more meat.

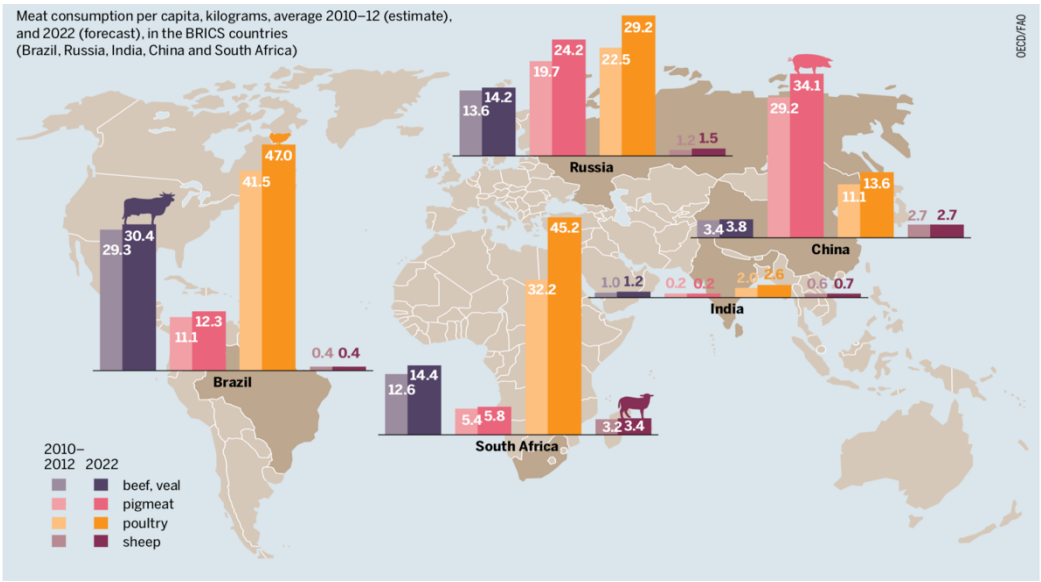

Figure 2.3: Meat consumption per capita, kilograms, average 2010–12 (estimate), and 2022 (forecast), in the BRICS countries (Meat Atlas, 2014)

Africa and Asia are the world regions where this phenomenon will mostly take place. This tendency is strictly linked with the fast urbanization that is taking place in these countries and that leads city inhabitants to change their diet and consume more meat. In China, there's a significant gap in meat consumption between rural and urban residents; in 2011 the average per capita meat consumption in rural areas had been 26 kg of meat, eggs, and milk, while one of the urban areas had been almost 50 kg (Heinrich Böll Foundation, 2014). However, as forecasts shows, contractions in HIC will not be sufficient to offset the overall global increase in meat consumption. Nevertheless, even if developing countries' meat consumption is growing at a fast rate

and although they have five times many people respect developed countries, their meat consumption starts from a low base. Therefore, the additional consumption of developing countries will keep being marginal respect with rich countries meat consumption. In fact, between 2017 and 2019 the average per capita meat consumption of developed countries was around 69 kilograms per year while one of developing countries was around 27 kilograms per year (Heinrich Böll Stiftung, 2021). In the next 10 years, African average per capita meat consumption will grow by 0.5 kilograms, from 17 to 17.5 kg per year, and Chinese people, whose demand for meat is higher compared with other countries, will eat meat less than half of the USA citizens (Heinrich Böll Stiftung, 2021). These data show how the meat industry's incredible high numbers will keep depending on the huge consumption of Western countries, even if macro-forces are reshaping geopolitical assets and demographic distribution.

By 2050 developing countries will get just 46 percent of their caloric intake by grains, while the 29 percent will come from meat; and to keep these growth rates, the world's farmers and agricultural companies should increase their meat output from the current 340 million tons to almost 470 million tons by 2050 (Heinrich Böll Foundation, 2014).

Poultry meat will account for 50 percent of additional meat consumed. Developing countries will continue to prefer it compared to other meat types thanks to its lower price, and developed countries will shift toward poultry consumption because it's perceived to be a healthier choice compared to beef or pig meat. This latter will represent the 28 percent of the increase in meat consumption in the next ten years, especially because of the Chinese demand, but in the long run, is expected to decrease thanks to a decline in most developed countries. Beef consumption, instead, will reach 16 percent of the overall additional meat consumption because of its high price and environmental issues linked to its production.

Worldwide, the per capita average meat consumption has increased around 20 kilograms since the 1960s, and in 2014 the average global per capita consumption was about 43 kilograms (H. Ritchie, 2019). Growth in meat consumption in the last decades has been strictly linked with strong economic transition, as in China where the average per capita meat consumption shifted from less than 10 kg in 1960 to 60 kg in 2017 (H.

Ritchie, 2019). However, the US still has the highest per capita meat consumption that nearly reaches 125 kg.

2.1.2 The meat industry structure

The Italian meat industry has always been characterized by a high number of small producers whose majority tried to keep traditional methods of production and high-quality standards. However, the structure of the Italian meat sector is changing, as it does in most European countries, toward an intensive model of production. These livestock management techniques are creating a market framework where few farms manage many large operations and most small farmers, instead, are giving up their business. Therefore, the Italian meat industry is getting more concentrated adopting an intensive production model (Heinrich Böll Stiftung, 2019). Furthermore, large farms are advantaged by the Italian government, and European funds are allocated to agricultural activities according to the Common Agricultural Policy. Even if these funds' aim would be the support of competitiveness and allow for higher technology investments in different strategic areas, there are no requirements on funds allocations that concern the protection of biodiversity, the compliance with sustainable production methods nor the diversification of crop types (Heinrich Böll Stiftung, 2019). Consequently, the distribution of funds becomes inefficient, does not create a highly competitive environment, and favours large operations farms.

Every year, the Italian meat industry generates revenues of around 30 billion euros that let this sector contribute for 15 percent of the overall revenues of the Italian food industry (Carni sostenibili, 2016). Italy is one of the biggest meat producers in Europe; in 2019 it produced 810 million kilos of beef meat (Luke, 2020) and 621 million heads of poultry (Statista , 2021).

However, even if Italy is a big beef meat producer, its domestic production is sufficient for just 55 percent of the overall national consumption, being one of the sectors with the lowest self-sufficiency rate in the Italian food industry. In 2020 the domestic supply of beef meat had a reduction of -13,6 percent, meaning a contraction of 48 million tons of meat, mainly caused by the pandemic negative effects (ISMEA, 2020). In Europe, the lockdown impacted trades, with a significant reduction of production in

Poland and France, the two biggest meat suppliers of Italy that imports 20 and 18 percent respectively of its total beef imports (ISMEA, 2020).

However, Italy reduced its imports by 8.1 percent, meaning that imports have been around 360 thousand tons, and despite this, a gap between the reduced demand of the hospitality sector and the national supply generated a beef meat overproduction with consequences on prices contraction between -1 and -7 percent (ISMEA, 2020). Even if beef production has slowly increased in the last years and dropped in 2020 because of the pandemic, it keeps being the most consumed meat-type by Italians, just after poultry, representing 44 percent of domestic purchases value and 33 percent of volumes of the national meat sector (ISMEA, 2020). In 2020, the domestic demand for beef had increased by around 7.5 percent, also due to the drop of the extra domestic demand, but in the first semester of 2021 it had a regression of 1.7 percent, while demands for other types of meat kept being positive (ISMEA, 2020).

If beef meat production in the last years has been almost stagnant, the poultry industry did not. Italy is the 7th poultry meat producer in Europe and its production continues to rise trying to stress the high qualitative standard of its livestock (ISMEA, 2020). During the pandemic, the poultry sector is the one that had minus negative effects, compared to other meat sectors, considering it has a strong vertical integration and its production is less dependent on the hospitality sector, and because its domestic production was sufficient to satisfy the internal demand. During the lockdown period, poultry sales increased by 25 percent with respect to the previous five years with a consequent price increase of around 6 percent (ISMEA, 2020). From 2016 to 2019, poultry production rose by 11 percent, with a production of more than 1 million tons of meat in 2019 (ISMEA, 2020). Poultry represents 35 percent of the overall Italian meat consumption, being the most preferred type of meat by consumers and the one with the highest consumption rate growth.

The pig meat sector is another important industry in the agricultural production framework, it contributes to generating values for more than 3 billion euros, the respective 5.7 percent of the total value of the agricultural industry (ISMEA, 2020). In the last years, the Italian pig industry saw some changes in its structure becoming more concentrated. In fact, in the last 5 years, a reduction of 14 percent of livestock number has been recorded, while there has been an increase in the number of animal

heads per livestock. However, the national supply satisfies just 66 percent of the internal demand and, therefore, pig meat imports are a consistent part of the total product supply. Italy mainly imports pig meat from Germany and Spain that in 2020 respectively accounted for 35 and 17 percent of total imports. Exports, on the other hand, regard 20 percent of swine meat production and are mainly made by cold cut as ham and speck. In the last 5 years, following the trend of western countries, even Italian consumers reduced their pig meat purchases by more than 9 percent (ISMEA, 2020). However, during the pandemic Italian citizens increased their pig meat consumption by 14 percent.

2.1.3 Main trends in the meat industry

High meat consumption levels led agriculture to become industrialized, and the meat industry structure today is more and more made by few corporations that manage large operations and have high market power. Therefore, in the global meat market, there are few companies that own many feedlots and that do not produce anymore just for local markets but for distant and foreign retailers (Heinrich Böll Foundation, 2014). Large operations management generates economies of scale that already are a feature of the global meat industry. Even though economies of scale can guarantee efficiency and lower waste levels, they can also lead to many problems related to consumers protection, human and animal health, and the environment. The market concentration can affect average prices which can depend more on speculative actions instead of being based on the usual equilibrium of demand and supply.

Furthermore, huge size livestock contributes to creating antibiotic resistance and threatening human health. Livestock made by tens of thousands of animals can put in danger the whole production chain that may become more vulnerable to pathogens spreading and keep hygienic standards with these volumes is a challenge most of the time. Intensive livestock is also a source of biodiversity loss and overexploitation of soil, and, as many studies of J. Poore show, the majority of meat industry environmental impact is due to the few big actors that operate in it (Poore & Nemecek, 2018). In western countries, there's a growing tendency toward meat and dairy product consumption reduction. This phenomenon is not just given by ethical issues, but also by concerns about meat safety and its implication for human health

and by the awareness of the negative effect of the meat industry on the environment. This trend is particularly diffused among the millennials which ask for more information about the origin, production stages, and environmental impact of meat production. In response to these phenomena, big meat producers are starting to adopt marketing campaigns aimed at communicating how meat is a natural, traditional and healthy food choice that is at the centre of our nutritional diet. The industry is trying to highlight the benefit of meat consumption compared to innovative meat alternative foods which are defined as artifacts, non-natural products that are not part of our diet habits and could not be healthy (Agricoltura.it, 2021).

The meat industry feels to be threatened by these new vegetable-protein products that are stepping up in the developed countries' market. However, it seems to be another parallel trend that goes together with the one of meat consumption reduction. Organic and non-processed food products have still higher costs compared to convenience and highly processed foods, it is estimated that a healthy diet costs five times more than another one based on convenience food (Will Italia, 2021). Therefore, many people's choices are driven by low prices that let cheap meat be more appealing compared to its organic alternative or compared to many types of vegetables.

Asia is now living the economic transformation that occurred in Western countries during the 1960s. In China, around 50 percent of pigs are owned by small farmers, but the framework is changing because technologies already used in the western meat industries are spreading in developing countries too, allowing for higher integration in global value chains (Heinrich Böll Foundation, 2014). When the USA and Europe had their industrial transition, energy and natural resources like water and soil were considered almost unlimited and had relatively low costs, that's why beef livestock saw rapid growth. Today, resources are scarce, and their costs are high, therefore meat production concentrates more on pig and poultry that need a lower level of resources to be produced, as mentioned above. Markets are an important driver of this tendency because they ask more and more for "cheap" meat, this is the main reason why the beef market is projected to stagnate while poultry and pig ones will grow in the next years.

Besides giant companies that shape the industry, other players that have a great influence on it are retailers. They are gaining power and are expanding also in developing countries responding to the demand of rising middle classes. City expansion is another reason for the growth of convenience food and fast food; traditional supply meat methods seem to be not suitable for the contemporary way of living. Retailers' chains have high market power and can impose their conditions over suppliers hitting prices down and leaving no chances to small retailers.

Consumers in developing countries, especially new generations, are attracted by the "western lifestyle" and prefer to adopt these food habits instead of their traditional ones. In India, as an example, many people have a vegetarian diet that has deep cultural origins, but today, thanks to economic development, being "Non-veg" is becoming a new status symbol. Therefore, increasing meat consumption trends are due not just to population growth but also to changing lifestyles. This trend generates higher demands for ready-to-eat meals that are already a popular phenomenon settled not just in Western countries but also in Asia where new fast-food restaurants open every day. Ready-to-eat meals (both with and without meat) is a fast-growing business that in many Asian countries is worth more than 600 million US dollars (Heinrich Böll Foundation, 2014).

2.2 Meat supply chain impact

Among all human systems that use natural resources, food systems are the main actors in triggering climate crisis (WWF, 2021). It is estimated that agriculture is responsible for 80 percent of biodiversity loss (WWF, 2021), it uses 70 percent of global freshwater withdrawals, keep being the major cause of water pollution (OECD, 2021), and the 50 percent of global habitable land is dedicated to agriculture (Our world in data, 2021).

Food systems, as previously discussed, have a great environmental impact that can reach 34 percent of total GHG emission if post-retail steps of the supply chain are considered (Crippa, 2021). However, different food sectors contribute differently to environmental impacts, and for this reason, researchers worldwide are providing evidence that consumers' choice on what to eat, territory and method of food

production, size of the business, and transportation can be key drivers of food systems environmental impact.

The meat industry, as discussed, is keep growing and its responsibility toward climate crisis is doing the same. Among the food system's sectors, the meat industry is the one that has the highest footprint, impacting land and water degradation, deforestation, biodiversity loss and eutrophication, and generating high emission levels. In this industry, even the impact of the lowest-impact animal product, in most cases, exceeds the average impact of vegetable proteins for GHG emissions, land and water use, eutrophication, and acidification (Poore & Nemecek, 2018). However, the environmental impact of the meat industry's actors widely changes according to geographical location, production size, and intensive or extensive method of production.

Therefore, high-impact producers of beef meat, which are mostly international companies that adopt an intensive production method, release 12 times as much Co2 as their low-impact counterparts and they need up to 50 times more land than the low-impact farmers do (Lazzaris, 2020). Just 20 meat and dairy products companies release more GHG emissions than Germany or France (The Guardian, 2021), and the 5 biggest companies of the industry emit the same volume of GHG as the oil giant Exxon (Heinrich Böll Stiftung, 2021). These meat sector giants have a huge market power that enables them to make the rules of the industry and push global production toward intensive models. Most of the meat industry's impacts on the environment are linked to these big players. Brazil is the country of origin of the biggest global meat company and its business is mainly export-oriented. Deforestation of the Amazonian Forest has been proved to be mainly caused by the meat industry, both for expanding livestock land and for crops aimed at feeding those animals. The Brazilian area dedicated to raising cattle is about 175 million hectares, the same as the total European agricultural area, and if deforestation will continue to have this speed rate, the Amazonian Forest could disappear in the next 100 years (Heinrich Böll Stiftung, 2021). This phenomenon is generating problems of land conflicts, the expansion of animal agriculture is threatening the existence of pasture smallholders and indigenous communities on one side and is putting in danger natural ecosystems on the other. Many pristine ecosystems, never contaminated before by human actions, rich in

biodiversity of flora and fauna, have been exploited and destroyed. The amount of meat consumed in rich countries has a big share of deforestation responsibility, and the European Union has been defined as an importer of “incorporated deforestation”, meaning that it caused around 16 percent of deforestation linked to the international trade mainly due to imports of meat and soy (WWF, 2021). Today, the effects of intensive farms are impressive; among the whole mammal’s species, 60 percent of their total weight on earth is represented by livestock animals, cattle and pork mainly, another 36 percent is made by human species and just 4 percent is constituted by wild mammals (WWF, 2021). There are other global risks strictly linked with intensive livestock, as pandemics. Usually, animals’ pathogens do not affect humans, but the reduction of biodiversity, destruction of natural ecosystems, and intensive farming methods exponentially increase this risk. According to the UN, 75 percent of new diseases of the last 10 years have been spread by animals to humans (UN, 2020). The world is still facing the effects of a pandemic that generated both health and economic crises. However, the zoonosis number is keeping growing (WWF, 2021). In intensive livestock, viruses spread at a high fast rate, and recent studies have provided evidence on how intensive farming practices generated an increase of 25 percent of infective diseases and 50 percent of zoonosis (WWF, 2021). Unfortunately, these numbers could even increase with the expansion of intensive livestock models. Consequently, spill over effects, so the jump of the virus from one species to another, will happen with a higher likelihood.

The current meat industry structure has an unsustainable impact on the environment, and even if, in some cases, consumers can shift their preferences toward more sustainable products, macro- policies aimed at supporting and incentivizing sustainable consumption are factors that could make the difference. Set of measures that enable this transition are necessary both on the supply and demand side. For the first one, standards on animal welfare and environment, reduction of farming animals per livestock, obligation on providing products lifecycle assessment information, and support on the production of plant-based substitutes could stimulate the reduction of the industry footprint. While, regarding the demand side, taxation of high environmental impact meat products, discount on plant-based alternatives, and

standardized labels schemes that provide information on the impact of the production methods and animals living conditions can help consumers on driving their choices toward more sustainable options (Heinrich Böll Stiftung, 2021).

Labelling schemes, in particular, can enhance transparency in the industry, leading to higher product differentiation in internal markets and providing higher competition perspectives for sustainable meat producers. In this part, the impact of the meat industry on water and land resources, and on the contribution of GHG emissions will be analysed more in-depth.

2.2.1 Meat water footprint

The term *water footprint* indicates the amount of direct and indirect freshwater used in a certain production process or activity (Science , 2017). Three different components contribute to the calculation of water footprints: blue water, green water, and grey water footprint (FoodPrint, s.d.). The first one is the amount of surface water and groundwater used in a production process, while the green water footprint is the amount of rainwater necessary to make a certain item, and the grey water footprint is the amount of freshwater that would hypothetically be needed to dilute pollutants and make water pure enough to meet EPA water quality standards (FoodPrint, s.d.).

Food systems are the human activities with the highest water footprint, and among them, animal productions of meat and dairy products heavily contribute to it, requiring 29 percent of total agricultural freshwater withdrawals, a quantity three times higher than 50 years ago (Heinrich Böll Stiftung, 2021). Generally, the amount of water needed to produce meat products is higher than the one required by vegetable foods. In fact, according to a report published by the Institution of Mechanical Engineers (IME), producing 1 kilogram of beef meat takes an average of 15,415 litres of water, the same amount of pork meat production consumes almost 6,000 litres, while one kilogram of bananas takes 800 water litres and the same amount of potatoes just 300 litres (The Guardian, 2016). On average, a cattle is slaughtered at three years of age and during its life, it consumes around 1,300 kilograms of feed as soy and other cereals and 7,200 kilograms of grass, plus it drinks 24,000 litres of water, however, the majority of water use is taken by feed production (Heinrich Böll Stiftung, 2021). Nevertheless, as introduced before, different types of production systems have widely

different impacts on water resources. Livestock animals raised under an industrial production system take less time respect with pasture animals to get ready for the slaughter phase but are fed with concentrated feed that requires a high amount of water and fertilizers to be produced. Pasture cattle, on the other hand, need high amount of green water to be raised and their time to get to proper slaughter weight is longer than intensive livestock animals. Furthermore, industrial productions have to manage huge quantities of manure and wastes that many time ends up on polluting surface and groundwater sources (FoodPrint, s.d.). Consequently, the grey water footprint of intensive farms can get up to 61 times as much as that of pasture farms (Heinrich Böll Stiftung, 2021). In general, considering the impact on green, blue and grey waters, meat produced by pastured animals has a lower water footprint compared to that of industrial productions.

Environmental impacts on water resources are also caused by a rising problem that is becoming more and more serious in many parts of the world, eutrophication. This phenomenon is defined as the pollution of water bodies and ecosystems with an excess of nutrients (Our world in data, 2021), and nitrogen is the main substance that contributes to it. Livestock manure generates a significant quantity of nitrogen that pollutes rivers, lakes, and groundwaters. Beef meat production is one that most causes runoff of nutrients leading to severe environmental problems. The production of beef meat generates, on average, 365 grams of excess nutrients per kilogram of meat produced, while pig meat releases around 76 grams, and peas and soy productions just 7.5 and 6 grams respectively (Our world in data, 2021).

Industrial livestock farming systems use nitrogen manure as a fertilizer for crops, and at the appropriate quantity, nitrogen is a good fertilizer for the plant. However, intensive livestock has to manage huge quantities of manure and nutrients runoff that happen on a daily basis. The European Union has set a limit on nitrogen quantity of water that is 50 milligrams of nitrate per litre of drinking water, but in countries like Germany, Denmark, and the Netherlands, where the concentration of livestock is high, often this limit is overcome (Heinrich Böll Stiftung, 2021). In many other parts of the world, this phenomenon takes place, as in USA and China. In the United States of America, thousands of kilos of nitrogen contaminate rivers every year devastating entire ecosystems (Heinrich Böll Stiftung, 2021). These substances are washed down

rivers into the sea generating the phenomenon of dead zones, which are enormous ocean parts with no kind of life, not even micro bacteria. The excess of nutrients carried out by the Mississippi River in the USA gives rise to an ocean dead zone that enlarges around 15,000 square kilometres every year in the Gulf of Mexico (Heinrich Böll Stiftung, 2021). Ocean dead zones are a severe climate change threat because they inhibit both the function of oceans of releasing oxygen and the capability to store carbon dioxide.

2.2.2 Meat land use

The global habitable land covers 71 percent of the Earth's surface and, of this percentage, half is dedicated to agriculture (FAO, 2019). The global meat production kept rising for many years and today it absorbs 77 percent of total agricultural land, both considering livestock areas and crops used for animal feed (Our world in data, 2021). Among several types of food, meat is the most inefficient one concerning land use, in fact, it uses most of the arable land producing just 18 percent of the total world's calories (Our world in data, 2021). Producing 1000 calories of beef meat requires on average 120 squared meters, while apples or soybeans could provide the same caloric intake just using 1.3 squared meters of land (Poore & Nemecek, 2018). Also in terms of protein intake, data show how meat and dairy products need significantly higher land portions compared to other vegetable food products; beef meat productions need on average 104 squared meters to provide 100 grams of protein which is a significant difference with pork meat productions that needs on average 8.3 square meters and many vegetables that normally require less than 6 squared meters to provide 100 grams of proteins (Poore & Nemecek, 2018). However, the study run by Poore and Nemecek shows the differences in land use that exist among high and low impact producers, where 25 percent of the highest impactful beef producers use 61 percent of total land dedicated to beef meat production (Poore & Nemecek, 2018). Beef production's land use per 100 calories could range between 7 and 369 squared meters (Poore & Nemecek, 2018). This large interval is determined by the yield of livestock, where higher yields productions need lower land areas compared to low yields livestock. Even though intensive livestock could seem to do not need huge land portions, they do because of the vast amount of land areas needed

to grow feeding cereals for the industrial production, where for every 100 calories of pasture just 17-30 calories are converted into the meat and directed to human consumption (Heinrich Böll Stiftung, 2015). A high-impact meat producer can use as much 50 times land as a low-impact producer does (Will Italia, 2021). An increase in meat consumption is leading to a growing demand for livestock feed. Moreover, environmental variables could strongly affect the number of natural resources needed to grow livestock, in fact, land areas needed to feed farm animals In South America can be 7 times larger than those needed in Europe (Will Italia, 2021).

Soybeans and maize are the two types of cereals mostly requested by intensive livestock and every year around one billion tons of them are consumed by intensive animal farms; soybeans are the main protein sources in feed and since 2001 their international trade have grown by 5 times (Heinrich Böll Stiftung, 2021). Around 80 percent of soybeans production becomes farms feed and just the remaining part goes to human consumption (Lazzaris, 2021). Furthermore, soybeans together with livestock farming are the main cause of deforestation in any part of the world. In 20 years, the soybeans cultivation has grown from 77 to 125 million hectares (Heinrich Böll Stiftung, 2021), and the Amazon rainforest is the main victim of this phenomenon. Two third of deforestation of the Amazon rainforest is due to the creation of feeding crops (Heinrich Böll Stiftung, 2021). This rainforest is the richest ecosystem in the world where 10 percent of terrestrial species live and its destruction, like many other biodiversity-rich territories, would speed up the effects of climate change (WEF, 2020). Furthermore, in soybeans crops, a huge number of pesticides and herbicides are used. These substances threaten the fertility of soil through processes of salinization and desertification and generate human health respiratory problems, as happened in Argentina where chemical pesticides are highly adopted in cereal crops (Heinrich Böll Stiftung, 2015).

Therefore, the intensive expansion of pasture and livestock land is enhancing environmental risks as unpredictable rainfalls and droughts, and severe fires and floods (WEF, 2020). These phenomena lead to a vicious loop that ends up in higher food price volatility and insecurity due to the unpredictable output of food productions determined by extreme environmental events.

2.2.3 Meat carbon footprint

The meat industry is the greatest GHG emissions contributor to whole food productions. According to the FAO, 14.5 percent of global anthropogenic emissions, which amount is around 7 gigatons of Co2 equivalents, came from the livestock industry in 2013 (FAO, s.d.). Livestock and fish industries generate 31 percent of total food emissions with just their on-farm production activities (Poore & Nemecek, 2018). Furthermore, soil portions dedicated to pasture create direct emissions of agricultural productions, that mainly comes in the form of nitrous oxide and carbon dioxide, that account for 6 percent emissions of total food productions, while the land use for livestock generates

another 16 percent of emissions that is mostly caused by a land-use change (Our world in data, 2021). Consequently, the meat supply chain releases more than 50 percent of GHG food sector emissions but provides just 18 percent of total calories and 38 percent of proteins supply worldwide (Heinrich Böll Stiftung, 2021). The expansion of meat production requires more land for both livestock and feed agriculture. However, land-use change is a great contributor that led to emissions' increase (V. Sandström et al., 2018). The land-use change process determines a reduced soil capability in carbon storage that combined with huge amounts of fertilizers results in higher greenhouse gases emissions. Deforestation and drained peatlands activities are part of land-changing processes. Worldwide, many peatlands have been drained in order to address new land to livestock, however, this type of soil contains as twice as much carbon dioxide as forests biomass (Heinrich Böll Stiftung, 2021). Therefore, peatland drainage causes higher greenhouse gases emissions. In Europe, carbon-rich soils account for 3 percent of total areas addressed to agriculture, but their drainage mostly made to raise livestock, is responsible for 20-25 percent of total European emissions of the agricultural sector (Heinrich Böll Stiftung, 2021). As previously mentioned, on-farm stages of the supply chain generate most livestock sector emissions, where apart from Co2, GHG emissions comes in the form of methane and nitrous oxide.

Figure 2.4 shows how animal productions outstand most of the vegetable ones for greenhouse gases emissions and, in particular, highlights the environmental impact of beef production. In fact, cattle livestock produce 60 kilograms of GHG per kilogram of meat, while peas or soymilk is just around 1. Other animal-based food, like poultry and

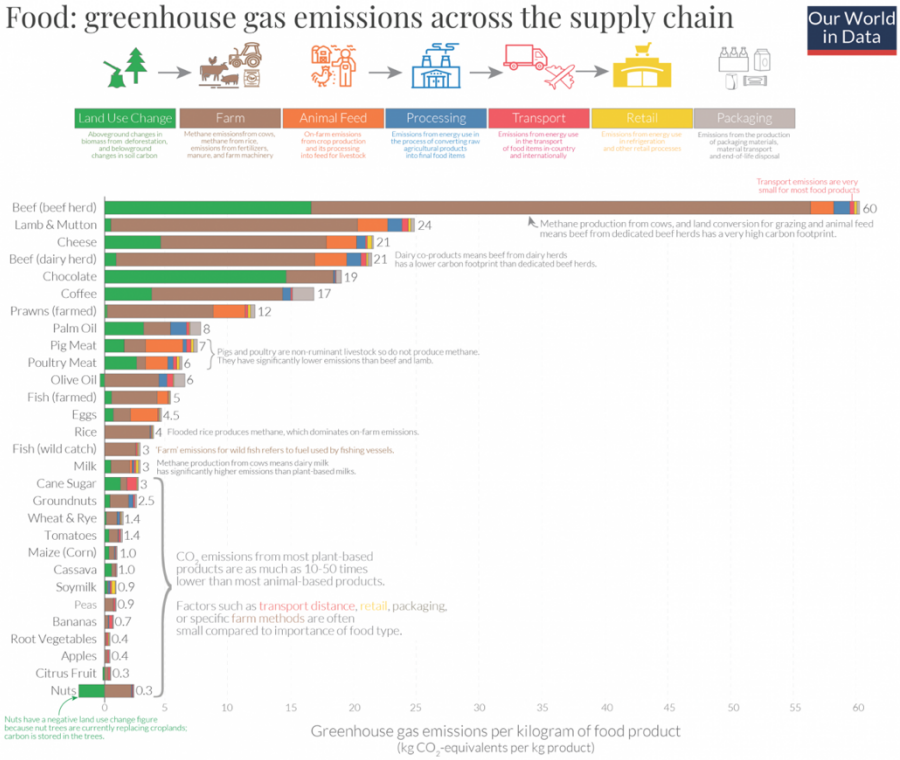

Figure2.4: Greenhouse gas emissions per kilogram of food product (Our world in data, 2021)

pig meat, releases lower greenhouse gases compare to beef livestock, but they are still significantly higher than plant-based productions. In general, in Europe, most food sector emissions are due to protein-rich products, and meat, dairy, and egg productions are estimated to release 83 percent of the total food sector GHG emissions (Our world in data, 2021). Cattle and lamb are ruminants, and their emissions are mostly due to enteric fermentation and come in the form of methane. Therefore, beef productions generate 44 percent of total anthropogenic CH4 emissions and are responsible for 65 percent of emissions of whole animal-based productions (FAO, s.d.). Methane releases mostly take place during the early steps of the supply chain, so the land-use change and on-farm activities. On average, ruminants' supply chain during feed production and enteric fermentation process generates 45 and 39 percent, respectively, of its total emission, plus 10 percent of manure management and storage activities (FAO, s.d.). The last stages of the supply chain, however, as for

many other types of food, have a marginal impact on the total emissions of animal-based food products. In fact, in the beef industry transports account for less than 1 percent of total GHG emissions (Our world in data, 2021).

The carbon footprint of food, as for soil, significantly changes according to the method of production adopted. In the case of beef, the range of emission goes from 9 to 105 kilograms of Co2 equivalents emitted for every 100 grams of protein produced. In fact, the 5 biggest meat companies generate combined emissions as major oil producers (Heinrich Böll Stiftung, 2021), while the 25 percent of high-impact players of the beef sector are responsible for 56 percent of GHG emissions of this industry (Poore & Nemecek, 2018). Plant-based food, instead, tend to have a lower carbon footprint with respect to meat products, as in the case of beef that generates on average 90 times higher amount of GHG than peas to produce 100 grams of protein (Poore & Nemecek, 2018). Consequently, diet composition is the most important driver of GHG emissions generated by the food sector (V. Sandström et al., 2018). Considering that meat products have a high environmental impact, the reduction of meat consumption would lead, therefore, to lower levels of greenhouse gasses emissions and work, then, as a climate change mitigation measure (V. Sandström et al., 2018).

2.3 Meat demand: the importance of changes in consumption patterns

Meat demand, as previously discussed, is projected to keep rising due to various socio-political macro forces. The constant growth of meat demand from the middle of the XX century has set the ground for a modern and industrialized structure of the livestock sector. Furthermore, globalization and its convergence of cultures among countries and economic growth led to a progressive likeliness of needs and a consequent decrease of traditions' differences, which determines the "Globalization of flavors" (Barilla center for food and nutrition, 2012). This gradual homogenization of tastes changed the attitude toward meat consumption leading animal protein to become a fundamental complement of most diets in the world. On the other side, awareness of climate change and meat-related health problems are leading to a rising consumers category that asks for a more sustainable supply chain, transparency, and products

traceability, and to new food categories of plant-based protein products that are threatening the global meat industry.

2.3.1 The relation between market dynamics and consumption patterns

In the past, livestock supply was determined and limited by local resources, as feed inputs, but industrialization enabled livestock systems a higher number of resources (Naylor et al., 2006).

Demand for meat led to production rise, but also supply factors had a crucial role on increase in consumption; feed prices decrease, development of new technologies, higher crop yields, and cheaper cost of transportation are critical variables that changed the dynamics of the meat industry making this product more accessible (Naylor et al., 2006). Furthermore, operational steps of the livestock supply chain have become more geographically concentrated in world areas where there's a high number of natural resources, lower production and inputs costs, and fewer environmental and hygienic regulations for livestock growth compared to western countries (Naylor et al., 2006). These areas comprehend vast land portions of South America, as Brazil that today is the leading country in livestock exports. These changes in the market structure let the livestock industry become integrated into global economies and favoured the rise of international big companies (Conner, 2002). Consequently, a more efficient supply chain had an impact on market prices that started decreasing and allowing meat becoming a commodity product in many western countries. However, these new market settings, if on one hand ensured the access to the most of food products so far considered as a luxury one, on the other hand, gave rise to several problems.

Industrial agriculture success has been determined also by the possibility of externalizing production and distribution costs to social and natural capital (Conner, 2002). Then, costs externalization is a natural consequence of industrialized systems. The international company aims to enhance crop yields and abate costs have largely been reached. Furthermore, Industrial productions created also information issues about products origin, production method used, and social and environmental footprint. All these variables led consumers to think about meat as a less scarce good whose decreasing price is justified by this reason. However, this process created a

vicious circle in which at the increase in meat production a consequent decrease in prices was expected.

For a long time, and in some cases still are, consumers have not been aware of the negative effects of their consumption choices because of market failure on providing accurate products information (Naylor et al., 2006). The big issue and challenge today is to let consumers know the real price of their food in order to reshape food systems asking for more sustainable supply chains that could be effective mitigation measures for both climate change and social environments.

2.3.2 The effects of cutting back on meat consumption

In previous parts, environmental impacts of the meat industry have been described, and it emerged that this system is the most environmentally damaging among food sectors, and it highly contributes to climate change negative effects. Most importantly, it has been highlighted how, in any case, low impacts meat producers use greater amounts of natural resources, in terms of water, soil, and biodiversity loss, and produce a higher quantity of GHG than almost every type of vegetable product, even the highest-impact ones (Poore & Nemecek, 2018). Mitigation of this industry's negative externalities would imply the increase in yields of feed crops and livestock, reduction in meat consumption, and institutional effort in order to promote plan-based diets and punish the company with high environmental impacts. However, the increase in yield of crops and livestock are projected to have marginal improvements in the next future; many improvements have been already done in the last decades thanks to technology and livestock yields are near to their maximum.

In a scenario in which the world's population would adopt a plant-based diet, the reduction in land use would be around 76%, an area as large as the USA and Brazil together, carbon emissions would halve, and acidification, deforestation, water eutrophication, and biodiversity loss would setback (Poore & Nemecek, 2018). There's a debate on the hypothetical consequences of cutting meat consumption, and some researchers support a thesis through which lands used for livestock growth would be mainly addressed to cereals and vegetable production in order to fill the food gap that cuts in meat would cause and consequently creating marginal benefit for the environment (Will Italia, 2021). Other researchers, on the other hand, assert that the

global population would not need most part of the land now used for livestock to convert it into agricultural production (Will Italia, 2021). Just one-third of land areas addressed for livestock would be used for additional vegetable production, considering that 80 percent of agricultural land, today, is used by the meat industry (Will Italia, 2021). The remaining land areas could go back to natural revegetation and processes of restoration of wild animals' life, favoring mitigations to biodiversity loss and GHG storage. Furthermore, cutting meat productions would generate an increase in food efficiency, because the meat supply chain works as a filter of nutritional intake of cereals and vegetables, while direct consumption of these vegetable products allows fewer caloric dispersals (Will Italia, 2021). Nevertheless, making a hypothesis on global plant-based diets with no meat productions and consumption is a utopian view of food systems. In fact, meat is a fundamental component of many diets, especially those who are poor nutrition and need animal products as a basic protein intake. This dietary shift would be easier for western countries that have other options for protein intake, including new innovative products as plant-based meat and cell meat.

Moreover, as the research of Poore and Nemecek has proven, a reduction in consumption of 50 percent of animal-based products combined with their purchase just from low-impact producers, would have 70 percent beneficial effects of adopting a completely plant-based diet (Poore & Nemecek, 2018). However, there are problems for consumers in getting information about production methods and then recognizing low-impact meat producers. It does not exist an international labeling scheme that proves the environmental impact of producers and consequently, consumers are not confident with products prices and their reflection of certain production and animal welfare standards (Heinrich Böll Stiftung, 2021).

Apart from consumers' purchase choices, governments have the highest power on leading the transition to more sustainable diets and then mitigating the impact of the livestock industry on climate change. However, as discussed previously, international meat companies receive huge funds from governments worldwide, Brazilian meat giants received from public funds more than they had to pay in taxes for example (Will Italia, 2021), but international institutions are afraid to get in contrast with meat global leaders. European Union, among many countries, is proposing some policies aimed at enhancing transparency in the sector. The "Farm to Fork Strategy", which is part of the

"Green Deal", wants to achieve a "fair, healthy, and environmentally friendly food system" in the Union by 2030 (Heinrich Böll Stiftung, 2021). Regarding the livestock sector, the aim of the program is to limit its contribution to climate change, reduce biodiversity loss and emissions, diminish the use of antibiotics and increase animal welfare. This strategy's goals are also the reduction of imported feeds in order to better control suppliers' compliance with environmental laws, increase these lasts and promote a campaign to support the adoption of more plant-based diets considering that Europeans consume around 80 kg of meat per year (Our world in Data, 2019), while guidelines for a healthy diet recommend to consume at maximum 26 kilograms of red meat per year (AIRC, s.d.).

3. The psychology of reducing meat consumption: theoretical framework

The dynamics of food chains and their evolution toward more sustainable systems are driven by several factors, most of which have been previously discussed, and consumers' food purchasing choices play a major role in the development of sustainable food production (Grunert, 2010).

Consumers, through their food choices, have an influence on which foods are produced and the ways in which they are produced. Moreover, consumers make more sustainable decisions by choosing of where to buy, the mode of transportation and food storage, disposal, and preparation. Consumers also have the power of rewarding sustainable food production and at the same time to punish less sustainable options

(Grunert, 2010). However, macro-forces such as institutional policies and market dynamics have a fundamental impact on driving sustainable production. Retailers are other important agents that could enable this shift by making sustainable products available to the mass market.

Consumers' needs with respect to food have changed with the times, and some of these needs have taken many years to develop, while others are of a more recent nature. Of late, several food trends have followed each other. A few decades ago, the healthy food trend began to spread, giving priority to the nutritional value of food. This was followed by a surge towards convenience, helped by mass production (Grunert, 2017). The convenience food trend was observed regarding product prices, the effort of shopping and the required time for preparation. At first, the interest in convenience food was mainly displayed by consumers who were largely disinterested in nutritional properties and food quality; however, this interest gradually shifted toward higher-quality products. A prominent trend in food production nowadays is the demand for authenticity: consumers demand that food industries have a transparent food chain and products be unrefined, real, and natural (Grunert, 2017). The trend towards food authenticity has given rise to an increasing consumer interest in food sustainability, thanks to which more and more people are informing themselves about the impact of food production and, above all, about the environmental impact of meat production. Meat consumption is driven by diverse factors ranging from an individual's personal and social identity to external influences. These factors hold the potential of directly affecting consumer behavior. Therefore, this chapter aims to analyze the factors which influence meat consumption, and which can lead to its reduction and the adoption of plant-based protein sources.

3.1 Personal factors

3.1.1 Knowledge and Skills

Many studies have demonstrated the importance of knowledge and skills as two personal factors driving meat consumption behavior. *Knowledge* is defined as the awareness of issues, while the term *skills* is used to describe procedural knowledge of action strategies (S. Stoll-Kleemann et al., 2016). People's awareness of the environmental impact of meat production plays a vital role in meat consumption

reduction choices, and recent years have seen an increase in knowledge of meat production impact (Fitzpatrick, 2014). However, an international study reports that, while more than 80 percent of respondents recognize human activities as a driver of climate change, merely 30 percent agree on the contribution of meat production to it (T. Garnett et al., 2015).

Moreover, compared to other food sustainability issues, awareness of the environmental impact of meat production and consumption appears to be lower, which may constitute a barrier for reducing consumption (Fitzpatrick, 2014). As shown by Fitzpatrick's research, consumers attribute more positive environmental effects to choosing food with less packaging compared to the willingness to decrease meat consumption (Fitzpatrick, 2014). This result shows a lack of information on the proven impact of meat consumption; furthermore, as highlighted by C. Tobler, the more frequent consumers' meat consumption, the lower their subjectively perceived environmental benefit of a reduction in meat consumption (C. Tobler et al., 2011). Consciousness of health problems related to meat consumption is higher compared to the awareness of environmental issues, even though it depends heavily on the socio-demographic group; therefore, there are conflicting views on the relevance of meat, its function in the human diet, and the benefits of a reduction in consumption (S. Stoll-Kleemann et al., 2016). Moreover, it has been proven that many people perceive their diets to be healthier than they really are, which poses a potential hindrance in reducing meat consumption (Fitzpatrick, 2014). Health concerns also steam from a lack of knowledge about the nutritional value of meat substitutes. Many people perceive a meat-free diet as lacking proteins and iron, unaware of the high protein content of many vegetables, cereals, nuts, legumes and plant-based meat alternatives. Therefore, raising awareness of the effects of meat consumption hold the potential to drive dietary shifts. Institutions could convey this information to the public and thus increase peoples' knowledge about the benefits of reducing meat consumption and about a plant-based diet (S. Stoll-Kleemann et al., 2016). Alongside a lack of knowledge, factors such as the novelty of plant-based products and their comparatively low sensory attractiveness contribute to the reservations about them (C. Martin et al., 2017). Numerous studies have demonstrated that additional information printed on the packaging of meat products and plant-based substitutes

can enable shifts toward a more sustainable diet (E. Castellari et al., 2019) (C. Martin et al., 2017). Information about the negative effects of meat on both the human health and the environment can increase consumers' knowledge, while information about the nutritional value and the lower environmental impact of plant-based substitutes can contribute to an increased consciousness of the benefits of these innovative products as well as instill a positive attitude in consumers (E. Castellari et al., 2019). Information provided on the packaging of plant-based meat substitutes can also influence purchase preferences and help rebalance diets in favor of plant-based products (C. Martin et al., 2017). However, an increase in knowledge about these products alone is not sufficient for initiating significant changes in diet; therefore, regulations are needed to pursue these actions through fiscal measures such as higher meat taxation and subsidies for high-protein plant-based products in order to provide further motivation for diet shifts (E. Castellari et al., 2019).

3.1.2 Values and Attitudes

Values and attitudes are two fundamental components that drive peoples' behavior. The former are defined as "guiding principles" that individuals use to judge situations (S. Stoll-Kleemann et al., 2016). Schwartz, who theorized a structure of universal values in order to categorize them, defined values as "concepts or believes, pertaining to desirable end states or behaviors, transcendent of specific situations, guiding selection or evaluation of behaviors and events, and ordered by relative importance" (Schwartz, 1992). While values transcend situations and contexts, attitudes do not. In fact, even though they are affected by values, attitudes can change from one situation to another and are context-specific, depending also on other contextual and situational factors (Rohan, 2000). Values can be considered general overarching structures that influence attitudes, which in turn consist of beliefs about specific behaviors (Lanzini, 2018). Consequently, values and attitudes are predictors of eating behaviors and several studies have proven their importance in driving the willingness to reduce meat consumption and adopt a plant-based diet (M. R. Eckl et al., 2021).

Values in particular have been shown to be indicators of eating behavior, as they are of a more long-term nature than attitudes (A. Hayley et al., 2015). Values that lead to meat consumption reduction are both pro-social and pro-self-oriented (S. Stoll-

Kleemann et al., 2016). Concerns about ethical issues related to animal suffering, poor hygienic conditions on farms and, more generally, animal welfare and their use as a food source have been the main motives of plant-based diet adoption among consumers (S. Stoll-Kleemann et al., 2016). The moral values driving these behaviors have been found to be associated with strong convictions about the reduction or removal of animal food products from diets, and people who are moved by these values show a lower abandonment rate of their diet regime compared to people moved by different values (A. Hayley et al., 2015). Other values that influence an individual's choice to reduce meat consumption are rooted in an individualistic orientation and provide a sense of personal achievement felt when belonging to the pro-self-sphere (S. Stoll-Kleemann et al., 2016). This category of self-focused values includes personal health concerns, which are the second most important motive for reducing meat consumption after animal welfare considerations (A. Hayley et al., 2015). Despite remaining at a low level, public awareness of the impact of meat consumption has been rising recently; this has led to an increase in consumers cutting back on meat due to pro-environmental reasons, which in turn are generated by other-focused values (Profeta el al., 2021). Several studies have drawn on Schwartz's universal values model to examine how different values influence the engagement with meat-reduced diets (A. Hayley et al., 2015).

Universalism, one of the categories Schwartz allocates to the self-transcendence section of his model, includes values such as tolerance, appreciation, protection of human welfare and nature (Schwartz, 1992). People who engage with the issue of meat consumption and who consider or practice meat reduction have been found to hold universalist values (A. Hayley et al., 2015). On the contrary, people who rate values of power, assigned by Schwartz to the self-enhancement section, such as masculinity and social dominance, are more willing to consume red meat (A. Hayley et al., 2015). Meanwhile, security values, as part of the conservation section, stem from motives of health preservation and can generate both positive and negative attitudes towards reducing meat consumption (A. Hayley et al., 2015). Moreover, the aspect of gender plays a role in defining values and, consequently, behaviors: women tend to cherish self-transcendence values while men favor self-enhancement values.

Therefore, women show a relatively positive attitude toward meat-reduced diets, vegetarianism and veganism; they have a comparatively negative attitude toward the taste of meat and estimate its nutritional value to be lower when compared to men, who rate meat as a symbol of power (A. Hayley et al., 2015) (F. Michel et al., 2020). Besides gender, culture also plays an important role in defining values and, therefore, in influencing food consumption.

Attitudes toward meat replacement products are affected by consumers' diets; vegetarians and vegans commonly display a highly positive attitude toward meat alternatives and rate them higher than meat in taste, texture, appearance, and smell (F. Michel et al., 2020). Simultaneously, non- consumers of meat alternatives exhibit comparatively negative attitudes toward these products and rate the aforementioned features of meat as much better (F. Michel et al., 2020). Furthermore, many people that do not consume meat alternatives recognize them to be a more ethical food product compared to meat but lack the strength of ethical conviction and self-transcendent values to cut back on their meat consumption (De Boer et al., 2011). Attitudes toward meat replacement products are also influenced by the diets of one's peers, so the meat consumption in an individual's social surroundings affects the outlook held on these products (F. Michel et al., 2020). For instance, it has been shown that during formal occasions such as banquets, people develop a more negative attitude toward meat alternatives, while during informal meal situations they show a more positive one (F. Michel et al., 2020).

3.1.3 Emotions and Cognitive dissonance

Human decision-making processes are considerably influenced by emotions, which are broadly defined as "how people feel about something" (Evans, 2013). In the field of Psychology, emotions are frequently classified as separate from attitudes, while other theories consider them a joint entity with attitudes determining "cold evaluations" and emotions governing "hot evaluations" (Evans, 2013). Emotions, therefore, are crucial component in decision-making, and feelings of satisfaction and apathy are two examples of this category. In the case of meat-reduced diets, emotions can manifest in an affective involvement in animal suffering, and the more people experience such emotive reactions, the more likely they are to change their purchasing behaviors and

their diet (S. Stoll-Kleemann et al., 2016). Consequently, increased incorporation of emotional components into factors that affect food choices would be helpful in shifting toward more plant-based diets (S. Stoll-Kleemann et al., 2016). However, many studies report that enjoyment of eating meat and simultaneous concern over animal suffering can coexist in an individual (C. Hartmann, 2020). In such cases, justifying meat consumption frequently triggers mechanisms of cognitive dissonance, which often prevent people from following their emotions and changing their eating behaviors accordingly, thus impeding the consumption of meat alternative products (S. Stoll-Kleemann et al., 2016). Cognitive dissonance is a theory developed during the 1950s by the psychologist L. Festinger, who defines it as the state of having feelings, beliefs or attitudes that are irreconcilable with one's behaviors, which lead to a general sense of mental discomfort (Festinger, 1957). These cognitive dissonance mechanisms can prompt individuals to either decrease their sense of discomfort by acting in a more consistent way or, conversely, to avoid situations that could increase it, e.g. by not informing themselves on an issue (Festinger, 1957). Therefore, cognitive dissonance often mitigates the effects of emotions on behaviors. In the context of meat consumption, cognitive dissonance can generate the so-called "meat paradox", defined as mental discomfort felt by meat eaters whenever they are reminded that their behavior is incompatible with their values and attitudes, thereby creating a disparity between what they feel and what they do (S. Stoll-Kleemann et al., 2016). In order to evade this sense of discomfort, some consumers refrain from educating themselves on the negative effects of meat production and consumption because such insights might highlight the conflict between their hedonic attitude toward meat and the moral one (C. Hartmann, 2020). Furthermore, in the purchasing context, factors such as price can have more influence on behavior than ethical motivations (C. Hartmann, 2020). Cognitive dissonance, as described above, can lead to cognitive disengagement through the deactivation of moral self-regulation processes and is aimed at protecting the individual from a sense of mental discomfort (C. Hartmann, 2020). This disengagement can take place in different forms: moral justification, ascription of responsibility and denial of negative effects of meat productions. There are unapologetic and apologetic strategies to justify meat consumption: the former include the positive attitude toward the taste of meat, religious justifications, denial of

animal suffering, and the view that humans are biologically designed to eat meat (C. Hartmann, 2020); the latter encompass the avoidance of thinking about slaughter processes and the dichotomization between pet and farms animals (C. Hartmann, 2020).

A relation has been established between the use of meat-eating justifications and the meat consumption frequency of individuals (Rothgerber, 2012). Unapologetic meat-eating justifications pose a considerable hindrance to the reduction of meat consumption and to the willingness to substitute meat with other products (C. Hartmann, 2020). Therefore, a decrease of meat intake becomes unlikely in the face of justification strategies (C. Hartmann, 2020).

3.1.4 Habits and Taste

Habits are key to understanding behaviors as they affect individuals' choices. The concept of habit is often associated with frequent activity; however, while a relevant catalyst for building habits, frequency alone is an insufficient criterion for defining the term (Wood, 1998) (Lanzini, 2018). In order for repeated behaviors to develop into habits, a stable context is also needed (Lanzini, 2018). Therefore, the more stable a context, the more likely it is for habits to be developed, while changes in context favor the consideration of different options and lead to different behaviors (Lanzini, 2018). Furthermore, habits, in order to be defined as such, require automaticity, i.e. actions that are performed automatically with little or no conscious intent (Wood, 1998). Another element that contributes to the establishment of habits is the factor of reward, in other words, the outcome of a behavior that can increase the strength of the respective habit (Lanzini, 2018).

All in all, habits have been defined as goal-directed, automatic behaviors activated by specific environments that limit the number of alternatives considered by individuals (Dijksterhuis, 2000). So far, habits have played a marginal role in research on individual behaviors, but they are being paid increasing attention in the field of consumer behavior (Lanzini, 2018).

In the domain of food consumption, the purchase and the preparation of food constitute automatic and low-effort activities repeated daily (S. Stoll-Kleemann et al., 2016). Several studies have examined the impact of changing habits on the adoption

of plant-based diets and identified them as a barrier, especially for individuals emotionally and habitually attachment to meat consumption (Graça et al., 2015). Additionally, purchasing habits are enhanced by the convenience factor of products, both in terms of price and preparation time and the respective skills and interest in cooking (S. Stoll-Kleemann et al., 2016). Meat is considered a convenience food because of its price democratization and efficiency of preparation, both of which are incentives for consumers. However, food behaviors entail individual choices with varying levels of automaticity, and these decision-making processes change with the time and differ from one country to another (Montanari, 2004). It is worth noting that an individual's habits and tastes do not always match (Montanari, 2004). Establishing food consumption habits contributes to the development of psychological and physiological consistency but does not always evolve into food appreciation (Montanari, 2004). As mentioned, one of the barriers deterring consumers from switching to plant-based alternatives is the unwillingness to cut back on meat because of its taste. Therefore, the higher the enjoyment and appreciation of its taste, the lower the probability of a shift toward meat alternatives. Changes in the food habits of meat lovers are particularly difficult to implement given that they often use justification strategies as a response to cognitive dissonance (Rothgerber, 2014). Therefore, individuals sympathetic to meat consumption require indirect engagement approaches in the form of structural changes, such as easier access to plant-based products, which would make them more common among consumers and thus raise their profile (Graça et al., 2015).

3.1.5 Sociodemographic factors

Research has demonstrated the influence of sociodemographic factors on eating behaviors, and, more specifically, on meat consumption (S. Stoll-Kleemann et al., 2016). The most salient aspects are gender, age and socioeconomic status (S. Stoll-Kleemann et al., 2016). Gender closely correlates with meat consumption; women are more concerned about their health compared to men and show a higher willingness to cut back on meat (Lea et al., 2001). What is more, Tobler defines gender as the strongest predictor of a reduction in meat consumption (C. Tobler et al., 2011). Women are more likely than men to be in the active stage of reducing meat

consumption, a fact that is shaped by the confidence in the health benefits (C. Tobler et al., 2011). Meanwhile, men show less concern about the negative effects of meat consumption on their health and are more frequently influenced by their friends' opinions (Lea et al., 2001). Besides, women tend to hold more pro-social values; they are more sensitive about environmental topics and animal welfare, all of which enhances the likelihood of the adoption of a plant-based diet (S. Stoll-Kleemann et al., 2016). Men, however, frequently lean towards pro-self-values manifesting themselves in the striving for power and social dominance; they tend to associate meat with values of power and are consequently less willing to reduce meat consumption and adopt plant-based diets (A. Hayley et al., 2015). Therefore, male and female behavioral patterns should be distinguished when trying to change their meat consumption (Lea et al., 2001).

Another important influence in reducing meat consumption is a person's age. Young people's food habits differ from those of older generations. A higher percentage of young people adopt plant-based diets, which indicates a discrepancy in attitude and behavior regarding meat consumption (S. Stoll-Kleemann et al., 2016). Younger generations have been found to be more sensitive to environmental problems and more aware than elderly people of the negative environmental impact of meat production (Heinrich Böll Stiftung, 2021). Hence, sustainability issues are the most important motive for choosing a plant-based diet in younger individuals, while ethical or health reasons are the most common reason for older people (S. Stoll-Kleemann et al., 2016). Moreover, the flexitarian diet, i.e. the choice to only occasionally eat meat, has risen significantly in popularity among young adults in the last years; this is also likely to be linked to environmental reasons (Heinrich Böll Stiftung, 2021). Another factor is the openness of the young generation toward new food habits, whereas senior citizens commonly lack this attitude and are less receptive to changes in their habits. Moreover, some studies have provided evidence that personal beliefs are an important catalyst in the food consumption behaviors of elders (Lea et al., 2001). Therefore, older generations, affected by their cultural and historical backgrounds, perceive meat as an integral component of the human diet which cannot be eliminated (Lea et al., 2001).

Socioeconomic status is another factor influencing meat consumption; income is a vital driver of food consumption patterns. It has been observed that low-income social milieus have difficulties maintaining a balanced diet and often consume foods high in added sugar, saturated fats and refined grains because of their low cost and long shelf life (Drewnowski, 2008). Consequently, a healthy diet is associated with a higher income and time consumption (Drewnowski, 2008). Moreover, individuals belonging to the lower socioeconomic strata tend to ascribe higher nutritional value to meat, to therefore view it as an indispensable food, and to allocate a great portion of their total food purchasing expenses to it (S. Stoll-Kleemann et al., 2016). Throughout most of human history, meat was considered an elitist foodstuff unavailable to most. After the Second World War, its consumption became more common, thanks to industrial food production that led to price democratization. However, in becoming more accessible, meat gradually lost the allure of a highly sought-after food (Montanari, 2004). Nowadays, meat no longer carries connotations of status, especially in wealthy milieus. On the contrary, over the last decades a new model of healthy diets that focus more on quality than quantity, has taken root in most developed countries. Plant-based diets are now associated material wealth and high education levels (S. Stoll-Kleemann et al., 2016). Hence, a high income positively correlates with the adoption of plant-based diets.

3.1.6 Behavioral Control

Some psychological theories, such as the theory of Planned Behavior that will be analyzed in the following paragraph, describe perceived behavioral control as an antecedent of behavior, which is of high importance to the domain of sustainable behaviors (S. Stoll-Kleemann et al., 2016). More specifically, perceived behavioral control is defined as the "perceived difficulty in implementing a given activity" (Lanzini, 2018). An example with respect to plant-based meat alternatives is the perceived lack of availability of these products in supermarkets. Perceived behavioral control can pose a hindrance to sustainable behaviors; it can even prevent positive intentions and mitigate social pressure toward the implementation of a specific activity (Lanzini, 2018). An experimental study has found that people who already lead a plant-based diet have a higher sense of control compared to people who are only considering

switching to a plant-based diet or who are in the precontemplation stage (Wyker et al., 2010). Furthermore, vegetarians do not appear to perceive high prices and small product ranges to constitute barriers when compared to the perception of meat-eaters (S. Stoll-Kleemann et al., 2016).

3.2 Sociocultural factors

Apart from the personal factors analyzed above, an individual's attitude toward meat is also driven by sociocultural components. Cultural and religious traditions have a significant influence on meat consumption, as do social norms, roles and relationships, alongside social identity and lifestyle.

3.2.1 Culture and Religion

Cultures and their traditions change over time, and symbols – as cultural products – evolve and differ from one culture to another in accordance with individuals' behaviors (Montanari, 2004). In modern times, cultures have been reshaped by globalization, which has given birth to new cultural frameworks in which local and global practices coexist (Montanari, 2004). Naturally, this phenomenon also affects food cultures that have seen an evolution toward "*glocal*" consumption patterns.

The Mediterranean diet, for instance, has traditionally relied on plant-based ingredients, but the global food industry has introduced higher quantity of meat (Montanari, 2004). Meanwhile, meat is an integral component of the diet in many other cultures. Meat has a multitudinous and complex symbolism attached to its production, preparation, consumption, as well as rules and prohibitions, all of which are direct expressions of culture (Beardsworth et al., 2004). Members of a culture are, similarly to gender, characterized by overarching values, and those focused on self-enhancement and especially power are likely to consume more meat (S. Stoll-Kleemann et al., 2016). In various cultures, we find ambivalent meanings attached to eating meat: it can be desirable as an affirmation of power, and undesirable as it is linked with ethical, environmental, and human health issues (Beardsworth et al., 2004).

The use of animals as food raises many issues in different, and many rules and prohibitions have been created around it, often dictated by religion. Most world

religions regulate the meat production processes, such as the halal slaughtering method in Islam. Simultaneously, other religions prioritize the protection of all living creatures, imposing a plant-based diet on their followers. One example of this is Hinduism, which is why India is the country with the highest percentage of vegetarians worldwide.

3.2.2 Social norms and relationships

Social norms precede intentions and therefore influence behaviors. Social norms are defined as "cognitive representations of what relevant others would typically think, feel or do in a given situation, which people use as a reference point to guide and assess their own thoughts, feelings and behaviors" (Turner, 1991). Norms affect behaviors because they are associated with social judgment; they are generally more likely to be followed when a certain degree of uncertainty exists about specific behavior, or when there is a significant level of identification within a social group (Higgs, 2015). Descriptive norms are defined as externalized behavior, i.e. what the others do or what one thinks they do, while injunctive norms regard what behaviors are expected, so what the others endorse (Higgs, 2015). With respect to food, social norms can even change the sensory appreciation or disgust of a specific product and thus drive food choices. Social eating norms affect, for example, the size of food portions and the type of food consumed (Higgs, 2015). Therefore, an individual's food behavior is linked to the diet behaviors of their close social surroundings and, therefore, can present both an opportunity for or a barrier to meat consumption reduction (S. Stoll-Kleemann et al., 2016). A survey conducted among young university students in the USA found that the attitude toward the adoption of a plant-based diet is strongly affected by the normative beliefs of family, friends and other peers; if they endorse a plant-based diet, individuals are more likely to have an intention of adopting it (Wyker et al., 2010). However, social norms can also play an obstructing role in an individual's decision to cut back on meat. In fact, several studies have found that social norms can mitigate intentions to switch to a plant-based diet, as shown by Salonel and Helne, who discovered that participants' resolutions to adopt a vegetarian diet were noticeably diminished by the negative views of their relatives (Salonel et al., 2012). Especially men regularly experience social pressure brought on by their potential

willingness to take up a plant-based diet because of their gender. This is due to the aforementioned salient correlation between meat consumption and masculinity, which leads to vegetarian men being perceived as less masculine than omnivore men (Ruby et al., 2011). However, even if social norms still constitute an obstacle to plant-based diets, awareness of the benefits of reducing meat consumption is rising in modern societies, and so social norms are likely to shift toward more positive views of plant-based diets (Salonel et al., 2012).

3.2.3 Social identity

In all cultures, individuals use diverse markers of identity to express their social belonging, one of which is food (Montanari, 2004). Culinary culture both constructs and reflects social identity, and quality and quantity of food communicate this. As outlined above, through large stretches of history meat used to be consumed exclusively by the gentry and thus it embodied both the symbolic and functional power over the lower social classes who viewed meat as the most desirable food because of its inaccessibility (Montanari, 2004). It is not a coincidence that many orders of monks decided to exclude meat from their diets to reject the pursuit of power and social dominance (Montanari, 2004). Today, just as in the past, it is common among people to adopt certain eating behaviors in order to create a specific public image and make a certain impression on others (Higgs, 2015). As the section on personal factors has highlighted, people who decide to relinquish or reduce meat consumption are moved by self-transcendent values, and thus create a public image of environmentally conscious and respectful individuals. In the past few decades, there has been a surge towards plant-based diets and new food styles like “flexitarian” or “pescatarian” have emerged (S. Stoll-Kleemann et al., 2016). These new dietary trends are adopted by some individuals in order to outwardly convey a gratifying social identity and lifestyle. Individuals adopting plant-based diets are frequently highly educated, have a medium-high income utilize their dietary choices to display a new level of wealth and to express their social identity (S. Stoll-Kleemann et al., 2016).

3.3 External factors

Beyond personal and social components, there are also external factors that affect meat consumption behaviors. Political and economic macro-forces hold significant power over societies' food consumption choices, as does the general food environment which encompasses the extrinsic product attributes, product accessibility and the meal context.

3.3.1 Political and economic factors

The second chapter dealt with the importance of government policies endorsing meat replacement products in order to promote plant-based diets and reduce meat consumption. Such nudging policies are critical in expediting dietary shifts, and civil society and institutions should cooperate on all levels to pursue the same goal. Reports have claimed chronical inaction on the part of governments regarding these issues, even though the tendency is slightly changing nowadays in accordance with the UN sustainable development goals. However, there are conflicts of interest that restrain governments in taking steps toward promoting a plant-based diet, mostly linked to the enormous financial power of major meat companies (Heinrich Böll Stiftung, 2021). Indeed, meat giants receive numerous subsidies by institutions and to discourage meat consumption would mean to disturb this equilibrium. Moreover, collateral interests along the meat market supply chain, including the agrochemical, animal feed, and pharmaceutical industries further increase the dominance of the sector.

Individual economic factors also heavily impact eating behaviors, and meat consumption is no exception (S. Stoll-Kleemann et al., 2016). In western countries, where meat is a cheap product, meat prices disincentivize the reduction in consumption. A study conducted in the UK has identified price as one of the most important factors in meat consumption choice, alongside the country of origin and fat nutritional contents (Apostolidis et al., 2016). Another study conducted in Germany has highlighted that people attribute better value for money to meat in comparison with plant-based substitutes (M. R. Eckl et al., 2021). Therefore, meat prices directly obstruct the adoption of meat substitutes. A US study has exposed that leading a healthy diet is significantly more expensive, with meat products displaying the greatest differences in price between healthy and less healthy products compared to other

food categories (M. Rao et al., 2013). Thus, the study provided evidence on the higher cost of a healthy diet such as the Mediterranean one, which is rich in vegetables, fruit, fish, and nuts compared to diets mainly consisting of processed foods, meat and refined grains (M. Rao et al., 2013).

3.3.2 The food environment

The external factors of the food environment category include different variables such as the infrastructures that provide meat alternative products, the access to them and the product itself.

Retailers have an important role in promoting the switch toward plant-based meat substitutes, especially in Western countries where a few corporations dominate the business environment of large-scale distribution. However, it seems that these infrastructures are not oriented yet toward a significant supply of these food products, and their efforts to enable consumers to purchase plant-based meat alternatives are still limited. A study conducted in Canada analyzed how well plant-based products are supplied by food retailers. This research found that, according to the opinions of interviewees, the availability of plant-based products was quite limited and their shelf space was significantly smaller compared to the one allocated to meat products, and moreover, as a great barrier to purchasing, the position of plant-based alternatives was inconsistent and different from one retailer to another, thus requiring additional efforts on the part of the consumers (Gravely et al., 2018). It was also noticed that the amount of product types and brands was higher for animal- based and dairy products compared to plant-based alternatives (Gravely et al., 2018). More interestingly, interviewees reported that the promotion of animal-based products was more aggressive compared to plant-based products, and the communication of sales promotions was higher for meat (Gravely et al., 2018). Furthermore, meat products were described as being placed in clearly visible locations whereas meat alternatives were more out of sight (Gravely et al., 2018). However, as said in previous sections, the interest toward plant-based diets is increasing and the range of meat alternatives is too. New products made by legumes, soy and the most innovative of plant-based meat and cell meat are taking their first steps into the food market. This food market is getting bigger, and the range of available products is increasing (S. Stoll-Kleemann et

al., 2016). Therefore, supermarkets both enable and limit the spread and consumption of plant-based meat alternatives. They simultaneously offer an increased range of plant-based food whilst favoring meat products in terms of their marketing strategies (Gravely et al., 2018).

3.4 Cognitive models of food choice

The combination of factors previously analyzed contribute to a pattern of different theoretical models that explain the dynamics of food purchasing choices. Looking at sustainable behaviors, there are various cognitive models that study the main reasons that lead to behaviors in this domain. There are contrasting opinions on the importance of some socio-demographic variables such as gender, age, and income in terms of motivating sustainable behaviors. With that said, considering the act of reducing meat consumption and adopting more plant-based diets that include the consumption of meat alternative products, these factors, as previously highlighted, are significant. However, using simplistic segmentation-based approaches is not sufficient to understand motives behind sustainable behaviors (Lanzini, 2018). More complex decisional processes must be considered in order to identify the factors that determine how and to what extent individuals adopt sustainable behaviors (Lanzini, 2018). In literature, there are many theoretical models aimed at explaining sustainable consumer behaviors, and behavioral research is broadly categorized into two main branches. The first one is based on a rationalistic perspective while the other gives more importance to the impact of habits and their role in leading to unconscious behaviors (Lanzini, 2018). The second category considers habits as a predictor of behaviors and examines their influence on triggering lower levels of awareness evaluations. While from a rationalistic perspective, individuals are assumed to rationally evaluate information and possible alternatives through cognitive processes. In the case of purchasing plant-based meat alternatives, people's behavior is led by a rational evaluation of alternatives and the reading of information. The Theory of Planned Behavior (Ajzen, 1991) has been the most used model in analyzing sustainable behaviors. The Theory of Planned Behavior has its roots in the Theory of Reasoned Actions (Fishbein, 1975) (Ajzen, 1980), which has been modified by the former due to the limitation of not considering perceived behavioral variables, defined as the

perceived difficulty of performing a specific behavior. The Theory of Reasoned Action will be analyzed first, followed by the theory of Planned Behavior.

3.4.1 The Theory of Reasoned Action (TRA)

The Theory of Reasoned Action has been broadly adopted in many economic studies thanks to its rationalistic perspective. Two models of this theory have been developed, the first one in 1975 and the second in 1980. The most important assumption of this cognitive model is that the strongest indicator of actual behaviors are intentions. In other words, an individual performs a certain behavior because he develops the intention to do so. Intentions and behaviors are obviously correlated but they must be considered separately. In fact, intentions may develop into behaviors, but it doesn't always happen. There are some factors, that can both be contextual or subjective, that may prevent an individual from effectively adopting the intended behavior. Therefore, as already said, the main driver of behaviors are intentions, and their main determinants are attitudes and subjective norms. Attitudes belong to the personal sphere and represent predispositions, which can be impactful both in positive or negative ways in terms of encouraging a specific behavior. They are determined by the beliefs of individuals about a certain outcome and its evaluation in terms of desirability or avoidance of that specific outcome. While subjective norms reflect a kind of social pressure and represent individuals' beliefs on what referent social groups expect them to do. In the case of consumption of plant-based meat alternatives, if an individual thinks that his relative group expects him to not purchase and consume these products, he will probably change his actual behavior as a consequence of that subjective norm. It's important to highlight that attitudes and subjective norms are not always oriented toward the same outcome. For example, an individual could present a positive attitude and a negative subjective norm toward the adoption of a behavior.

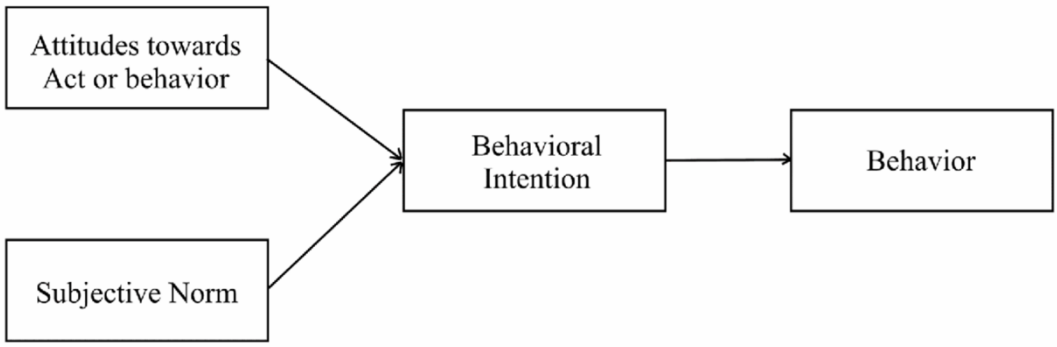

Figure 3.1 Theory of Reasoned Action, Source: Ajzen & Fishbein 1980

However, the Theory of Reasoned Action represented in figure 3.1, even though it has been widely used in many studies, has been criticized for two main reasons. The first is concerned with the adoption of an oversimplistic approach since this model considers only two drivers of behaviors. The second one mainly addresses the fact that the Theory of Reasoned Action assumes that every behavior is under volitional control, so individuals are considered to always act in rational ways, and it does not take into consideration external and uncontrollable factors that could have an influence on actual behaviors. Thus, it would be realistic to assume that both internal and contextual factors could affect the likelihood of performing certain behaviors. Consequently, in order to overcome the limitations of this model, the Theory of Planned Behavior has been developed and includes a third driver of behaviors: perceived behavioral control.

3.4.2 The Theory of Planned Behavior (TPB)

The Theory of Planned Behavior is maybe the most used theoretical model in investigating behaviors. It has been broadly adopted in studying behaviors in the sustainability domain, and moreover, its use has spread to the marketing field in terms of conducting research on consumers' behaviors. As previously mentioned, this model takes its roots from the theory of Reasoned Action, introducing the perceived behavioral control to the antecedents of behaviors. The perceived behavioral control, already analyzed in the paragraph of personal factors, represents the imagined difficulty of performing a specific activity. However, the theory of Planned Behavior has received some critics due to its incompleteness because it does not consider influencing factors of behaviors such as habits, culture and tradition, or emotions.

Nevertheless, given that this theory is regarded as effective at analyzing what drives specific behaviors, it has broadly been used to examine food consumers' choices in sustainable domains. Furthermore, this cognitive theory is well-suited to integrating other factors that contribute to driving behaviors. As an example, a study conducted in

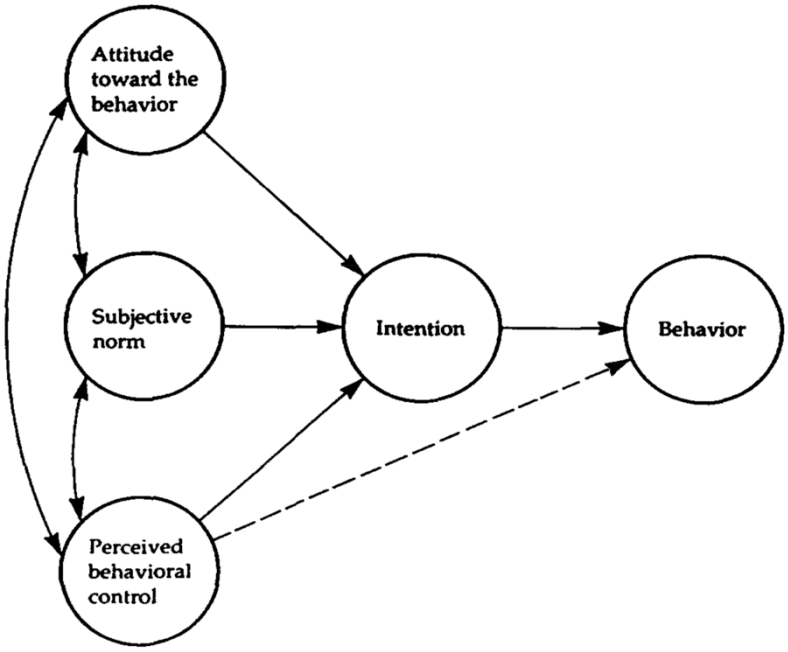

Figure 3.2 Theory of Planned Behaviour, Source: Ajzen 1991

China among young consumers integrated the model adding environmental concerns, a strong attitude toward the protection of the environment, and environmental awareness in order to understand what drives the purchase of organic food (Ahmed et al., 2020). This research discovered that all the factors considered in the extended Theory of Planned Behavior are motivators for purchasing organic food (Ahmed et al., 2020). The most impactful antecedent of these behaviors has been identified as subjective norms, especially found in the perceived social pressure exercised by family. Positive attitudes also seemed to be fundamental for purchasing organic food. Another interesting piece of research used this model to conduct a cross-cultural study among European Union Countries to understand their level of green purchasing behaviors (Liobikienė et al., 2016). This research discovered many differences across countries. However, it seemed that in every country the subjective norms were the most important predictor of green purchasing behaviors. Most Europeans agreed on the benefits of buying green products as well as the perception of social pressure having positive effects on green behaviors. Subjective norms also seemed to be negatively

correlated with income levels, and countries more oriented toward the high-power distance sphere that is characterized by power, privileges, wealth and status, seemed to be more influenced by subjective norms. Moreover, knowledge and confidence seemed to be quite important in influencing green purchasing behaviors. Moreover, the cultural dimension of uncertainty avoidance has been identified as highly important because of its effect on price sensitivity which directly affects behaviors. Cultures which are concerned with risk, such as Italy for example, demonstrated a higher interest in price as a determiner of green purchasing behaviors. While in other countries, like Germany and Austria, prices were less important as motivators. (Liobikienė et al., 2016).

4. The Plant-Based Meat: a sustainable meat alternative

4.1 Sustainable dietary patterns

The FAO defines sustainable healthy diets as "dietary patterns that promote all dimensions of individual health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable. Their aim is to achieve an optimal growth and development for all individuals of present and future generations, contribute to prevent all form of malnutrition and support the preservation of biodiversity and planetary health" (FAO, 2019).

The interest in sustainable diets, as highlighted in the previous chapter, is a recent trend of the food sector. This phenomenon led consumers to care more about the origin of their food, the organic produce, food waste, the social sustainability of food companies and their environmental impact. The interest toward sustainable diets grew as vegetarianism and veganism saw a rise in their adoption. Therefore, there has been an increase in awareness of the negative impact of meat production in terms of both the environment and personal health. Subsequently, concerns about the environment have led people to adopt more sustainable diets. As discussed in the previous chapter, these motivations are more common among young adults because of their attachment to environmental issues. Indeed, research conducted in Germany, where vegetarians represent between 4 and 6 percent of the total population, showed how young people eat less meat than older generations and, more interestingly, how among young generations there's a common sense of social responsibility in the adoption of more sustainable diets that are low in meat consumption (Heinrich Böll Stiftung, 2021). However, environmental motivations are only the most recent driving force for the adoption of sustainable diets, and the other two main reasons revolve around ethics and personal health. Sustainable diets with low or no meat consumption seem to be a quite recent development but actually have deep roots in ancient history. In fact, testimonies of diets that exclude animal foods date back to Ancient Greece, and more specifically, back to Pythagoras who is often considered to be the first vegetarian in history (Watson, 2020). Moreover, many other well-known characters throughout the centuries, from Seneca to Voltaire and Kant, made the same decision. However, the term "vegetarianism" was coined during the 19th century (Watson, 2020), and the term "veganism" was coined by Donald Watson during the 1940s in order to distinguish between the strict vegetarians who do not eat dairy products, and standard vegetarians.

However, before the 1960s and 1970s these types of diets were still regarded as a niche trend, and only in this period did they start to become more mainstream as non-conventional lifestyles became more popular (Watson, 2020). During the 1970s, more specifically, new motivations emerged as environmental concerns and animal welfare became drivers of vegetarian and vegan choices in tandem with an emphasis on personal health. In that period, publications such as the "*Diet for a Small Planet"* by

F.M. Lappé, where the relationship between meat production, food waste and environmental damage is addressed, contributed to raise awareness about the negative impact of the meat industry. Furthermore, many popular celebrities, like Paul McCartney, embraced these dietary regimes, allowing them to become more known among the mass public. In more recent years, there has been a rising interest in these dietary changes, with many alternative meat options being developed and new restaurant chains that focus on vegan and vegetarian dishes becoming more popular. In 2021, the market value of vegan products reached almost 16 billion dollars and by 2025 it is expected to reach around 22 billion dollars. Indeed, the whole USA market of plant-based products has been valued at more than 6.5 billion dollars in 2020 with a 45% growth from the previous year (Statista, 2022). It is quite difficult to know the precise number of vegan and vegetarian people in the world because individuals have differing conceptions about what these terms mean. However, it is known that the number of adherents to both of these dietary choices is increasing. It has been estimated that in 2014 there were around 380 million vegetarians, and data from 2020 indicate that 40% of global consumers tried to reduce their animal-food based consumption (Heinrich Böll Foundation, 2014) (Euromonitor International, 2021). Regarding vegans, they were estimated in 2018 to represent 7% of the English population, 3% of the US population, 6% of the German population, and 7% of the Polish population (Watson, 2020). A questionnaire examining Italian dietary choices showed that 6.7 % of respondents were vegetarian while 2.2% of them identified as vegan (Eurispes, 2020). However, it seems that the adoption of these sustainable diets has been stable in the last 6 years with only a marginal increase over the most recent period reaching around 9% of interviewees identifying as vegetarian or vegan (Eurispes, 2020).

As seen in the previous chapter, there are many drivers that can lead one to adopt a certain dietary behavior, and manifold motives for adopting a specific sustainable diet. It has been observed that the motivations that lead to vegan diets strongly correlate with motivations that drive vegetarian diets. In accordance with this finding, qualitative research in Australia aimed at investigating the dietary motivations of omnivores, vegetarians, and vegans was conducted (North et al., 2021). The results of the study showed that for vegans, the most important motivating factor was animal

welfare, with around 62% percent of respondents mentioning this followed by 53% that cited environmental issues and 50% expressing concerns about health (North et al., 2021). With regards to vegetarian individuals, the main reasons for diet adoption were also environmental and animal welfare motivations with 43% respondents mentioning these, followed by personal health reasons (North et al., 2021). Conversely, the most important motivations for omnivores were taste and enjoyment, as well as the convenience of the diet. The only overlap between omnivores and their vegan and vegetarian counterparts was an interest in personal health. Another interesting distinction was that for vegetarians the preference of their diet was itself a motivation: in other words, vegetarianism was viewed as inherently preferable as a dietary choice. Meanwhile, the study established that among vegans, the environmental concern was a consequence of their already-established behavior rather than a driving factor (North et al., 2021). More importantly, this study investigated how different motivations can lead to the adoption of sustainable diets and how over time, motivational driving forces can change among individuals.

Looking at Italian dietary choices, research conducted in 2021 discovered that the most important reasons for adopting vegetarian and vegan diets were linked to personal health, which was selected by around 23% of participants as the main driving factor, closely followed by concerns over animal welfare which was selected by around 22% of participants (Eurispes, 2020). Interestingly, almost 20% of interviewees stated that they decided to adopt these diets in order to reduce their calorie intake and to increase the quality of their diet, while around 10% claimed to embrace these dietary patterns out of curiosity. However, among the respondents only 5% prioritized environmental reasons as the most important factors in driving vegetarian or vegan dietary choices, meaning that in Italy the connection between environmental concern and meat production is lower than in other countries (Eurispes, 2020). Nevertheless, reflecting international trends, young people between 25 and 34 years old were more concerned about environmental factors compared to older generations. In addition, people between 18 and 24 years old generally indicated that environmental concerns were their primary motivation to adopt a sustainable diet.

4.1.1 The dichotomy between traditional and innovative food products

Generally, tradition and innovation are considered to be opposing forces. Especially in the food environment, this discrepancy can make innovations very challenging in terms of being accepted by consumers. However, innovations in the category of traditional food are feasible and have lead to the new concept of "tradfoods" (Grunert, 2017). Traditional foods, as previously discussed, have a fundamental role in European culture, and consumers can easily distinguish among traditional, and innovative and industrial food products. With this being said, innovations in the food sector can lead to many improvements in terms of food safety, nutritional content and efficiency of production processes whilst retaining some core features of traditional products to appeal to specific markets (Grunert, 2017).

Innovations in the food sector could be both challenging for the consumers to accept and for the structure of the food industry. The preference of European consumers for traditional food products, especially those high in quality, has emerged as a recent trend that is closely linked to notions of food authenticity. It has been observed that there is a higher willingness among customers to pay for traditional food products due to their perceived quality. At the same time, it is important to highlight that innovations in the food sector have been quite marginal because of the small size of many food companies and because of their low level of technology. Most of the innovations adopted in the food sector have been incremental, such as changes in packaging, product composition and product size (Grunert, 2017). However, in the last years, many technologically advanced companies have been working on the development of new innovative products, mostly in the field of plant-based and synthetic made foods that could substitute animal-based food products and introduce disruptive innovative products to the market. The benefits of these products can be expressed in terms of lower environmental impact, and improved animal welfare and nutritional content. However, some limitations of these products are linked to higher costs in production and the adoption of completely new food products. In the following sections, different types of innovation in the field of meat product substitutes will be analyzed.

4.2 The meat alternative food products industry

4.2.1 The development of meat alternative food products

In the last decades there has been an increase in the adoption of vegetarian and vegan diets that has led to the introduction of new food products on the market due to a higher demand for these animal-friendly and environmentally sustainable food. Many companies have decided to enter the market of plant-based alternatives and today there is a wide supply of available foods. Many meat alternative products are made by ingredients that have been used for centuries such as legumes, vegetables, and soy. On the other hand, there are new innovative products, including plant-based meat and cell meat, that are just entering or are about to enter in the market of plant-based meat alternatives and that require significant research and development processes, as well as high technological resources in order to be produced.

The meat alternatives are understood to be a food made from non-meat ingredients, available in different forms and that are structurally similar to meat products (Joshi et al., 2015). Today, the most common plant-based meat alternatives are made from vegetables, soy, legumes, grains, and wheat gluten. Plant proteins, however, are among the oldest food source for humans. In fact, legumes have been used for 10.000 years and there is evidence that soy and tofu were consumed in Asia in 965 A.C. In addition, wheat gluten and tempeh have been eaten for a long time in different regions of the world (Jung Lee et al., 2020). Products based on soy or wheat gluten are high in protein. In fact, a plant-based patty is estimated to contain around 19.5 grams of protein while a beef meat patty has around 23,3 grams (Jung Lee et al., 2020). Nevertheless, from a nutritional point of view, plant-based alternatives such as patties and burgers are higher in fiber and lower in cholesterol compared to meat, even if they lack vitamin B12, which can be found only in meat and dairy products. Even so, plant-based products seem to provide a sufficient protein intake and consequently be a good alternative to traditional meat products.

Figure 4.1 . The Protose vegetable meat; Source: History of Meat Alternatives, W. Shurtleff (2014)

The first attempt at creating a plant-based meat substitute was undertaken by Dr. John Harvey Kellog who,

in 1896, created *Nuttose*, a product made by combining nuts and cereals that resembled meat and had similar nutritional properties (W. Shurtleff et al., 2014). *Nuttose*, was never launched on the market, introduced the first meat alternative commercialized in the USA and the world's first canned meat alternative. The *Protose* meat alternative had been launched by the Sanitas Nut Food Co, a branch of the John Kellog firm. Then, after the market release of *Nuttose*, the term "meat substitute" and "meat substitutes" first appeared on newspapers and scientific reviews. Subsequently, during the first years of the 20th century other similar products were developed and in 1911 a food factory in Nashville, the Seventh-day Adventist Nashville Sanitarium, launched the commercial of its *Nutfuda* meat alternative product made by vegetables. After that, the variety of meat alternatives started growing, and it is worth mentioning the first soy-based meat alternative, called *Soy-Bean Meat*, made in 1922 by the Madison Foods. In 1937, this company also launched the first Soy-Burger which gave rise to an entire product category of burger made with plant-based ingredients (W. Shurtleff et al., 2014). In the 1950s, Robert Boyer, a young researcher employed first at the Ford Motor Co. and then at the Ralston Purina Co., developed a textured edible soy protein fiber using protein filaments and creating an innovative meat replacement product. From this innovation, terms such as "synthetic meat" and "simulated meat" were coined. During the 1960s, Boyer himself continued research on soy and developed new products made by isolate proteins of soy, enabling the Ralston Purina Company to commercialize meat alternatives containing soy fibers and launching the first frozen plant-based meat alternative product (W. Shurtleff et al., 2014). Between the 1960s and 1970s there was an increase in the adoption of vegetarian and vegan diets both in the USA and Europe thanks to the Hippy movement. As a result, the number of companies opting to produce meat alternatives increased and the market of plant-based meat alternatives started to take shape. During the 1990s the market of meat alternatives was already established and generated high revenues, and the Worthington Foods Company, that controlled around 60% of the US market of meat-alternatives, was purchased by The Kellog Co. for 307 million dollars. Another big player in plant-based alternatives, the Boca Burger, was acquired by the Kraft Foods Inc. At the start of the 21st century, Burger King became the first fast food chain to introduce a veggie burger on its menu (W. Shurtleff et al., 2014). Today, there's a wide

range of plant-based meat alternatives; there are vegan burgers made by many types of vegetables and they are available both at the large-scale distribution channel and in restaurants. The quality and palatability of these products has increased over time thanks to incremental product development and research. The majority of the so called “traditional plant-based meat analogues” belong to the category Textured vegetable protein (TVP): fabricated vegetable products that can totally replace meat in a food dish (Joshi et al., 2015). Today, soy meat products such as soy burgers are the most common products in the category of meat alternatives, being highly rich in protein with levels higher than 50%. Moreover, soy is a versatile product, used as the main ingredient in nuggets, burgers, and chunks and strip products. This enables consumers to try many different products and gives them access to various consumption methods. Another fundamental constituent in plant-based meat alternatives is tofu derived from the coagulation of soymilk. Tofu is considered to be the most legitimate meat alternative product thanks to its nutritional properties. In fact, it is high in proteins, vitamins and minerals but has no cholesterol and it is low in fats (Joshi et al., 2015). Seitan is another highly used meat substitute and it is obtained from the isolation of gluten part from wheat and is very high in protein. Apart from the nutritional properties, seitan, deriving from wheat, can be produced in many countries of the world and has the potential to be available on a global scale. Moreover, seitan is efficient in terms of costs and production and its consistency is quite similar to the consistency of meat.

In the USA market, meat alternatives are the third fastest-growing segment behind meat and other dairy plant-based products. Between, 2018 and 2019 they grey around 19% (Choudhury et al., 2020). During 2019, the top selling categories in the USA market of plant-based meat alternatives were identified as burgers, with revenues of $283 million; sausages and hotdogs with $ 159 million and then patties with $120 million (Choudhury et al., 2020). Today, the majority of plant-based producers are based mostly in the USA, which boasts around 60 companies compared to 17 for Europe, and a few others in Asia, Africa, and Australia. Traditional meat substitutes are already a product category known by the most individuals, but the industry is taking a step forward by producing innovative foods such as plant-based meat and cell meat that better imitate the aspect, taste and consistency of meat compared to the

traditional meat substitutes. These new products could potentially disrupt the market and substantially change dietary patterns.

4.2.2 The Plant-based meat industry

Apart from the category of traditional meat alternatives analyzed in the previous paragraph, there's an emerging product typology that has been called the next-generation of meat substitutes (Rubio et al., 2020). This category of novel products is characterized by a high product complexity and development, and it makes use of both plant-based and cell-based meat substitutes. Although the definition "Plant-based" is widely used to refer to a general product category, the "Plant-based meat" term indicates a specific product category, the aim of which is to imitate meat in flavor, aspect, texture and nutritional aspects.(Rubio et al., 2020). In fact, plant-based meat is a product composed only of vegetables and that is why it is sometimes known as "meatless meat" or "meat-non-meat". The most important difference between this product and the traditional meat substitute products category is that the objective of Plant-based meat is to strictly reproduce meat features and not just substitute their nutritional value. Therefore, besides the aim of reproducing meat features, an important and innovative macro-objective of Plant-based meat is to present the possibility to the mass market of consuming a meat-like product with important reductions in terms of environmental resources used, and in terms of animal welfare. Moreover, a wide consumption of Plant-based meat, thanks to its efficient production process compared to traditional meat products, would help food systems to become more resilient toward facing challenges like climate change and adapting to social macro-forces of population growth and urbanization. This is the motivation because next generation meat substitutes are defined as the protein food of the future. However, the production process of Plant-based meat requires high technological resources. The main ingredient in Plant-based meat that provides protein is pea, which together with around 20 ingredients make the production of this product possible; water is the main component of the product, while some seed oils provide the fatty components, and the beet root extract gives a red color reminiscent of meat. These do not contain soy, wheat or GMO ingredients (Bertera, 2020). The production process usually requires 3 steps: the protein isolation and functionalization, where the

target pea proteins are extracted from plants and are treated in order to improve their functionalities, then in the formulation phase proteins are mixed with other ingredients to get a texture similar to meat, and during the phase of processing ingredients undergo a protein reshaping process in order to imitate meat texture (Rubio et al., 2020). Furthermore, technologies also use 3D printing and the recombination of protein additives in order to obtain the final product.

Plant-based meat was first commercialized by *Beyond Meat,* a company that was founded in 2009 by Ethan Brown in Silicon Valley with the aim of making a product very similar to meat but made entirely of raw vegetable ingredients (Askwonder.com, 2019). Former investors of *Beyond Meat* have been Bill Gates and Tyson Food, the giant meat producer, and thanks to the number of investments received, the company was able to enter the retail market in 2013 (Logomyway, s.d.).

Figure4.2: The Beyond Burger, Source: Beyond Meat (2021)

Its first product supplied to the large-scale distribution was a plant-based chicken imitation, but the most famous Beyond Meat product is the plant-based burger, the *Beyond Burger*, that is a vegetable meat patty, launched in 2018 (Askwonder.com, 2019). The Beyond Meat products are composed of a powder made by extracting proteins from yellow peas called “pea protein isolate” (Askwonder.com, 2019). The Beyond Meat burger contains 20 grams of proteins and it does not use any GMO. It is completely plant-based so it is a vegan product that imitates meat in its aspect, smell,

taste, texture and nutritional components. Over the years, *Beyond Meat* increased its products on offer and today the products' range available include *Beyond Burger, Beyond Mince, Beyond Meatballs and Beyond Sausage, Cookout Classic, Beyond Chicken and Beyond Beef* (Meat, 2021). *Beyond Meat* has come to dominate the meat-alternative market. In 2018 the market leader of fast food, *McDonald's,* conducted a test in Sweden and Finland, adding a meatless burger to its menu, the *Beyond Burger*, obtaining unclear outcomes. In 2019, it definitively introduced the *Beyond Meat* option in the Canadian and German markets.

Then in 2021, *McDonald's* and *Beyond Meat* made a 3-year partnership in order to launch the *Mc Plant* Burger and other products using the *Beyond Meat*. The CEO of the brand defined this agreement as a "milestone" for the company. Moreover, *KFC* did a limited launch of plant-based chicken meat nuggets called *Beyond Fried Chicken* in partnership with *Beyond Meat in 2019* (Gizmodo , 2021).

Figure 4.3: The Beyond Fried Chicken, Source: Gizmodo (2021)

Thus, thanks to the success of the product launch, *in 2020 KFC* decided to make a limited-time national rollout. Interestingly, people declared that it was quite difficult to distinguish between real chicken nuggets and the *Beyond Fried Chicken* (Gizmodo , 2021). However, the price of the *Beyond Fried Chicken* is around double the price of normal chicken nuggets, and this could act as a barrier for potential consumers (Gizmodo , 2021).

In addition, Beyond Meat has made partnerships with other important fast-food chains such as *Taco Bell* and *Pizza Hut*. Together with *Beyond Meat,* there's another company that was founded in 2011, also from Silicon Valley. The *Impossible Foods* company,

creators of *Impossible Meat*: a plant-based meat mostly made of soy, potato proteins, wheat, coconut oil and heme, an essential molecule present in living organisms that gives the typical reddish meat color to the *Impossible Meat* product (Askwonder.com, 2019). The product range of *Impossible Foods* includes *Impossible Burger, Impossible Sausage, Impossible Nuggets, Impossible Meatballs and Impossible Pork* (Foods, 2021) . *Impossible Foods, together* with *Beyond Meat,* is a market leader in the US market, however its products are not available yet in Europe and they have just entered into large-scale distribution. In fact*, Impossible Foods* got popular thanks to its collaboration with famous chefs and exploiting social media, so it focused more on the B2B channel addressing its products to
restaurants, fast food chains and hotels (Choudhury et al., 2020).

Figure 4.4: Impossible Burger, Source: Impossible Foods (2021)

The success gained by these two companies led to higher attention focused on plant-based meat products and allowed various funders such as *Proveg* to support start-ups in researching new product technologies. European companies have since attempted plant-based innovations of their own. *Nestlé,* in fact, developed its plant-based meat, called *Incredible Burger,* directed at the European market, and launched the *Awesome Burger* in the USA, offering a product with less ingredients than the ones supplied in that market (Bertera, 2020). *Nestlé* also founded the brand *Garden Gourmet,* which

only produces plant-based products, and which is widely available in Italy. The range of *Garden Gourmet* products is quite wide and offers many traditional plant-based meat alternatives, for example the plant-based meat called *Sensational Burger.* Nestle has also recently launched an innovative plant-based product called *Vuna* that recalls the taste and texture of the classical canned tuna fish (Gourmet, 2021). Meanwhile, *Unilever* acquired a Dutch brand, *The Vegetarian Butcher,* that was getting popular because of the quality of its plant-based meat products in 2018. Interestingly, this company was founded by an ex-farmer, coming from a

nine-generation farming family, that for ethical reasons decided to stop its business and work on the development of plant-based meat products (Bertera, 2020). In 2019, *The Vegetarian Butcher* announced a partnership with *Burger King* to launch the *Rebel Whopper*, a plant-based meat burger comprised of soy, gluten wheat, vegetable oils, and herbs and onions. This was first introduced in 25000 *Burger King* restaurants in 25 different countries (Unilever , 2019). Then in 2021, Burger King launched two other plant-based meat products produced by *The Vegetarian Butcher*, the *Plant-based Whopper* and *Plant-based nuggets* respectively (The Vegetarian Butcher , 2021). Moreover, another partnership with Starbuck led the company to developing a plant-based fish product, the *Tu'Nah Sandwich*, which was launched in the UK (The Vegetarian Butcher , 2021).

In Italy, however, the plant-based meat concept has arrived later than in other countries. Nevertheless, there are some Italian companies and start-ups that have got into the production of this product. *Emilia Foods,* as an example, is a company specializing in frozen food mainly directed at the American and Asian markets and in 2019 it decided to develop and launch its plant-based meat product (Foodweb.com, 2019). A different Italian start-up, *Joy Food*, developed its own version of plant-based meat that is known for its digestibility and healthiness (Foodweb.com, 2019). Moreover, the multinational *Barilla* is a partner of the Smart Protein project which studies new plant-based products.

In Italy, the first plant-based meat arrived in 2018 thanks to the Italian burger chain *Well Done,* which introduced the Beyond Burger in its menu (Bertera, 2020). Since that time, many other restaurants have added a plant-based meat choice to their menus; *Burger Wawe, Avo Brothers and Ham Holy Burger* are some of them. The last is a

burger chain which added 5 different alternatives of Plant-based meat such as the *Zero Burger* and declared that around 35% of their clients choose the plant-based meat burger instead of the classical one (Bertera, 2020). Today, it is even possible to purchase this product at the large-scale distribution; many retailers in fact added plant-based meat to their plant-based products shelves area. *Beyond Meat* is the most popular and common type of Plant-based meat. It is distributed by the Italian firm *Bmfood,* which covers 90% of the Italian market and restocks 200 restaurants in most parts of the country.

The *Beyond Meat* products can be found at the *Esselunga*, *Alì and Aliper, and Carrefour* retailers in the north of Italy, and at the *Conad* that made a launching trial for these products (Bertera, 2020) (Io scelgo Veg, 2020). Moreover, the *Sensational Burger* of *Garden Gourmet* and the *Unconventional Burger* of the brand *Granarolo* can be found in many retailers. Valsoia, which is a very well-known brand as a result of its supply of plant-based foods, developed a plant-based meat product that, differently from other product types of this category, does not use coconut oil (Io scelgo Veg, 2020). Even discount retailers are getting into the plant-based meat sector. In fact, the retailer *Lidl* developed its own Plant-based meat product, the *Next Level Burger,* which is mostly made of mushrooms, pea isolated proteins, wheat, coconut oil and rape extract to obtain the reddish meat color. The *Next Level Burger* is a highly competitive product because its cost is around 60% lower than most other Plant-based meat products (Io scelgo Veg, 2020). The *Euro Spin* discount chain launched a brand dedicated to plant-based products only. The *Fior di Natura* brand supplies many low-cost products that imitate the flavor of meat, such as plant-based meatballs, chicken nuggets and strips (Eurospin, 2021). Moreover, *Euro Spin* developed its own version of plant-based meat that, similar to product made by *Lidl,* has a very low price and is extremely competitive on the market (Eurospin, 2021).

4.2.3 The environmental impact of the plant-based meat industry

The Plant-based meat product category has gained much attention in recent years thank to its ability to imitate the meat-eating experience whilst having significant benefits in terms of human health and environmental impact compared to standard meat. In the second chapter, the contribution of meat towards climate change and its

natural risks, and the impacts of the whole industry on natural resources, was assessed. Public awareness about the negative effects of meat products on health and the environment is increasing, and Plant-based meat could represent a solution that fits both health concerns and the need to mitigate the environmental impact of consumption choices through reductions in meat eating in Western Countries (Graça et al., 2019). Many societies are getting to a point where requirements in terms of nutrient intake can be easily met with plant-derived foods, which have a lower environmental footprint compared to animal-derived foods (van Vliet et al., 2020). Therefore, this reason could be a feasible motivation toward the adoption of plant-based meat. Indeed, as previously highlighted, environmental sustainability is a macro-objective of the Plant-based meat production. Indeed, the two market leaders, *Beyond Meat* and *Impossible Foods* both assessed their production impact and compared it to producers of real meat. The former company commissioned a study by the Center for Sustainable Systems of the University of Michigan which reported a detailed life cycle assessment (LCA) of the *Beyond Meat* foods' production. The LCA took into account the GHG emissions, water and land usage and energy consumption of the whole Beyond Meat production, identifying the production steps that required more resources (Heller, 2018). With regards to GHG emissions, the average amount of greenhouse gasses generated by the production of one *Beyond Burger* patty is around 0.384 kg of Co2 equivalents, and more than half a percent is due to the production and delivery of raw materials. 22% is due to packaging activities and around 13% to the processing of raw materials (Heller, 2018). The consumption of water, which is calculated by measuring the amount of blue water usage, is a bit more than 1 litre for every quarter pound of plant-based meat patty. The processing phases are the steps which require the most water resources, accounting for more than 40%. Contrary to popular belief, the raw ingredients production stages account for 20% of the total amount of water used. However, soil usage is almost entirely as a result of the raw ingredients production phase, accounting for around 80% of the total, and the packaging represents most of the remaining part of land occupation. On average, the production of a *Beyond Burger* patty asks for 0.3 squared meters of land. Looking at the cumulative energy demand, ingredient production is the area that consumes the most energy, with just the pea protein production phase using around 33% of the total

energy use (Heller, 2018). As highlighted by the study conducted by *Quantis*, an environmental consulting group which was enlisted by *Impossible Foods* to assess the environmental footprint of its production, both the plant-based and animal-based

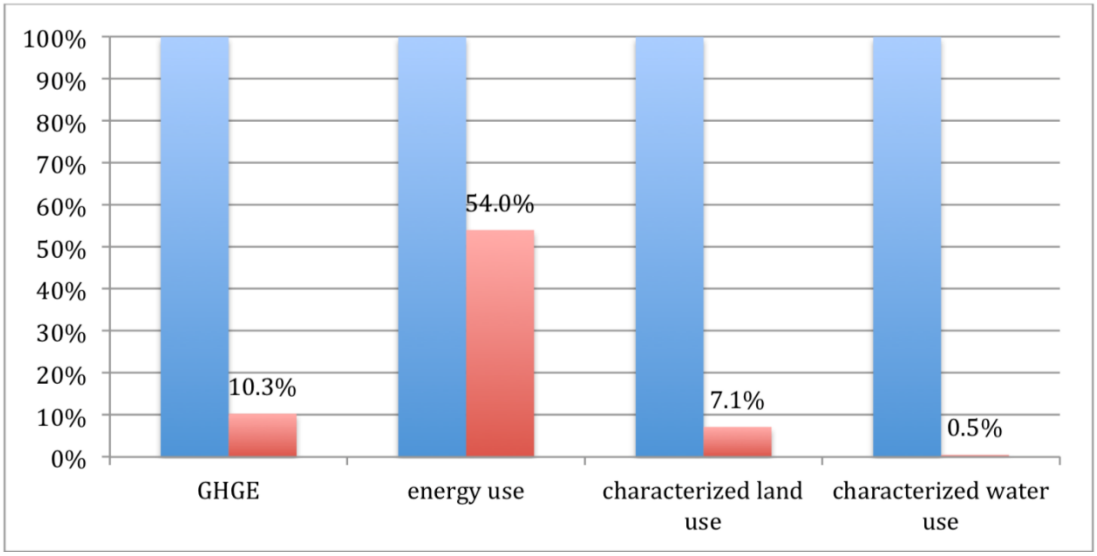

Figure 4.5: Relative comparison of impact between beef (blue bars, set at 100% for each indicator) and Beyond Burger (red bars). Souce: Heller (2018)

meat productions require far more natural resources in the raw-ingredients production steps of their supply chain (Quantis , 2019). Both pieces of research mentioned similar data from other studies on the environmental impact of plant-based meat products, and more importantly highlighted the huge differences with the conventional ground beef production (Heller, 2018) (Quantis , 2019). As the 4.4 figure shows, the research made by the Center for Sustainable Systems of the University of Michigan for *Beyond Meat* reported that the same weight patty of plant-based burger generates 90% less GHG emissions compared to a typical meat patty. The reduction in non-renewable energy use is around 46%. The benefits of *Beyond Burger* production compared to normal meat in terms of land resources used is around a 93% reduction, and water usage is reduced by more than 99% (Heller, 2018). Moreover, the *Impossible Foods* research states that the production of their plant-based products has an 89% lower impact on global warming and a 92% lower aquatic eutrophication potential compared to traditional ground beef productions (Quantis , 2019).

Both pieces of research mentioned excluded the impacts of retail, preparation, consumption, and end-of-life stages resources from their studies (van Vliet et al., 2020). It should also be highlighted that the number of resources required could

change considering the geographical location and type of production. In any case, the production of plant-based meat, considering it only requires raw vegetable ingredients, is lower than that of traditional meat (van Vliet et al., 2020). However, even though plant-based meat products have a significant reduced environmental impact compared to meat, this doesn't mean they are by any means perfect products. Scientists have looked at the long-term implications of plant-based alternatives to meat. Since plant-based meat is a highly processed product, it requires the use of tillage and different types of chemicals that contribute to soil destruction, and it generates concerns about plant-based meat adoption (Robicelli, 2021). Moreover, several plant-based meat products use soy, the crops of which are often treated with GMO. It should be said that many companies are trying to get over the issue of GMO soy (Mui, 2021). Another issue linked to these products is that they are based on vegetables which are cultivated in monoculture productions that favor genetic uniformity, triggering a lack of biodiversity of ecosystems (Mui, 2021). In addition, there are concerns about the healthiness of plant-based products, given that they are highly processed and could contain higher quantities of sugar, fats and artificial components compared to meat (Thomson, 2021).

4.2.4 The market acceptance of plant-based meat products

Developing healthy and sustainable diets is a possible solution to enable food systems to face challenges that will come in the next decades as a result of population growth and climate change(FAO, 2018). As highlighted in the first chapter, novel and unfamiliar foods, such as insects-based foods, cacti, plant-based and cell meat, could result in long-term sustainability in food systems. However, the consumers' acceptance of novel and unfamiliar foods is not always an easy process, and it could be challenging (Motoki et al., 2022). It has been observed that the consumption of plant-based products has increased worldwide and, as previously discussed, it is mainly due to ethical, environmental and health reasons (Heinrich Böll Stiftung, 2021). Barriers toward the adoption of plant-based meat substitutes can be determined by the personal and social sphere and contextual factors as shown in the third chapter. At first, many limits to the adoption of these products were linked to a lack of information about their production and composition, lower sensory attractiveness features and

higher prices compared to meat (Circus et al., 2018). Nevertheless, major acceptance of plant-based meat substitutes comes from people who do not consume meat and who are regular consumers of meat substitutes (Michel et al., 2021). Therefore, this category of consumer is more willing to positively evaluate plant-based meat alternatives, and do not search for meat resemblance in these products whereas people that consume meat expect plant-based alternatives to be similar to meat (Michel et al., 2021). Indeed, plant-based meat is a product mainly directed at the average meat-eating consumers, and not primarily to vegans or vegetarians (Michel et al., 2021). Plant-based meat would overcome one barrier which is regarded as particularly problematic: the sensory appeal of meat alternative products. However, a piece of research proved that whilst in countries such as China, India and the US plant-based meat has a good level of acceptance, in European Countries this is less so (Rubio et al., 2020). This is probably due to the long culinary traditions of Europe which often emphasize the "naturalness" of food. In fact, some European consumers perceive plant-based meat to be a highly processed product and therefore consider it as unnatural and not very healthy (Rubio et al., 2020).

4.2.5 Cultured Meat: the future of animal proteins

Plant-based meat is frequently associated and confused with another product: cultured meat.

However, they are completely different food products even if they are both innovative. While plant-based meat is composed entirely of vegetable ingredients, cultured meat is an animal-based product which is lab-grown and which closely resembles meat (Bingham, 2020). Cultured meat is also known as "cell meat", "lab-grown meat", "in-vitro meat", "synthetic meat", and "clean meat" (Bingham, 2020). Cultured meat is considered to be a revolutionary product owing to the fact that it is real meat but without animal cruelty. Cell meat is a lab-grown product generated by a muscle sample taken from an animal, which is often a cow (but it could also be a pig or a chicken), from which stem cells are isolated through advanced engineering and biology technologies, and then reproduced as meat tissues. An important feature of cultured meat is that some properties of muscle fibers can be changed and adjusted so that lower levels of saturated fats, compared to traditional meat levels, can be conferred

upon the product thus creating an improved version of classical animal-based products (Goodwin et al., 2013). Research examining how to get to a satisfactory product based on cultured meat remains ongoing. During 2002, in the USA NASA started doing some experiments in order to reproduce animal-based meat in a lab so as to create a possible food product appropriate for astronauts in space (Goodwin et al., 2013). In addition, in Europe some experiments looking into cell meat have been conducted, and cell meat started gaining popularity in 2006 thanks to some findings from the Eindhoven and Maastricht Universities (Goodwin et al., 2013). From that period, research into synthetic meat and investments toward this innovative product started rising.

However, the idea of this coming from the traditional animal growing process is not completely new. In fact, Winston Churchill in 1931 spoke of growing an entire chicken, in order to eat just its meat and wings, as an absurd activity and pointed out that it would be more logical to find a way of growing only what was to be eaten (Goodwin et al., 2013).

Today, there are more than 60 start-ups all over the world that produce their own version of cultured meat, in a few years these products could be launched into the market (Bingham, 2020). Among them is an Italian startup called the *Bruno Cell,* which was founded in 2019 in collaboration with the University of Trento (Bruno Cell, 2021).

However, cultured meat is not yet available to the mass market because of its very high production costs. The first cell meat packed hamburger was sold in 2013 in

Figure4.6: Cultured meat; Source: Bruno Cell (2021)

London during a press conference and it cost €250,000. It was the result of research that lasted many years conducted by the University of Maastricht and financed by the Google co-founder Sergey Brin (Mosa Meat, 2020). Nevertheless, many companies and startups have been able to significantly cut their R&D and production costs, and have stated that in few years the cell meat could be available for many people in several countries. As said, one of the most important benefits of cultured meat is its ability to closely resemble meat without contributing to harming animal welfare because it is not a slaughter product. Furthermore, there are also environmental benefits due to the avoidance of running intensive livestock productions. In fact, a single bovine muscle tissue sample could generate 80,000 quarter pounds of lab-grown meat, so the slaughtering of a single cow normally could produce around 1000 burger, while in the case of cultured meat just one cow could produce the same amount of meat that 80 cows could generate (Bingham, 2020). It has been assumed that cultured meat productions could cut emissions by more than three quarters and reduce water usage by 90% (Will Media, 2021). Moreover, many problems of food safety would be solved by avoiding parasites and bacteria as well as the use of antibiotics and pesticides (Bruno Cell, 2021). However, there are some doubts about the sustainability of cultured meat productions in the long term. Research conducted by the Oxford Martin School in 2018 found that GHG emissions due to the production of cell meat could, in the long run, have an even greater impact on the global warming effect compared to standard farming methods (Bingham, 2020). Therefore, if the ethical benefits are significant, there's still not a clear framework about the environmental ones. The success of cultured meat in the market is not a given, and even though it is an innovative product that could completely change traditional food systems, there may be some problems related to it. In fact, even if cell meat production costs have been significantly reduced, for many years it will still be a niche product affordable for only very small population categories (Will Media, 2021). Moreover, vegans and vegetarians would perhaps decide to not reintroduce meat in their diets and, on the other side people who consume meat would still prefer traditional animal-based meat instead of this lab-grown product (Will Media, 2021). As such, cultured meat would be a solution

only for people who want to consume meat for social and cultural reasons whilst trying, at the same time, to adopt more sustainable diets (Will Media, 2021).

5. Research about Consumers' attitude toward Plant-based diets and their opinions on Plant-based Meat products

5.1 Research Questions

Previous chapters of this study have been addressed to a review of changes occurring in food systems, the structure and the impact of the meat industry, the analysis of cognitive models that intervene in individuals' food choice and especially in reduction of meat consumption and the adoption of meat substitutes, and then the analysis of the industry of Plant-based meat products from its birth to possible evolutions. Then, considering the novel introduction of Plant-based Meat in the mass market and the rising interest toward plant-based diets, an experimental study has been conducted in order to deepen consumers' attitudes toward the adoption of more sustainable diets and the opinion toward innovative products as Plant-based meat is.

The first research question has been formulated following the research of EJ. Lea et al., (2006) that proved the importance of socio-demographic factors on the adoption of plant-based diets (Lea et al., 2006). Therefore, the first research question is:

RQ1: Which socio-demographic factors have a major role on determining the adoption of plant-based diets?

From this first research question, it has been interesting to explore which are the motivations that lead to the adoption of plant-based diets and possible barriers that restrain consumers to change their dietary patterns. Then the second and third research questions are:

RQ2: Which motivations lead individuals to adopt Plant-based diets?

RQ3: Which are the perceived barriers that have a major role in restraining the adoption of Plant-based diets?

Moving then to Plant-based Meat products, considering its novelty and that is not very likely that many consumers already tried this product, the aim of the following research questions was to investigates opinions, attitudes and possible intention to adopt Plant-based Meat products and to understand which consumers category, looking at dietary patterns, is more willing to introduce it in their dietary pattern. Then, the fourth and fifth research questions are the following:

RQ4: Which are consumers' opinions toward Plant-based Meat Products?
RQ5: Is Plant-based Meat a more suitable product for meat-eaters than for non-meat eaters?

5.2 Materials and Methods

The aim of this research is to investigate which are the main attitudes and intentions toward the consumption of plant-based meat products. The study has both a quantitative and qualitative approach and has been run in two phases. At first, a quali-quantitative survey has been disclosed and voluntarily addressed to individuals that both consume or not meat. The survey goal was to assess individuals' dietary habits, their attitude and barriers toward plant-based diets and traditional meat analogue products, and then to investigate the attitudes, intentions and believes about plant-based meat. While, in another phase an in-depth face to face semi-structured interview has been done to people that do not consume meat or do it rarely, in order to validate or reject the output of the survey, providing more specific opinions and intentions of non-meat consumers toward plant-based meat.

5.2.1 Survey

The purpose of this survey was to investigate dietary patterns, the perceived benefit and barriers toward plant-based diets, looking at the motivations that could lead to its adoption and then, the attitudes toward plant-based meat alternatives and more specifically on plant-based meat. The aim of this research was also to investigate dietary patterns as various as possible in order to understand different views toward plant-based diets and plant-based meat alternatives. The survey has been created

using a Google Module and it has been addressed toward an Italian sample of individuals, then the language used has been Italian. The questionnaire has been run in a self-administered, voluntary and anonymous way. Participants were alerted about the survey via word of mouth and through the use of social media profiles of the researcher as Facebook and Instagram and through WhatsApp messages. Thus, the sample of respondents was generated by a snowball effect leading to a snowball sampling. The survey (SEE APPENDIX A) was made by 32 questions and almost all of them were multiple choice questions with some answer options, and it was designed to collect information on participants socio-demographics, their attitude, perceived benefits and barriers on plant-based diets, their opinions on meat alternative products and then attitudes, intentions and opinions on plant-based meat. Then, the survey was divided into 4 parts plus an additional 1 addressed only to individuals that did not show any interests in the adoption of a plant-based diet and plan-based alternative products, and who never tried any traditional plant-based meat alternative. In the first part of the questionnaire, socio-demographics were investigated through a set of multiple-choice questions asking gender, age, level of education, occupation and residential area. The aim of this part was to build a consumers' pattern and use these variables to better understand motivations, attitudes and barriers beneath the adoption of plant-based diets and then of plant-based meat, following the research that has been used in the study of Lea et al., (2006). The second part of the questionnaire was dedicated to collect information about the attitudes, motivations and barriers toward a plant-based diet. This part was introduced with a definition of plant-based diet, and it was asked to the respondent if a plant-based diet is followed and the intention in the future to follow one, as suggested by Lea et al., (2006) (Lea et al., 2006). Moving forward, it was asked the type of diet followed, according to the research of Estell et al., (Estell et al., 2021) and a set of five closed-answer options were given: Omnivore, Flexitarian, Pescatarian, Vegetarian and Vegan. A more detailed definition of flexitarian and pescatarian was provided for individuals who maybe didn't know these terms. After that, a multiple-choice question on the motivation beneath the adoption of a plant-based diet were asked, as made in the survey of Lea et al., (Lea et al., 2006). Then, there was a question to investigate dietary habits and frequency of consumption of macro-categories of food. At this point, there were some sentences

aimed at studying the perceived barriers and benefits on the adoption of a plant-based diet, and a Likert scale with 5 answer options was provided to respondents, also these sentences were used by (Lea et al., 2006). Moving forward, it was asked the key question on the willingness to substitute some animal-based products with plant-based ones to investigate the attitude toward plant-based diets, following the research of Gonera et al., (Gonera et al., 2021). Respondents who negatively answered to the latter question were asked about the motivation of their choice, if they had ever tried any plant-based meat alternatives and which are the features of these products that should be improved in order to consider their consumption. For these respondents, then, the survey was over. While, for the others it continued with the third parts made by 3 questions and aimed at investigating consumption patterns and opinions toward traditional plant-based alternative products, suggested by a survey addressed to Norwegian consumers that studied ways to shift toward more sustainable diets and another one aimed at understanding how meat substitutes are perceived compared to meat (Gonera et al., 2021) (Hoek et al., 2011). Then, the section dedicated to Plant-based meat was introduced by its definition, considering it is a novel product and people could do not know its features. So, this section started asking if the Plant-based meat was a familiar product or not and then it was asked about the intention to both try it and to consider its introduction in their own diet. Then, opinions on this product were investigated through a set of multiple-choice questions with a 5 Likert Scale answer options. All the questions of this last part were suggested by a study aimed at studying the acceptance of cultured meat, and then adapted to the Plant-based Meat product (Bryant et al., 2019).

5.2.2 Interviews

The qualitative part of the research has been conducted using a one-to-one semi-structured interview. The aim of this step was to deepen investigate motivation beneath the adoption of plant-based diets, and the acceptance level of plant-based meat among non-meat eaters and low-meat eaters. Therefore, the interviews were administered only to vegans, vegetarians and flexitarian individuals. Moreover, the aim of this part was to confirm or reject the output of the quantitative survey.

Ten participants voluntarily took part in the research and answered to questions on their motivations that led them to embrace a plant-based diet, their attitude toward traditional plant-based meat alternatives and their opinions toward the novel product of plant-based meat. Intentionally, participants selected had different socio-demographic variables so participants with different sex, ages and level of education were involved in the interviews. Among the ten interviewees, there were five women and five men, and the age range shifted from 25 to 61 years old, with a mean age of 41,9. Most of the interviews, except two of them made online using Google Meet, were conducted in presence. Also in this case, the interviews were conducted in Italian, and they lasted around 20 minutes each. At the beginning of the interview the privacy policy on the confidential personal information were told to the interviewee and then few questions on socio-demographic variables as age, level of education and occupation were asked. The research continued with some questions about the dietary pattern and two participants stated to be flexitarian, so to rarely eat meat, while other seven declared to be vegetarian and one said to be vegan. It was also asked for how long that specific type of diet was adopted and the main motivation beneath that choice. Flexitarians, in addition, were asked about their average meat consumption. Moving forward, there was a question about the intention toward plant-based diet and it was asked about the possibility to change it in the next future. Then, a question about the willingness to try new type of food was aimed at understanding food neophobia levels. At this point of the interview, the attitude and consumption habits of traditional plant-based products were investigated through some questions on the average consumption and positive and negative opinions about these products' category. Then, the last part of the interview moved to the plant-based meat topic and started with a description of the product to the respondent. The attitude toward plant-based meat was investigated asking about the willingness to try it and then, a question about the possibility to introduce it in their own diet was aimed at studying the intention toward this products' category. Moreover, opinions on plant-based meat were studied asking about the perceived benefits and negative aspects related to this product. While at the end, interviewees had to make a hypothesis on which could be a fair price of plant-based meat both related to the average price of animal-based meat and traditional plant-based meat products. It has to be highlighted that every

interview structure could slightly differ from the question track just described because the aim of this qualitative research was also to create a dialogue with the respondent and follow the stimuli transpired through the discussion getting deeper to better understand motivations and intentions of people who already adopted plant-based diets.

5.3 Results and Analysis

5.3.1 Results from the survey

Socio-demographic results

The online survey was filled by 213 respondents; however one record was eliminated because it was not considered to be valid. As the Table 5.1 shows, the total records collected were 212 and the sample was composed by 76 men and 1356 women while 1 respondent did recognize their self in another category, so representing respectively the 36%, 64% and 0,47% of the sample.

Gender	Frequency	% Frequency
Male	76	36%
Female	135	64%
Other	1	0,47%
Total	212	100,00%

Table 5.1: Gender responses of the quantitative study

While most participants belonged to the age range between 20 and 30 years old, representing the 50% of the sample as shown by the Table 5.2. The other age categories were less populated, in fact both the range between 31 and 40 and below 20 represented the 8% of the sample and the category over 60 is just the 6% of the total records.

Age	Frequency	% Frequency
<20	18	8%
20 - 30	105	50%
31 - 40	16	8%
41 - 50	22	10%
51 - 60	38	18%
>60	13	6%
Total	212	100%

Table 5.2: Age responses of the quantitative study

Looking at the education level, most of the sample had at least a bachelor's degree. In fact, people with a degree together with those that had a master's degree and PhD

represent the 64% of the sample, while people with a high school diploma were the 29% of the sample and those with a middle school diploma were just 8%.

People taking part to the research were only Italian and came from different part of Italy, but there was a high concentration in the region of Catania. Then, 75% of respondents declared to live in urban areas, while 8% stated to live in country-side areas and the other 16% lived in mountain and sea-side villages.

Dietary Patterns Results

The second section of the survey started with the definition of what a plant-based diet is, and then was asked to respondents if their daily diet was a plant-based one. Half of the sample stated to have a plant-based diet while the other half said to do not. More interestingly, when was asked about the intention to adopt a plant-based diet in the future, just 13,6% of the sample stated that it will not happen, while 34,7% said to be in the evaluation phase of a plant-based diet adoption. Looking at the diet type followed by respondents, 38,1% said to follow a traditional omnivore diet, while 40,4% stated to have a flexitarian diet (so a dietary regime with low meat intakes), 6,1% of the sample was pescatarian (so a vegetarian dietary pattern that include fish products), 7,5% stated to be vegetarian and 7% to be vegan. For the purpose of this study, the dietary regimes were divided into 3 groups following the criteria of meat consumption. Therefore, the 1st group was composed by people who do not eat meat

	Diet 1		Diet		Diet 3	
Gender	Freq.	% Freq.	Freq.	% Freq.	Freq.	% Freq.
Male	9	11,84%	28	36,84%	39	51,31%
Female	35	25,92%	58	42,96%	42	31,11%
Other	0	0%	0	0%	1	100,00%
Age						
< 20	3	17%	8	44,44%	7	38,88%
20 - 30	18	17,14%	41	39,04%	46	43,80%
31 - 40	8	50,00%	4	25,00%	4	25,00%
41 - 50	8	36,36%	5	22,27%	9	40,90%
51 - 60	7	18,42%	20	52,63%	11	28,94%
> 60	0	0%	8	61,53%	5	38,46%

Table 5.3: Demographic responses associated to Diet's Groups

(vegans, vegetarians and pescatarians), while the 2nd group was made by people who stated to randomly eat meat (flexitarians) and the 3rd category was made by people who consume meat with no particular restrains (omnivores).

As the table 5.3 shows, women, compared to men, were more willing to adopt plant-

based diets, in fact they populated higher percentage of the 1 and 2 diet's groups, while among men there was a higher percentage on the 3 cluster which indicated the omnivore diet. These outputs confirm other researches that found out how women have a stronger attitude toward plant-based diets compared to men, and they also are more willing to be in the action stage than in the contemplation one (Lea et al., 2001) (C. Tobler et al., 2011). Looking at the age, the range with the highest percentage of people who do not eat meat was the one between 31 and 40 years old, while no one among over 60 does not completely eat meat. However, this age range is the highest in the 2nd diet's category which indicates the flexitarian diet, and in the same category, people under 20 had a high percentage too. Interestingly, when was asked about the willingness to substitute animal-based meat with plant-based products, 88% of the sample, so almost the total, confirmed they would be likely to make this switch. Women, compared to men, showed a higher positive attitude toward plant-based product substituting animal-based ones, in fact 91,11% of women against 82,89% of men stated to be willing to make this change.

Considering the demographic variable of the age, interestingly young people under 20 represented the category with the lowest percentage of positive attitude toward this substitution, showing a 72,22% of positive attitude toward the adoption of plant-based products instead of animal-based foods. While both the categories between 20 - 30, and 31 – 40 had the highest rate of positive attitude showing more than 93% of acceptance.

Considering the education level, the category with the lowest rate of acceptance was the one of the secondary license, with a 75%, while the highest one was represented by the category of graduated respondents that saw its rate rising until 94% of acceptance. However, as the general result showed, there were not many differences on the positive attitudes toward the substitution of animal-based products. Just 25 respondents, that represent the 12% of the sample, stated they would not substitute any animal-based foods with plant-based ones. To these individuals there was asked the motivation of their statement and it emerged that 8 individuals said they were not willing to substitute animal-based products because of their taste, and more specifically it has been mentioned the appreciation toward meat taste and its preference compared to plant-based products. Other motivations mentioned regarded

the dietary habits and the unwillingness to change them, while some others stated they tried plant-based substitute products and didn't really enjoy their taste. Moreover, it was also asked to these respondents which features plant-based products should have in order to consider their consumption; many of them answered that these plant-based products should resemble meat or even be more tasty to consider to introduce them in their diet, some other respondents also said that they would never think about the introduction of plant-based products in their diet as the response "*I would never eliminate meat from my diet*", no matter the features of this food category, while some other respondents stated that plant-based products should have higher nutritional values than meat in order to consider to consume them. Moreover, few answers were about the cost of the product, thus in order to be purchased plant-based products should be cheaper than meat, and few other answers stated that, on the contrary, this product category should not resemble meat features as the response "*They should not have the same taste and texture of meat*".

Motivations behind plant-based diets

One of the aims of this research was to investigate the motivations beneath the adoption of a plant-based diet. Therefore, there was made an analysis to understand which types of motivations recurring the most in different diet's group.

A multiple-choice question was provided with the most recurrent motivation toward the adoption of a plant-based diet. It emerged that, in absolute terms, the most frequent motivation was the health one, which has been chosen by 42,3% of the sample, followed by the environmental reasons with 29,1% and the ethical one with 16,9%. Then, as the table 5.4 shows, respondents belonging to the 1st cluster, so vegans and vegetarians, pointed out ethical motivations as the main driver for their

	Diet 1		Diet 2		Diet 3	
Motivations toward a plant-based diet	Freq.	Freq %	Freq	Freq. %	Freq.	Freq. %
Environmental motivations	9	20,45%	34	39,53%	20	24,39%
Ethical motivations	22	50,00%	9	10,47%	8	9,76%
Health motivations	6	13,64%	40	46,51%	45	54,88%
Economic motivations	0	0,00%	0	0,00%	1	1,22%
All of the above	5	11,36%	1	1,16%	0	0,00%
None of the above	2	4,55%	2	2,33%	8	9,76%
Total	44	100%	86		82	100%

Table 5.4: Motivation toward a plant-based diet and dietary groups

choice to adopt plant-based diets whit a 50% of preference, while the second most preferred motivation was the one related to the environmental issues that was chosen by 20,45% of cluster 1 respondents. These outputs match with other researches' results that show how for vegans and vegetarians the ethical reason to the adoption of a plant-based diet (North et al., 2021). Looking now at the 2nd cluster populated by flexitarians, it emerged that the main motivation driver of this category was the health reason with a 46,51% of preferences, followed by the environmental one with 39,53%, and as expected, ethical motivations had a lower importance for these respondents compared to the previous category having a 10,47% of preferences against the 50% of the 1st cluster.

While the 3rd cluster, that differently from the other two, did not adopt any plant-based diet, preferred the health reasons as main potential motivation for the adoption of a plant-based diet showing a 54,88% of preferences. This category is the one that reasonably showed a lower interest into plant-based diets and therefore almost 10% of respondents said that none of the given motivations would be chosen for the adoption of a plant-based diet. The economic reason was chosen just by one individual belonging to the 3rd category. Going deeply in the understanding of motivations beneath the plant-based diet choice, there was made an analysis looking at the relation between motivations and some socio-demographic variables as gender, age and education levels. Both men and women showed a preference for the health motivation with respectively 46,05% and 41,48% of preference rate. It can be highlighted a difference in the choice toward the ethical motivation that was more common among women compared to men, with a 22,22% compared to 11,84% of men preferences. While, there's a marginal difference in the preference for the environmental reasons, in fact 27,41% of women chosen it against 32,89% of the male sample. More interesting differences could be found looking at the relation between motivations and the age variable. As the table 5.5 shows, the environmental motivations category is most recurrent among the young people of the sample below 20, with a preference of 55,56%, confirming other researches that found out young people to be more sensitive toward environmental issues compared to other generations (Heinrich Böll Stiftung, 2021). While, for this first age category, reasonably, the health motivation is not quite important, in fact just a 16,67% chose it as the main

	< 20		20 - 30		31 - 40		41 - 50		51 - 60		>60	
Motivations toward a plant-based diet	Freq.	%	Freq	%	Freq.	%	Freq.	%	Freq	%	Freq.	%
Environmental motivations	10	55,56%	36	34,29%	3	18,75%	3	13,64%	6	15,79%	5	38,46%
Ethical motivations	5	27,78%	17	16,19%	6	37,50%	5	22,73%	6	15,79%	0	0,00%
Health motivations	3	16,67%	45	42,86%	4	25,00%	9	40,91%	23	60,53%	7	53,85%
Economic motivation	0	0,00%	1	0,95%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
All of the above	0	0,00%	4	3,81%	2	12,50%	0	0,00%	0	0,00%	0	0,00%
None of the above	0	0,00%	2	1,90%	1	6,25%	5	22,73%	3	7,89%	1	7,69%
Total	18	100%	105	100%	16	100%	22	100%	38	100%	13	100%

Table 5.5: Motivations toward plant-based diets and age

driver for the adoption of a plant-based diet. The health motivations, as expected, are more important for people over 50, in fact both the category of 51 - 60 and over 60 showed a preference above the 50% for this motivations' category. However, also people in the age range of 20 - 30 seemed to give an important weight to health motivations, in fact this category is the preferred one of respondents between 20 – 30 with a preference rate of 42,86%.

While, looking at the socio-demographic variables of education, it emerged that respondents with high level of educations, such as master and PhD, showed higher preference toward the environmental motivations, with respectively 40% and 50% of preferences, confirming several researches which associate the adoption of plant-based diets and the environmental motivations pointing out the influence of high education's levels. Instead, people with high school diploma and bachelor's degree showed higher attitudes toward the health motivations, with respectively 43,44% and 44,55% of preference rates. Interestingly, people with the lowest education level, so the secondary license, showed a higher preference toward the environmental motivations, with 37,50% preferences, compared to the categories of high school license and bachelor's degree that respectively express 25,81% and 26,73% preference rates toward the environmental motivations.

Perceived barriers in the adoption of plant-based diets

The survey aimed at investigating the major perceived barriers toward the adoption of plant-based diets that could restrain people from taking a dietary shift.

Therefore, a list of 14 statements about difficulties on embracing plant-based diets was provided to respondents which had to express their agreement in a 5 option Likert Scale from "very much" to "not at all". This question investigated some drivers that are part of the Theory of Planned Behaviors, as attitudes, subjective norms and perceived behavioral control toward the adoption of plant-based diets. Some of the statements

provided were not perceived as important barriers from the respondents, such as the statements "*I don't want to eat foods considered not conventional or strange"* or "*A plant-based diet could threat my health".* Other statements that were not perceived as a barrier for many respondents were "*I don't know which plant-based food products to eat instead of meat"* and *"I don't know how to cook plant-based foods".* On the contrary, the 3 strongest perceived barriers to plant-based diets adoption seemed to be related to subjective norms and perceived behavioral control. These statements regarded the lack of willpower toward the adoption of plant-based diets, the perceived lack of family desire to alter their current diet, and the perceived lack of control in the choice of which type of food to eat. Another perceived barrier, even if not in the top three, concerns the lack of information about plant-based diets. Then, at the statement *"I don't have enough willpower to adopt a plant-based diet",* 23 respondents answered "very much" while 64 selected "somewhat". Looking at the table 5.6, as expected, respondents belonging to the 3rd cluster perceived a higher lack

	Diet 1		Diet 2		Diet 3	
I don't have enough willpower to adopt a plant-based diet	Freq.	%	Freq.	%	Freq.	%
Very much	2	4,55%	5	5,81%	16	19,51%
Somewhat	5	11,36%	31	36,05%	28	34,15%
Neutral	3	6,82%	8	9,30%	15	18,29%
Not Really	10	22,73%	25	29,07%	16	19,51%
Not at all	24	54,55%	17	19,77%	7	8,54%

Table 5.6: The perception of willpower as a barrier in plant-based diets adoption and diet's clusters

of willpower, with 19,51% and 34,15% respondents of this category that responded "very much" and "somewhat", to adopt a plant-based diet compared to the other two clusters. Instead, those who were in the 1st diet's cluster had a significant lower perception of willpower as a barrier. While 36,05% of flexitarian responded "somewhat", maybe because of the perceived lack of willpower to adopt a completely free-meat diet as vegetarian and vegan diets are.

While, another statement perceived as a strong barrier in the adoption of a plant-based diet regarded the social sphere and more specifically subjective norms, the statement was *"My family would not adopt a plant-based diet".* This barrier highlights the importance that respondents gave to their relatives and how they think dietary

patterns of relatives could affect their own one. In terms of frequency, 29 individuals responded “very much” while 46 chose “somewhat”. It did not emerge any particular differences in this response with regard to some socio-demographic variables, as for example differences between men and women, while looking at the age categories, young people below 20 expressed a higher perception of this barrier compared to the other age categories, showing a 11,11% and 33,33% of responses of respectively “very much” and “somewhat. As for the previous perceived barrier analyzed, reasonably, there were differences in perception among the three different diet’s clusters where the 1st has perceived as less impeding the statement about the adoption of a plant-based diet from their own relatives.

The third strongest barrier perceived was about the perceived behavioral control and the statemen was “*Someone else in my family determines food products that I eat*”. In relation to the age variable, it emerged that young individuals below 20 perceived a higher impediment toward the adoption of a plant-based diet considering they would not directly control they food choices. Then, as the table 5.7 shows, the 16,67% of the under 20 category stated it would be very much difficult to adopt a plant-based diet due to the fact they do not choose most of what they eat, and the 33,33% declared it to be somewhat difficult. This trend changed a bit moving to the next age range of 20 – 30 that perceived a lower barrier compared to the previous category. While, 42,11% of individuals belonging to the 51 – 60 category stated they would de somewhat favor to adopt a plant-based diet considering they do not determine food products they eat.

	< 20		20 - 30		31 - 40		41 - 50		51 - 60		>60	
Someone else in my family determines food products that I eat	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Very much	3	16,67%	9	8,57%	1	6,25%	3	13,64%	0	0,00%	1	7,69%
Somewhat	6	33,33%	20	19,05%	4	25,00%	4	18,18%	16	42,11%	3	23,08%
Neutral	0	0,00%	14	13,33%	1	6,25%	4	18,18%	4	10,53%	0	0,00%
Not Really	6	33,33%	33	31,43%	3	18,75%	3	13,64%	10	26,32%	3	23,08%
Not at all	3	16,67%	29	27,62%	7	43,75%	8	36,36%	8	21,05%	6	46,15%

Table 5.7: The perceived barrier of lack of food choice control and the age variable

Consumers' opinions toward Plant-based Meat

The last section of the survey has been dedicated to investigating attitudes, intentions and opinions toward plant-based meat, making also some comparisons with animal-based meat. In the analysis it has been looked at how the attitude toward plant-based meat is driven by the type of dietary habits and socio-demographic variables.

From the analysis emerged that 84 of the 130 individuals that arrived at this last part of the survey, did already know what plant-based meat is. Specifically, the 75% of individuals of the 1st cluster did know what plant-meat is, while just the 25,61% of respondents belonging to the 3rd cluster did know about it, and in the 2nd cluster the 34,88% did. Five questions investigated opinions toward plant-based meat compared to traditional meat, and more specifically they made comparisons on the environmental impact, naturalness, palatability, ethics and nutritional properties of the two products' category in order to understand the respondents' attitude toward plant-based meat. Respondents, then, had to express their opinion, on a 5 options Likert scale from "strongly agree" to "strongly disagree", of the perceived environmental impact of plant-based meat compared to traditional meat products. As expected, the opinions of vegans, vegetarian and pescatarians belonging to the first diet's group were more in favor of plant-based meat judging this product more favorably than traditional meat in almost every of the domains shown in the table 5.8. Opinions toward plant-based meat of the 2nd diet category composed by flexitarians, showed similar attitudes, a bit lower in positive evaluation than the 1st group, while omnivores respondents of the 3rd group were more skeptical on the properties of plant-based meat compared to traditional meat. The plant-based meat feature perceived as the most outstanding compared to meat was the ethics, so plant-based meat products were perceived to be very much more ethical products than animal-based meat. While, the palatability feature and the nutrients properties were the domain in which plant-based meat scored a lower evaluation than traditional meat. Among flexitarians, plant-based meat was perceived to be more respectful of the environment and more ethical than traditional meat, while their opinion scored lower in the domains of palatability, nutritional properties and naturalness of the product. Looking at the 3rd dietary group, individuals seemed to better evaluate meat in

palatability and were quite unsure about the nutritional properties and naturalness of plant-based meat.

	Diet 1		Diet 2		Diet 3	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
How environmentally respectfull do you think Plant-based meat is compared to traditional meat?	4,64	0,57	4,17	0,67	3,89	0,73
How natural do you think Plant-based meat is compared to traditional meat?	3,9	0,95	3,6	0,96	3,02	0,98
How tasty do you think Plant-based meat is compared to traditional meat?	3,45	1,1	2,96	0,87	2,24	0,98
How ethical do you think Plant-based meat is compared to traditional meat?	4,78	0,41	4,29	0,83	3,97	0,83
How nutrient do you think Plant-based meat is compared to traditional meat?	3,83	0,91	3,25	0,74	2,78	0,67

Table 5.8: Mean opinions on Plant-based meat compared to traditional meat. (1 much less - 5 much more)

Looking at the perception of the environmental impact of Plant-based meat, it was perceived to be much more respectful of the environment by many young respondents below 20 years (50,00%), but also among other age range as 31-40 (72,73%). As expected, elder people over 60 had a different opinion toward the environmental impact of plant-based meat compared to traditional meat and just the 20% stated that plant-based meat is for sure less impactful, while 40% stated that it maybe is less environmental impactful. Interestingly, just the 36,73% of participants belonging to the age range of 20-30 stated that plant-based meat is for sure less impacting on the environment compared to meat and the 47,83% preferred to state that it maybe is less environmental impacting than meat. However, not any participant of the sample stated that plant-based is never less environmental impactful than meat. Therefore, looking at how level of education impacts the opinion toward the respect of the environment of plant-based meat (Table 5.9), it has been interestingly found out that respondents with the lowest level of education showed the highest frequency of responses on the agreement that plant-based meat is less impacting than meat. While participants with the highest level of education showed the lowest percentage of frequency on “strongly agree” compared to other categories. It is quite interesting because many studies relate the awareness of the environmental impact of the meat

industry to education levels, stating that the higher it is the more the awareness on this issue.

	Secondary License	High school Diploma	Bachelor Degree	Master	PhD	Total
Respect of the environment	% Freq.	% Freq.	% Freq.	% Freq.	% Freq.	% Freq.
Strongly agree	66,67%	38,89%	37,50%	52,94%	16,67%	40,31%
Partially agree	16,67%	41,67%	50,00%	47,06%	66,67%	46,51%
Not sure	16,67%	19,44%	9,38%	0,00%	16,67%	11,63%
Partially disagree	0,00%	0,00%	3,13%	0,00%	0,00%	1,55%
Strongly disagree	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%

Table 5.9: Opinions on Plant-based respect of the environment compared to meat and education level ("strongly agree" much more – "strongly disagree" much less)

Looking at opinions on naturalness of Plant-based meat, respondents among the age range of 41 – 50 showed the highest percentage on evaluating this product as much more natural than traditional meat (38,46%), while among young generations of respondents belonging to the category of under 20 and 20 – 30, just the 12,50% and 15,94% judged plant-based meat as more natural than traditional meat. However, in this category, as in the one regarding palatability, the percentage of participants who answered they were not sure about plant-based meat to be better or not than traditional meat was quite relevant. Moreover, the socio-demographic variable of gender did not show significant results on affecting attitudes toward Plant-based meat.

Plant-based meat attitudes and consumers target

One of the aims of this research was to deepen investigate the intention toward Plant-based meat adoption of the participants, mostly looking at their dietary patterns. Therefore, in the section of the survey dedicated to plant-based meat there was a multiple-choice question asking if respondents would consider consuming plant-based meat on a regularly basis. In order to make the output analysis, this question has been associated with diet's categories. Thus, as shown by the table 5.10, the diet category with the highest percentage of people that definitely would introduce plant-based meat is the 1st one (33,33%), which is higher than the percentage of flexitarian people that would do so (21,57%). Many flexitarians (41,18%), instead, preferred to state that they would probably introduce plant-based meat in their diet. The intention of adoption falls if considering the 3rd dietary group of omnivores where just the 5,56% of respondents would for sure introduce plant-based meat, while the great majority of them preferred to state that it's not sure about it (41,67%).

	Diet 1	Diet 2	Diet 3
Intentions toward regular consumption of Plant-based meat	% Freq.	% Freq.	% Freq.
Absolutely yes	33,33%	21,57%	5,56%
Maybe yes	38,10%	41,18%	30,56%
Not sure	16,67%	29,41%	41,67%
Maybe not	11,90%	7,84%	19,44%
Absolutely not	0,00%	0,00%	2,78%

Table 5.10: Intentions toward the regular consumption of Plant-based meat and dietary groups

Moreover, considering the average animal meat consumption of respondents, among people who eat meat 3 – 4 times in a week, 20% declared they would consume plant-based meat for sure. And those which the meat consumption is around 1 - 2 times in a month and 1 – 2 times in a week, were also willing to regularly introduce plant-based meat in their diet, with both categories with a 14,56% of respondents who stated they would introduce plant-based meat products in their diet for sure and respectively 38,10% and 41.07% that would probably do so. On the contrary, heavy meat eater, so those who consume meat every day or more than 5 times in a week, had a more negative approach toward the plant-based meat adoption and no one of these two categories stated it would consider to regularly eat plant-based meat, actually participants of those two groups just stated they would probably do not eat plant-based meat or that they were not sure about it. However, intentions of plant-based meat consumption changed when was asked about the willingness to substitute animal meat with plant-based meat products. In this case, among people consuming more than 3 times a week animal meat, negative response as “absolutely not” or “maybe not” were quite common, even if 30% of participants belonging to the category of meat-eating frequency of 3 – 4 times in a week stated they would probably make this switch toward plant-based meat.

It was also asked to participants if they were willing to cut off their consumption of traditional plant-based products, such as soy burgers, and substitute them with plant-based meat. This question was aimed at investigating the intentions of participant who already adopted plant-based diets or consumed plant-based products, to include plant-based meat in their dietary habits. It emerged that the 1st dietary group made by pescatarian, vegetarians and vegans was the most willing to shift toward plant-based

meat products considering that 45,24% stated they would do it for sure, while among flexitarians just the 13,73% declared it. More specifically, looking at the composition of the 1st dietary group, pescatarians were the less willing to substitute traditional plant-based meat alternatives, 27,27% of them stated they would shift toward plant-based meat for sure while 36,36% stated they would probably do it. Instead, vegans and vegetarian had higher percentage of participant whit positive intentions toward the adoption of plant-based meat, in fact the 53,33% of vegans and 50,00% of vegetarians stated they would shift toward plant-based meat. Moreover, considering the respondents average consumption of traditional plant-based meat substitutes, it has been observed that the more frequent their consumption of these products the higher the willingness to adopt plant-based meat.

While, if looking at the willingness to pay plant-based meat products compared to traditional meat, 48,5% of the whole samples stated they would pay the same price, while 34,6% would pay a little more for plant-based meat. Specifically, there were significant differences in willingness to pay between the 2nd and 3rd dietary group. In fact, 45,10% of flexitarian stated they would pay a little more for plant-based meat against the 16,67% of omnivores.

5.3.2 Results from interviews

Once the survey records have been collected, the research continued with the one-to-one interviews. Ten interviews have been run, and the individuals taking part to the study had different socio-demographic features but all of them had adopted a plant-based diet. From the interviews, many insights emerged regarding inner motivations, perceived barriers, social relationships that affected the adoption of a plant-based diet, and also food consumption habits and opinions and attitude toward plant-based meat.

The main motivations emerged from the interviews that mostly driven the choice to adopt a plant-based diet mainly regarded the ethical and personal health sphere, while just one participant mentioned the environmental one as the main driver. More in depth, individuals which stated that their choice was driven by health reasons were moved by health problems that incurred in their life, the need to enhance their

performance in sport competitions or by the willingness to adopt a healthier diet due to aging. Both the two individuals above 55 years old, stated that their main motivation to adopt a vegetarian diet was due to health reasons and that "*time was ripe to make this choice"* [Interviewee 1_CM]. Half of the interviewees mentioned the ethical motivation as the most important one, so it has been the most frequent major motivation. Animal welfare, love for animals and reject for the slaughtering processes have been mentioned during interviews. The environmental motivation was the most important one just for a participant which was 25 years old and adopted a flexitarian diet. Interestingly, the environmental issues and the impact of the meat industry on the environment have been mentioned by most of the participants, but it has always been a secondary motivation in order to reinforce the choice toward the adoption of a plant-based diet. Then, as emerged by the output of the survey, the ethical motivation was the most recurrent one among non-meat eaters, while in this questionnaire the health motivations seemed to be quite more important than appeared from the survey output.

Moreover, from the interviews emerged some common barriers that at first restrained the participants to adopt a plant-based diets. Three of them declared that when they took the decision to become vegetarians, they were teenagers and had issues on make their own family accepting this decision, so for a while they could not fully embrace their dietary choice; sentences that expressed this perceived barrier were*: "I was forced to eat the food in my dish and I could not get up from the table until I ate everything on my plate" [*Interviewee 10_CM*]* and "*I was still attending the high school and I didn't choose what to eat at home, so it was difficult to have a different diet from my family"* [Interviewee 5_MF]. On the other hand, family and affiliates seemed to be fundamental even in the adoption of a plant-based diet. In fact, five out ten of the participants declared to have been influenced by other people close to them that already had a plant-based diet. Specifically, two participants stated that they had been influenced by their partners' vegetarian and flexitarian habits, and one of them stated: *"I don't know if alone I would have arrived at this decision, for sure having by my side a person that helped me on being aware of the effects of the meat industry on the environment has been impactful"* [Interviewee6_FF]. Other participants have been influenced by close friends and one of them from her brother. Then, as also emerged

from the survey, family has a great impact on affecting the choice to embrace or not a plant-based diet, and also affiliates have an important influence in driving and determine these dietary shifts. Moreover, with respect to decisional processes occurred in order to adopt a plant-based diet, all the participant said to have elaborated this choice, but some of them said they had a sort of "revelatory moment" such as an epiphany and then decided to change their dietary pattern, as in the statement: *" One day, me and my husband should go to a Barbeque lunch, and that day we decided we would have stopped eating meat"* [Interviewee1_CM] or "*The Covid-19 pandemic made me reflect a lot, and then I decided to be vegetarian"*[Interwee4_MP], while some others gradually reached their objective in the adoption of a plant-based diet. One common feature among participants was that all of them were very proud of their choice and had no regrets. None of them stated to be likely to reintroduce meat in their diet, except for flexitarians which eat it rarely. The only reason mentioned which could persuade some of the participants to reintroduce meat in their diet would be health problems and medical advice to eat it.

From interviews emerged also different consumption patterns of traditional plant-based meat alternatives. A common opinion toward these products that emerged was about their lack of naturalness because they are industrial and processed products, so generally, interviewees were not very favorable to a daily-basis consumption of these products. Some of them, both the two participants over 55 years old but also a very young vegetarian girl of 26, stated that they almost never purchase industrial plant-based meat alternatives but prefer instead to use legume or dried soy to prepare their own fresh and healthy dishes, and that the consumption of prepared plant-based meat alternatives rarely happens due to their time convenience feature, such as in the statement *"I like to be more independent and buy raw ingredients to prepare my own dishes. However, in my fridge there are always some packed meat alternatives, as tofu, that I use in case of need because they're very fast in preparation, so every two weeks I usually eat these products"* [Interviewee4_MP], while another statement was "*At home, we don't need to use industrial packed meat alternatives. We are able to prepare tasty and very good dishes that are better than industrial products, then we prefer this fresh type of preparation"* [Interviewee8_MB]. On the other hand, some other participants stated they consume these food products several times because of

their ease in preparation and due to their nutritional features that help them for a protein intake, as in the statement "*Today there are many plant-based meat alternatives and I eat them because they are easy in preparation and I also know I need them in order to substitute an omnivore diet, but if I would not need them, I had for sure cut their consumption because they are industrial products and I prefer fresh ones"* [Interviewee5_MF]. Another critical aspect linked to plant-based products was about their taste, that sometimes has not been judged as positive and satisfying, and most of the participants declared that the price of these traditional meat alternatives is too high as in the statement "*A family of 4 people could maybe not afford the high price of these products, they cannot eat 2 burgers in a whole day. Then, these products should me more affordable and competitive on the market"* [Interviewee1_CM].

Moving then to the attitude toward plant-based meat, some different opinions, attitudes and intentions emerged about this product category. First, it should be said that three out of ten participants already tried the Plant-based meat at the time of the interview. One of them, a vegan 28-year-old male, stated that he regularly consumed plant-based meat and that since he tried it, he was enthusiastic because he found a food product that reproduce meat texture, that is what he missed the most in food plates, so he said *"More than the flavor, I care about having products with a similar texture to the one of meat. Many times, plant-based products have a lighter texture than meat, so for example, if I eat a burger with a potato patty, I appreciate it less than a burger with a plant-based meat patty because it better reproduces the texture of meat"* [Interviewee2_DP]. While another participant that tried plant-based meat was not very satisfied about its taste and texture. However, a general tendency that emerged from these interviews was that who already adopts a plant-based diet do not search for something that has the meat taste, and seven out of ten participants mentioned it in statements like "*I don't even remember the taste of meat, I just know I chose to not eat it, then I don't think I would like something that recreates its taste"* [Interviewee10_CM], or "*I have tried the Beyond Meat, but I'm not very interested into this product. For sure I would not buy it for myself at the supermarket, because I don't miss at all the taste of meat"* [Interviewee4_MP]. It emerged that, among people not interested in plant-based meat itself, those moved by ethical reasons were more skeptical about their adoption of this product, while those moved by personal health

reasons were more interested in nutritional properties of plant-based meat and stated that considering its nutritional values they could even consume it. Then, a participant belonging to the latter category stated: "*I would try plant-based meat given one condition, it should really have the nutritional properties of meat, then it would really be an interesting product"* [Interviewee1_CM]. While other individuals which care more about the ethical reasons of their choice made some statement such as this one: *"My diet is driven by the willingness to do not harm animal welfare, then a product which has the same aspect, smell and taste of meat would maybe disturb me. When I'm at the supermarket and I see these products that really resemble meat, I have a strange feeling, I am squeamish with these products"* [Interviewee5_MF]. While, the approach of a flexitarian participant was quite more positive and he stated: *"Yes, I would consider to introduce plant-based meat in my diet because it would help me on cutting back meat consumption once and for all" [Interviewee6_FF].*

5.4 Limitations of the study

This research has several limitations. First, it was not an in-field research, then actual purchases and behaviors of consumers had not been observed, but the study relied on self-reported general behaviors, attitude and intentions. This limitation is also valid for any study which imply hypothetical choices. Furthermore, this research could be limited by the self-selection bias because participants have selected themselves to be part of the survey, therefore people not very interested in these topics could have decided to do not take part of it, while people interested in it could have selected themselves generating this bias. Moreover, the sample has been generated through a snowballing-effect that could generate several limitations. Therefore, the representativeness of the sample is not guaranteed due to the fact that the researcher had few controls on the sampling method and collection of records, and also the true distribution of the population and of the sample was not controlled. Moreover, another limitation occurred and linked to the snowball sample, was that many records were collected in a specific geographical area and maybe that affected the output of the study. Other limitation of this research could arise because of the innovativeness of the plant-based meat products, therefore people who still don't know it could have problems on expressing opinions, attitudes and intentions toward it.

Conclusions

The aim of this thesis has been to investigate attitudes and opinions toward the innovative product of plant-based meat. Specifically, the objective of the research has been to understand which are the socio-demographic variables that lead people to adopt a plant-based diets understanding their motivations and perceived barrier toward the adoption of these dietary habits, and make a focus on the product category of plant-based meat understanding the perception of consumers toward it, and trying to identify potential customers target that from a business perspective should be well known by plant-based meat producers.

First, it should be said that the great majority of the sample seemed to be in favor to plant based diet and many individuals would also be favorable to substitute animal-based products with plant-based ones. Generally, as confirmed by several studies, women showed a more positive attitude toward plant-based dietary patterns while other socio-demographic variables didn't show significant differences in determining the adoption of plant-based products instead of animal-based ones.

In terms of motivations beneath the adoption of plant-based diets, the most recurrent has been the personal health one, followed by environmental and ethical reasons. Specifically, the main motivation to adopt a plant-based diet for the first dietary group has been the ethical one, while among flexitarians it has been the health reason. As expected and confirmed from both the survey and interviews, motivations changed according to the age range, in fact people over 50 gave more importance to health reasons while young participants showed major interest toward the environmental drivers, as confirmed by several studies.

With respect to perceived barriers toward the adoption of a plant-based diet, it has been interesting to found out that the most recurrent in the survey were also the most mentioned during interviews. Then, family and affiliates, seemed to have a major role in affecting the choice to adopt a plant-based diet or not, so they both have positive and negative influence toward this choice. Therefore, social relationship emerged as fundamental components in these dietary behaviors. Major barriers were identified in

a perceive lack of acceptance from the family to adopt a plant-based diet, and also the lack of control, when living with other family members, to autonomously choose which food types to consume and the dietary pattern to follow, and as expected these barriers were most perceived by young respondents. On the other hand, family members, close friends and partners had also a persuasive power and some participants of interviews stated that their relationship with a certain specific person who already adopted a plant-based diet had been fundamental in making the decision to embrace this choice. Nevertheless, another important perceived barrier toward the adoption of a plant-based diet has been the perceived lack of willingness to keep having those dietary habits and exclude some animal-based products.

When considering opinions toward plant-based meat, most of respondents judged it as quite more ethical and respectful of the environment compared to animal-based meat. However, many respondents were not sure about its nutritional properties and naturalness in its raw components, while opinions toward the palatability of plant-based meat were negative compared to traditional meat. From interviews, it emerged that the naturalness is a fundamental feature of food in general, and maybe Italian culinary culture has a role in determining this interest, thus plant-based meat, as other traditional plant-based products, was not positively judged because it is an industrial and not fresh product. Nevertheless, from interviews it emerged that palatability seemed to both be a potential advantage or disadvantage of plant-based meat. In fact, some participants stated that it could allow a total elimination of traditional meat in favor to these plant-based products, or that it could allow people that already have a plant-based diet to have meals in which they could eat something that resemble to meat in its consistency. On the other hand, some vegetarians stated that it would be strange to eat something like meat and that they would not be interested in this product because they do not miss the meat taste.

Interestingly, from the survey it emerged that people with lower education level judged plant-based meat as less impacting on the environment, if compared to traditional meat, respect to people with higher education levels as PhD. This result is in contraposition to other researches that demonstrated that the higher the education

level the higher the awareness of environmental issues and thus sustainable behavior embracement.

Even though most of participants showed their willingness to try plant-based meat, not as many stated they would consume plant-based meat regularly. Furthermore, from the survey results and differently than many other studies, people which already adopted a plant-based diet have quite more positive attitudes and intentions toward plant-based meat compared to flexitarians and omnivores. While, considering this latter group, people with a high frequency of meat consumption showed almost no interest in the innovative product of plant-based meat, and those who had a rarer meat consumption seemed to be more interested in it. Moreover, a significant percentage of people whose meat consumption was rare, stated they maybe would be willing to substitute traditional meat with plant-based meat. Looking at the results of the interviews, different attitudes and intention emerged among participants who already adopted a plant-based diet. Most of those moved by ethical reasons toward these dietary patterns, declared to be not interested in plant-based products because of its strict resemblance with traditional meat, while some others which main motivation were linked to personal health were very interested into nutritional properties of plant-based meat and stated that they could consider its adoption in case its nutritional values would be the same as traditional meat. Moreover, from interviews it emerged the problem for some people who already adopt plant-based diet to find a food type that could have the same function meat has into dishes in term of texture, and that plant-based meat could be the solution for this issue.

In conclusion, today consumers seem to be quite aware of the impact of the meat industry on the environment, personal health and animal welfare. Therefore, many people seem to be in favor to adopt plant-based diet and reduce their meat consumption, but it seems they are not fully ready to abandon meat consumption adopting an innovative product as plant-based meat is. Also, among vegan and vegetarians there are significant differences in the attitudes and intentions toward plant-based meat. It should also be said that plant-based meat is just arrived at the mass market, so it would maybe take some time for consumers to accept its novelty

and recognize its function. Hopefully, in the next years more versions of these product will be introduced and the awareness of consumers toward the negative impacts of meat industry would rise giving more motivations toward its consumption abandonment.

6. Appendices

Appendix A: Questions track for survey

1. Sesso: Uomo ; Donna; Altro.

2. Età: <20; 20-30; 31-40; 41-50; 51-60; >60.

3 Livello di Istruzione: Licenza Media; Diploma Superiore; Laurea; Master; PhD.

4. Occupazione: Impiegato amministrativo; Operaio; Libero professionista; Studente; Disoccupato; altro.

5. Residenza: Città; Paese montano; Paese marittimo; Campagna.

6. Provincia di residenza:

[Definizione dieta a base vegetale: Una dieta a base vegetale è un regime alimentare caratterizzato dal consumo di prodotti vegetali freschi e poco processati, e una ridotta assunzione di prodotti di origine animale. Una dieta a base vegetale non è necessariamente di tipo vegetariana o vegana.]

7. La dieta che segui normalmente è a base vegetale? : Sì; No.

8. Credi in futuro adotterai una dieta a base vegetale? : Sì; No; Lo faccio già; Sto valutando.

9. In quale di queste tipologie di diete ti identifichi?
- Onnivora
- Flexitariana (dieta onnivora che riduce il consumo di carne)
- Pescetariana (dieta vegetariana che comprende il consumo di pesce)
- Vegetariana
- Vegana

10. Quali sono i motivi per cui adotteresti una dieta a base vegetale?
- Motivi Etici
- Motivi ambientali
- Motivi di salute
- Motivi economici
- Nessuno dei precedenti
- Altro: specificare

11. Con che frequenza consumi questi cibi?
(Frutta; Verdura; Frutta secca e semi; Legumi; Pane; Cereali (ex. Pasta, Riso); Pesce; Carne Rossa; Carne Bianca; Uova; Latte e latticini)
[Mai; 1-2 v. al mese- 1-2 v. a sett.; 3-4 v. a sett.; 5-6 v. a sett.; Ogni giorno; Più volte al giorno]

12. Alcune persone credono che una dieta a base vegetale presenti alcune difficoltà. Tra queste, quali afefrmazioni condividi? "Adottare una dieta a base vegetale sarebbe per me complicato perchè…."
[Moltissimo; Abbastanza; Non saprei; Poco; Per niente]

- Mi servono più informazioni riguardo questi tipi di dieta
- Non voglio cambiare le mie abitudini alimentari
- La mia famiglia non adotterebbe una dieta a base vegetale
- Non c'è abbastanza scelta di cibi a base vegetale quando mangio fuori
- Non ho abbastanza forza di volontà per adottare una dieta a base vegetale
- Qualcun altro nella mia famiglia determina la maggior parte dei cibi che consumo
- Sarebbe troppo costoso
- Non voglio consumare cibi non convenzionali o considerati strani
- Non ci sono abbastanza proteine in questi tipi di dieta
- Non mi sazierebbe abbastanza
- Causerebbe problemi alla mia salute
- Non saprei come preparare cibi a base vegetale
- Non sarebbe una dieta abbastanza saporita
- Non saprei quali cibi mangiare al posto della carne
- L'uomo ha bisogno della carne nella propria dieta

13. Alcune persone credono che una dieta a base vegetale presenti alcuni benefici. Tra queste, quali affermazioni condividi? "Adottare una dieta a base vegetale sarebbe per me utile perchè…."
[Moltissimo; Abbastanza; Non saprei; Poco; Per niente]

- Mi aiuterebbe a ridurre l'assunzione di grassi
- Aumenterei l'assunzione di fibre, vitamine e minerali
- Mi aiuterebbe a prevenire alcuni tipi di malattie (diabete, cancro, malattie cardiovascolari)
- Avrei una dieta più sana
- Mangerei una maggior varietà di cibi
- Avrei una miglior qualità di vita
- Avrei più energie
- Avrei una dieta saporita
- Sarei più soddisfatto del mio regime alimentare
- Aiuterebbe l'ambiente
- Migliorerebbe in benessere degli animali
- Ridurrebbe la fame nel mondo

- renderebbe la mia dieta più efficiente in termini di quantità di cibo prodotto
- Sarebbe economicamente vantaggiosa
- Mi aiuterebbe a risparmiare tempo
- Mi renderebbe più "cool" tra i miei amici

14. Saresti disposto a sostituire prodotti di origine animale con prodotti di origine vegetale?
[Sì; No]

Sezione dedicata a chi non è disposto a sostituire prodotti di origine animale con prodotti di origine vegetale:

15. Per quale motivo? [Risposta aperta]

16. Negli ultimi anni sono stati commercializzati nuovi prodotti vegetali alternativi alla carne. Esempi di questi sono burger vegetali, salsicce vegetali, straccetti e nuggets vegetali.
Hai mai provato alcuni di questi prodotti?
[Sì; No; Non ricordo]

17. Quali caratteristiche dovrebbero avere i prodotti vegetali sostitutivi della carne perché tu possa considerarne il loro consumo nella tua dieta?
[Risposta aperta]

Fine sezione

18. Con che frequenza consumi prodotti vegetali sostitutivi della carne?
[1-2 volte al mese, 1-2 volte a settimana, 3-4 volte a settimana, 5+ v. a sett.]

19. Ti ha soddisfatto il sapore dei prodotti vegetali sostitutivi della carne che hai provato?
[Moltissimo; Abbastanza; Non saprei; Poco; Per niente]

20. Quanto sei d'accordo sul fatto che tali prodotti vegetali sostitutivi della carne abbiano le seguenti proprietà?
[Moltissimo; Abbastanza; Non saprei; Poco; Per niente]

- Rispettosi del benessere degli animali
- Naturali
- Sani
- Nutrienti
- Gustosi
- Rispettosi dell'ambiente
- Buona consistenza

[Definizione: La plant-based meat è un prodotto interamente vegetale il cui scopo è riprodurre al meglio l'aspetto, la consistenza e il gusto della carne animale; in questo questionario con il termine "carne vegetale" si farà riferimento alla Plant-based meat]

21. Conosci già la carne vegetale?
[Si; No; Non Ricordo]

22. Saresti favorevole a provare la carne vegetale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

23. Credi la carne vegetale sia un prodotto più rispettoso dell'ambiente rispetto alla carne animale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

24. Credi la carne vegetale sia un prodotto più naturale rispetto alla carne animale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

25. Credi la carne vegetale sia un prodotto più gustoso rispetto alla carne animale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

26. Credi la carne vegetale sia un prodotto più etico rispetto alla carne animale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]
27. Credi la carne vegetale sia un prodotto più etico rispetto alla carne animale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

28. Credi la carne vegetale sia un prodotto più nutriente rispetto alla carne animale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

29. Quanto saresti disposto a pagare la carne vegetale rispetto alla carne animale?
[Molto di più; Poco di più; Nè più nè meno; Poco di meno; Molto meno]

30. Consumeresti regolarmente carne vegetale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

31. Saresti disposto a sostituire la carne animale con la carne vegetale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

32. Saresti disposto a sostituire i prodotti vegetali ad alto contenuto proteico (ex. burger di soia) con la carne vegetale?
[Assolutamente sì; Probabilmente sì; Non saprei; probabilmente no; Assolutamente no]

Appendix B: Questions track for interviews

1. Età

2. Livello d'istruzione

3. Occupazione

4. In quale tipologia di dieta ti identifichi?

5. Da quanto tempo adotti questa dieta?

6. Qual è stato il motivo principale che ti ha spinto ad adottare questa dieta?

7. Qual è il tuo consumo medio di carne mensile? (solo per flexitariani)

8. Credi la tua dieta cambierà nel futuro prossimo?

9. Sei una persona a cui piace provare nuovi cibi o che preferisce consumare principalmente cibi già noti e familiari?

10. Consumi prodotti a base vegetale sostitutivi della carne?

1.1 Con che frequenza?

12. Quali credi siano i maggior benefici relativi ai prodotti a base vegetale sostitutivi della carne?

13. Quali caratteristiche miglioreresti dei prodotti a base vegetale sostitutivi della carne?

14. Saresti favorevole a provare la carne vegetale?

15. Consideri la possibilità di inserire la carne vegetale nella tua dieta?

16. Quali caratteristiche della carne vegetale

17. Quali caratteristiche della carne vegetale non ti convincono?

18. Quanto dovrebbe costare la carne vegetale rispetto al prezzo della carne?

19. Quanto dovrebbe costare la carne vegetale rispetto ad altri prodotti vegetali sostitutivi della carne?

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