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FoodTech: a new solution to make the food sector more sustainable by combining tradition and innovation.

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*A chi ha sempre creduto in me,
a mamma e papà.*

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Introduction

The following thesis deals with the analysis and explanation of FoodTech as an innovative system that has supported the food sector in order to increase its sustainability, since 2016. Through the presence of this ecosystem, it is possible to reduce the impact that our diets have on the environment and on the health of the entire population.

The aim of the project relates to the desire to increase human awareness that every action taken today will lead to future consequences. It is precisely on the basis of this concept that we must try to adopt corrective policies from the very first moment in order to limit the negative impact that companies and our habits have on the ecosystem. Today, trying to respond to the constant environmental and social challenges is no longer forward-looking, but it is something that has become urgent as well as indispensable.

This thesis develops over three chapters. A path that leads, from the identification of environmental problems and those arising from the increase in population that we will face in 2050, to the presentation of innovative and technological solutions to be combined and introduced in the more traditional sectors, without however destroying their values.

The work of writing the report was organised as follows.

The first chapter consists of a careful analysis of the 2020 environmental problems that we are facing in the present day. These include the phenomenon of drought, the rise in temperatures, the emission of greenhouse gases and the exploitation of exhaustible and non-renewable resources. After having taken stock of the negative consequences of many years of wrong choices, the 2030 Agenda presented by the UN and its SDGs is analysed. The 2030 Agenda was created with the aim of defining a plan of action for people, for the planet and for prosperity. Signed in 2015 by 193 United Nations countries, among them Italy, it aims to ensure a better present and future for the Earth and for its inhabitants by defining 17 Sustainable Development Goals - SDGs.

For the first time ever, a clear judgement is made on the unsustainability of the current development model, not only from an environmental perspective, but also from an

economic and social one, thus definitively abolishing the idea that sustainability is only an ecological issue, through a focus on reducing the problems connected with malnutrition. The last part of this chapter presents the problems concerning population growth and insufficient food supplies that we will face in 2050. This will require variations in food regimes and eating habits, which over the years have changed considerably. As predicted by demographers, the population will most likely be close to 9.8 billion in 2050, even if this growth rate slows down compared to current standards. While we might be faced in the future with a problem of food shortages due to a population that is too numerous in relation to the food available, today the rate of malnutrition in underdeveloped countries is still increasing as a result of inefficient distribution.

On the basis of the above, the second chapter of this thesis is characterised by the identification of a solution to the problems previously outlined. FoodTech in fact is a system that integrates the technology with the existing systems of food production, consumption and distribution, thus increasing the efficiency of activities and ensuring a greater sustainability. Beginning with an analysis of the food regimes that have evolved throughout history, one will then go on to analyse how today's system based on intensive agriculture and livestock breeding, has been found to be the main source of air pollution. Technological innovation and changes are therefore essential to ensure the advancement of the food sector and at the same time the satisfaction of the needs of final consumers, who demand healthier, more genuine products, with greater ease of finding and more support in making their decisions, thanks also to the role of food/lifestyle coaches. The six ecosystems of FoodTech are Foodservice, Delivery, Coaching, Retail, Agtech and Foodscience.

The third and final chapter is mainly focused on two of the six systems listed above. Through an analysis of different case studies, the Agtech and Foodscience ecosystems, also known as Next Gen Food & Drinks, will be examined in detail. The research has been carried out with the support of interviews with the founders of the startups considered and followed by a desk analysis. It has also been possible to identify common factors among companies, in order to analyse different aspects of innovative projects with the same critical eye.

The first part of the chapter focuses on the introduction of Agriculture 4.0, through the

explanation of how new technologies have been introduced directly into the fields of cultivation. This has been done with the aim of supporting work that until a few years ago relied directly on the farmer's manual labour and on weather forecasting.

Today, however, thanks to the use of Precision Farming and the Internet of Farming, there is an automated process that makes it easier to reduce the impact this sector has on the environment. Through a more targeted and efficient use of resources, the use of water for the irrigation process and the land area under cultivation can be reduced.

If we can say that with Precision Farming one has an innovative procedure through the introduction of agronomic software that allows the management of the field, then with the Internet of Farming one obtains a more integrated and interconnected analysis of data relating to the whole farm previously obtained from specific analysed agricultural areas.

Technological innovation does not only concern land control but also the introduction of new cultivation methods. On this basis, three different realities from different parts of Italy have been analysed in order to better understand the applicability of these technologies by means of vertical and aeroponic cultivation.

The startups analysed are: ONO Exponential Farming, Agricooltur, Dashfrm.

Finally, the second part of the chapter is focused on the Next Gen Food & Drinks ecosystem, with an overview of the impacts that the livestock sector has on the environment.

According to recent statistics, it has been noted that the emission of gases originating from animals is the main contributor to rising temperatures. For this reason, it is imperative to create alternative foodstuffs based on proteins reproduced in the laboratory in order to prevent further deterioration of the environmental situation. Meat consumption has been on the increase over the years, both because of wrong diets and lack of health consciousness. Thanks to the introduction of new technology, it is now possible to replicate animal tissues and fibres in the laboratory in order to subsequently turn them into ready-to-eat steaks or burgers.

Also in this context, two startups have been brought in as examples, one in the cultured meat sector, through Juicy Marbles and their extrusion technique and the other in the fish sector through the 3D printing of salmon proposed by Revo Foods.

The appendix contains the interview sheets of the companies questioned.

“The true worst-case scenario might be one where
we don’t venture out from our safe harbors of
knowledge to explore the more treacherous shores
of uncertainty”

- Dr Gavin Schmidt, Director of the NASA Goddard Institute for Space Studies.

Chapter I

Environmental and food evolution from 2020 to 2050

1.1 Introduction

Until a few years ago it was believed that global warming was characterised only by the rise of temperatures, the melting of polar ice and the rise of sea levels in the long term.

Today we know the phenomena to be different.

In fact it turned out to be even more complex, more dangerous and even closer to us than what we believed before. There are many signs that can be associated to the climate change and we can already measure and this data represented in thousands of articles in the most prestigious international scientific journals, later summarized in the Intergovernmental Panel on Climate Change (IPCC)¹ volumes.

Thanks to many studies, nowadays we have lots of information about climate change: we have understood that the planet is going to rise in temperature and this will continue to increase over the next few decades because of human activities – in particular the burning of carbon, gas and oil. Extreme events such as floods, dryness, heat waves are constantly increasing in different parts of the world jeopardizing the idea of stability, causing economic losses and communities that have been devastated by natural disasters.

This increase in temperature is due to the continuous growth and concentration of greenhouse gas emissions such as carbon dioxide (or CO₂), methane and nitrous oxide. This combined with alter the temperature variation more rapidly than has ever occurred over the last thousands years.

Those climate changes have always affected the Earth but if until some century ago they were slow and due to natural disasters, today humans are the only ones responsible for it.

¹ The IPCC is the United Nation body responsible for the assessing of science related to climate change. It provides also analysis on its impact and future risk and options for adaptation and mitigation.

The planet will be more and more crowded and its inhabitants will be concentrated in cities. By 2050, the world's population will reach 9.8 billion people and we will be facing growing demographic, economic and climate challenges that will inevitably have to be addressed quickly in order to prevent an irreversible situation.

Technological development will lead to the production of more income, but inequalities and sustainability will have to be taken into account. The result will be a world with a very different economic balance compared to the current one, with China and India at the top of the list of the most developed countries. However, these changes in per capita income will have a negative impact on the food demand, which will increase too much in relation to the food supply, creating problems of food shortages. In order to curb the problem it will therefore be necessary to develop new green technologies to ensure that global growth in terms of food and environment is sustainable.

1.2 Environmental current situation in the world

The fundamental challenge of this century is to preserve and ensure a world development able to balance social, economic and environmental aspects.

The expectations of citizens to live in a healthy environment must not be disregarded and this will require renewed attention to the implementation of EU and national policies.

In the light of the above, it doesn't mean just doing more but it also means acting differently.

In fact, over the next decade we will need very different responses to the world's climate and environmental challenges than the ones we have had over the last forty years.

The message of urgency cannot be overstated. As we can learn from the last report of the European Environmental Agency *"In the last 18 months alone, major global scientific reports from the IPCC, IPBES, IRP and UN Environment have been published, all carrying similar messages: current trajectories are fundamentally unsustainable; these trajectories are interconnected and linked to our main systems of production and consumption; and time is running out to come up with credible responses to bend the trend."*²

² BRUYNINCKX H. , *The European environment — state and outlook 2020. Executive Summary*, European Environment Agency, Copenhagen, 2019, p. 3.

Now the focus must be on strengthening, accelerating, rationalising and implementing the many solutions and innovations already existing – both technological and social – trying to stimulate additional research and development activities, catalysing behavioural changes and, a fundamental aspect, starting to consider and commit citizens.

This decade has been fundamental in determining Europe's opportunities in the 21st century and 2020 represents a crucial turning point for Europe.

Although EU climate and environmental policies have brought substantial benefits in recent years, Europe faces persistent problems in areas such as biodiversity loss, the use of resources, the impact of climate change and environmental risks to health and well-being.

Major global trends such as demographic change, intensify many environmental challenges while rapid technological change brings new risks and uncertainties.

Since 1950 the global population has tripled to 7.5 billion and the number of people living in cities has quadrupled to over 4 billion; economic production has increased by 12 times, combined with similar growth in the use of nitrogen, phosphorus and potassium-based fertilisers with the use of primary energy that has increased five times. On the basis of the latest trends and analyses carried out, it is estimated that the world population will grow by about a third to reach 9.8 billion by 2050 and the exploitation of resources could double by 2060, with an increase in water demand of 55% by 2050 and an increase in energy demand of 30% by 2040.³

Although this great acceleration has undoubtedly brought important benefits, such as for example alleviating suffering and improving prosperity in many parts of the world, the Earth is experiencing an exceptionally rapid loss of biodiversity and the number of species in danger of extinction is now the highest in the history of humanity.

We are therefore facing the sixth mass extinction.

In a direct or indirect way, these pressures are enormously damaging not only for the environment but also human health and well-being.

³ BRUYNINCKX H., quote, p. 6

The incidence of the morbidity and mortality rate related to environmental pollution is already three times higher than the one of AIDS, tuberculosis and malaria combined.

Prolonging the great acceleration of that phenomenon could create even greater threats if pressures trigger the collapse of ecosystems such as the Arctic, coral reefs and the Amazon forest. These kind of sudden and irreversible changes can seriously jeopardise nature's ability to provide essential services such as food and resources, the maintenance of clean water and fertile soil and the protection against natural disasters.

Those events are all the consequence of weather changes caused by the continuous rise of temperatures.

As outlined in the recent National Climate Assessment of the United States, we will move towards a continuous evolution of the climate that will get progressively worse over the years.

In accordance with the latest World Health Organisation (WHO)⁴ statistics, around 95% of the EU's urban society is exposed to higher concentrations of polluting dust on a daily basis, resulting in around half a million premature deaths each year. Therefore, it is essential for us to understand and try to foresee the small and large scale implications of air, soil and biodiversity change.

One of the main aspects that must be taken into account before defining policies in order to improve the environment and to reduce the pollution level, is the preservation of biodiversity because it is essential for our survival.

In fact, even if it has a separate value compared with other monetary aspects, biodiversity is also the basis of our economy, safety, health and well-being, since it provides clean air and water, food and the raw materials needed for production processes.

It is also important to keep in mind that the continuous and regular decisions taken on how to produce and use food or the use of water and natural resources affect the availability of ecosystem services for the society.

⁴ World Health Organisation, *"Over half a million premature deaths annually in the European Region attributable to household and ambient air pollution"*, 2018

One of the most successful aspects for the mitigation and the adaptation to climate changes is the one of working through activities linked to nature to manage and to restore ecosystems.

Recent research has found that the restoration of natural ecosystems associated with an increase of these due to the restoration of 30% of land previously converted to agriculture, would decrease by more than 70% the risk of the expected extinctions of mammals, birds and amphibians.⁵

This type of nature conservation-based solutions presented before would be particularly effective in helping the mitigation and the adaptation of climate change itself.

Considering the environmental aspects and conditions of biodiversity we can define that not all soil is the same all over the Earth, hence why different ecosystems respond differently to problems.

For example, the Arctic is one of the most climate-sensitive regions, since the average temperatures are rising by about twice the overall global reference rate.

This unusual phenomenon is leading to radical changes in the landscape, generating the melting of permafrost and a greater capacity of the ocean to absorb solar energy provoking the rise of global temperatures. Arctic sea ice is in fact is crucial in balancing the Earth's climate and its decline is one of the major variables considered as the cause of extreme cold in North America and Europe.

This anomaly of conversion from glacial areas to marine areas also allows greater man accessibility to oil wells located in new places on the Earth, going to increase its extraction and resulting in other problems linked to those previously mentioned. According to the Climate and Clean Air Coalition⁶, black carbon, tropospheric ozone and methane are among the major heating agents and they are responsible for 45% of all global warming caused so far.

⁵ United Nation Environment Programme WCMC, *"Tackling climate change and biodiversity loss together"*, 2020

⁶ The Climate and Clean Air Coalition is a voluntary partnership of governments, scientific institutions, businesses, intergovernmental organizations committed together to improve air quality and protect the climate situation through specific actions.

The deposit of black carbon on glaciers leads to an acceleration of heating and melting in the Arctic, while for many urban areas the problem is triggered by the so-called "heat islands". They heat the atmosphere in a non-uniform way and cause rapid changes in wind patterns, changes in cloud formation and large-scale precipitation.

Based on the theory that climate and its negative externalities are a set of interlinked variables, we can agree on how an evolution of these has enormous effects on the decline of food stocks, on the creation of new tensions between communities, on the opening of new maritime routes and on the development of natural resources.

As for forest areas, we can see that they cover about 30% of the total earth surface and they play an important role in stabilizing the rise in temperature by sequestering and storing carbon. The increase of deforestation in the tropics is therefore a critical problem because it is necessary to sustain livelihoods and support biodiversity.

Therefore, it can be seen that the combustion of fossil fuels, is absolutely linked to this phenomenon and according to an assessment of The Intergovernmental Panel on Climate Change⁷ Tropical deforestation is responsible for about 10% of global greenhouse gas emissions.

However, alongside the deforestation caused by man the current events are causing enormous and significant drought problems leading to the frequent occurrence of fires.

Based on the studies carried out in recent years, we can see that about one-third of these forests have disappeared, either because converted into agricultural land or because intended for other uses.

Tropical countries are the main victims of deforestation, both because they are economically viable for the exploitation of the human resources present and because of the fertility and the quality of the soil. They are in fact the main producers and exporters of raw materials such as palm oil, soya and beef used by most of the world's food industries.

However, numerous international initiatives have sprung up in recent years as a response to safeguard the land with the creation of a group of 180 nations, companies, indigenous groups and other organisations committed to halving the global loss of natural forests by 2030.

⁷ World Economic Forum, "SDGs 15- Life on Land" – Deforestation and climate change

Therefore, most of the actions taken consequently reduce air pollution also.

The European Environment Agency's 2020 Report (EEA) has described Europe's environmental outlook for the coming decades as bleak. The next ten years will be crucial in tackling climate change and trying to embank biodiversity loss.

The success will require coordinated global interventions and actions that address both problems in an integrated way, increasing the use of nature-based solutions.

Indeed, our continent is suffering from increasingly intensive farming, perennial damage to biodiversity associated with a decline in wildlife. Choosing better daily habits would make it possible to minimise soil degradation and make it sustainable again by maximising its resources.

Agricultural land is used for the cultivation of temporary annual or continuous crops over the years and may include areas periodically left fallow or used as animal feed. The transformation that has taken place in recent decades, from natural land to land used in agriculture, continues to be one of the main reasons for the loss of biodiversity and soil degradation.

As quoted by the Food and Agriculture Organization of the United Nations (FAO)⁸, the land area is composed of approximately five billion hectares devoted to agriculture (1/3) and livestock farming (2/3), comparable to 38% of the Earth's total surface.

If we look at the area allocated exclusively to agriculture, we can see that 10% is used by permanent planting systems, such as fruit and vegetables, palm oil or the major raw materials required by the food sector.

This increase in planted land is the result of an explosive rise in global demography that shows no sign of ending. Between 1961 and 2016, growth doubled, with negative implications for food demand. The strain on the Earth, which is a finite resource, has consequently increased.

The World Bank has on several occasions sounded the alarm regarding the food emergency because if temperatures were to rise, even by just 2°C, there would be a reduction in productivity, for example of soya by 30-70% in Brazil and 50% of wheat in Brazil, Central America and the Caribbean.

⁸ Food and Agriculture Organization of the United Nation, *"Land use in agriculture by the number"*, 2020

Moreover, the net potential of the land is currently exploited by about a quarter to a third to meet primary needs for food, feed, fibre, timber and energy, providing also the basis for many other ecosystem functions and services essential to humanity.

Another resource that is bound to run out with population growth and rising temperatures is water.

In other words, to meet the world's need for food and the demand for water used for irrigation, provoke a continuing need for access to this irreversible source.

The agricultural sector is responsible for about 70% of the global water withdrawal, even reaching about 90% in intensively farmed countries⁹.

This situation implies immediate action in order to reduce food waste and improve the efficiency of resources used, by limiting consumption.

One of the key factors in this problem is the lifestyle and the diet of the global population, which is increasingly based on a high consumption of animal proteins, eggs and dairy products, resulting in an increase in the intensive cultivation of cereals, corns, animal grains and in turn the use of water.

Moreover, there is a significant depletion of minerals in the water due to the fact that the underground aquifers have been deteriorated by pollution over the years.

Given the complexity and the intensity of today's environmental issues in Europe, the Environment Action Programme must be implemented by establishing a synergy of action between states and regional governments, as holders of key competences.

Their commitment, together with the one of all the stakeholders involved, such as companies, citizens, institutions and research centres, is crucial in defining and implementing the environmental policies needed to address these issues.

Today we have a high level of knowledge of what the negative consequences of high temperatures and lack of water in cultivation might be, but less awareness of the consequences in terms of livestock feeding, livestock production, fishing and aquaculture. We have a large quantity of research (reports, surveys, dossiers) on the effects of climate change on available water resources, but despite this, there are still

⁹ Food and Agriculture Organization of the United Nations, *"Water for sustainable food and agriculture"*, Rome 2017, pg.4

many doubts and uncertainties about the role of carbon dioxide (CO₂) and especially its effects in the Earth's ecosystem and global water cycle system.

According to economists such as Nicholas Stern¹⁰, the climate crisis is the result of multiple market failures.

For many years, economists and environmentalists have urged policymakers to increase the price of greenhouse gas emitting assets since it is considered one of our biggest environmental problems, through for example carbon taxes aimed to stimulate the introduction of low-carbon innovations.

In order to reduce emissions in a more rapid and efficient way, governments do not only need to massively increase the green innovation investment for the reduction of low-carbon energy cost, but they should also adopt a set of policies that address each of the market failures.

Based on that, we can observe that a national carbon tax is currently implemented in 25 countries around the world, including various EU countries, Canada, Singapore, Japan, Ukraine and Argentina. However, according to the Organization for Economic Co-operation and Development (OECD) Tax Energy Use Report in 2019, current tax structures are not adequately aligned with the pollution level of energy sources.

In accordance with above, in fact it suggests that carbon taxes are not tough enough for coal production, although they have proven effective for the electricity industry.

Another example of carbon tax that has actually been implemented is the one present in Sweden; the carbon tax is \$127 dollars per ton and has reduced emissions by 25% since 1995, while its economy has grown by 75% over the same period of time.¹¹

The organisation United Nations is not currently prepared to face the climate crisis. In fact, originally it was formed to prevent another world war with little success. It is important to also remember that the members are not obliged to respect any suggestion or recommendation made by the Organization.

¹⁰ N. Stern is a British economist. He is IG Patel Professor of Economics and Government and Chair of the Grantham Research Institute on Climate Change and the Environment at the London School of Economics.

¹¹ V. GASPAR, P. MAURO, I. PARRY, C. PATTILLO, *Fiscal Policies to Curb Climate Change*, International Monetary Fund Blog, 2019

For example, as confirmation of what already mentioned above, if we consider the Paris Agreement, an agreement within the United Nations Framework Convention on Climate Change, we can easily observe that it is voluntary and there are no real repercussions for non-compliance by their members. The signing of this agreement states that countries must significantly reduce greenhouse gas emissions, needed to decrease global temperature by 2 degrees Celsius by 2100.

Moreover, the issue of fairness remains a controversial topic as developing countries – such as China – are allowed to emit more pollution to develop their business until the point where they can introduce technologies in order to emit less.

Analysing the EU's environmental policies, we learn that they are therefore now guided by three political priorities contained in the 7th EAP:

1. protect, conserve and enhance the EU's natural capital;
2. transform the EU into a low-carbon, improve the efficiency of resources;
3. to protect EU citizens from environmental pressures and risks for their health and well-being.

Linked to this kind of implementation, in recent years the EU has also adopted a number of strategic framework policies focused on transforming the EU economy and specific systems (e.g. energy, mobility) in a manner that delivers prosperity and equity, while protecting ecosystems.

At the Paris Climate Conference (COP21) in December 2015, 195 countries adopted the first universal and legally binding global climate agreement.

The Agreement was reached on 12 December 2015 and entered into force on 4 November 2016, following ratification by the EU. It sets out a worldwide plan of action, designed to put the world back on track, with the aim of avoiding climate change and seeking to limit global warming.

A key element of the Paris Agreement is the transition to green energy, which requires a reallocation of investment from polluting fossil fuels to sustainable sources of energy, both globally and in Europe, through a strong involvement not only of governments but also of cities, businesses and civil society.

The policies that have been adopted play a significant role in defining and eventually improving the environment in which we live. European climate policies have made quite significant progress in adopting legal acts based on the policies.

1.3 2030 Agenda and SDGs

According to IPCC forecasts, if we continue to emit the same rate of polluting gases and fumes as we are currently, the global average temperature could rise by more than 4°C by the end of the century (compared to pre-industrial levels), even with urgent mitigation measures - despite the fact that the international community has set itself the goal of limiting the increase in global average temperature to no more than 2°C compared to pre-industrial age.

Looking at it from an international perspective, as mentioned at the beginning of the thesis, many countries are already suffered the consequences of climate changes, and as a result of the increase in average temperature observed over the last century. The entire ecosystem is being transformed and 84% of the economic impacts of drought are absorbed by the agricultural sector. As consequences of this, food security of many people is threatened, especially in developing countries since they are less well equipped and more vulnerable to these changes.

Sustainable development, climate change, biodiversity and environmental technologies are just some of the environmental subjects that are directly addressed by the United Nations together with the EU, in particular the EU Commission's Directorate-General for the Environment, and that make our continent a region with the highest environmental standards.

2015 was called the "Year of Sustainable Development" because of a series of events and political meetings with the aim of negotiating development actions that were necessary to define the strategy for the years to come.

This process of increased sustainability undertaken by UN member states started in 2000 and it was primarily dictated by the deadline of the Millennium Development Goals (MDGs) in 2015.

They had contributed to setting global and national millennium priorities but, although important achievements were apparently reached, such as poverty reduction, reduction in child mortality and maternal mortality, the findings of the 2015 Final Report of the MDGs suggested the opposite. In fact, there was a situation in which progress had been uneven, leaving significant gaps in many of the areas covered by the objectives.

The MDGs were therefore seen as the result of unfinished business, where there was a need to implement a new action plan to achieve the goals set. From the progress made, as well as from the failures, the international organisations set themselves new challenges and new global priorities, which were later embodied in the definition of a new development plan. In the second half of September 2015, there was in New York the United Nations Summit to adopt the post-2015 development agenda. As a result of the Summit, the UN General Assembly formally adopted the agenda 'Transforming our World: The 2030 Agenda for Sustainable Development'.

This document contained the Sustainable Development Goals (SDGs), which replaced the Millennium Development Goals (MDGs)¹² previously mentioned.

The SDGs, also known as the Global Goals, officially came into force on 1 January 2016 with the aim of ending poverty, protecting the planet and ensuring prosperity for all.

The 2030 Agenda has been developed against a background of major social, climate and environmental changes and has been considered as a major historical event for several reasons.¹³ Together with the 17 goals endorsed by the 193 countries members of the UN Assembly, its adoption is intended to change the dominant paradigm and demonstrate the unsustainability of the development model adopted prior to this.

One of the innovative elements of the Agenda is precisely the move away from the idea of sustainability as only an environmental issue but also the consideration of it as essential to an integrated vision for different development dimensions.

¹² Millennium Development Goals are eight goals that all 193 UN member states have committed to achieve by the year 2015.

¹³ ASVIS-Azienda Italiana per lo Sviluppo Sostenibile, *"L'Agenda 2030 dell'Onu per lo sviluppo sostenibile"*, Roma

Indeed, according to the Summit meeting, it was felt that sustainable development must be integrated with economic growth, environmental protection and the respect of human and social rights.

Another crucial element of the Agreement is the recognition of the contribution and effort of every country to bring the whole world to sustainability, without distinction between developed and developing countries. For the Goals to be achieved globally is essential a strong mobilisation of all components of society (public and private companies, institutions, universities and civil society).

In addition to the above, the 2030 Agenda has incorporated and included the results of all major UN conferences and summits on sustainable development held since the 1972 Stockholm Conference. In fact, it also refers to the principles of the Millennium Declaration and the Rio Declaration on Environment and Development.

Structurally, the Agenda is made up of four basic sections: the Declaration, the Goals and Targets, the Implementation Instruments, and the Implementation Monitoring and Review.

The Agenda is therefore composed of an unprecedented and relevant scope and it is accepted by all countries, taking into account national realities, capacities, different levels of development and combining state policies and priorities.

In addition, the universal character of this Action Plan is strongly highlighted, focusing on the call of both developed, developing and emerging countries to act in a new direction.

The universality of the new Agenda is reinforced by the principle of "no one will be left behind" which has become one of the crucial elements of the document. In addition, the Agenda is vast and complex, because it is the result of a long and inclusive process of negotiations among governments on the basis of the OWG proposal.

The objectives mentioned in this treaty are based on 5 fundamental pillars, also called the '5 Ps':

- People: aimed at ending poverty by ensuring that all human beings can realise their potential in dignity, equality and in a safe environment;
- Planet: protect the planet by managing natural resources in a sustainable way in terms of consumption and production, by the adoption of urgent measures concerning the planet's climate in order to preserve it for present and future generations;
- Prosperity: ensure that all human beings can enjoy prosperous and fulfilling lives in harmony with nature;
- Peace: implementing actions to promote peaceful, just and inclusive societies, free from fear and violence. In fact, there cannot be sustainable development without peace and viceversa.
- Partnership: establish partnerships for a sustainable development based on a sense of global solidarity, in relation to the needs of the poorest and most vulnerable, by involving all relevant stakeholders.

Through the sharing of common goals and greater cooperation between parties, this can lead to a greater realisation and achievement of the set objectives.¹⁴

The programme is therefore ambitious and transformative as it marks a change to complete the incomplete work of the MDGs¹⁵.

In fact, contrary to the past, the focus is now mainly on prioritising vulnerable and marginalised people. Aiming to eliminate problems and including challenging targets in fields such as health, education and gender equality.

¹⁴ UN Resolution, *Transforming our World: the 2030 Agenda for Sustainable Development*, New York, 2015, pag.2

¹⁵ Objectives defined in order to eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases, ensure environmental sustainability, develop a global partnership for development.

All of this shows a higher level of ambition within the UN, which is inclined to imagine a world where each person has the essential services to live a respectable life, free from poverty, hunger, disease, fear, violence, with access to employment and quality education at all levels. It aspires to a world where human rights, human dignity and cultural diversity are protected and where gender equality prevails.

This is a plan of action that aims at the elimination of poverty in all its forms and dimensions and the achievement of a fundamental requirement of peace for sustainable development.

Considering that these global challenges must be tackled with an interconnected and universal logic, all countries involved are called upon to commit themselves to changing the planet. For this reason, each of them are required to define their own strategy for achieving the 17 SDGs and subsequently report it to the rest of the countries involved.

Through this initiative, the UN is thus ready to fulfil its desire to safeguard and protect our planet through integrated and indivisible objectives.

The 17 Sustainable Development Goals with their 169 targets and more than 240 monitoring indicators form a coherent and holistic framework of global aspirations that the world is committed to achieving by 2030. As mentioned before, the Goals are multidimensional since they cover a range of different issues, including economic, social and environmental aspects, consistent with the three dimensions of sustainable development.

Figure 1. Sustainable Development Goals



Source: <https://sustainabledevelopment.un.org/sdgs>

While the SDGs begin with Goal 1 "No poverty" to highlight the continued ambition of the MDGs to eradicate extreme poverty, they end with Goal 17 "Partnerships for the goals" to underline the importance of working together to achieve the SDGs.

Regarding the order of the other Goals, no priority has been indicated, as all are crucial and interdependent.

The following is a short list of the targets associated for each Sustainable Development Goals¹⁶:

1. No poverty: ending extreme poverty by 2030, including the alleviation of ordinary poverty by at least 50% through a social protection system for all. Through the definition of targeted policies and the creation of development policy strategies, this SDG aims to ensure equal rights to property, basic services, technology and economic resources for all.
2. Zero hunger: achieving food security, improving nutrition and promoting sustainable agriculture for all. There is the desire to create a nutrition-free world where everyone has access to safe, healthy and sufficient food all year round. Ending all forms of malnutrition and ensuring the doubling of productivity and consequent incomes for small-scale food producers. Through this objective, there is also the commitment to ensure sustainable food production systems and the support for investments in rural infrastructure, agricultural research and technological development. It is therefore important to try to prevent distortions in world agricultural markets and to guarantee the stability of food commodity markets.
3. Good health and well-being: based on activities to reduce the overall maternal mortality rate to less than 70 per 100,000 live births. Furthermore, on the basis of the MDGs, there is a continued focus on ending the outbreaks of AIDS and other transmissible diseases, which would lead to a decrease in premature mortality from non-transmissible diseases by one third. Other activities to ensure the health of the population include the implementation of preventive measures against substance abuse and the reduction of road fatalities worldwide by achieving global health coverage.

¹⁶ United Nations, *"The 17 Goals – History"*

4. Quality education: provide quality, equitable and inclusive education and provide learning opportunities for everyone, thus eliminating differences between girls and boys. Provide primary and secondary education for all, giving equal opportunities to children with disabilities, persons from minority groups and those affected by human conflicts. Building and upgrading school buildings, increasing teachers' knowledge and skills and offering the opportunity to receive scholarships to continue learning important technical skills, both at home and abroad.
5. Gender equality: achieve gender equality and empower all women and girls by ending all forms of discrimination, violence and exploitation against them. Through the abolition of forced marriages and female genital mutilation, women around the world would be granted equal rights. This kind of women's empowerment is also realised by enhancing the participation and full opportunities at all levels of decision-making in the political, economic and public spheres.
6. Clean water and sanitation: ensure the availability and the sustainable management of water, guarantee sanitation to everyone through the supply of clean, safe and accessible water. Promote systems for re-use, protect and restore water ecosystems.
7. Affordable and clean energy: ensure that each person has easy access to affordable, reliable, sustainable and modern energy systems. It also reduces energy waste and encourages research, technology and investment in greener systems.
8. Decent work and economic growth: promoting long-term, inclusive and transparent economic growth, full and productive employment and dignity in work for all. This fosters sustainable economic growth by providing opportunities for creative work that encourages people to develop their potential. Ensure respect for and protection of natural resources and the establishment of working conditions that support youth employment and avoid child labour in all its forms.

9. Industry, innovation and infrastructure: build a resilient industry and enhance innovation and fair, responsible and sustainable industrialisation. Create quality and reliable infrastructure in order to expand access to services, financial markets, information and communication technologies.
10. Reduced inequalities: reduce income inequality within and between nations; support social, economic and political inclusion universally; implement tax policies that promote equality; provide greater representation and voice for developing countries in the decision-making process of international economic and financial institutions; implement responsible and well-organised migration strategies; encourage increased development assistance and investment in developing countries.
11. Sustainable cities and communities: making cities and human habitats inclusive, durable and sustainable. Guarantee adequate quality accommodation, eco-friendly transport systems and address the needs of children and women. Involve citizens in the participation of decisions concerning the planning and development of urban areas, preserve and enhance the cultural and landscape heritage.
12. Responsible consumption and production: ensure responsible food production and consumption in order to reduce wastes. Improve the management of food and chemical wastes and by incentivising companies to be more responsible.
13. Climate action: promote action, at all levels, to combat climate change through the implementation of urgent policies; improve education, green awareness and ensure that people are prepared for climate change and other disasters.
14. Life below water: conserve and make sustainable use of the oceans, seas and marine resources for the achievement of long-term development by significantly reducing all kinds of marine pollution; preserve fish markets and species in danger of extinction. Finally, reduce the amount of waste present in the water and preserve marine biodiversity.

15. Life on land: protect, restore and promote sustainable use of the earth's freshwater ecosystem, forests, mountains, dry lands. This objective aims to combat desertification, protect biodiversity and natural habitats, eliminate poaching and trafficking in protected species.
16. Peace, justice and strong institutions: promote peaceful and inclusive societies by combating all forms of violence and exploitation against children. Take action to ensure equal access to justice, fight the corruption and organised crime, strengthen institutions to prevent violence, terrorism and criminality.
17. Partnerships for the goals: strengthening the implementation tools and setting up global partnerships for renewable development. Developed countries must fulfil their Official Development Assistance (ODA) commitments, including the target of 0.7% of Gross National Income to developing countries and allocate between 0.15% and 0.20% of ODA/GNI to least developed countries. Implement activities in order to support developing countries in achieving debt sustainability and encouraging new sustainable technologies.

As noted above, the Agenda and the relative 17 SDGs are a follow-up to the MDGs set in 2000. However, there are significant differences between the two action plans.

Firstly with regard to their creation, considering that the MDGs were developed by an agreement reached by the International Monetary Fund, the World Bank and the UN Secretary General. This approval, without any public discussion, had created 'discontent' in civil society and also among Member States.¹⁷ In comparison, the process of definition of SDGs was more open, as they were produced by the Open Working Group of the General Assembly (OWG) with the cooperation of UN states and numerous stakeholders, including the civil society and the private sector.

Given their large number, it is clear that the SDGs have proven to be more articulate and complex by going beyond the MDGs objectives, addressing the root causes of poverty, recognising the importance of taking an integrated view of sustainability and including 'new issues' such as climate change, sustainable consumption, technological innovation and the importance of peace and justice to everyone.

¹⁷ Langford M., *Lost in Transformation? The Politics of the Sustainable Development Goals, Ethics & International Affairs*, 2016, no. 2, pp. 167 – 176.

With regard to their scope, the Global Goals are universal as they apply uniformly to everyone and to all countries, leaving governments the decision on how to implement them within their internal processes. These decisions are taken regardless of their level of development, while simultaneously respecting different national realities and priorities.

Six years after the adoption of the 2030 Agenda and the related SDGs, we can analyse the report published by the United Nations, "The Sustainable Development Goals Report 2020"¹⁸ in order to determine if the actions taken have laid the right foundations for achieving their goals. The report provides an overview of the progress made in some areas, while still highlighting how far there is to go.

The Report analyses the latest available data to show us that, prior to the COVID-19 pandemic, the progress remained uneven and it was not on track to meet the 2030 targets. While some milestones were so evident prior to Covid-19, such as for example the decrease in child illiteracy, the decline in the occurrence of some transmittable diseases, the improvement of accessibility to clean water in many villages in developing countries and the increase in the number of women in political and managerial positions, for other SDGs the goal was still far off.

It was noted in fact that there was a dramatic increase in the rate of population suffering from food insecurity and a continuing deterioration of the environment where we live.

Currently, due to the pandemic and the related unprecedented social challenge, the achievement of the set results is even more ambitious than before because of the real disparities between developed and undeveloped countries. However, based on the Report's findings¹⁹, it is not only important to look at the targets that have not been met, but also to highlight the progress made in the area of access to electricity by developing countries and the improvement in energy efficiency. As for poverty, improvements are still continuing but the rate has slowed down considerably. The deceleration suggests, therefore, that the world is not on track to meet the target of reducing the extreme poverty level to less than 3% in 2030.

¹⁸ United Nations, *"The Sustainable Development Goals Report 2020"*, 2020

¹⁹ United Nations, *"The Sustainable Development Goals Report 2020"*, 2020

In addition, private investment flows are not aligned with established development and institutions are not strong and effective enough to adequately respond to these massive and interconnected global challenges.

The profound causes of this situation are so illustrative of exactly why we need urgent implementation of the 2030 Agenda, the Paris Agreement on Climate Change and the Addis Ababa Action Agenda.

In conclusion, with regard to the 2030 Agenda's central principle of 'leaving no-one behind', this has proven complex to implement and requires the transformation of deeply embedded economic, social and political systems, governance structures and business models that are often based on unequal distributions of wealth and decision-making power.

1.4 The challenge of 2050

On the basis of data collected in recent years by scientists and members of the National Centre for Climate Restoration²⁰, we can define that the climate change we are now facing, overlaps with international security risks and pre-existing national security risks. This leads to an acceleration of threats and instability in the system, contributing massively to humanitarian and socio-political crises, conflicts and forced migrations.

In addition, the impacts of climate change on today's food and water systems, the decrease in crop yields caused by drought and the related increase in raw material prices, the presence of social disintegration and the conflicts throughout the Middle East, the fires and their consequences, have become catalytic contributors to the European migration crisis.

Understanding and preventing such events is therefore crucially dependent on an appreciation of the information emerging from climate science studies and the real limitations and strengths we are facing.

After having examined in the previous sections of the thesis the current situation of the planet and its corrective policies for the achievement of an economically, socially and

²⁰ It is an independent think tank that develops critical thought leadership to influence the national climate debate and policy making.

environmentally sustainable world - Agenda 2030 -, we can now go on to better understand what the future implications of today's decisions will be.

As predicted by Xu and Ramanathan²¹ carbon dioxide levels will have reached 437 parts per million by 2030 with a global warming close to 1.6°C, but pollutant emissions will peak and lead to an additional global warming of 3° C by 2050 - due to the activation of a number of carbon cycle feedbacks, higher levels of ice albedo and cloud feedbacks compared to current models that they assume.

Over the coming years, a number of ecosystems will collapse, including coral reefs, the Amazon rainforest and a large part of the Arctic.

Some poorer nations and regions will become non-viable due to the inability of the population to survive these extreme temperatures, which will also be due to the lack of financial resources needed to support technological innovations. As a result, 35% of the earth's surface, where 55% of the world's population lives, will be hit by lethal heat waves for at least 20 days per year.

We will be faced with a situation where the availability of water will decrease dramatically in regions located at lower latitudes (dry tropics and subtropics), thus making agriculture in these areas no longer sustainable. Crops will collapse by 20%, causing a dramatic rise in commodity prices and leading to at least one billion 'climate refugees'.

If drastic mitigating measures are not taken with immediate implementation, the 2050 will be the beginning of the end, not only because of the environmental deterioration but also because of the population growth.

Indeed, the world's population is expected to increase by two billion, from the current 7.7 billion to 9.8 billion in 2050, before peaking at almost 11 billion by the end of the century, with fertility rates that will continue to decline²². During this period, the global population will become more urbanised and half of the demographic increase that will occur will come mainly from nine countries: India, Nigeria, Pakistan, Democratic

²¹ United Nation, *UN 75 - I grandi temi: una demografia che cambia*, 2020

²² United Nation, *UN 75 - I grandi temi: una demografia che cambia*, 2020

Republic of Congo, Ethiopia, Tanzania, Indonesia, Egypt and the USA (in descending order of increase).

At present, cities account for less than 2% of the world's total land area and produce 80% of global Gross Domestic Product (GDP) but they are responsible for more than 70% of carbon emissions.²³

The speed and magnitude of urbanisation, nowadays, presents challenges in terms of ensuring proper accommodations, infrastructures and transports, as well as curbing conflict and violence. Indeed, nearly one billion people are classified as 'urban poor' and most of them live in informal urban settlements.

Another consequence of the demographic growth we will see will be the over-65 class exceeding the total number of children under five.

This situation is already present in Europe and East Asia, which are facing a major challenge in supporting and caring for the ageing population. Considering that life expectancy continues to rise, this could play an increasingly significant role in societies and their economies, leading to an adaptation of the educational, health and social systems in order to provide a public security network for this growing age group.

As a result of the 2050 sustainability problem and the relative exponential population growth in the world, food supply and food security are two of the newest challenges we will be facing.

As anticipated by the second SDGs of the UN 2030 Agenda - "zero hunger" - hunger and food insecurity have globally increased and malnutrition still affects millions of children. Unfortunately, the situation is likely to get worse due to economic slowdowns, recessions and disruptions caused by the current pandemic situation we are experiencing.

Since 2014, the global undernutrition rate has remained more or less stable at just under 9%. However, in the following years, the total number of people suffering from hunger has increased, reaching almost 690 million undernourished people in 2019.²⁴

²³ United Nation, *UN 75 - I grandi temi: una demografia che cambia*, 2020

²⁴ United Nation, *"The sustainable development Goals Report 2020"*, 2020, pg.26-27

A recent estimate also defines that while in 2014 we were facing a situation of moderate or severe food insecurity that affected 22.4% of the world's population, in 2019 the rate has increased to around 25.9%, corresponding to almost 2 billion people.

One of the factors that explains the dietary problems faced by part of the population has been studied to be not only a limited availability of resources but also an income that is too low to ensure a healthy and well-balanced diet.

Those facing severe food insecurity - around 750 million people - tend to remain without food and, in the worst cases, to spend a day or more without eating.

It was also found that more than a half of the infants suffering from malnutrition live in Central and South Asia, the only region with a prevalence of more than 10% of the inhabitants suffering from it.

In 2019, 6.9% of the victims of wasting and acute undernutrition were children under the age of 5 (equivalent to 47 million), due to limited nutrient intake and subsequent infections. This number can therefore be described as being far above the overall 5% target set for 2025, and even further away from the final target of 3% for 2030.

While today we are dealing with this kind of food problem, which seems to be far from our own Italian reality, it is nevertheless essential to start thinking in a future perspective of safeguarding this sector, necessary to meet the needs of a massively growing population that will reach record numbers in the next 30 years.

There is an urgent need to change the way food is produced and consumed. Agriculture will have to be able to provide enough food for a population expected to reach almost 10 billion people and the global farming system will have to find ways of meeting the ever-increasing demands of consumers.

Given that, the agricultural sector will continue to be a source of inclusive, economic and social development through poverty alleviation in the smallest villages, it must also take actions to limit its negative environmental impact. As shown in the previous chapters, agriculture is responsible for various phenomena such as soil degradation due to intensive cultivation, substantial water use and related climate change impacts.

With the rise in per capita incomes in today's underdeveloped countries and the increase in population across the world, total food demand will grow by more than 50% compared to today, with animal food demand up by 70%.

Based on current trends, both agricultural and animal production will need to increase their annual output levels by about double in order to fully meet expected food demand.

The challenge of 2050 is therefore to create sustainable food in the future by balancing conflicting needs. By then, the world will have to feed more people, it will have to ensure a reduction in global poverty through the implementation of new agricultural activities in underdeveloped countries and it will have to contribute to an inclusive economic development. All this must be done with a focus on the climatic and environmental aspect, by reducing the greenhouse effect and gas emissions (GHG), by restoring terrestrial and marine ecosystems and habitats, by safeguarding freshwater basins that are currently almost entirely exploited by agriculture, and by limiting other related environmental impacts.

Because of the interconnection between these objectives, we can therefore say that failure to achieve one of them will have a negative impact on the implementation of strategies related to other targets.

Quantifying the focus of the future challenge through the GlobAgri-WRR Model²⁵, we can see that there is a need to fill three main gaps²⁶:

1. making food production more efficient by reducing the food gap;
2. making agricultural land more sustainable;
3. mitigating greenhouse gases (GHG).

In relation to the first gap, we can define the food gap as the difference between the amount of food produced in 2010 and the amount that will be needed in 2050 to ensure a sufficient level of global food for the achievement of common nutrition. This therefore indicates the extent to which food demand must be reduced and at the same time production supply increased in order to avoid food shortage problems.

The gap can and must be overcome both by measures that decrease the growth rate of excess demand and by measures that augment supply.

²⁵ GlobAgri-WRR is a global accounting and biophysical model that quantifies food production and consumption from national diets and population, the land-use demands and the GHG emissions. This version has developed jointly by the CIRAD), the Institut national de la recherche agronomique (INRA), WRI, and Princeton University.

²⁶ World Resources Institute, *“Creating a sustainable Food Future”*, 2019

Increased demand for food will widen this food gap to 56% by driving up demand for animal products through an increased consumption of milk, meat and foods that rely heavily on grazing for their production.

In order to get a clearer picture of what the food demands will be in 2050, FAO has conducted an analysis of economic growth in different countries and their income trends, since 2012. It has also studied the projection of the daily diets consumed by an average person.

Based on recent studies carried out in the food sector, we can certainly state that world food distribution is highly unequal. In fact, about 820 million people in the world are still undernourished, despite the fact that there are more than 2 billion people who are overweight or obese. Based on this, if we consider the claim that the world already has enough food if distributed in a uniform way, we have to make a number of important assumptions including the presence of food losses and waste.

Regarding the second gap, the one concerning the land, we can define that a strategy to reduce the food gap and make food production more sustainable could be to reduce the amount of land designated for agriculture, by avoiding its expansion beyond the amount used in 2010. This kind of policy is needed in order to safeguard the natural ecosystems that constitute the basis of agriculture since they are responsible for the regulation of water flows, atmospheric temperatures, soil stabilisation and the presence of pests.

It is also required in order to protect biodiversity, given that the extinction rates of animal species have been increasing and have reached 0.6%.

For these reasons, agriculture has long been viewed as the main cause of biodiversity loss and it is expected that this situation of deterioration will persist in the future unless major changes occur.

As with the first gap, the land gap is the difference between the agricultural area used in 2010 and the area required in 2050, despite the fact that the growth in the rate of crop yields and the amount of grazing land involved remains the same or even lower than in previous years.

According to the Report²⁷, under this current projection, the agricultural area would grow by 3.2 billion hectares beyond the approximately 5 billion hectares in use in 2010, eliminating most of the world's remaining forest and savannah.

The agricultural expansion that is taking place today appears to have developed in areas which are very critical from the point of view of the presence of a diverse biodiversity, causing frequent negative social consequences such as the migration of entire native populations to other villages due to a scarcity of water now used for agriculture, a deterioration of the soil and a loss of cultural identity

The countries most affected are Brazil, Indonesia, parts of Africa and even parts of the United States and Canada once occupied by large grasslands.

The area of cropland required to satisfy future needs will also depend on the increase in its yield, since greater efficiency would ensure greater production with a reduction in exploited land.

However, it is impossible to define this indicator with certainty, since in recent years the definition of the growth rate has taken into account not only private initiative but also the huge investments in science and technology made by the competent governments. Although the main focus is directed towards the decrease of land used for agriculture, it is important to consider that the remaining used land is destined for the expansion of pastures. Globally, livestock farming requires about two to three times the amount of land used for crops, so that it has been considered the leading cause of land degradation in Latin America.

With the increase in demography and a resistance to change in current diets, we will therefore be faced with a situation where the area of pastureland will continue to expand due to the growth in demand for dairy products, meat and by-products, whose production is based on feeding animals on the land in discussion.

However, estimating the actual land take for the animal sector is even more difficult than estimating the land requirements for the agricultural sector. The measurement of its yield and its efficiency depends not only on the yield of hectares but also on the yield of other feeds and the ability to convert the feed into milk, meat or other products.

²⁷ World Resources Institute, quote, pg.19

The third and final gap is the greenhouse gas mitigation one, given by the difference between the projected level of emissions in 2050 and the level needed to reduce them in order to re-establish an acceptable global climate and temperatures.

Emissions from the agricultural sector occur mainly through methane and nitrous oxide and from greenhouse gas traces produced by microorganisms in ruminant stomachs, soils and manure slurry.

Ruminant livestock, such as buffaloes, cows, goats and sheep, are responsible for generating almost half of all emissions related to food production. About 80% of these occur in territories located in developing countries where the economy is mainly based on these less industrialised activities.

Quantifying the gap requires, firstly, projecting the level of emissions in 2050 and, secondly, establishing a reduction target. Based on the information and analysis of the current situation, however, it can be said that the total agricultural emissions per year will increase to 9.3 GtCO₂, resulting in a rise in total emissions to 17.1 GtCO₂ per year, including those from land-use changes.²⁸

On the basis of the three gaps just explained, we could therefore search to further define seven actions that might help to guarantee food progress all over the world and that might improve the capacity of the ecosystem to better cope with population growth.

The strategies are:

1. Raise productivity: actions aimed at improving efficiency in the use of natural resources, not only to ensure crop yields above historical levels but also to ensure land benefits. This would result in higher milk and meat production per hectare of pasture, based on current data, and a reduction in greenhouse gas emissions, allowing the Paris Agreement targets to be met.
2. Manage demand: actions aimed at trying to slow down the rate of growth in food demand which will be necessary to reduce the food gap. This will mean a reduction in food losses and waste, and a shift from diets mainly based on animal protein to one based on vegetables.

²⁸ World Resources Institute, quote, pg.24

3. Linking agricultural intensification with natural ecosystems protection: in order to ensure an increase in food production, it will be necessary to improve land yields rather than increase the land area used, otherwise changes in land use will increase greenhouse gas emissions and biodiversity loss. Governments will therefore have to commit to define policies aimed at protecting the environment and biodiversity.
4. Moderate ruminant meat consumption: considering that the demand for ruminant meat is expected to grow by 88% between 2010 and 2050, we should try to limit its consumption to avoid further environmental problems. Furthermore, if we analyse the caloric contribution of these foods in a person's daily diet, we can see that animal meat (mainly beef) provides only 3% of the calories needed, but has a huge environmental impact for its production.
5. Target reforestation and peat land restoration: by reforesting some marginal and difficult-to-improve resource-efficient grassland, it would be possible to limit the global temperature increase to below 1.5 °C and potentially achieve one of the SDGs targets. However, this will only be possible through a reduction in the growth of food demand for resource-intensive agricultural products and an increase in the yield of crops and livestock.
6. Require production-related climate mitigation: activities through which it will be possible to encourage the reduction of greenhouse gas emissions from agricultural production sources, in particular enteric fermentation of ruminants, manure, nitrogenous fertilisers and energy use.
7. Spur technological innovation: in order to totally fill the gaps, there will be a need for technological intervention that will make possible the reduction of methane emissions, the creation of new forms of fertilisers and new processes based on solar energy necessary to produce them.
In addition, a new innovation in molecular biology will open up new opportunities for crop screening and the creation of proteins in the laboratory as a substitute for those made by animals.

To achieve this progress, it will then be necessary to increase R&D funding and to have flexible regulations that encourage private industry to develop and commercialise new technologies.

In conclusion, we can say that the issues of food production, land use and greenhouse gas reductions will be implemented through policies that will be different from region to region.

In general, developing countries will be more exposed to problems related to food growth due to an increase in population growth, while developed countries will face more problems related to industrial pollution.

On a global level, 'the Three Gaps' make it possible to define a new challenges facing the future of food.

Chapter II

Evolution of a new discipline: FoodTech

2.1 Introduction

After having analysed in the first part of this thesis one of the biggest problems that modern society is now facing, climate change and all the externalities linked to it, and after having highlighted the urgent need to implement environmental policies aimed at the resolution of these problems, we can state with certainty that there is a need to change people's food and non-food habits in order to better preserve our planet. The depletion of natural resources as well as the uncertainties of short-term and long-term food security, energy poverty, air pollution, greenhouse gas emissions, water and fossil fuel issues, have all created a fragmented situation in which it is necessary to enter a new phase of transformation within society.

In this second part of the thesis we will therefore analyse the impact that our diet has on the environment and we will define a possible solution to the problems mentioned above.

The food system today can be said to be in a disastrous state. We are currently in a period in which more than 30% of food globally is wasted, where the percentage of the global population who is overweight is growing more rapidly compared to those people who are undernourished, where the Earth's resources are increasingly exploited and usually put to inappropriate uses.

All these system failures and the occurrence of continuous problems present an opportunity to define and to undertake a process of transition of the food system. The direction this will take will be decided by the people's needs without, at the same time, violating the limits of environmental and food sustainability. In fact, the satisfaction of their food needs could be achieved by using considerably less raw materials and by improving the efficiency and yield of the goods during the production stage.

The real question we have to ask ourselves is, therefore, how we can ensure that the way in which humanity feeds itself will be sustainable, considering the population boom we will face in 2050?

In fact, within this sector, production, processing, distribution and consumption contribute massively to environmental non-sustainability, since they are responsible for the generation of wastes and pollution.

We are now in a situation where the need to find solutions is essential and no longer an eventuality. If society continues to show indifference to these problems, the consequences for our economy, our environment, our health, our society, will be catastrophic – multiple reports confirm what has been said regarding research carried out by important world institutions such as FAO and WHO.

Although different historical periods have seen a greater or lesser acceptance of technology than in our lives, because of differences in social, economic, political and historical backgrounds, we can nevertheless say that this millennium has seen a tremendous push for innovation. In fact, in order to find smart, alternative solutions, more space has been given to technological innovations in recent years, which have always been the basis for the economic and social progress of countries.

This latter phenomenon has recently led to the emergence of the so-called Foodtech sector, consisting of high-tech companies and startups aimed at finding new and innovative answers to sustainability questions.

The FoodTech sectors in which these players are concentrating most, can be classified in 8 macro areas:

- Innovative food products
- Food safety and security
- Food delivery
- 3D printing of food products
- Food robotics
- Customised nutrition
- Fight against food waste
- Internet of Things applied to the food industry

The global FoodTech ecosystem is growing rapidly and, according to a report from DigitalFoodLabs²⁹, investments in European countries has more than doubled in the last two years. Rising from €900m in 2018 for 353 deals to €2.4bn for 271 deals in 2019, with around half of that budget allocated to the support of four global players in the delivery sector: Deliveroo (€520m), Glovo (€300m), Picnic (€250m) and Wolt (€115m).

FoodTech, therefore, includes all services and technology that aims to increase the efficiency and sustainability of agriculture and farming: in particular, this type of ecosystem is the first in terms of number of companies with 1,521 and \$14 billion of investments. However, the best performer in terms of "funding", with respect to the number of companies involved, is the delivery sector with 889 startups, with an estimated investment of \$31.5 billion (corresponding to 48% of the entire FoodTech sector).

Another booming area is the next-gen food and drinks sector with meat-not-meat, insect proteins, mushroom products, drink alternatives and dairy products reproduced with other ingredients. We can expect to see a very variegated food market in the future. The other trends ranking highest in the most profitable ecosystems include cloud kitchens and restaurants with 396 businesses for \$4.8 billion, apps and consumer services with 584 companies, innovative recycling with 350 companies, food processing with 165 companies and finally traceability with 233 players.

On the basis of the trends we have observed, technology will continue to have a central and pivotal role in our future, since they will increasingly represent the main axes around which food production will be structured.

2.2 Technological evolution in the food sector

The beginnings of technological evolution in the food sector can be attributed to the scientific revolutions in the 1500s and 1600s, but it has only been in more recent years that food technology has developed to the point where it has taken a central position on crucial issues concerning our work, our role as consumers and our citizenship.

²⁹ DigitalFoodLabs, *2020 STATE OF THE EUROPEAN FOODTECH REPORT*, 2020

Among the many interconnected challenges that have been emerging in recent years those concerning environmental sustainability and food security are most prominent. They have become central points of social debate and are reinforced by the alarming statistics provided by the FAO every year.³⁰

According to the definition introduced by FAO, food security can be defined as the achievement of a situation in which all populations have physical and economic access, at all times, to sufficient, safe and nourishing food to satisfy their dietary needs and preferences in order to pursue a healthy and active life.

As we can see, this definition emphasises nutritional security for all populations regardless of the geographical area considered, while also focussing on the factors related to it, such as, the importance of food security and the environmental and ethical issues.

On the basis of the environmental studies carried out and considering the related future trends analysed in the previous chapter of this thesis, we can say that these have had and still have a decisive impact both on the development and design of new food products, on the technology used during the production processes and on the consequent consumer perception of such goods.

In support of this thesis, we must also take into account the fact that the United Nations' forecast of an increase of the world population up to 10 billion by 2050 leaves no doubt about the necessity to involve scientists from various backgrounds in order to develop technological strategies for guaranteeing global food security over time.

One of the possible solutions to meet the demand for food in the coming decades may in fact not only be about increasing the level of output in primary production, but also about designing a system that optimises the food transformation process during the final post-harvest. This would lead to more sustainability and a decrease in the energy crisis, a reduction in malnutrition and greater efficiency in the management of wastes, thanks also to the presence of production chains defined in relation to the energy consumption required.

³⁰ FAO negli ultimi anni ha fornito i dati relativi alla malnutrizione e all'insicurezza alimentare sottolineando la sempre maggiore e rapida crescita del problema.

Consequently, there would be an upgrade in the nutritional quality and yield of the final products and of a recycling process based on the destination of food processing waste, including sectors such as textiles, chemicals or biofuels.

Based on these reasons, the food and beverage industry is one of the main fields characterised by a high concentration of new technology around the processing of products.

As per definition, food processing may refer to any variation of the food raw material carried out before the consumption stage. This transformation may lead in some cases to negative effects, such as, a decrease in nutritional value caused by the destruction of important nutritional compounds.

Nevertheless, food processing is essential for many reasons, such as increasing shelf life and making food consumable over time, improving the bioavailability of critical nutrients and decreasing the perishability of raw materials involved. While green and sustainable products are a new source of economic reward for companies and help to appease modern consumers' 'obsession' for healthy and natural food, they could also provide useful solutions to meet food security in both developed and developing countries.

Considering all these reasons, it is therefore necessary to define new techniques that improve the food production chain by using more sustainable energy, having at the same time a lower impact on the environment and on the initial nutritional characteristics of the raw materials used. From an industrial point of view, food safety would therefore be the result of specific combinations arising from technological progress and made possible through social acceptance. This can be achieved through cooperation with political organisations and specific and targeted market operations.

In this regard, research and development must adopt a multidimensional approach that takes into account all the aspects of the food production and consumption chain, including cultural, economic, environmental, political, social and technological aspects.

Over history, technological innovation has been one of the driving forces responsible for all major changes in manufacturing and consuming habits.

Among these, the most noticeable today is digitalisation, which has had a significant upsurge since the last century and it has led to an increase in efficiency and precision throughout mass production processes.

The 21st century has been and will continue to be marked by multiple environmental challenges of unprecedented magnitude that will lead to an increasing number of threats to human survival. The combined impact of global climate change, energy and water shortages, environmental pollution, the changing of worldwide demography, food insecurity and the growing number of pandemics due to diseases are all placing undue stress on the planet's food system, which is already in a delicate balance as far as its ecosystem is concerned. These natural and man-made dangers are therefore forcing the scientific community to proactively seek new innovative diet and nutrient solutions to ensure global food sustainability and nutritional security in the future. In order to achieve this goal, innovative answers must take into account the entire supply chain. This includes food choices and dietary models, to provide significant improvements in the food supply, decision making process, nutrition and health status of the final consumer.

In order to better understand the technological evolution that has been occurring over the years in the food sector, it is useful to go back to the concept of food regime developed by Friedmann and McMichael³¹ in 1989.

The 'food regime' theory was introduced with the intention of providing an explanation for economic and political changes in food systems in a particular historical period when both food security and technological progress played a major role in society. As such, this tool proved able to identify the social, political and economic reasons for the success or failure of a functional food system in a given historical period.

Friedmann and McMichael hypothesised the existence of a first dietary regime during the period of 1870-1914 and a second regime between 1945-1973. Once both models were defined, they were subsequently examined and used by various researchers in order to analyse and verify the efficiency and supply of food during the chosen periods and the various aspects related to them in political, historical, environmental and

³¹ Friedmann H., & McMichael P., *"Agriculture and the state system: The rise and decline of national agricultures, 1870 to the present."*, 1989

economic terms. This study gave a concrete idea of the fundamental role that industry and technology played in the development of the food sector.

Furthermore, on the basis of Campbell's studies in later years, it was confirmed that food security was the basis for the development of the second food regime. This was due to a social establishment that food production was organised around well-defined industrial models and effective technological processes.

The first food regime

If we analyse the first food regime developed between 1870 and 1914, in more detailed terms we can see that it was used to determine the properties of a country's food supply in that historical period and it was used to study global characteristics of hegemony, such as British influence on colonial food production³². At that time, thanks also to the advent of the Industrial Revolution, numerous technological innovations could be observed especially in the area of storage and transport of raw materials and foodstuffs from colonies located in tropical geographical areas to those located in the British region.

With the development of these new techniques and a reduction in borders due to the introduction of innovative transport means, the daily diet also started to see the introduction of certain tropical foods such as vegetable oils, tea, coffee, sugar and bananas. It was at this time that Western diet was introduced, helping to stabilise the status of food security in the growing industrial Europe. Later important imports were those of meat and wheat, which were the primary foodstuffs of industrial European workers.

It was also during this period that the main forms of food processing already in use were improved and today's technologies were introduced in their crudest forms. Examples of this can be seen in both in the chemical sector and those related to the development of vacuum canning; in particular the first forms of meat canning which allowed the export of a large part of the market from Australia and South America. Finally, the refrigeration sector also became one of the indispensable partners in enabling the industry to move from a market purely focused on durable goods to one also characterised by the presence of more perishable foods.

³² McMichael P "A food regime analysis of the 'world food crisis'. Agriculture and Human Values", 2009.

These technologies, even if considered quite basic in the 21st century, had the capacity to revolutionize production and processing operations. Therefore, from a sociological perspective, the acceptance of this first model was probably determined by liberalization and decrease of working time and physical presence of human labour in the various processes.

The second food regime

The second food regime, which was developed between 1945 and 1973, owes its success partially to the political support it received during the Green Revolution and 1970. In addition to this there was also investments made in the science field over the years, everything from new farming techniques, to the development of infrastructure and a growing target market.³³

Indeed, from the 1950s onwards, the technological advances initiated during the war period with innovative tools and equipment began to be used in agricultural production in both industrialised and non-industrialised countries, leading to a period known as the Green Revolution. This period turned out to be of considerable importance because of the changes it introduced in the food supply chain given that it helped to radically change diets through a new system of consumption mainly based on a significant presence of specific food crops (wheat, maize, rice).

The Green Revolution played an important role in establishing globally intensive agricultural production methods and in shaping dominant philosophies of traditional agricultural practice.

Although global food yields were steadily increasing in the 1950s, today we are faced with the largest amount of production ever. This dramatic increase was also partly caused by the introduction of intensified productive practices caused by the Green Revolution. These were later criticised for driving the society towards ecological degradation, unsustainable consumption of limited resources, and dependence on non-renewable resources and fossil fuels.

Intensification, consolidation and specialisation are just some of the large-scale behavioural trends that are inherent in that food system.

³³ Campbell, H., *Food systems failure, the global food crisis and the future of agriculture*, 2012, (pp. 30–45). London: Earthscan.

At that time, intensive practices dominated the sector as a whole and a small number of actors in the production, processing and retail control sectors were in command of most of the food system, influencing in a strong way the policy making in a strong way. The loopholes in trade agreements began to be widely exploited by more powerful nations, resulting in the creation of unfair competition with developing countries.

Contemporary to this phenomenon, the world was witnessing a rapid rise of fast food and global chain restaurants. This increase, together with the growing expanse of the food industry in general via powerful cooperation in the sector, led to the creation of powerful national and international policies designed to support the wave of agricultural intensification. These policies concerning the support of food production and the price stability system, particularly in the United States as the first mover in this field, were a follow-up to the Marshall Plan and they contributed to the political hegemony of the United States itself.

The foreign political decisions imposed by the United States and later by the United Kingdom and Europe played a part in the early growth of the agri-corporation, and it was in this context that the main developments in food technology that we know today began to manifest themselves, in order to effectively meet the needs of mass production. It can thus be observed that the canning techniques (mentioned in the first regime) began to be progressively industrialised and more efficient, and that at the end of the Second World War refrigeration techniques progressed not only on an industrial level but also and especially on the domestic level.

It is precisely after this period of changes that the transition from a primarily plant-based diet to one enriched with animal foods, fats and oils, sugars and processed carbohydrates began to take place. In fact, there was a real 'food transition' that was the main driver of the change in habits during the second regime and the following one. On the basis of what we have said, we can define that this transition took place in two different phases. The first phase focused on increasing the variety of diets available for the population by the introduction of products of more diverse ingredients. The second phase was developed through the creation of specific diets in relation to the social class to which people belonged. In fact, different classes had different needs and desires that had to be satisfied through personalisation and variations in food consumption.

For the working and poor classes, the diet was mainly based on relatively cheap, high-calorie and highly processed foodstuffs in order to gain the right amount of calories at a low cost for performing heavy work; for the middle and upper classes, the diet was predominantly based on expensive and sophisticated products such as fruit and vegetables or other more expensive foods.

During the 1980s, the first signs of the negative impact of the Green Revolution and of intensive agriculture began to appear. The new high-yield crops were responsible for the use of fertilisers or pesticides and, together with field irrigation, contributed to the beginning of the soil degradation, the overconsumption of water resources and the spreading of chemicals into the ecosystem.

Today, we can therefore say with complete certainty that the second regime contributed to both the current global environmental challenges and for the birth and later rise of obesity and type II Diabetes resulting from the new forms of nutrition developed during those years.

The current food regime

While some researchers have recently identified the period from the 1980s to the present day as a time of transition in terms of dietary regimes, others have proposed the emergence and existence of a third regime taking into account the ecological and cultural dynamics that are taking place. In this regard, two main theoretical proposals have been recognised. The first one is called the 'industrial corporate food regime' and was suggested by McMichael³⁴ at the beginning of the millennium, while the second one, of which Friedmann³⁵ is one of the creators, is based on a framing of the current state of food relations as the identification of a third regime, and it is also known as the 'corporate-environmental food regime'.

³⁴ McMichael, P, "Global development and the corporate food regime. *Research in Rural Sociology and Development*", 2005

³⁵ Friedmann, H. (2005). "From colonialism to green capitalism: Social movements and emergence of food regimes". In "New directions in the sociology of global development", ed. F. Buttel, and P. McMichael. Amsterdam: Elsevier

The 'corporate industrial food regime' constitutes a regime which operates primarily on the basis of food technologies that are heavily employed in production activity.

This system in fact provides for increasingly innovative and automated solutions in order to reduce the human presence in plants responsible for the creation and processing of products. If we consider this first hypothesis as the actual existing regime, then it would be essential to note the urgent need for a definition and the implementation of green strategies aimed at sustaining agri-food systems, for example through the promotion of chemical fertiliser and pesticide-free methods in both the agricultural and industrial food sectors. The existence of this regime would lead to an increase in both food safety issues and the role of technology as complementary to evolution itself

In contrast to what has been mentioned above, the model proposed by Friedmann is based on the conviction that today's alternative food networks are founded on the presence of other actors and trends - such as for instance supermarkets, audits or organic food. They are evidence of the existence of a different configuration of relations, leading to the presentation of a different possible regime called the 'environmental-farming regime'. This model would provoke the growth of a new line of food production and the following chain of consumption on the basis of movements aimed at emphasising social and ethical concepts such as fair trade, natural foods, promotion of consumer health and protection of animal welfare. In contrast to the first theoretical proposal of the potential current regime, the latter type is based on the opposite aspects of technology-intensive systems.

Moreover, food security considerations would take on a different perspective, since such shocks to the food supply (environmental, political, social or economic) could be absorbed without causing huge effects as seen in the past.

Food safety is not only a global challenge of our time, but it is an essential part of having a healthy human society.

Since prehistoric times, people have used food transformation techniques to extend the useful life of food materials and their safety. In particular, at this point in our history, the food production and consumption system is required to meet very complex demands.

It is not only about solving hunger and/or nutritional inadequacy, but also about doing so with sustainable approaches that ensure the survival of our ecosystem as a whole.

We can therefore say that any change in the food supply will inevitably have an impact on food, nutrition and health policies in the future, particularly with regard to food production, agricultural practices, dietary patterns, nutrition, health guidance and management. Climate change, droughts and floods have increased the level of concern about the availability of land for agriculture use, animal and plant production, and their quality and yield. Moreover, the resulting effect of energy shortages is directing attention towards biofuels as an alternative source of energy, particularly the ones coming from crops such as maize and oilseeds.

However, at the heart of the success of these possible changes, however, remains the crucial role of the consumer. Indeed, negative consumer attitudes and the nature of the risks are among the most significant factors preventing of the full benefit of new food technologies being achieved. It is precisely for these reasons that the trend whereby consumers are favouring products that are minimally processed, with a low content of food additives and produced through a totally sustainable process, is of considerable importance.

Consequently, one of the main needs at the moment is to coordinate consumer acceptance of the new technologies that are currently available.

This therefore lays the framework for finding alternative solutions to improve the efficiency and sustainability of the food chain.

2.3 The development of FoodTech

In order to sustainably meet the growing demand for food in the coming years, industrial production and agricultural systems will have to shift from the dominant paradigm of self-sufficiency, effectiveness and affordability to a more sustainable model that focuses even more on the conservation of water, land and plant and animal resources. This step should be technically appropriate, economically viable and socially acceptable.

For these reasons, recent efforts have started to include to the pre-existing model's to approaches that co-existence and co-evolution, at the same time able to compete one with the others, in order to develop and implement alternative forms of production processes and management in the food sector by introducing industry 4.0 and IT.

On the basis of the above, FoodTech has developed in recent years.

FoodTech is the ecosystem made up of all the entrepreneurs, stakeholders and agri-food startups that carry out activities between the production and distribution sectors able to create innovation in terms of products, distribution, marketing or business models.

It is the emerging sector that explores how technology can be exploited to improve efficiency and sustainability in both the food and environmental sectors.

The six FoodTech categories are represented by the food value chain from the activities of farming and agriculture (AgTech), the culinary aspects (FoodService for restaurants, Foodscience for CPG products) and to the ones involved in distribution (Delivery, Retail and Coaching).

Driven by its positive economic impact and thanks also to the growing awareness of the problems faced by our environmental and food system, the FoodTech sector has been transformed in the last 5 years from an emerging trend that was thought to be destined to die soon into one of the "hottest" topics in the startup world.

According to the FoodTech Data Navigator by Forward Fooding, an international company dedicated to the agri-food industry with the partnership of Accenture, Unilever and Var Group, the FoodTech sector is not suffering any crisis. In fact, with 65 billion investments in ten years, more than 5,348 companies, 4,500 operators and an annual growth rate of 42%, FoodTech is developing very rapidly on the global market.³⁶

Also according to a recent analysis by Emergen Research, the global food technology market is expected to be worth \$342.52 billion by 2027. This high growth can be attributed to the growing penetration of the Internet and smartphones in the developing economies. However, it is true that the food processing industries are increasing the adoption of advanced technologies due to the new and strict regulations implemented by the government and social organisations on food safety, animal welfare, health, climate and the environment.

In fact, there is an on-going quest to minimise food waste and reduce energy consumption, both of these factors are driving market growth in the FoodTech sector.

Geographically, while the US has led the charge, both in terms of the number of startups (1,300+) and levels of investment made, we now face a situation where Europe and Asia are rapidly catching up.

European startups still account for a small proportion of the total funding that the global FoodTech sector received, even though the two trends have crossed over in 2019. On a worldwide level investments have declined mainly in food marketplaces, a category characterised by a few European companies, while European total investments have strongly increased in many sectors including in the delivery field.

The preliminary 2020 investment statistics (pre-COVID-19) have confirmed this trend of a European FoodTech ecosystem rising on the global stage. At the same time, with more than 1,000 start-ups focused on FoodTech and especially AgTech, Silicon Valley, London and Israel are attracting more than 30% of global investment, although contemporary newer centres such as Singapore, Paris or Berlin are starting to emerge.

As can be seen from recent analyses on this topic, modern agri-food markets are strongly influenced by the dominance of multinationals and large corporations. In fact, if we use the production and the commercialisation of wheat as an example, we can see that about 4% of the companies operating in that sector control over 90% of the full trade.

This leads to negative effects on food safety, on the environment and on the market. From an economic point of view there is a situation where the market is mainly controlled by big companies without any great possibility for smaller companies to intervene, while from an environmental and ecosystem point of view this phenomenon leads to the exclusive use of a large areas of arable land for the creation of crops. This leads to a scarce presence of biodiversity in order to satisfy global market demand. In other words, there is a decrease in the number of varieties cultivated and a consequent destruction of the ecosystem.

However, if we consider less the production aspect of goods and more the consumption activity, we can observe that despite the top 10 global food and drink companies already

³⁶ Forward Fooding, *"The Stage of Global FoodTech Report"*, p.11, 2021

dominating almost 40% of the global market share, but they still continue to actively pursue Mergers & Acquisitions in order to increase their market influence and importance.³⁷ Thanks to this growing presence on the market, they are in a position that allows them to influence the entire agri-food sector, including end consumers, with their decision-making processes. The operation can also be politically successful in terms of pressuring governments, influencing policy agendas and driving the change.

For the reasons listed above, the establishment of corporate partnerships with startups can therefore direct this influence and buying power towards innovation in order to try and reduce the problems facing the food industry.

If we look at the growth trend of investments being made in the agri-FoodTech sector, we can see that since 2016 it has started to gain in importance, mainly due to an increase in the number of investments from large corporations but also because of the presence of incubators.

Since then, the sector has continued to grow at a CAGR of 42% despite the global pandemic and 2020 investment levels have reached a record growth of more than €17 billion. The partnership between companies and startups has evolved a lot in recent years. Initially it was a purely financial operation, today however, this merging strategy is based on important exchanges not only focused on the financial gain, but also increasing the information available in the company and learning new skills to make improvements within the organisation and solve core business problems.

Big companies are the holders of large amounts of capital for R&D and technological innovation, whilst startups are the strategic partners that offer new knowledge and expertise in the field. Thanks to the development of technology in recent decades, the emphasis on the role of startups is increasing, thus allowing other players involved to recognise their strength in rapidly creating and developing new innovations and new products.

According to The Unilever Foundry³⁸, the current industry landscape shows us that we are currently living in the perfect mood and conditions for successful food and beverage

³⁷ The Rise of Mega Companies in the Global Food System, 2019

³⁸ Unilever Foundry, *"The future of innovation: global study predicts startups and corporates to work under one roof by 2025"*, 2017

collaborations. There is an expected growth in collaboration between startups and corporations of around 46%.

The on-going upheaval of markets and global supply chains as a result of the COVID-19 pandemic, has only confirmed the need for a supportive ecosystem for innovation. Thanks to their agility and flexibility, young businesses are therefore able to cope with changes as the market and consumer trends change and they also have the advantage of operating in less bureaucratic conditions in comparison to large companies.

On the contrary, big brands are characterised by a more conventional model based on the continuity of successful strategies implemented in previous years and with few incentives to change. This is largely due to constant pressure and scepticism of shareholders in the face of a new emerging risk.

Indeed, innovation can disrupt existing processes with potentially high short-term costs and low immediate returns, thus not allowing an alignment of interests among the various stakeholders. To this end, it is notable that the R&D investment of US food and beverage companies in 2018 amounted to \$6.88 billion in contrast to the total amount invested in technology, which was approximately \$268.84 billion³⁹.

As the Circle Up statistic shows, we are faced with two different strategic choices depending on whether we consider a large corporation with many employees, with a solid core business and successful products on the market or whether we consider an innovative startup based on flexibility and technology development.

In the first case, particularly for Consumer Packaged Groups (CPGs), they have invested less than 2% of their revenue in R&D over the last year, compared to 15% of revenue spent on marketing operations for already existing products.

In the case of new technology startups, the situation is the opposite, as investments are higher, which helps to explain the rapid growth of the FoodTech sector.

In 2019, the most active investor in the food sector were Unilever Ventures undertaking 7 investments that allowed them to maintain their leading position in the market share compared to their competitors.

Other big players that have made significant investments in the last three years in sectors not closely related to their core business are: Amazon through an investment in

³⁹ Forward Fooding, *"The Stage of Global FoodTech Report"*, p.20, 2021

Plenty, a startup focused on vertical agriculture, Google Ventures with a loan to Impossible Foods and finally Levi's with Agriloop, a startup able to convert food crop waste into high-value natural fibres.

In recent years, thanks to increased awareness of the importance of collaborations between startups and corporations, there has been a real search by companies for the best projects to invest in. Food industry leaders hope to connect with highly-dynamic startups before other companies in order to do business through accelerator programmes. This has led to the evolution of accelerators. Accelerators are developers that help the mother companies to finance internal or external initiatives with their own resources for the support of long-term strategic objectives.

According to an estimate by the Forward FoodTech Data Navigator, it is thought that about 70 accelerators have developed in the last 5 years supported by corporations and businesses specialised globally in FoodTech, together with about 263 Corporates/CVCs. This new model of open innovation therefore allows startups to be more open to the market, grow rapidly and to be able to benefit directly from the whole CPGs ecosystem.

Among the new accelerators that have decided to invest in Italian FoodTech we can find Plug and Play, the global innovation platform born in Silicon Valley which provides an open innovation model in order to match big companies with the most promising international startups. Founded in the 2000s as early investors in Logitech, Google, Paypal and Dropbox, it is now present in more than 30 cities in America, Europe and Asia, with 300 large partner companies and 10,000 startups involved.

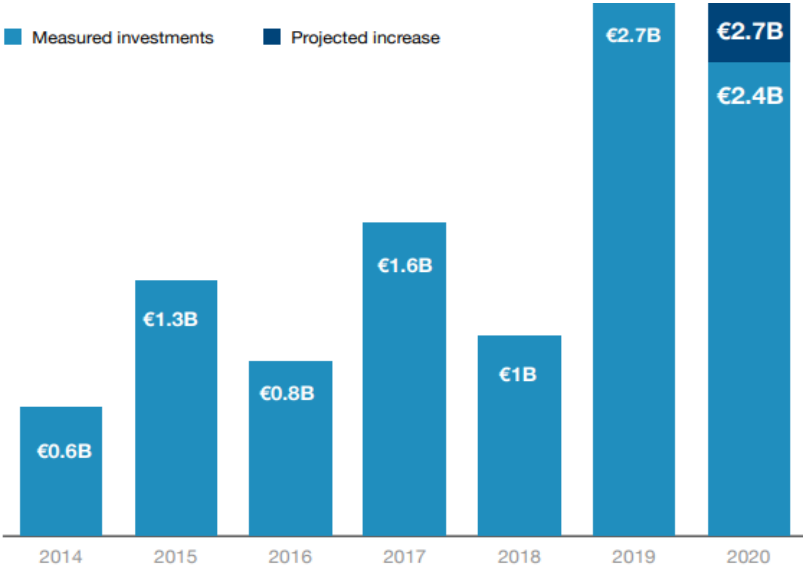
Given its great success, in April 2019 the accelerator decided to expand its business through a penetration of the Italian market. In particular, the marketplace of Milan saw the launch of a new Plug and Play accelerator within the food & beverage area with Esselunga, Lavazza, Unicredit and Tetra Pak as corporate partners involved in this new project.

The accelerator team is always structured around 3 different functions. The first is characterised by constant work with already affiliated partners and communities involved, the second consists of the definition of scouting programmes in order to find new startups to invest in, both for corporate partners in the case of Italy and for general investments (about 10%). Finally the third is about bringing new corporate partners on board.

As another major player committed to the promotion and encouragement of new businesses, Intesa Sanpaolo is one of the leading banks in Europe that has always been very close to the food sector. In fact, in order to guarantee support for the development of the Italian territory, the banking group considers the identification and sponsorship of Italy's main representative food production chains as a top priority. One of the most important sectors is represented by Agri-Food one, and precisely for this reason Intesa Sanpaolo has recently created StartUp Initiative, an international acceleration project promoted by and aimed at all entities operating in the world of FoodTech. This is dedicated in particular to projects in the fields of agriculture and animal farming (regenerative agriculture, urban farming, hydroponics and other similar projects), machinery and equipment (connected machines, automation and robotics, smart cooking, 3D printers), and food quality and safety (control and diagnostics, natural preservatives and additives, traceability, compostable packaging, recyclable packaging).

In 2020, European FoodTech startups raised €2.7 billion from investments by external companies, equalling the amount achieved in 2019. Maintaining this high level of investment in such a complicated year is therefore a confirmation of how well this new sector is growing and evolving, thanks above all to its ability to find alternative and sustainable solutions for most companies operating in the food industry.

Figure 2. State of the European Ecosystem - Investment



Source: <https://FoodTech in Europe in 2021-DigitalFoodLab>

Early figures for the first quarter of 2021 indicate that this trend will continue in the following months, with the investment share expected to rise further.⁴⁰

Despite the pandemic, the total amount of money invested in FoodTech companies has increased significantly globally, resulting in a decrease in the European proportion of the total ecosystem (12%).

Focusing our analysis on the European market and trends in this sector, we can define that after a careful analysis of several years of data collected in the FoodTech observation, we can conclude that there are three generations of startups that have followed one after the other. The first generation was initially focused on restaurant delivery, an activity that during the pandemic has continued to see significant growth in adoption even by many small and medium-sized restaurateurs or grocery shops. On the basis of these results, the second generation of startups was initially based on a development of home delivery related activities, also seeing a transition of ideas regarding not only restaurants but also groceries. Due to this increase in interest, many non-delivery businesses have started to receive significant funding. On the other hand, the latest generation of European FoodTech startups developing are more diversified than the others, since they are based on investments in potential future food leaders and a greater focus and appeal on combining Industry 4.0 and automation in production processes.

This last group of startups are therefore very different from the previous ones in many features precisely because they are not only based on the continuation of ideas already developed in previous waves such as home food delivery, but they have also invested in projects aimed to safeguard and ensure food safety.

Considering the future growth trends and what has been said in the previous chapters about the raise of the world population and the negative consequences that this will bring, it is important to carefully analyse the new activities being launched and the trends that are emerging in the market. One of the new challenges for the coming years will be the reduction of gas emissions resulting from intensive livestock breeding, which will imply a subsequent reduction of this kind of food in our diet.

⁴⁰ DigitalFoodLab, *"FoodTech in Europe in 2021"*, 2021

For this reason, some new startups are trying to create new food categories consisting of alternative proteins derived from insects, mushrooms, vegetables, soya or directly reproduce them in their laboratory. Contemporarily, on the basis of general FoodTech components, there is an increasing presence of cloud kitchens in Europe and the incorporation of robotics in the cultivation and production processes in order to reduce human intervention and use resources (water, insecticides, soil) more efficiently.

On the other hand, considering the investment process by big corporations, which used to be manifested only when startups had already launched their activities and therefore they had a real analysis of returns, today we can say that it takes place on a fiduciary basis even before having certain data on the success or failure of the idea. Firstly, this shows that investors have more confidence in the future of the companies they are betting on, and at the same time it is also a sign of increased competition among investors to join the best companies on the market.

This is therefore something new and very positive for the future of the European ecosystem, ensuring that even long-term projects that will not generate significant revenue in the short term will be able to obtain significant funds for the development of projects.

Although FoodTech is in a state of constant evolution and although Europe is experiencing rapid expansion with still plenty of resources to be invested there is no certainty that it will become the sector leader in the coming years, or overtake the United States of America.

Nevertheless, success would still be guaranteed if large companies would continue to express their confidence in emerging young companies by investing in medium and long-term projects, regardless of their short-term profitability. It would require them to see the future of local agri-food enterprises as strategic.

In addition, the creation of greater collaboration between institutions, research centres, universities, incubators, companies and entrepreneurs will be of fundamental importance to ensure a path to internationalisation of European products.

2.4 The FoodTech taxonomy

The digital ecosystem is a pre-requisite for the evaluation of any kind of FoodTech startup. Within this emerging environment, there is a continuous exchange of information, goods and services between different types of stakeholders who would otherwise not be able to interact with one another. This is made possible by enabling platforms that facilitate these transactions through complementary actors who share a network ecosystem.

FoodTech finds its logic and natural habitat in a digital system where its components act as a networked intermediary hub.

The six FoodTech categories are represented by:

- 1- FOODSERVICE: concerns all startups that improve the world of HoReCa (hotels, restaurants, catering). The introduction of these technologies helps to make structures more hospitable and to better manage the companies involved. Traditional realities are thus merged with innovations such as robotics and cloud kitchens.
- 2- DELIVERY: concerns all startups responding to the continuing and emerging challenges of delivery in the food and non-food industry through the introduction of home delivery services.
- 3- COACHING: concerns all startups that provide answers to questions posed by the final consumer. These days, in fact, more and more people are questioning the quality of the food they eat, the benefits it has and the correct caloric contribution to be taken daily. These services help people to have a better view of their purchases also for the achievement of personal goals.
- 4- RETAIL: concerns all startups that are developing solutions to make the supply chain more digital and to improve the in-store shopping experience for the final consumer.

- 5- AGTECH: concerns all startups that are involved in the design of new methods of agriculture. They suggest solutions to improve crop production and quality, quantity and efficiency through the use of drones, IT, sensors and management software targeted also at small farms. They also deliver new cultivation techniques based on aeroponics, hydroponics or vertical cultivation.
- 6- FOODSCIENCE: concerns all startups aiming to create and discover new food products that address emerging food needs in a more sustainable way. This implies greater transparency, a stronger focus on people's health and control of environmental considerations. The focus ranges from market innovations on existing products to the introduction of radical disruptions in the food sector, such as the creation of fake meat.

FoodService

As far as the first component is concerned, the so called FoodService, we can say that digitisation has simplified the user-experience process and it has allowed both restaurateurs and retailers to get more returns on their business.

While at the end of the 1990s the fastest way to book a table was to phone the restaurant directly, already in the 2000s, thanks to the evolution of operating systems and a general improvement of the broadband, restaurants started to equip themselves with personalised websites introducing the first online reservations. The hotel and tourism sector were the first to bring a decisive impact to the world of online bookings, introducing always more advanced and sophisticated systems.

Thanks to the development of such platforms and other services, the general public has become accustomed to this new logic of consumption, inevitably involving the catering sector soon afterwards.

We can consider the launch of The Fork (La Fourchette) in 2007 as the breakthrough moment for what would become FoodTech years later. The Fork, which started in France as a platform connecting restaurants and their clients, has later evolved into a solution for managing online bookings and increasing a restaurant's performance, until

the moment in which it finally became a reference point for the entire customer experience in a restaurant.

Today, thanks to this app, consumers can find thousands of locations to suit their needs, they can leave or evaluate the service received through online reviews and they can make their own reservations.

The year 2007 was also the year of the explosion in the adoption of Yelp. Yelp is a business founded in 2004 by two entrepreneurs coming from the famous PayPal company. Developed in the United States and then reaching markets in Europe and Asia, Yelp played a major role in improving online review platforms in partnership with Tripadvisor.

The interest of the FoodService today therefore seems to be focused on the emergence and development of startups related to B2B services and applications also for the daily management of commercial activities. These include electronic invoicing services necessary to improve company management, services for an effective and more efficient management of raw materials and meals in order to reduce food waste, services for the management of employees through support and recruitment activities. The presence of technology can also be seen in the creation and implementation of cloud kitchens through startups that can manage them entirely, kitchen robots to help or replace human tasks, the inclusion of 3D printers for the production phase, automated kiosks and robot bartenders.

In addition, given that the importance of customer care is developing rapidly, some innovative startups have been created to provide services to enhance the customer's time and experience within the facility.

Thanks to FoodService, some other new services are guaranteed, such as the one of POS payment systems, catering solutions that allow anyone to benefit from the services offered by chefs in organizing personalised dinners or events at home, or the service given by the possibility to book tables in restaurants with a reserved discount in order to encourage the consumer to choose that establishment.

The FoodService ecosystem saw 2020 as a year of fluctuating performance levels due also for the pandemic. While some sub-categories of FoodTech have been hard hit in Europe, at the same time the presence of cloud kitchens has increased dramatically both

in terms of the number of adoptions and in the amounts of investment they have received - among the most prominent ones there is Karma Kitchen, a leader in the sector and in continuous expansion throughout Europe.

Another fast-growing European sector is that of ePOS service startups that are able to drive the trend towards greater digitisation of the value chain by also increasing relationships between restaurants and their suppliers.

Delivery

For the FoodService world, as we have seen, it was the demand that drove the technological revolution in the restaurant and hospitality sector. However, gradually the focus began to shift towards the entire customer experience with the aim of anticipating customer needs and optimising the use of available resources.

One of these needs has resulted in the emergence of the delivery service that meets the needs of both consumers and restaurateurs, allowing the first to optimise the time it takes to request food to be delivered home and the second to increase revenues by offering personalised offers.

Globally, there are two companies that have distinguished themselves most in door-to-door delivery: the British giant Deliveroo and the UberEATS food solution created by the US transport company.

In addition to these types of startups, the sector is also made up of businesses that regularly deliver to their customers' homes special kits containing all the ingredients needed to make a recipe or regarding the discovery boxes. These boxes are made up of a careful selection of selected and sophisticated products, such as wine, tea, coffee, exotic foods from all over the world able to guarantee a culinary experience directly at home.

Delivery startups therefore respond to the new challenges of the food industry, with grocery home delivery, restaurant meals or meals prepared in their kitchens through the application of new technologies such as drones or robots for food delivery, food e-commerce platforms, farm-to-home solutions and delivery made directly from shops.

From an economic point of view, however, when we analyse the European industry trends we can see that since 2014 there has been an unusual evolution of investment levels in the Delivery sector.

In fact every two years, in this type of startup the level of investments have declined. Despite the fact that 2020 was characterised by a historical pandemic that accelerated the adoption of Delivery even by different realities and despite the development of other local startups related to this service, investments were lower than in previous years. With a very sharp drop of around 65% less of money invested compared to 2019, the year 2020 has thus seen a decline in what was once the driving force behind the entire FoodTech ecosystem, dropping from €634M to €171M.⁴¹

Coaching

Moving on to analyse the third FoodTech ecosystem, we can notice that, as mentioned above, consumers questions and doubts regarding the quality of what they consume and whether or not these foodstuffs are good for their health are constantly growing. Precisely for this reason, new forms of Coaching have been developed to put technology alongside traditional methods.

This service aims to provide consumers useful tools to orient themselves in their nutritional choices through the inclusion of a figure such as the "food coach" who naturally becomes the actual person responsible for the client's diet. Through a series of initiatives, some meetings with experts, information and awareness raising activities, its fundamental role is to take care of people's nutrition and food culture by offering guidelines for daily training in more healthy ways of eating and better lifestyle.

These services address the final customer by assisting him to have a clearer view of his purchases, mainly by conditioning his food consumption in order to achieve personal goals.

The companies involved are those that offer analytical services using genome or microbiota-based tests to establish the personalised nutritional needs of each client, and the ones that combine advice and opinions of specialised nutritionists with technology provided by apps. They can help manage the organisation of meals during the day, provide fit alternatives to more elaborate recipes without compromising on flavour, and help manage food and drink shopping lists more accurately in accordance with each customer's expectations. The work of the startups is characterised by the use of algorithms based on artificial intelligence capable of generating direct consumer

⁴¹ DigitalFoodLab, "FoodTech in Europe in 2021", 2021

engagement through interactive games or engaging videos broadcast on social networks.

When it relates to the food industry, transparency has always been fundamental to conduct a healthy and balanced life. For this reason, technological solutions have been developed in order to give consumers easy access to information on the origin, quality, nutritional values and production chains of the products they buy.

Coaching initially emerged and developed in the United States of America, partly because of the dramatic numbers of obesity and nutritional diseases that still effect the nation. In contrast, in Europe this sector has been stagnant for years, with no real leaders companies. Until the early 2020s, European consumers showed limited interest in contacting and approaching a nutrition specialist for advice on what to eat and what to avoid, either in person or digitally. For these reasons, levels of investment in these types of ideas also tend to be unequal when considering one region rather than another.

Retail

The fourth component of FoodTech is the Retail sector, which includes all startups aiming at finding solutions for the food retail industry in order to ensure a better in-store shopping experience for the final consumer through targeted digitalisation. This is made possible by the presence of businesses that are able to address food supply chain challenges through tools aimed at improving the management of collected data.

Moreover, supply management is of fundamental importance in achieving the purpose of FoodTech Retail, for the building of strong relationships between the brands involved and their customers, and for the establishment of links that favour the knowledge of the end consumers in order to study their behaviour and be able to offer more personalised solutions that meet the needs of the market.

One of the most successful companies in this innovative ecosystem is ALKEMICS, a young company based in Paris that helps retailers to digitise their processes. With a customer portfolio of more than 17,000 brands, it has been able to raise €21 million to develop its supplier-retailer platform.

As can be seen from the graphs presented in DigitalFoodLab's latest report, even in this Retail ecosystem the European market presence remains weaker than the American one.

Possibly due to a divergence in culture, in the USA the biggest businesses have developed by transforming existing shops into digitalised experiences without the traditional presence human contact. These aspects turn out to be almost totally absent in the European landscape. Moreover, around the years 2016 and 2017 this ecosystem went through down moments due to the creation of the blockchain and the consequent migration of entrepreneurs in the use of the same in business management without great success.

Agtech

The final two aspects that compose FoodTech, and on which the second part of the thesis will focus more, are Agtech and FoodScience.

The Agtech sector is characterised by all those services and technologies that aim to increase the efficiency and sustainability of agriculture by reducing at the same time the resources used in the production process. This procedure is done by integrating traditional farming methods with technology thanks to the use and introduction of field sensors, drones, management software and automated machinery. So, over the years, new cultivation techniques have been developed, such as for instance the one involving aquaculture, vertical agriculture, and the breeding of insects used for crop protection.

The food sector, and in particular the agriculture one, has always been the most important economic resource characterized by a permanent customer base of about 9 billion people.

For these reasons, the World Bank estimates that food and agriculture industries are responsible for about 10% of global GDP.

However, because of this strong and growing population base, the food industry is facing unprecedented challenges due to an expanding production demand.

Drawing on the research previously presented in this thesis, we can define that some of the main objectives set to address this food challenge are based on the need to address the on-going environmental problems caused by this area.

The dependence on heavy use of pesticides and fossil fuels, together with the use of some of the common methods present in current ways of agricultural production, must

be gradually eliminated over time by making the transition to a new model of resilient and sustainable agriculture.

In addition, recently the demands and attention of consumers have also started to shift significantly. They are becoming more focused on sustainability, health protection and freshness of food.

It is therefore necessary to define a new era of agricultural production centred on the maximisation of production for farmers whilst not damaging the ecological resources on which it is based.

One of the key aspects of the AgTech strategy is defined by an approach made up of numerous agricultural options that can be implemented in different contexts according to individual needs. Since it is not a 'one size fits all' strategy where there is only one solution applied to different problems, a wide number of potential actions have been identified as being potentially available to significantly reduce the impacts of implementing conventional farming practices.

The transformation of agricultural systems, and more generally that of food systems, which we are currently experiencing, has been the subject of debates and studies for several decades. Indeed, based on evidence from analyses carried out by FAO or by other environmental organisations, there has been an increase in concern about food security and sustainability in the last few years. This has generated the beginning of social change and the subsequent development and adoption of new dietary regimes.

At the heart of this there is the key presence of agricultural innovation systems (AIS) that include a network of players from the world of science, business, civil society and government. They are responsible for the creation of technological, social and institutional innovations that shape modern food systems.

The new ways of production proposed by the Agtech ecosystem differ substantially from the current methods used, which are usually based on the massive use of land, the fundamental human presence and the use of machines that are not fully digitalised.

They are also incorporating a range of technologies used for sustainable solar power generation, and creating nature-based and ecologically green solutions through the application of robotic technology.⁴²

AgTech is thus characterised by startups researching and developing new ways of safeguarding the ecosystem, as well as startups providing farmers with electronic devices like robots and drones that can support and sometimes replace human labour. An application of technology to the previous cropping systems is being carried out through the development of vertical farming, an innovative technique that will allow the achievement of agricultural sustainability while ensuring the mass production necessary to meet market demand. This method is developed through the presence of special multilevel buildings located in non-fertile land areas, hence reusing uncultivated spaces or the urban agglomerations. Fruits and vegetables may be produced all year round, with advantages both for the consumer, who is guaranteed fresh products at all times, and for producers, who can save energy, reduce production waste and cut costs for pesticides and transport.

In addition to these solutions, the sector includes startups for the collection and processing of data obtained through special systems installed directly in the fields, and startups that act as marketplaces and e-commerce for the purchase of commodities and innovative work equipment.

In recent years, through the development of targeted software, it has been possible to reach a level of optimisation and control of resource use that ensures efficiency and sustainability in all agricultural activities.

A growing number of farmers are realising that information and communication technologies (ICT) are no longer a futuristic novelty, but a current reality because of their capacity to transform the nature of work and the structure of the workplace.

Smartphones based on new sensing technologies, artificial intelligence (AI) and machine learning algorithms (ML) create a new intermediate level of intelligence between people and systems to efficiently solve complex problems or even tackle commonplace everyday challenges. As a matter of fact, while smart applications were identified as one

⁴² Klerkx L., Begeman S., “*Supporting food systems transformation: The what, why, who, where and how of mission-oriented agricultural innovation systems*”, 2020

of the top ten strategic technology trends globally in 2018, the year 2021 represents a significantly higher growth year.

The need for new platforms that help and facilitate farmers' tasks is growing and it is becoming an indispensable tool at a personal, social and professional level. It is actually an added value to develop systems that farmers can access directly and intuitively through the use of mobile apps allowing them to store and collect all the different crop information on a single device. From there, farmers can monitor yields in real time, receive plant status alerts and perform activities from a remote location.

From New York to Milan, from Paris to other large cities, the innovation that is spreading increasingly is the presence of urban gardens that bring the agricultural sector closer to the citizen. They now account for 24% of all investments made in AgTech and they make possible a reduction in the distance between production and consumption by increasing the availability and the sustainability of products on the market.

As we can see from the current trends, the volume of investments has increased significantly over the last six years⁴³.

While the entire European FoodTech ecosystem experienced some declines in almost all areas of the industry, AgTech startups have increased their investors by 44% between 2019 and 2020, now accounting for 33% of the total 2020 investments made in the entire European FoodTech startups.

Analysing the data of the European Trend Report, it can be deduced that stakeholder attention is mainly focused on AgBiotech business, which accounts for 64% of AgTech investments. This type of activity is based on all the technologies used during biological or chemical processes.

This is a very broad category involving many types of science associated with innovation, including animal breeding, breed genetics, microbiome research, animal health and their nutrition. Overall, it has recorded a 21% increase in the value of investments in 2020, rising from USD 229 million to USD 277 million in a very brief period of time.

⁴³AgFunder, "2020 European Agri-FoodTech – Investment Report", 2020

At the top of the AgBioTech rankings can be found the Spanish startup PlantResponse Biotech, a spinoff from the Technical University of Madrid, the French M2I Life Sciences which obtained the second largest funding with a round from the British Cibus Fund, and the Belgian Biotalys (previously known as AgroSavfe) which develops new crop protection products by synthesising insect DNA.

We can then see that the presence of opportunities arising from the application and development of startups related to the AgTech ecosystem is attracting new investors who are willing to contribute to the increase of agricultural profitability.

Next Gen Food and Drink

The last FoodTech ecosystem to be analysed is the FoodScience ecosystem, also known under the name of Next Gen Food and Drink.

As we have already seen, nutrition is today the focus of numerous studies and research in order to define more sustainable production processes both from an environmental point of view and for the protection of human health. To address these problems, some governments have issued targeted policies to reduce and avoid problems of malnutrition and obesity.

Unfortunately, despite numerous efforts made, some objectives and general guidelines have never been achieved, such as those defined during the period between 1980 and 2010 by the United States. They provided suggestions for the population on how to spread a culture of well-balanced nutrition and optimal health by encouraging them to cut down on high-sodium food, saturated fat, high-cholesterol and sugar products while increasing the consumption of fruit, vegetables and low-fat alternatives.

According to a statement by the UK Government's Office for Science in a 2011 report⁴⁴, there was a need to undertake more technological investment in the nutrition sector in order to cope efficiently with the rising challenges of the next several years.

On the basis of these needs, different technologies and methodologies have been developed over the years, and they have been adapted to the discipline being analysed. They include nanotechnology, genetic variation, bioinformatics associated with chemistry and biofortification, big-data analysis and risk assessment and management,

⁴⁴ UK Government's Office for Science, *"Foresight Project: Global Food and Farming Futures. Executive Summary Crown copyright"* URN 11/547

neuroscience and finally neuroimaging.

After a decade, we can now say that to solve today's complex problems there is a strong need for the development, application, coordination and sharing of integrated research approaches and solutions defined across disciplines.

To enable the application of specific technologies more relevant to each individual situation, there is a need to understand the basic mechanisms of food-substance interactions in order to achieve full consumer acceptance of food. It is therefore necessary to give and ensure them sufficient time to change their diet and habits in order to carry out the process.

In accordance with what has been said above, the development of FoodScience is consequently predominantly based on the identification and development of new food products able to respond to consumers' demand for improved transparency, health and sustainability. A veritable science of nutrition has developed with the presence of startups that are responsible for the introduction of revolutionary ingredients into the market, leading to radical changes.

Another key component of the FoodTech ecosystem is the presence of Future Foods. Innovative foods created by business development companies with the aim of reproducing and designing in a laboratory food products capable of replacing the ones currently in use with more sustainable variants. This process of innovation is also achieved by establishing partnerships with companies currently working on already existing products or markets, thus complementing each other and making their own divisions more transparent.

They thereby offer greater tailor-made customisation and more efficient means of distribution.

In addition, the so-called meal replacement foods are becoming increasingly popular among the younger generation: bars, drinks or powders provide nutritious and calorie-rich alternatives to traditional meals.

The FoodScience ecosystem is not only about identifying new foodstuffs but also about developing innovative drinks. In recent years, many startups have focused on the conception of new beverages with a reduction in sugar and calories, even coming up with non-alcoholic alternatives in cases where we would never have expected them.

As is the case with food, this choice was born not only out of a marketing drive, but also and above all out of the need to introduce products into the market that would meet the continuing requirements of consumers.

This whole process and continuous innovation aimed at promoting new products is therefore intended to achieve a healthier lifestyle by adopting a different diet compared to those previously used.

Confirming the previous observations, the FoodScience ecosystem in 2020 also achieved excellent results and performance for European trends. The food industry has been booming in recent years, thus contributing to the narrowing of the gap between investments being made in the USA and those made in Europe. For these reasons, public administrations are beginning to be interested in making investments in this sector, such as for example as the European Union's Green Deal project, which will play a fundamental role in the growth of FoodTech.

These funds should primarily be used to implement short-term trend acceleration projects, such as innovation in plant-based products that mainly characterise the Future Food sector, and then subsequently move towards the creation of long-term future food solutions.

The economic advance of FoodScience turned out to be very impressive, especially for startups developing alternative proteins. The number of partnerships and the amounts invested in products of these companies were huge compared to the ones of previous years.

In fact, it passed from an investment level of €203M in 2019 to a €566M in 2020, with 30% coming from investments in FoodScience in general and the remaining 70% coming from investments in alternative proteins.⁴⁵

The reason behind this breakthrough and this seemingly unexpected growth trend has instead been identified as the delayed 'Beyond Meat effect'. After the Ethan Brown startup went IPO in 2019, experiencing huge success both as the stock and as the product, there was a rise in the number of investments and financiers.

Founded in 2009 by the current CEO, the Californian company is a startup that produces meat from plants aiming to ride the wave of the growing demand for vegetarian food

⁴⁵ DigitalFoodLab, *"FoodTech in Europe in 2021"*, 2021

alternatives and the increasing popularity of veganism in order to boost research and development in the sector.

In fact, instead of basing their business on growing low-value protein food for animals, they hope to create a future of farmers growing higher value protein products for more direct human consumption via processed plant-based meat. Among the supporters of Beyond Meat we can find the US meat producer Tyson, the founder of Microsoft, Bill Gates, and the Hollywood actor and environmental activist Leonardo Di Caprio.

As a result of this movement, new realities have emerged within this new section of 'alternative proteins' through various production segments:

1. short-term alternatives related to plant-based food startups such as Oatly, which is specialised in dairy substitutes, and Meatless farm, which is specialised in creating meat substitutes;
2. medium-term alternatives through the precision fermentation and biomass developed, for example, by the Legendairy startup;
3. long-term alternatives such as cellular agriculture presented by MosaMeat and the one regarding the conversion of CO₂ into protein developed by Solar Foods.

The European FoodTech ecosystem has prospective champions in all sub-segments of alternative proteins, with The Meatless Farm set to go public soon together with businesses such as This, Heura and Oatly. The IPO of the latter could have the same effect on the alternative dairy segment that Beyond Meat's IPO had on the meat ones. We could see a wave of investment in dairy alternative products aiming at diminishing the one coming from milk, yoghurt and cheese transformation, which represent the increased focus of innovative attention due to both the rise of vegan diets and the increase in the number of lactose-intolerant people.

To conclude, we can describe and interpret FoodTech as the use and insertion of digital technologies along the entire production and distribution chain of the agri-food field. This represents an outstanding potential to contribute, even if only partially, to the achievement of the second SDGs based on ensuring food security for the entire global population and reducing malnutrition-related problems.

It also represents an alternative way of limiting the impact of the whole sector on the environment, through a more responsible use of resources and avoiding a massive increase in the production of food.

It is therefore important that the focus of this operation is not limited to a single technology, but to the entire technological field, including the detection and analysis of big data, the use of blockchain as a new management approach and the presence and application of artificial intelligence.

These make a significant contribution to the improvement of the global agri-food chain through an inclusive process able to simultaneously and compatibly address all the SDGs of the 2030 Agenda, and not just those related to food.

Chapter III

A comparison between two words: AgTech and Next Gen Food & Drinks

3.1 Introduction

Large companies, especially in the food sector, are in urgent need of disruptive new business models that allow faster growth and more stable market share, whilst at the same time facilitating the establishment of their corporate image and the introduction of new products on the market.

As a result of the aforementioned point, digitisation is now at the heart of this new process of technological innovation. Through corporate venture capital and the increasingly presence of start-up accelerator programmes and related incubators, large companies are now looking for more sophisticated ways to increase their profits. In fact, more and more top businesses are actively investing in the development of the ideas of young people in order to combine and match their financial resources with the knowhow and technological skills typical of the startups.

The food and drink industry is one of those that is currently experiencing a collective change. In a world situation that is facing its biggest challenges - overpopulation, climate change, virus outbreaks, stagnating resources and changing consumer demands - new startups in the food sector are working on innovative concepts to make our diet more resourceful, efficient, waste-free and consequently more sustainable.

In this chapter, we will highlight the various trends in the agricultural field and the product segment of the food and beverage industry. More specifically, we will focus on how investment trends are accelerating the industry's transition to a more sustainable future in AgTech ecosystem, in the Next Gen Food & Drinks ecosystem and in ingredients innovation.

According to studies carried out by National Geographic, it has been predicted that the population's food consumption will increase by 35% by 2050.

Under our current food system, the world's food giants will therefore have to face new challenges, especially now that human awareness about the impact that this sector has and will have on the environment is constantly increasing.

The capital investment by large companies in FoodTech startups is thus becoming the indispensable precondition for the change, for digitisation and for the slow but steady transition to a more green industry.

Nestlé, for example, has accelerated its efforts by announcing that it will achieve zero net emissions by 2050 and zero environmental impact by 2030. This process will be implemented through the transformation of its products, in line with consumer trends and choices, by increasing technological initiatives in the agricultural field in order to absorb more carbon, and by using fully renewable electricity in their factories, warehouses, logistics and offices.

Similarly to the previous example, also Unilever⁴⁶ is currently taking action through its participation in the MPM Advisory Council. In fact, it invites other companies to join its initiatives in order to achieve a collective vision of a global economy in which all companies work together to create a more shared and sustainable future for all.

The research tool used for the writing of this chapter is the semi-structured, discursive, in-depth interview, which was necessary to gather information. The form of interview considered to be the most suitable for this type of research is, therefore, the one that explores the creation of startups, their mission and the path that led them from the moment of conception and development up to the present day. Through these meetings a certain margin was left open for the interviewee's digressions, but at the same time it turned out to be sufficiently focused on the topic I wanted to explore. The interviews have been structured in such a way to respect the privacy and needs of each individual entrepreneur, who freely decided to collaborate after having been adequately informed about the purpose and motivations of this project. After the interview, the transcription of the recording was read through and carefully analysed. The complete text can be

⁴⁶ Unilever is one of the main players in the B-Corp movement. B-Corps are companies that together form a global community that aims to spread a more advanced business paradigm. Around the world, certified B-Corps stand out in the marketplace from all the other firms because they go beyond the profit goal and are continuously innovating to maximise their positive impact on employees, on the communities in which they operate, on the environment and on all stakeholders involved. In fact, B-Corp voluntarily and formally chooses to produce social and environmental benefits at the same time as it achieves its profit results.

found in the "Appendix" section at the end of this thesis and it has been transcribed with the intention of remaining faithful to the recording.

After a brief description of the ecosystem analysed, the sub-chapter will consist of two parts: the first giving an explanation of the startups involved, while the second discusses the definition of common aspects in order to better understand the equality and diversity of the companies' realities.

The companies questioned were:

- AgTech Ecosystem: ONO Exponential Farming, Agricooltur, Dasfrm;
- Next Gen Food & Drinks Ecosystem: Juicy Marbles, Revo Foods.

3.2 AgTech ecosystem

A research project carried out by the Smart AgriFood Observatory has highlighted the fact that digital technology is the key component in ensuring the future of the agricultural sector. Thanks to changes within the AgTech ecosystem, it is now possible to define solutions able to increase the competitiveness of the entire sector and improve the quality and traceability of Made in Italy food products.

There are now several technological solutions available on the Italian market and at least 40% of the innovative farms which have adopted them have consequently improved both efficiency and effectiveness, thus reducing production times and costs.

What stands out above all others are the digital solutions for the achievement of objectives defined in the Report "State of Food Security and Nutrition in the World" by the five United Nations agencies involved in the sphere of nutrition (FAO - IFAD - WFP - UNICEF - WHO). This data therefore highlights how extremely difficult it is to achieve Sustainable Development Goal 2 (SDG), which aims to zero hunger in the world by 2030. The report has also introduced a new indicator to measure food insecurity on the basis of different levels of severity - medium or high risk - and to monitor progress towards the Sustainable Development Goal. More than 2 billion people, most of whom live in low and middle income countries, are not only lacking healthy nutrition but they also lack safe and regular access to healthy, nutritious and sufficient food.

Based on the above considerations, we can say that, at present, almost a quarter of the startups in the FoodTech world operate in the field of Agriculture 4.0.

Agriculture 4.0 can be defined as the harmonious use of a mix of digital technology in order to improve the efficiency, performance and sustainability of crops, the quality of the production process and the end products, and the working conditions of the workers.

The main innovations used in Agriculture 4.0 are geared above all towards precision farming through the application of specific agronomic software and, to a lesser extent, towards interconnected agriculture, the so-called Internet of Farming.

Precision Farming is an innovative procedure that makes possible a series of machining operations in a much more precise and automatic way. It is a type of agriculture based on the application of agronomic software that allows a company management (in agriculture, but also in forestry and zootechnics) to be based on the observation, measurement and evaluation of the set of quantitative and qualitative variables intervening in the production phase, both inside and outside the field. After an analysis of site-specific data, this process is necessary for the definition of a decision support system for the entire management of the company. All enabling the optimising yields with a view to advanced climatic and environmental, economic, productive and social sustainability.

Moreover, through this type of technology is possible to optimise production efficiency and quality, reduce company costs, optimise the inputs used, minimise environmental impacts and at the same time increase the creation of business opportunities such as consultancy companies, outsourcing and innovation brokers.

The main enabling technologies in Precision Farming are:

- Electronics technology (basic or even very advanced) designed to both acquire data in the monitoring phase, and to use information within the production context in the operational control phase. Technologies therefore that generate and use information throughout the whole process of the production cycle;
- Positioning technology by which information for the production cycle is combined with additional essential data when a geographical or site-specific dimension comes into play in the production process;

- Hardware information technology for the physical management of data. Consisting of systems and physical media or channels that display, store, transmit data via various types of networks and telecommunications systems and usability;
- Software information technology for processing data and interfacing the digital functionality of hardware for end-user usability. This also includes all decision support systems and the software systems for analysis, even automated, capable of establishing actuations through other types of systems (i.e. hydraulic, electronic, mechanical).

The whole or partial use of these technologies contributes to a series of agronomic, economic and environmental benefits, as a result of reduced pressure exercised by agricultural systems on the environment.

In fact, the precision tool introduced by technologies makes it possible to carry out, for both open field and protected crops, a targeted distribution of water, fertilisers, phytosanitary products only where it is needed and in the quantity corresponding to the real needs of the growing crop.

In addition, the use of sensors also allows a real-time monitoring of the health status of the plants, controlling for example the emergence of phytopathology, environmental conditions or reducing inappropriate agronomic practices that could induce pathogenesis in the plants themselves.

This also means savings in synthetic chemical substances needed for crop protection, which is also good for the environment.

Internet of Farming, on the other hand, proposes a more integrated and interconnected view than Precision Farming. This is achieved by making large amounts of data relating to an individual farm readily available. This type of agricultural innovation consists of combining previously collected farm data with data obtained, for example, from weather satellites or by the use of a drone capable of flying over a specific agricultural region.

After this first step of collecting information and indicators, there is then, also in real time, the grouping of common factors among farms of a specific homogeneous territory.

This is done in order to obtain results that make it possible to better understand the events that occur in the fields of cultivation considered.

For example, this technology may make it possible to define why some plots of land are more fertile and productive than others, thus enabling an even higher overall level of efficiency and effectiveness to be achieved. This can be achieved thanks both to the presence of much more complete data and to the presence of a process that simultaneously extends the advantage and benefits not only to a company but to an entire territory and/or entire supply chains.

The growing technological offer is therefore pushing the Agriculture 4.0 market towards rapid and continuous expansion. In 2018, the sector reached a value between €370 and €430 million with an increase of 270% in just one year, equivalent to about 5% of the global one and 18% of the European one. This corresponds to a market made up of more than 110 innovative agricultural supplier companies, including established players and startups.⁴⁷

The technologies of precision agriculture, which exploit the Internet of Things and Big Data Analytics, and those related to the Internet of Farming, constitute a new face of agriculture. By cross-analysing environmental, climatic and crop factors, they allow the definition of nutrient and water requirements for cultivation, prevent diseases, identify pests before they proliferate in order to carry out targeted interventions, save time and resources, positively affect product quality, as well as improve yields and working conditions.

According to the Smart AgriFood Observatory, in regard to the innovations used, we can say that about 80% of the agricultural technologies offered are used in the cultivation phase and only 12% in the planning phase. The vast majority of solutions (73%) exploit data and analytics, while 41% the Internet of Things and 57% computing and user interface software systems. Most of the solutions (50%) can be used irrespective of which the agricultural sector it is, whilst 27% are specifically aimed at fruit and vegetables, 25% at the cereals sector and 16% at the wine sector. In terms of activities, 48% of solutions enable the mapping and monitoring of land and crops, 42% enable the monitoring and control of the movement of machines and equipment present in land, and 35% are focused on irrigation and fertilisation in a predetermined area.

⁴⁷ Euler Hermes Italia, *"Innovazioni agricole, un'evoluzione continua - Le tecnologie agricole potenziano il Made in Italy alimentare"*, 2019

As regards the ability to obtain loans, while the world's precision farming sector receives the highest number of funds (37%), this sector is in Italy in second place (35% of funds), preceded by environmental sustainability, which manages to obtain half.⁴⁸

Although our country is the European nation with the largest number of AgTech startups present in the territory, it only accounts for 1% of the total funding received by startups, which amounts to only €25.3 million. Among the most relevant sectors, the fruit and vegetables industry stand out with 17% of international startups, followed by precision agriculture and food quality, which are respectively the most explored and most interesting application areas for investors. The most important sector in Italy is also the fruit and vegetable industry (composed of 14% of Italian agricultural startups), followed by the wine industry (9%) and cereal (7%). Quality and environmental sustainability are the areas in which they are most active, with 50% of funding raised, followed by precision agriculture (35%) and food quality (29%).⁴⁹

The main area of interest for agricultural startups is principally the e-commerce, with 65% of international innovative agricultural companies active and 84% of the total funding. That is followed by Food Delivery companies, platforms that compare deals and allow you to order meals, and the aggregators, which are aimed at facilitating the exchange of information, products and agricultural equipment.

Italian agriculture is one of the most environmentally sustainable at EU level, with scarcely 7.2% of all emissions at national level (30 million tonnes of CO2 equivalent in Italy).

If we compare those results with the ones of other countries we can see that France is double (76 million tonnes), Germany 66 million tonnes, the UK 41 million and Spain 39 million.⁵⁰

⁴⁸ Euler Hermes Italia, *"Innovazioni agricole, un'evoluzione continua - Le tecnologie agricole potenziano il Made in Italy alimentare"*, 2019

⁴⁹ Euler Hermes Italia, *"Innovazioni agricole, un'evoluzione continua - Le tecnologie agricole potenziano il Made in Italy alimentare"*, 2019

⁵⁰ Unioncamere, Symbola, *"GreenItaly Report 2020- Un'economia a misura d'uomo per affrontare il futuro"*, 2020, pg.156

Despite the difficulties described above, the Italian agri-sector is still the greenest in Europe, as can be seen from the statistics and the factors reported in this paragraph of the thesis.

As a result of this Italy is a nation that is attentive and responsive to various aspects of sustainability. Starting with land management, we have the fact that, in addition for the contribution of the beauty of our landscapes, this prevents adverse flooding events, which are unfortunately so frequent in our country. Other examples include the protection of biodiversity, the growing spread of organic farming, the efficient use of chemicals and water, renewable energies, from biogas to photovoltaics, which often make use of by-products or production waste with a view to the circular economy, and new technologies and the contribution of new skills on this path towards innovation.

This turns out to be a unique development model that can also guarantee Italy first place in the EU in terms of added value (with 31.8 billion euros in 2019), surpassing France (31.3 billion), leaving Spain in third position (26.6 billion) and Germany (21.1 billion).⁵¹

Despite this situation, Italian agriculture is the least well subsidised of the main European countries, with France in first place, followed by Germany and Spain. The Italian agri-sector, therefore, manages to combine environmental protection, production quality and the country's economic growth, and plays a leading role in terms of environmental, social and economic sustainability.

The introduction of new products and technology into the market, which allow processes to be changed and the development of new organisations, has led to a continually revolutionised the structure of the economic system, and as a result in significant changes in economic and market models.

This dynamic results in the introduction of innovation in the performance of companies favouring those able to see new opportunities and anticipating the new needs of society and consumers.

From this perspective, small and medium-sized enterprises, including those in the agricultural sector, can recover their own dimension which is that of organising the factors of production in a strategic manner, regaining through success a greater identity

⁵¹ Unioncamere, Symbola, *“GreenItaly Report 2020- Un’economia a misura d’uomo per affrontare il futuro”*, 2020, pg.144

and autonomy with respect to markets dominated by large companies and multinationals.

Innovation, therefore, goes hand in hand with entrepreneurship, not only because it is the product of the latter but because it reinforces it and gives it a new meaning. It represents an environment where it is possible to express and test personal abilities, where it is possible to draw immediate satisfaction, where the relational component is and becomes increasingly important both as a key component of the product and as an instrument of the various business functions. These are the aspects that today are driving young people to 'do business' in the manufacturing sectors and increasingly in the agricultural sector based on the idea that success and greater sustainability require changes that are often completely unpredictable.

New technologies today, are emerging and it is thanks to their presence and continuous development that all the necessary conditions for the transition to a fully automated agricultural sector in the next few years are being created. We can therefore say that the introduction of this new method of cultivation is not only indispensable in order to reduce the environmental impact of this field, but also aims to improve man's work, making it less tiring, more energy efficient and using resources and skills that are accessible to all.

On the basis of what has been said above, data management is the key element of agriculture 4.0. However, in order to be useful, this information must subsequently be translated into knowledge and therefore into added value.

Hence the importance of agronomic software for analysing this specific data. One of the problems is in fact the ability to read, harmonise and standardise them, given that they come from different sources.

For this reason, the researchers of the Smart AgriFood Observatory warn that it is necessary to invest in training, as well as in overcoming the obstacles to innovation.

A new category of farmer has therefore emerged. It is made up of real entrepreneurs, intellectually active, young and curious people. The farmer today has a greater interest in product quality, competitiveness and the defence of Made in Italy rather than in the past.

They know that technology is one of the main means of achieving a sustainable product, a trade-off between costs and benefits and greater quality.

Agriculture 4.0 requires an integrated approach between its various components.

In recent years we have seen an on-going shift from the work of the traditional farmer, based solely on the use and cultivation of the land, to a more technological approach. This results to be so innovative and sophisticated and it has changed the concept of farming over the years, creating 'white-shirted' farmers who do not work the land directly.

There is in fact a greater search and need for knowledge not only in the agricultural sector but also in the acquisition of specific skills typical of agronomists, computer scientists and engineers.

In this new model, the farmer becomes a modern digital manager able to manage fleets of agricultural machinery and irrigation systems with a 'single click' and able to communicate with his workers through unified communication systems.

While these systems were totally unimaginable for agricultural production environments just a few years ago, today people are even able to conduct sophisticated video and chemical analyses of the natural elements present in the field and of the results of their crops. This process could be possible by combining their agricultural experience with information support offered by collaborative data analysis platforms.

This new method of working no longer takes into account atmospheric disturbances and no longer assesses the quality of the soil and the seeds. It principally addresses synoptic pictures offered by the computer system they use, as well as video and chemical analyses of natural elements.

Despite the fact that the role of the farmer is still stereotyped today, the application of technological control systems is already widespread among younger workers who are in any case more responsive to the changes introduced by technology.

This is also due to the daily application in the field of drones, precision irrigation systems and satellites monitoring the land.

While strawberries and small fruits are already being grown in greenhouses outside the ground, today the production approach and the customer's needs and perception of the end product are changing.

Millennial and the new generations are no longer only interested in the growing location and the methods used, but they are paying attention to the impact they have on the planet and the consequent search for sustainability, thus slowly changing culture.

It is precisely for this last reason that in Italy it remains very difficult to overcome and break down the barriers to entry of the agricultural sector and completely penetrate it with indoor farming. We are a nation based on passing down from father to son the passion for the land and a concept of greater physical proximity to nature.

3.2.1 Case study

This section of the thesis explores a number of entrepreneurial projects that present typical characteristics of the agricultural innovation concept, developed however through different modes and schemes. The qualitative research was carried out through interviews and the use of documents summarising the entrepreneurial action. The first part of each case study is a concise presentation of the social issue that the business manager wants to revolutionize and is therefore identifiable with an analysis of the general context. The primary objective of the interview was to get to know the motivations behind the innovative project, gaining a better understanding of the activities carried out and the evolution and measurement of the social and/or environmental impact.

During the interview, which lasted about 30 minutes, the interviews offered me a privileged insight seeing as they play a very important role in their respective companies. The reference figures are:

- Thomas Ambrosi, Chairman CEO&Founder at Ono Exponential Farming;
- Bartolomeo Marco Divià, Presidente at Agricooltur;
- Stefano Boaretto, imprenditore at Dashfrm.

The questions part of the interview are grouped in macro-areas, listed below:

- General information: name and surname, role within the business, how the project came about (needs, aspirations and inspirations);

- Drivers: project objectives/mission, funding structure, promoted values and/or needs to be met, project start date;
- Target: description of the target beneficiaries of the activities, data and information about social and/or environmental impact, based on the set objectives, impact they had on Italian culture;
- Outcomes: alternative projects and key competences/advantages compared to these, possible problems faced in the management of the implementation of the project, developments and improvements over time.

The interview outlined a general picture from which to start from. This the in-depth study of the elements arising from the interview came through the study of ad hoc materials.

ONO Exponential Farming

ONO Exponential Farming (ONO EF), is an innovative startup company based in San Giovanni Lupatoto (Verona), active in the AgTech and vertical farms sector. It was founded with the aim of studying and implementing high-tech vertical solutions, oriented towards the highest level of productivity per cubic metre of space occupied, guaranteeing a level of sustainability without the use of pesticides.

The idea of Thomas Ambrosi, Chairman CEO&Founder at Ono Exponential Farming, was born at the end of 2018. At that time the global demand for food was beginning to grow rapidly and the food supply system was entering a crisis. But it would be just a few years later that, in a state of emergency such as that resulting from the spread of Covid-19, Ono EF's project would find its full expression.

ONO EF owes its great technological success also to the knowledge and skills held by the founder of the startup. In fact he already led a family business in the fields of mechanics, mechatronics and information technology through the management of a number of business branches specialising in robotics, industrial machines, intra-logistics, automated warehouses and business intelligence applications.

As can be seen in the interview, it was exactly as a result of these special initial conditions that the idea of developing an innovative cultivation system arose from needs related to the automation business.

In fact, there was a need to create a storage system that would allow the optimisation of vertical spaces in order to guarantee greater efficiency in the positioning of inanimate mechanical objects, i.e. objects for the operation of industrial machinery.

Consequently, just on the basis of the projects outlined for the satisfaction of this need, the idea of being able to use the international patent began to take hold also in the agricultural sector and for other applications in the field, i.e. farming.

The main cause that led to the application of this kind of technology in the agricultural sector, was just the beginning of the emergence of FoodTech especially in the United States of America. There, there was and there still be a greater awareness of all the issues related to food shortage in 2050 and the path that will lead us to that moment. In fact, it is essential to understand that the reduction of environmental impacts and the decrease of climate change can be faced only with the implementation of new production techniques and the introduction of new habits, from now on. It is therefore something that must be addressed well before 2050 and not only afterwards.

On the basis of these principles and along the same line of thought, in the same period ONO EF began to identify vertical farming as something interesting to be applied within its vertical module. It started to physically insert different technologies able to help the cultivation sector, thus transforming what until that moment had only been developed at a theoretical level into something real.

The first prototype implementation designed by the startup was made possible in 2019 thanks to the intervention of Angels Investors who provided the funds necessary to start the activity. In addition, thanks to the knowledge and network created in the previous years by Mr. Ambrosi, it was also possible to see the involvement of several entrepreneurs responsible for the contribution of technologies, machinery, components, experience, and so on.

In 2019, the first Farm Zero was completed and was able to take Agriculture 4.0 to a new level through the world's first hyper-efficient, modular and scalable, fully automated vertical intensive farming platform. Artificial Intelligence was the real key to this evolution.

Farm Zero was the first farm located in Verona where continuous and different experiments both on plants for human consumption (food) and for experiments related to the cultivation of crops for the pharmaceuticals and cosmetics world are carried out. The latter are cultivations that need total and complete traceability in order to guarantee a quality harvest and continuous supply. In fact, growing in the field or in a greenhouse has its limitations, since traceability is not guaranteed in its entirety because of problems related to the agents that pass over the plant, what the groundwater used for irrigation contains, whether there have been changes in climate or in biodiversity itself, or what minerals may have arrived in the rain.

Thanks to Indoor Farming and CEA (Controlled Environment Agriculture), and, therefore, to the cultivation systems in controlled environments similar to a laboratory, presented by Ono Exponential Farming, it is possible to control each parameter of the plant through a technological system, such as humidity, temperature, air saturation at CO₂ level and nutritional components. Moreover, thanks to their systems, it is possible to obtain a CO₂ consumption during the production cycle, unlike what happens in the cultivation on the ground, which is instead the first responsible for its production.

In addition, fully enclosed environments based on specific patents allow for continuity of production through the placement of growing systems side by side.

In this way, different plants can be grown simultaneously with different techniques. For example, ONO EF has recently begun to experiment with growing basil along with, within the same structure, to the simultaneous cultivation of those so-called micro-greens. If basil has a growing temperature of around 25°C, micro-greens grow best at 20°C. Obviously, if the greenhouse was made up of a single structure, it would not be possible for both crops to coexist at the same time and in the same space. Nevertheless, it is thanks to the technologies developed and the creation of sharable environments that we have an environment with a double temperature guided by the same computer system.

Although indoor farming is based on a purely industrial application, at the same time it has the possibility to be inserted in home and urban contexts, due to the small size of the system. The facility can, therefore, be easily installed even in more limited environments, however implying the presence of many consumers around able to

receive and consume a massive volume of product in order to avoid food waste.

Today in Italy, especially Veneto and Verona, there is a great deal of involvement in this ecosystem. As a result of this, a change in terminology and processes related to this area is occurring, leading to the need to support this shift that leads to a continuous improvement of this concept. What ONO Exponential Farming does still have a significant competitive advantage over its competitors. They have succeeded in creating a system and a platform that is becoming and wants to become in the future democratic towards farmers, offering new systems that allow everyone to approach the agriculture sector.

Agricooltur

The company named Agricooltur is a startup that has been operating in the province of Turin since 2018. It is the creator of a new and effective method of aeroponic cultivation born with a share capital of €10,000 and that within six months has grown to a value of €510,000.

The idea is the result of the union of the skills of agronomist Alessandro Boniforte and the industrial expert in automation Bartolomeo Marco Divià, respectively CEO and President of Agricooltur. This kind of technology has been made possible by bringing together apparently distant backgrounds coming from different sectors. There is agriculture knowledge, which is fundamental for this work, but there is a lot of electronics and industrial automation that automates the process. The result is in fact given by a balance of the qualities of each model: the care and freshness of the products and a cyclical model of production that reduces waste. For this reason, the aeroponic system, which involves the nebulization of nutrients for the plants, is not only able to increase the density of cultivation per unit area, but it is also able to decrease the use of water, with a 95% reduction compared to traditional procedures. The fact of not being strictly linked to the land also offers a great opportunity for urban redevelopment in areas that have been abandoned or disused for industrial reasons.

Last but not least, it allows the production chain to be brought closer together, no longer on a 'zero kilometre' basis, but on a 'zero centimetre' basis.

Over time, human intervention has led to a great imbalance within the traditional model, damaging not only the biodiversity of some areas but also the whole ecosystem.

So, now, also in light of the European objectives of 2030, several companies such as Agricooltur have decided to change this system with the aim of bringing it back to a circular and more sustainable economic model.

As explained by Bartolomeo Marco Divià, at the beginning the idea of developing a new method of indoor aeroponic cultivation was the result of a project in collaboration with the supermarket chain Auchan in Turin, where there was the aim to reproduce in an innovative way all the areas and production processes involved in the supermarket. From here, the idea of proposing an indoor cultivation project to recreate the cultivation of fresh fruit and vegetables inside shopping centres was developed.

Precisely on the basis of this idea and taking advantage of the innovativeness of this project, comes the desire to turn it into a real business with the creation of the startup Agricooltur. The real dilemma remained until that moment, however, was how to differentiate themselves and how to bring out the diversity of cultivation since these would then be perceived by consumers as fresh food but still found on the counters of a supermarket. The added value that had to be underlined was instead given by the fact that for the first time the production was based on the cultivation of products at cm zero and not only at km zero.

Therefore, the aim was to sell the live product through a further development of the pre-existing technologies, so the one of aeroponics, which turned out to be extremely more versatile compared to the other non-soil cultivations.

In fact, this gave the possibility to be installed anywhere and it allowed a 98% decrease of water used, obtained also thanks to the 3 patents permitting a maximization of the resources used by limiting the quantities.

As of today we can say that the goal of Agricooltur has not only been achieved with great success, but has left plenty of room for the development of new forms of innovation.

Their market positioning is mainly based in the RE.CA sector (restaurants and catering), in the retail industry and in offices within company canteens, also guaranteeing a welfare concept for the employee who has the possibility of taking home a product that is essentially collected at the moment and consumed alive. In fact, it can be kept alive at home by immersing the seedling in a glass of water.

Moreover, thanks to the increase of competences in this sector, the Agricooltur team has recently started a new project based on the creation of a second agricultural company

with €200.000 worth of capital. This is now about to be subscribed by important companies – It wasn't possible to know the names of the companies involved since they are still in the final negotiation phase. However, the only known name of these participating companies is Maria Ausiliatrice Institute of the Salesian Institute that will train young people to conduct and export these agricultural activities in city sites.

In addition to what has been presented thus far, there is an increasing development of the HORTUS project about urban cultivation in big cities, especially with the construction of a city production site in Milan City Life. This will make it possible to test a new sales format through a B2B and B2C channel that will be carried out by means of special containers for the cultivation of live products with the aim of reproducing a real vegetable garden. The same type of cultivation is also going to be applied in Genoa, in the antique port area, via the installation of new production containers.

A new type of interlocutor is being approached and a different target is being reached through these new technologies. In fact, this project is not aimed at the traditional farmer but rather to the entrepreneur or the young person who wants to enter this new profession in the field of Agrifood business.

The core business of Agricooltur is therefore characterized by the presence of three patented systems. Aeromatic is an automatic machine that moves cultivation plates: in this way the plants are fed according to their needs and the process is automated from the seeding phase to the harvest one. Aerosmart, on the other hand, is a system of spray tanks connected to one another. Above the tanks the transportable cultivation plates are placed: in this way plants arrive from the production center to the point of sale still alive and always fresh. The production site, known as The Plant, has an Aeroshell microclimate structure where the Aerosmart and Aeromatic lines are installed. Aerofeed is also part of the site and it is the module that controls plant nutrition and the microclimate inside the structure.

Dashfrm

From the merging of their over twenty years of experience in the field of information technology Stefano Boaretto and Andrea Guglielmi have created the innovative startup called Dashfrm.

The project, related to the theme of AgriTech, deals with the design, development and

maintenance of systems for the production of plants in high-pressure aeroponics.

The idea comes from the desire to follow and pursue the goals of the UN 2030 Agenda for Sustainable Development and the reduction of pollution especially at the territorial level. So the masterminds of the project took a cue from this goal by expanding it and transforming it into an above-ground planting system.

Dashfrm operates in the perspective of the vertical farms: to be able to build large installations of plants in small spaces using the vertical height. But that's not all. Among the other advantages of the project there is the possibility to give a new life to abandoned buildings and constructions. The idea was born at the end of 2019 in the land of origin of the two founders, the Veneto region, where there are still many abandoned industrial areas. They followed an event entitled "Food Sense - Vertical farming in support of the sustainable city" and so decided to focus their attention on this new topic. It was at that point that the two entrepreneurs immediately realized where was the perfect place to use their skills, knowledge, abilities and technologies. It was in the world apparently furthest away from theirs, so the Agriculture one.

With the use of precision agriculture developed by Dashfrm, these technological products, defined by the V-Frm project, could become the sites of highly efficient ecological plants. In fact, any closed environment, even multi-storey ones, lends itself favourably to the installation of the systems, making agricultural production possible even in urban centers for a real "km 0".

From an ecological point of view, Dashfrm operates on two different fronts: water consumption and soil quality. The system developed by Boaretto and Guglielmi, uses water sprayed at high pressure directly on the roots of the plants in a continuous cycle that allows the recycling of water and a drastic cut in consumption. This type of technology, therefore, finds its use in places where the amount of water available is very limited, such as for example in countries of Sub-Saharan Africa, where the temperature of the water itself does not allow its use or where the cost of water is very high, as for example on the island of Singapore. On the other hand, the aeroponic cultivation method overcomes all the difficulties due to the quality of the soil because it does not require the use of plant protection products and pesticides. It is practical and most of all ecological, since the massive use of fertilizers can cause the pollution of groundwater.

The startup works mainly on two kinds of plants: the first one is the industrial plant, which can be installed on large spaces and can be developed vertically, designed for the massive production of plants. The second one is the so-called domestic plant, which is a high-design preservation plant. In particular with this last type the startup wants to enter the superyacht market with the possibility to have and consume the plants directly on the boats, thanks to the low weights of the structure. The ultimate goal of the company is to give the possibility to final customers to eat the live plant: instead of consuming a cut plant, the final user would have a seedling to be consumed whenever he/she wants. In this regard, it must be remembered that no skill or ability is required from the user since the system automatically guarantees the maintenance of the cultivation.

Dashfrm is only one of the alternative farming methods that is possible to hear about, but unlike these it offers countless advantages. For example, compared to growing in a hydroponic system, the aeroponic one reduces total water consumption by about 20 to 30%, ensuring a much lower water commitment. Without considering that the only weight that the structure can support is that of the tub, which weighs a few kilograms. The excellence of Dashfrm's project has been confirmed by its participation in BeFactory, the innovative project that integrates and completes Progetto Manifattura, Trentino Sviluppo's business incubator. It is transforming Rovereto's historic tobacco factory into a center of industrial innovation in the fields of green building, sustainable mobility, and sports technology.

3.2.2 Relevant common aspects among the analysed startups

After having presented in the previous section of the thesis the ideas and motivations that led young entrepreneurs to undertake activities such as the creation and prototyping of new methods of cultivation in the AgTech ecosystem, in this second part will be explore the common drivers that characterize the companies in question.

In fact even if they have totally different business and their background seems to be not the same, they will be able to follow similar drivers.

After an initial research phase based on the interview of the founders and entrepreneurs of ONO Exponential Farming, Agricooltur and Dashrm through a series of questions

aimed at getting to know the most hidden aspects of their business, the second phase of the research is focused on the processing of ideas and information received.

The results have been subsequently increased by desk researches that highlighted four fundamental aspects:

- 1- Technological driver and the background of knowledge owned: it was easy to outline that the success of these three startups was not only due to innovative projects, but also and especially thanks to the abilities and skills of the entrepreneurs involved.
- 2- Financial drivers and obtainment of funds for the development of prototypes: all startups have been characterized by investments coming from private Angels and with little intervention from the State and Institutions.
- 3- Drivers of sustainability and reduction of food waste: through the implementation of innovations in the field of agriculture specifically built and designed, the startups interviewed have demonstrated sustainable solutions in order to create the right amount of product in the exact place of demand, thus avoiding transportation of goods.
- 4- Drivers of preservation of Made in Italy and of the quality of the products: all the companies allow an almost completely faithful reproduction of the products coming from the land in order to guarantee a high quality standard, typical of Italian raw materials.

The following section will analyse each point more specifically in order to understand the salient aspects of the case studies presented.

Driver 1: technological driver and the background of knowledge owned

If once upon a time it was indispensable to own a wide knowledge of the land and of all the agricultural aspects in order to grow crops in the best way, today we are faced with a totally different situation.

In fact, based on what emerged in all three of the companies interviewed, the success of technological application in such an old sector is made possible also in part by the ability

of managers to combine and apply knowledge from the fields of chemistry, automation, robotics and information technology in a totally different market.

In this respect, Thomas Ambrosi from ONO Exponential Farming suggests that in recent years we are increasingly witnessing a change in the AgTech area, based on a predominance of young startupper. Thanks to their innovative way of thinking and their ability to find quick solutions to common problems, they are trying their hand at implementing and producing horticultural systems in small areas or farms.

The cultivation systems previously introduced are in fact characterised by the expertise of the farmers, which has allowed the definition of a new paradigm that differs from those already present on the market. In fact, the presence of the aeroponic technique is less developed than in other realities, since it is characterised by a more complex technology with much more complicated systems that are not perceived by the final user. For example, if we consider the technological development on which the cultivation process of the startup Agricooltur is based, we can see that it is mainly based on an analysis and the study of the production of products over a period of time of one year. This has subsequently allowed the definition of algorithms capable of controlling and managing the presence of light, humidity, environmental conditions, temperatures, the level of growth of the product and the type of nutrient the plant needs. So it's a fully automated system with a central core that interacts with growing modules through a communication network between the components. The process involves a plug-and-play solution whereby processes can be integrated through methods of detection and management. In order to achieve all of this, it has been necessary to concentrate a great deal of effort in terms of knowledge, time and technology. It allows the end user, i.e. the customer using the production site, to have an automatic system controlled remotely through a control room that allows monitoring and possible correction of management parameters.

The other advantage that the system proposed by Agricooltur has over the aeroponic solution is the possibility for the customer to be able to provide different nutrients to different products at the same time, which is not possible with classic aeroponic models due to the large amount of water used.

Dashfrm, through the development of the V-frm project, has also followed in the steps of technological advancement in order to propose a more efficient solution capable of

responding to market needs. In fact, as presented by the President Mr Boaretto, the unique ability of the installation to expand vertically in a multi-storey view for several metres high, represents an innovative element in the world of aeroponics where there are companies that build simple greenhouses or can only expand in height for one or two levels. Again, this process is made possible by the limited amount of water in the tanks.

The system is based on high-pressure spraying directly onto the root system. V-firm is the first company in Italy and in the world to set itself the objective of developing and installing aeroponic production systems that, while maintaining the same technology and operation, have a dimensional structure that can be configured according to the different space and crop requirements of the customer.

Furthermore, as seen above, in the same plant there is the possibility of producing different types of crops simultaneously thanks to the use of LED platforms equipped with parametric software that allow the creation of different growing environments - for example mountain and marine areas.

The startup's latest objective is to develop a 'Free-from-Rich-in' cultivation system for end consumers: through water spraying it is possible to precisely control all the nutrients given to each single seedling. This control makes possible the withdrawal of non-tolerated elements like nickel, pesticides and fungicides, while at the same time enhancing nutrients that are useful for the health and well-being of people through the transformation of crops into real integrators.

If up to five years ago it seemed like we were talking about solutions that were impossible to introduce in the agricultural sector, today we can say that the whole world is increasingly adopting these sustainable techniques in order to present a finished product with zero waste and high quality. When ONO Exponential Farming designed and then implemented this project, Thomas Ambrosi looked neither at the AgTech situation in Europe nor that of Italy, but more at what was developing in America at the time.

Farm Zero, presented after months of study and prototyping, is a vertical seed-to-pack solution, a multiple system defined by ONO EF as not just a Vertical Farm, but a real ecosystem with which to grow vegetables all year round. In addition, within the platform, insects and algae autonomously acclimatise themselves according to the cultivation needs managed by the Artificial Intelligence engine, thus reshaping the

production process.

Thomas Ambrosi has an important entrepreneurial background and understands well how Farm Zero and ONO EF, technology solutions and not production solutions, even if they effectively overturn the process-product paradigm, are not very sustainable in terms of business model in a system like the Italian one. These would in fact have the need to find other markets with higher energy sustainability, with a more articulated and widespread food-supply-chain, expressly in countries such as North America, the Emirates and some areas of South-East Asia.

Drawing on the support and industrial experience of Tor. Mec Ambrosi S.r.l, the precision engineering company brought its own important mechatronic contribution to the development of ONO EF. In fact, the stated aim of Farm Zero is to achieve maximum productivity per cubic metre of space occupied and the maximisation of the quality parameters of the plants through what are considered the three distinctive elements of the project concept: innovative energy management, individual nutrient management and optimal microclimate management. Compared to the technologies used by other companies today, ONO EF employs only 20% of the workforce, making this type of cultivation extremely profitable, especially in countries where conditions are not favourable for agriculture. With their reality, they can therefore be considered Game-Changers to all intents and purposes, wanting to give a "boost" to current Vertical Farming technology thanks to their strong know-how in automation.

Driver 2: financial drivers and obtainment of funds for the development of prototypes

In order to transform the high potential of young scientists and innovators into entrepreneurial realities that can successfully establish themselves on the market, it is necessary to invest significant financial resources and propose an integrated offer of infrastructures. It is also necessary to offer excellent training courses and specialised know-how, combined with a wide and dynamic matrix of scientific, institutional, financial, professional and entrepreneurial networks, both in national and international contexts.

While some sectors in Italy are chronically slow to introduce innovations compared to other countries, agricultural and agro-industrial worlds are showing a growth dynamic

that is even higher than the international one. In fact, in 2019 we have seen an 11% progression compared to the data collected in 2018, with a strong affirmation and a growing global business.

The 2030 Agenda for Sustainability Development has increased the general interest in finding alternative solutions in all sectors in order to achieve the set goals. According to the FAO, the current situation of hydrogeological instability at global level is now a huge and serious problem: 33% of the global soil is said to be severely degraded and half of the arable lands in the world are used for agriculture. Today, agri-food systems account for up to 25% of greenhouse gas emissions and according to recent ISPRA research, 57 million square metres of soil were consumed in 2019 in Italy only, at a rate of 2 metres per second with 70% of fresh water withdrawn for agricultural production.⁵²

On a global level, indoor farming is the business that many investors are focusing on. It is interesting to note that in recent years many startups have closed significant investment rounds: \$2.9 billion was invested in the vertical farming market in 2019 with a forecast to reach \$11.7 billion in 2027, while the indoor farming market had an investment of \$31.7 billion in 2019 and will reach a figure of around \$49.6 billion in 2025.

However, from what emerges from the company case studies analysed, it can be seen that in all three situations only a small part of the funding for the initial development of the business was provided by credit institutions or public institutions, such as European or Italian funds, leaving more space for private investors.

Indeed, in Italy, it is very difficult for young startups to obtain funding from credit institutions without providing valid guarantees. If ONO EF is one of the Italian companies to have succeeded in raising more than €1,000,000 from private Angels and investors/entrepreneurs who already believed in them, it was only because behind the creation of this company there was a team of entrepreneurs with a solid background, made of knowledge, experience, reliability and a credibility developed and maintained over the years. Moreover, in their particular case, there was also the presence of Italian ex-entrepreneurs who had emigrated abroad and who had decided to become part of it in the role of financiers, seeing the emergence of an Italy-based initiative highly

⁵² Data provided directly by Stefano Boaretto during his interview for Dashfrm. They can be checked in the "Appendix" section at the end of the thesis in the area dedicated to his intervention.

competitive with that of the United States.

All these conditions resulted in the belief of mainly private individuals who invested in their vision and thus made it possible to develop the first Farm Zero.

While the Italian system is based on a grant of money made possible only by the provision of numerous guarantees, in Europe it is necessary to have a series of studies that allow you to go and define and intercept the various horizons.

Looking at all the statistics, however, it is easy to see that very few startups are able to ride the wave and successfully emerge in such a constantly increasingly competitive market.

Along the same lines of thinking we can also find the managers of Agricooltur and DashFrm companies.

Respectively, Agricooltur at the beginning of the project self-financed the development of the new cultivation technique with both its own capital and partly with contributions from private investors who later joined the company. In contrast to what happened with ONO EF, Agricooltur obtained a grant of €400,000 through a regional call for proposals in Piedmont. However, these are private funds that had already been previously spent and invested in research and development activities. The latter, Dashfrm, is currently participating in a number of Italian and European funding competitions in order to integrate the current private investments necessary for the continuation of the activity.

Drivers 3: driver of sustainability and reduction of food waste

The third common aspect that emerges from the three interviews conducted is the desire to achieve sustainability not only by reducing polluting gas emissions or the environmental negative impact, but also and above all by guaranteeing a production characterised by totally sustainable processes aimed at eliminating any kind of waste.

The world-wide Vertical Farming, mostly in Europe but even more so in our country, is experiencing a large-scale process, in which only widely developed industrial production solutions show an effective efficiency of business models.

However, at a global level, about 14% of the food produced is getting lost between the

moment of harvest and the moment of sale.⁵³

Significant quantities appear also to be unused and thrown away even during the retail stage and at the per capita consumption level, thus causing an overall waste of all the resources involved in production - water, land, energy, labour and capital.

In addition, the disposal of lost food and waste in specific landfills leads to an increase in greenhouse gas emissions, contributing in part to climate change and the rise of temperature.

The transfer of waste to a different centre from where production takes place, the use of aircraft (in the case of exports) or other means in the case of internal movements within the farm, the consequent creation of CO₂ during the process of cooling or warming up of the huge cultivation areas, all contribute to the loss of the concept of sustainable precision farming and therefore the meaning of vertical farming.

It is increasingly necessary to define and implement actions at both global and local levels in order to maximise the use and consumption of the food we produce. The introduction of technology, innovative solutions thus including e-commerce platforms for marketing and mobile, retractable food processing systems, new ways of working and good practices to manage food quality and reduce food loss and waste, are fundamental aspects of implementing this transformative change.

In order to achieve positive results, it is therefore mandatory that all stakeholders involved in this process take part in it, through a sharing of objectives and interests. It is a combined process aimed at all operating actors: from producers themselves to actors along the food supply chain, from food manufacturers to retailers and final consumers.

It is exactly on the basis of this thinking that ONO EF has structured its internal business. In fact, even in the name ONO it is possible to notice a tribute to Taiichi Ohno, the engineer who founded the Toyota system. They wanted to highlight and underline their tendency to produce just in time, characterised by the correct quantity, with no waste and with maximum efficiency.

This has its roots in the industrial world and in the lean production systems, but it has

⁵³ Food and Agriculture Organization of the United Nations (FAO), *“International Day of Awareness of Food Loss and Waste”*, 2020

not yet been effectively introduced in the agricultural system.

What ONO Exponential Farming wants to introduce is in fact a system of lean farming, that corresponds to an upgrade of current agricultural systems and based on a production process in the right place, at the right time and in the right quantity.

The paradigm shift that is taking place in these last few years of expansion of the AgTech ecosystem and the FoodTech world is slowly leading to Controlled Environment Agriculture (CEA) and it is for this reason that ONO EF has recently introduced the CEA Platform.

This means that we are faced with a new production model that differs from those of other companies since they are mainly aimed at creating giga farms characterised by huge production quantities. In these cases, the fact that it is necessary to provide heating or cooling for large rooms with the same type of crop results in a huge waste of resources, both energy and food, because the system used does not allow individual growing areas to be made independent for different types of product. Moreover, mass production entails the need to adopt economies of scale which are necessary to lower production costs and the resulting selling price. However, while there are economic advantages to be gained, at the same time a significant amount of pollution is produced.

Lean production, on the other hand, is a production system that counteracts and avoids the creation of this waste, relying on limiting and reducing CO₂ emissions and ensuring product availability in a sustainable manner. So, instead of producing 30% more than the market demand and then being unable to use it because of fast perishability, thanks to the technologies developed by ONO Exponential Farming you can only grow what you need and exactly in the quantity required. This is a type of production that is pulled by demand and not pushed by the market.

If we imagine the production process as a chain, we can see that if we push it from behind, the chain becomes a tangle, but if the chain is pulled from the front, we have a process characterised by efficiency and effectiveness, while maintaining a certain degree of order. We must therefore try to stop making choices that encourage over-consumption but instead pull and adjust production in accordance with the needs of the moment.

Through the production systems implemented by the company it is now possible to create modular enclosures that can be scaled up as the demand arises. They are based on technology that permits them to be managed independently and to be switched off in sectoral areas to save light and energy.

The need to present a sustainable agriculture that is accompanied by equally responsible systems has also been adopted by the other two companies, which have themselves designed independent farming systems to meet the concept of lean production.

In this new ecosystem there are certainly companies that are growing in an important way and that are mostly based on mono-cropping and consequently mono-production, as for example only tomatoes production, only salad or crops with characteristics that are easier to reproduce and obtain. In the case of Agricooltur company, on the other hand, there is a reality that is trying to enter a different market niche. In fact, their mission is not characterized by the interest in making quintals of products nor even selling them at prices regulated by the Italian food market. They want instead to try to offer solutions that enable the catering and retail sectors to be supplied with raw materials that are always fresh, high-quality, alive, but in contrast to the already existing ones, grown in total harmony with the environment.

Drivers 4: drivers of preservation of Made in Italy and of the quality of the products

The last common driver identified is the one regarding the creation of high quality products capable of satisfying both the expectations of end users and of guaranteeing the protection of Made in Italy.

In the food sector, the Italian economy has a primacy linked to its territory.

In fact, Italy's crops and food production make its products highly appreciated and desirable: not only wines, sparkling wines, oil and cheese, but also organic products have brought Italy worldwide fame. The exports of these products experienced an exponential growth in 2020 (+1.9%) that is still continuing despite the general decline due to the health emergency.

As published by Coldiretti after analysing ISTAT data on production and exports in the single regions, the South of the country is the main supplier of those products, with the Molise, Basilicata and Campania regions at the top of the ranking. More than 55% of the output goes to the European Union, with the remainder that goes to the United States.⁵⁴ Made in Italy results to be in fact one of the main sources of Italian profit and this is why the systems designed by ONO EF, Agricooltur and Dasfrm try to make possible the inclusion of the particular characteristics of the soil and the needs and growth path of specific products, for example for the basil of Albenga.

Thanks to the technologies involved, there is therefore a replication of environmental models as well as of the soil. This allows the absolute recreation of any product from any part of Italy in any part of the world and vice versa.

Considering Agricooltur case study, they take great care in managing the cultivation of the products themselves, succeeding in obtaining the best organoleptic qualities for each product. According to what emerges from the interview, at the moment 7/8 different types of product can be found in the same system simultaneously, each with different climatic conditions. Thanks to sophisticated cultivation systems, they have recreated the best macro environment ad hoc for each variety of plant, thus providing the right nourishment necessary for proper growth and ripening. This is necessary in order to simulate the most suitable conditions for each individual product.

Their plantations present a very wide range of products that ranges from ginger to saffron, blueberries, all kinds of aromatic plants, genepy, white aubergines, cucumbers, peppers, classic salads and different types of strawberries.

The feature that certainly differentiates these types of goods from those grown directly in the ground is that, by bringing the crop directly to the consumer they provide a product that is still alive.

This guarantees that its organoleptic qualities do not undergo any kind of decline during the post-harvest phase. It sometimes happens in fact that in large industries and large-scale distribution the ripening process takes place directly during the transport phase, thus depriving the plant of its proper nutrient requirements.

All products can be replicated and grown in a natural way in different Continents.

⁵⁴ Exportiamo, *“Export Agroalimentare nel 2020: è Record per il Made in Italy”*, 2020

In the last period, Agricooltur managers were in fact negotiating with one of the best Italian cooking schools.

It has been understood that it is not important to go and teach world Chefs how to cook with our made in Italy products, but that it is necessary to put them in the conditions to have the same kind of product with the same qualities and the same Italian seed but reproduced in their country.

Only in this way will it be possible to export Made in Italy in innovative forms and only in this way will it be possible to preserve one of Italy's main sources of profit.

This type of innovation also leads to a better quality of products because they are subject to a continuity and stability of climatic conditions that would otherwise not be possible in real fields due to storms or weather that do not allow them to survive.

By being able to control the entire growth process, a maximum yield of production and excellent quality is usually achieved. Nowadays, some chefs base their choice of raw materials on the organoleptic standardisation of the product, ensuring consistency in both texture and taste.

Among the restaurateurs who have decided to adopt the technologies proposed by Agricooltur to cultivate and cook first quality vegetables, we can find Marco Sacco with his starred restaurant Piccolo Lago in Verbania, and the new restaurant Piano 35 in Turin.

In addition, the team has recently agreed to a partnership with Eataly in Genoa in which the restaurant Il Marin uses aromatic herbs from their cultivations, given the exceptional scent and taste they possess.

3.3 Next Gen Food & Drinks ecosystem

In countries with economic wealth, there is growing consumer awareness and interest in alternative proteins. Meat has been the main source of protein in developed countries for decades, but in recent years there has been a significant increase in the daily diets of developed populations.

However, as presented in the previous chapters, the emergence of a new food regime and the consequent change in consumer behaviour, has led to a growing interest in alternative sources of protein - due in part to concerns about health and the

environment, as well as animal welfare.

A number of players in the alternative protein business are already launching new technologies and ingredients, with some looking to consolidate their place on the market. Innovative food companies today are able to mirror the customer's experience of eating meat at a much higher level. This is parallel to strong marketing campaigns on social media to gain some traction for their products.

The emerging shift in dietary habits may explain why the overall growth rate of meat consumption worldwide is expected to fall by half, even though aggregate consumption of meat proteins is increasing. The sales of plant-based foods, the largest source of alternative proteins, increased by 17% in 2018 confirming that the use of these proteins in consumer products is expected to continue to grow.⁵⁵ In 2019, the evaluation of the alternative protein market base was about \$2.2 billion compared to a global meat market of about \$1.7 trillion, making the growth rate of new proteins marginal compared to the overall meat market.⁵⁶ While consumer packaged goods (CPG) companies and food manufacturers would have significant margin for investing and growing themselves in the alternative protein market, at the same time we are faced with a situation where many companies do not have the production capacity to capture this market opportunity, nor do they know where to focus their efforts.

The United Nations and other non-governmental research Institutions have highlighted the fact that the meat and dairy industries are the two sectors that have contributed most to climate change.

The World Economic Forum, through its articles, has also stated over and over again that the industry has created more greenhouse gases than the whole of transport, including the aviation sector.⁵⁷

Furthermore, the United Nations Intergovernmental Panel on Climate Change (IPCC) has defined that "*plant-based foods and sustainable animal-sourced food could free up several million square kilometers of land by 2050 and cut 0.7-8.0 gigatonnes a year of carbon*

⁵⁵ The Good Food Institute "*Plant-based market overview*," 2018

⁵⁶ McKinsey & Company, "*Alternative proteins: The race for market share is on*", 2019

⁵⁷ World Economic Forum "*The UN says we need to reduce our meat consumption to fight climate change and improve food security*", 2019

dioxide equivalent".⁵⁸

FoodTech startups around the world have been the first able to recognize the problems and the resulting potential opportunities for change by conceiving 'foods of the future' that make the food sector more sustainable through the reduction of pollutants. Beyond Meat and its meat-free burgers have pioneered this field of culinary innovation and they have increased the number of investors and players within the industry, thus starting to make meat-free meat widely accepted by the market. In accordance with studies carried out by the company's R&D department, meatless burgers require 93% less soil to be cultivated, they are responsible for 90% less greenhouse gases emitted and 46% less energy used than what happened for a beef burger, while having a 99% reduced impact on water.

Tyson Foods, the largest US livestock and meat processing company, bought five per cent of Beyond Meat's shares in October 2016 and today, only five years later, veggie burgers are available in fast-food restaurants including KFC and McDonalds. Also other companies are increasingly expanding their business. For example, the US startup 'Just' is based on the analysis of plant properties in order to imitate animal products in the most authentic way possible. They have managed to use mung beans to produce an egg substitute with the same taste and texture. A similar goal is pursued by the company 'MyEy', which offers vegan egg powder that can be used in the preparation of several dishes.

In 2019, the North American plant-based food and beverage market was valued at \$14 billion. In the same year, the European plant-based market was valued at approximately \$7 billion.⁵⁹

While these numbers are still small in percentage terms, sales of plant-based foods have grown 11% in the last year and 29% in the last two years.

⁵⁸ UN action on climate change during the Geneva meeting in 2019. It was defined in order to discuss and finalise the report containing guidelines for governors for the reduction of negative impacts on the environment.

⁵⁹ Timo Hahn, *"The Future of Food – Innovative Foodtech Startups Creating A More Sustainable Food System"*, 2020

At the peak of purchases during the first Covid19 pandemic period in the US, sales of refrigerated plant-based meat were three times those of the previous year and have maintained a growth rate of over 100% in the following four weeks. In addition to innovative startups created by young entrepreneurs or young people with a background in technology and chemistry, food giants such as Nestlé and Unilever are increasingly turning their attention to alternative plant-based products by investing in these projects through the creation of their own incubators and accelerators. If the first one launched the Incredible Burger, at the same time Unilever launched the Rebel Whopper in partnership with Burger King.

The type of alternative biological proteins to animal ones used for the production of fake meat can be divided into four categories:⁶⁰

- Plant protein: the most popular of the alternative protein sources. It is derived from protein-rich seeds through a process called fractionation. The most popular types for consumers are soybean, followed by peas and several niche types, such as chickpeas, rapeseed and lupin.
- Insect protein: crickets and grasshoppers are a good source of protein that producers are exploring. Indeed, some farmers are already using their flour in the production of food. However, it is currently cost-prohibitive to isolate protein from flour since the cost of crickets is very high and makes the process difficult to be economically scaled. Food producers are also exploring the use of grasshoppers as a source of edible insects, although development is still at an early stage.
- Mycoproteins: products made from fungal biomass are rich in protein, fibre and have no cholesterol. This protein source is typically composed of whole, unprocessed filamentous fungal biomass, commonly known as mildew. It has existed since the 1980s and is produced through the fermentation of organic raw materials. Mushrooms contain about 40% protein, are rich in fibre, have limited carbohydrates and contain no cholesterol.
- Cultured meat: it uses tissue culture technology to regenerate a single cell in order to create muscle tissues that appear to resemble animal muscles.

Scientists have been working on this protein since 2013, when the first lab-grown hamburger made its public launch. Cultured meat is made using tissue culture technology, the process by which animal cells are regenerated using a single cell as a source to propagate animal cells in vitro. This process then creates muscle tissue that mimics animal muscles by possessing the same protein profile.

The technology for production of alternative proteins is advancing rapidly.

Cultured meat based products, often called 'lab-grown hamburgers', are the result of a non-invasive and painless microbiopsy that captures animal cells.

Cultured meat producers differentiate muscle cells and regenerate them as would happen naturally in the animal.

A British startup 3D Bio-Tissues, for example, uses cellular meat production technology to recreate the complex tissue structure of animals with just a few cells. They are then placed in a nutrient-rich substance that allows them to divide. On the basis of this advanced process, it would be possible to reduce animal mortality resulting from intensive livestock farming while ensuring a sustainable and ethical food supply for the entire population.

This emerging food technology is expected to become a major industry based on the interest shown by many FoodTech and sustainable agriculture companies.

The Next Gen Food and Drinks ecosystem has evolved over the years not only because of the introduction of new foodstuffs, but also and above all because of the conception of technologies that enable their production. One of the main innovations is the one of using 3D printers in the food sector, thus replacing the plastic filament normally used for printing with one made of a mix of ingredients.

The spread of such an innovative technology on the global nutrition front, however, cannot come without widespread economic and social changes. 3D food printing involves many processes in which ingredients, such as various powders and liquids, are stacked together layer by layer through a variety of combined methods in order to obtain solid three-dimensional edible structures.

⁶⁰ Talent Garden, *"4 Foodtech Trends to Keep Track of in 2021"*, 2021

3D food printing can be classified as a sub-branch of a wider sum of 3D printing technologies that are commonly referred to as 'additive manufacturing' or alternatively 'free-form manufacturing', with the solid form of the finished product.

The necessary models and commands are extracted from the corresponding databases and used to reproduce the original projects in identical copies.

This, in essence, means that the designs are reproducible by anyone with the access to the database and can be shared without effort worldwide.

In general, 3D printing has benefited from the integration of numerous technological applications in various fields and industries, and it has developed around the fusion phase, the layout and the cutting phases, each specifically used with different materials to ensure the success of the product.

Usually, the so-called 'soft materials' are exploited because of their extrusion characteristics. In this approach, edible constituents are stacked to a solid shape through the use of 3D printers.

The most crucial attribute for the selection of the materials involved is the viscosity, which must remain consistently low in order to ensure easy extrusion of the product, but at the same time solid and compact.

In food production, additive manufacturing classifies materials into three main categories according to the degree to which they are used. The first group includes materials that are 'natively printable' and consists of all the physico-chemical characteristics that enable ease of application in 3D food printing scenarios. This means that they have all the necessary stability traits to maintain their shape and structure after the extrusion without the need for further processing.

Then, there are the "non-traditionally printable" materials that require further post-baking processes to achieve the same effect of the first material. 'Non-printable' ones, on the other hand, cannot be committed in any way without the addition of hydrocolloids and meticulous processing.

The identity of the main industrial players in the field is currently made up of mainly startups and small companies that drive innovation and undertake the major risks associated with research and development.

There is, for example, a small number of companies in Europe, the United States, and other countries that present different solutions and technologies, but all with the same goal of creating something more sustainable. The aim they refer to is therefore embedded in the social and environmental issues that are currently taking place in our newspapers and in public debates. These include the potential decline of climate change through more technologically advanced agricultural and livestock production.

As a matter of fact, 3D printing in the food world has been highly anticipated by industry activists in order to positively engage in improving its ratings and performance.

The high diversity of actors involved during the early stages, in which the technology currently finds itself, complicates the collage of information conveyed together with the motives behind each study and the expected results. This is becoming substantially more diversified across the spectrum of research entities that may consist of operations between multinationals, innovative startups and academia, up to and including food activists and the various agents of food movements around the world.

3.3.1 Case Study

As previously presented for the AgTech ecosystem, this section of the thesis will analyse in a more detailed way some business projects focused on the creation of fake meat and fish through the use of innovation in the laboratory. The research is of a qualitative nature and was carried out by interviews and by the use of documents that summarise the entrepreneurial action. The first part for each case study will be focused on the explanation of two similar but opposite issues. In fact, not only the problems arising from land-based farming will be presented, but also the marine problem of the resulting phenomenon of overfishing. The primary objective of the meeting was to get to know the motivations behind the innovative project, to appreciate the activities undertaken and their evolution and to measure the social and/or environmental impact. In the course of the interview, which lasted about 30 minutes, the interviewees offered me a privileged design point of view, since they play a very important role in their respective companies. The reference figures are:

- Maj Hrovat, Co-Founder & Head of R&D presso Juicy Marbles;
- Robin Sisma, Co-Founder and CEO presso Revo Foods.

Also in this case, the questions asked during the interview have been grouped into the macro-areas listed here:

- General information: name and surname, role within the project, how the project came about (needs, aspirations and inspirations);
- Drivers: project objectives/mission, funding structure, values promoted and/or needs to be met, project start date;
- Target audience: description of the beneficiaries of the activities, data and information regarding social and/or environmental impact based on the set objectives, and impact they had on the Italian culture;
- Outcomes: alternative projects and key competences or advantages compared to these, any problems faced in the management of the project, evolutions and improvements recorded over time.

The interview provided a general picture of the society examined. Starting from this, the in-depth study of the elements resulting from the interview came through the study of ad hoc materials.

Juicy Marbles

The Slovenian FoodTech startup Juicy Marbles has revealed the world's first 100% plant-based filet mignon, which claims to have the same oily marbling that can be found inside a real cut of animal steak. Developed using their 'reverse grinder' technology which is currently patent-pending, the startup was able to recreate the texture, look and taste of filet mignon by layering fibres derived solely from plants.

Juicy Marbles has debuted with the first vegetable-based marbled filet line in the world, through a reproduction of the finest cut of meat: an 'ultra-tender' filet mignon. The startup, based in Ljubljana, has been recently incubated by the prestigious accelerator Y Combinator, and has managed to develop such a hyper-realistic version of the premium steak thanks to its 'Meat-o-matic Reverse Grinder' technology.

Maj Hrovat and his colleagues, who were his friends at the time, started working on this innovative project to generate synthetic meat at the end of 2018. In fact, at that time a

hackathon, also known as hackafest, had taken place. It was an event in which experts from various fields of IT such as software developers, programmers and graphic designers usually participate presenting their ideas.

This week-long event regarding commercial, educational and social issues was focused in that case upon one of today's biggest challenges, the one of identifying and finding a more sustainable solution to the beef production.

This was the start of the research phase for all the relevant information on: the use and consumption of water during production phase, the size of the areas allocated to the cultivation of wheat for animal feed, the level of pollutant gas emissions coming from the supply chain and all other factors related to livestock farming.

The solution they proposed to overcome these kinds of problems was not only about creating vegan products that were already on the market such as tofu, seitan, tempeh or similar foodstuffs, but the real challenge was to try to modify them and turn them into something more attractive to meat-loving consumers.

This idea, profoundly developed through the use of fermentation technology, won the hackathon challenge, thus signifying the beginning of their industry journey in that field.

After they had the opportunity to market for the first time the plant-based burger they were working on, other much cheaper plant-based solutions from international retailers, such as supermarket chains like Lidl, began to appear on the market at the same time.

The competition at the end of 2018 was therefore beginning to become untenable due to the presence of large giants who, through economies of scale and investments in startups with knowledge, were able to bring highly successful products on the market in a short period of time.

In 2019, the focus of Maj and his colleagues will therefore shift to the creation and conception of technologies capable of producing something different and difficult to be replicated by competitors, since it was characterised by a specific technology and has a clear objective to pursue.

The growth of the FoodtTech community, and in particular of this ecosystem, has led to the identification of the main goals to be pursued by 2050: trying to replicate the

texture, fibres and structures of chicken and beef, or more generally of meat products. While some startups have presented this type of product supported by the introduction of 3D printing in the food sector, Juicy Meat preferred to focus its attention immediately on a system for fermenting and extruding products. After a very long process of research and study, including careful analysis of the scientific literature in order to better understand the technology behind these procedures, they were finally able to explore some interesting concepts about the deformation of proteins due to their natural composition. After a few months of conception, at the beginning of 2020 the first fillet mignon prototype was created with fibres reproduced using a bar extruder. They improved the recipes, the mix of ingredients and their combinations over time, becoming more and more realistic products.

The product is no longer a reproduction of protein but a 'real' steak. Since the early days of their plant burger business, Maj and his friends had been very interested in entering into accelerator programmes in order to raise funds necessary to penetrate a larger market share. Today, two years after that challenge, they can say they are very proud of the success and marketing of a totally innovative product. Thanks to this change, they have succeeded in establishing themselves on the market and creating a network of customers willing to test their products. Due to this successful outcome, the current production plan is becoming insufficient to meet the requirements of market demand, making it necessary to relocate the production site to another plant.

Revo Foods

Revo Foods is an Austrian startup company that has developed a new method of printing a reproduction of salmon based on vegetable proteins through the use of a 3D printer. It therefore tries to develop plant-based alternatives to seafood by completely recreating its texture, structure, taste and nutritional profile, in particular similar to salmon and tuna, but using 100% plant-based ingredients.

The company has developed a new technology based on a 3D food printing process that accurately recreates the real texture and appearance of seafood. During the printing process, natural and healthy ingredients including pea protein, seaweed extracts and

dietary fibres, are used and then combined together to recreate excellent nutritional value and taste. This gives Revo Foods' products a realistic appearance. In addition, the procedure used for the production of fake salmon has been optimised in order to avoid food waste in the making process and to maintain a constant level of vitamins and omega-3 oils in the finished goods.

The idea of presenting such innovative food was born, as in the case of Juicy Marbles, from the need to address one of the most crucial issues we are facing in recent years. It is worth remembering in fact that not only intensive land cultivation and farming are now contributing to the destruction of the ecosystem, but also the problem of overfishing and the consequent intensive exploitation of marine resources are causing several problems.

Since ancient times, man has looked to the sea product for his livelihood: there are finds from prehistoric times that document man's relationship with the sea and fish resources, which in the ancient world was marked by a rhythm in keeping with sustainability. As time went by, however, the methods and tools used for fishing changed, together with man's demand for fish, leading to a huge increase in the amount of fish caught to facilitate trade.

We now know that fish resources are not inexhaustible and that overexploitation of marine ecosystems and their inhabitants leads to the impoverishment of the seas in terms of both species richness and hence biodiversity, and ecosystem services.

The term 'overfishing' refers to fishing methods that are damaging to the environment. The continuous exploitation of fish resources has drastically reduced their abundance, with negative consequences for the fishery sector itself, such as the reduction of catch processes and the reduction of profitability of the companies involved. A fish stock is therefore defined as overfished when the increase in fishing effort, consisting of the number of fishermen, engine power and fishing hours, is not matched by an increase in fishing yields.

In order to minimise the negative effects caused by this phenomenon, there is now a move towards sustainable exploitation, that means harvesting fish in a way that does not irreversibly compromise their presence in nature.

It is for these reasons that Robin Sisma created a startup in 2020 in Vienna that is able to overcome the problems of exploiting the seas by proposing an extremely sustainable and technological solution.

It was necessary to offer consumers an ethical consumption of seafood in order not to further damage the ecosystem anymore. The products will be marketed in the second quarter of 2021, but the first articles are already in the production phase: smoked salmon strips (The Smokey One) and salmon spreads (The Creamy One), with a parallel focus on the development of salmon and tuna sashimi.

3.3.2 Relevant common aspects among the analysed startups

After illustrating the two startups involved in this second phase of interviews on the Next Gen Food & Drinks ecosystem, and after having learned about the willingness of young people to search for and propose alternative solutions to safeguard our planet, in the following paragraphs we will identify and highlight the common aspects that these two realities possess, although different.

In fact, after an initial research phase based on interviewing the founders of Juicy Marbles and Revo Foods, by asking them a series of questions aimed at getting to know the most hidden aspects of their business, we moved on to a second research phase focused on processing the ideas and information received.

As in the case of the companies analysed in the AgTech ecosystem, the research was subsequently supplemented by desk research that made it easier to identify the four fundamental common aspects in order to allow a general comparison of the FoodTech sector in the following conclusion chapter.

The identified drivers are:

- 1- Technological driver necessary for the realisation of future foods: the main feature of the two startups considered is to be able to create, through advanced technology, the animal fibres of meat and fish using two different production processes;
- 2- Financial driver and the obtaining of funds for the development of prototypes: through incubators and private fundraising, the two startups both obtained the necessary money for the prototyping of products;

- 3- Driver related to ecosystem performance and competition: analysis of the Next Gen Food & Drinks sector considering the inclusion of new players in the market;
- 4- Driver related to the consumer's perception of the products: on the basis of the feedback deriving from the numerous test phases carried out by the two startups, it is possible to define how consumers have perceived the product and consequently analyse how they can be related to the Made in Italy culture in the food sector.

Driver 1: technological driver necessary for the realisation of future foods

The first breakthrough in vegan meats with an authentic taste was the introduction of the Impossible Burger by Impossible Foods. Beyond Meat soon followed with their own line of vegetable patties, sausages and reproduced meat burger. However, in almost all of these brands there was only an offer of alternatives to processed meat products rather than a real piece of meat with fibres that resembled the original one. Juicy Marbles capitalised on this gap in the plant-based market and it decided to develop a real steak, made from plants.

Reproducing the texture of the fibres of the meat in a steak is extremely difficult. If one adds to this the highly desirable taste and mouth feeling of marbling, it seems to be almost easier to pick up and eat a steak directly from the butcher's shop and avoid any kind of more sustainable solution. In Israel, the first piece of lab-grown meat has been produced using a special tool in a particular machine. Redefine Meat used 3D printing technology to replicate the texture of muscle fibres in their laboratory-grown meat. However, Luka Sincek, one of Juicy Marbles' co-founders, a microbiologist by profession, explained that these production methods were too complicated and slow to achieve. They, therefore, developed their own patent-pending technology, called the 'Meat-o-Matic Reverse Grinder 9000'. This allowed the Juicy Marbles team to control the alignment and layering of the soy-based fibres that compose each steak, recreating the satisfying mouth feel you get from a delicious filet mignon.

Another factor that emerges from the interview with Maj Hrovat is that both he and the other co-founder of Juicy Marbles wanted to include intramuscular fat in their vegetable-

based steak, simply known as marbling by meat lovers. In fact, the most expensive steaks in the world are noted for their flourishing marbling, which is a result of the type of meat and a farming system based on the use of quality nutrients and feed for the cows. In an effort to recreate this characteristic of fine cuts of meat, Juicy Marbles uses unsaturated sunflower oil which not only allows it to mimic the appearance, but also adds an element of richness to the vegan meat by contributing to its juiciness.

This is the reason of the name 'Juicy Marbles'.

The technology used by the startup, which is still patent pending, is known as Meat-o-Matic REVERSE Grinder 9000, and therefore allows the muscular structure and marbling of meat to be imitated by aligning and layering the fibres from the bottom up.

This innovation in fact combines some pre-existing technologies, to which some modifications have been made, with the technologies they have designed over the years. The outcome of this process is a machine that allows full control over fibre alignment (texture), fat structure (marbling), flavours, aromas and other key parameters.

If the production of meat requires a certain amount of effort to recreate the fibres, so does the 3D printing of salmon or tuna slices. The 3D printing technology used by Revo Foods is in fact the result of numerous studies and experiments aimed at creating the same elasticity in the slices and the same texture as those from harvested fish.

Using medical engineering to produce sustainable food without sacrificing taste was the challenge faced by the team at Revo Foods. They had the brilliant idea of inserting different types of vegetable inks into the bioprinters of Dutch company Felix Printers, recreating the connective tissue typical of salmon. In this way, print after print, the fibrous component has taken shape and now it is possible to overlap the individual layers, resulting in a fillet that is very similar - if not identical - to that of animal origin.

The results of the blind tastings carried out by the researchers also reveal a surprising affinity between the taste of the real seafood and that of the vegan substitute, which is made up of mushroom and pea proteins (their combination perfectly 'mimic' the compact structure of smoked meats), starch (a natural thickener) and seaweed agar (necessary to reproduce the strong flavour of salmon).

Food 3D printers operate in the same way as conventional 3D printers, with the very important difference that they do not extrude plastic materials but rather foodstuffs reduced to a paste.

This technology is currently in its very early stages, but there are already several models in circulation, even though there are many limits to be overcome. First and foremost the printing speed, since the printers currently available on the market take a long time to produce food.

The main developmental challenges in the current situation are not only speed of production but also yield in terms of quality and cost. Nevertheless, thanks to companies such as Revo Foods and through the commercialisation of their products, these particular technologies will very soon reach our tables.

Driver 2: financial driver and the obtaining of funds for the development of prototypes

In the last five years, the FoodTech sector has confirmed its exponential growth not only with the increase in the number of startups, but also with the number of investors present in the ecosystem.

Next Gen Food & Drinks ecosystem, a category that includes all alternative ingredients such as plant-based meat, insect products, mushroom products, functional foods and beverages and meal replacements, has raised 6.2 billion in 2020 only. This phenomenon was driven by the exponential growth of the alternative protein sector, which registered record investment figures in the last year.

As for all young innovative startups in the FoodTech sector and others, it was necessary for Juicy Marbles and Revo Foods to raise funds in order to develop their initial ideas.

In contrast to the previously analysed startups ONO EF, Agricooltur and Dashfrm, which have been created by entrepreneurs already established in the automation and robotics sector, and therefore possessing a solid network and great credibility on the market, in the case of Robin Sisma and Maj Hrovat the path has been much more difficult.

From what emerges from the interview with Robin Sisma, at the beginning it was really difficult to find people who believed in them, both because they were talented young people with no guarantees and because their project to create sea food products in the laboratory was still far from the European culture.

In addition, the infrastructure and institutions were not so welcoming and available for financing. Since their business was very innovative compared to what was present on the market and lacking in history, it was therefore difficult to try to convince investors that their idea would be a successful one ready to enter the European market within a few months. While in the United States the FoodTech sector was able to emerge more quickly and involve a larger number of startups and investors, the situation in Europe was different.

Fortunately, in a short period of time the situation changed. Revo Foods closed its first fundraising round in early 2021 for a total of more than €1.5 million. Representatives of the company said in response that they were and still are excited to be working with fantastic strategic investors who would really accelerate their entry into the 3D printed seafood market. The investors involved in this project include Hazelpond Capital, Friends2grow and MKO Holdings, as well as national funds from the Austrian Research Promotion Agency FFG and the Vienna Business Agency.

In addition, Europe is also starting to define funds for the growth of this sector.

In the case of Juicy Marbles, however, at the beginning of the prototyping phase they had found money from local communities, basically a mentor and angel investors, who gave them about \$10,000 to produce the first version of the fillet mignon. Subsequently, thanks to the skills acquired and the network created in the sector, they have been able to enter an acceleration programme proposed by Y Combination standard, a startup accelerator in California created in March 2005.

Y Combinator has created many successful startups and is considered one of the best accelerators in the US, supporting more than 2,000 companies, including Stripe, Airbnb, Cruise Automation, DoorDash, Coinbase, Dropbox, Twitch.

Thanks to the intervention of Y Combinator, they got through the first milestone. This usually means that they have managed to get to the point where they have built something impressive enough to raise money on a large scale.

The opportunities for growth are therefore greater today and people are more inclined to invest as they have begun to understand the true power of these new technologies applied to the food sector. What really helps fundraising and the obtaining of funding is firstly the fact of being seen as a big player associated with other successful companies,

and secondly the fact of being a technology startup working in this field and not just a technology retailer. If at the beginning the founders of Juicy Marbles were basically interested in the idea of developing machines and after that in selling the production processes, they have now realised that large corporations are more interested in putting their money in a company that can create the machines, design the process and sell its end product directly.

Driver 3: driver related to ecosystem performance and competition

The plant protein sector has seen an increase in the number of startups and its own success thanks to the IPO of Beyond Meat. In fact, following this event, the interest in the Next Gen Food & Drinks ecosystem has dramatically increased, leading to more and more sustainable solutions in the creation of food substitutes. Today there are thousands of startups around the world that produce plant-based burgers and these traditional vegetable products are very competitive on the market, both in terms of price and the ingredients used. At the same time, however, there are only a few companies that are specialised solely in the pure and true recreation of fibres in the laboratory, with results that are not always satisfactory. It is really interesting to see how in the last couple of years these few alternatives of meat reproduced in laboratories or the development of new proteins in general are increasing their importance, both in a technological sense and in terms of the consumer's perception of them. As suggested by Maj Hrovat, today there is a better understanding of why consumers buy these types of products and that is somehow the reason why a huge niche market is being created. All companies are trying to follow the footsteps of Beyond Meat. At the same time, however, one has to try to come up with something innovative as there is a risk of being one of countless competitors on the market with no real added value. In recent months, there has been a change in the processes used by companies and a shift towards a more precise, waste-free and efficient production method. Every day even large corporations are trying to pursue greater sustainability by investing capital in talented startups or by creating acceleration programmes.

Although the final consumers are still more interested in the meat and chicken sector, the sector of Revo Foods is also starting to gain market share. The artificial seafood sector is also improving in the number of companies involved in this growth path, with

more investors present able to generate higher revenues. In conclusion there is an incredible increase that will lead to the creation of new and better products. This will allow the sharing of knowledge and the improvement of know-how and will cause a huge development among interconnected startups.

Driver 4: driver related to the consumer's perception of the products

In Italy, the consumption of meat has always been a fundamental element of the population's daily diet. Today, partly due to changing habits and a heightened awareness of the effects that wide consumption has on our health, beef consumption has declined sharply since the slaughter stage. Thanks to the variations in eating habits, about 2.6 million animals were slaughtered in 2019 compared to more than 3.8 million in 2010. This is because the consumption has fallen from 23.7 kg per capita to 17.2 kg. According to the latest studies, this phenomenon has occurred because red meat and the classic 'steak' have come to be seen as a meal to be enjoyed only on rare occasions and no longer as a daily, healthy meal. Until a few years ago, beef was consumed at least once a week by around 70% of the population, while in 2019 it was only consumed by 61% of the population. Another important data is that the number of breeding dairy cows has also decreased by 3%, together with imports, which have dropped by 33%. Per capita milk consumption has fallen from 54 kg per year to 46 kg in 2019.⁶¹

One of the biggest challenges that Revo Foods and Juicy Marbles have had to face is precisely that of offering a product which meets and satisfies consumer expectations and, in the case of the latter startup, is appreciated by meat lovers.

A good piece of steak, properly cooked on the outside while remaining juicy and pink on the inside, is one of the features that meat experts most appreciate and research in its preparation.

However, our current methods of producing these products bring with them a collateral number of problems. Apart from the ethical considerations of raising animals for slaughter, there are additional problems relating to the environment, human health, and its failure to effectively feed people. In this regard, according to the co-founder of Juicy Marbles, Maj Hrovat, plant-based meats offer a more sustainable alternative, able to be

⁶¹ Report "2010-2019. Dieci anni di zootecnica", 2020

produced in larger quantities in a more efficient way, and using new technologies, resulting in a product with the same taste as the real thing.

If at the beginning of its project Juicy Marbles was driven in some way to get the product on the market as soon as possible, today the team needs to refine some taste aspects in order to present a finished product that can really compete with a real steak. Their goal is to manipulate all the individual elements characterizing the lab-grown meat in an attempt to replicate different types of beef coming from all over the world by faithfully reproducing the natural flavours. This is the real challenge.

Indeed, beef is the meat with the most difficult taste to reproduce, as it has a very particular fibre structure that is difficult to create. At the same time, it offers advantages in terms of reproducing its meatiness, allowing a very realistic production with completely different ingredients.

Nowadays, the main ingredients used to reproduce meat fibres are obtained from soya processing, beetroot powder gives the steak its red colour whilst other natural flavourings help to build up and layer the taste we associate with the product. The result is therefore a plant-based filet mignon that is said to look and taste like real meat. In fact, Juicy Marbles recommends preparing it in the same way as preparing a real piece of meat, given that the appeal of meat is not only its texture or flavour, but also the simplicity of its preparation.

In order to fully satisfy the wishes and expectations of meat lovers, Maj Hrovat says, a few more improvements will have to be made in both texture and flavour areas.

In the coming months, the flavour department will develop a newer and more innovative solution than those currently available on the market. Another interesting aspect to be considered in the analysis of this product is the impression it has and will have on the final consumer. Regular meat consumers consider the filet mignon to be a food that can be related, both in taste and texture, to a small portion of real beef, although with some changes. Interviewing people with a predominantly plant-based diet revealed, however, that they are unable to grasp the subtle differences, seeing it as definitively a piece of meat. What Juicy Marbles is trying to do is delineate this customer segment in order to understand the real perception of the product and provide them with the best experience.

In early March 2021, although the R&D team was not totally satisfied with the product, it was still decided to make some pieces of product available on their online marketplace in order to see whether consumer expectations were met or not. Initially, the starting price in Slovenia was €15/kg, which was a competitive price compared to real beef and it attracted positive customer feedback. The situation has since improved over the following days, with sales peaking at 200 orders, making rapid supply impossible because of long production times. Production capacity was very limited and the machines were already at their maximum capacity.

Due to this unexpected success, the second step to be considered was the analysis of the willingness to pay by the final consumer. Being a completely innovative product and not yet present on the market, the main consumers were the early adopters, that correspond to the users of new services or technologies just before their mass diffusion. Based on these considerations, given that they were the people who were most interested in this area and were willing to pay more for it, the Juicy Marbles team decided to apply a pricing strategy focused on increasing it in order to increase its 'perceived value'. The price increase resulted in an unexpectedly drastic increase in sales, having increased the perception of quality and of the products by making them look like premium ones.

Once it reached a price of \$81.59 for 140g of filet mignon, the product was declared sold out by the company in order to allow them to make improvements and better satisfy their customers. In fact, the idea of Juicy Marbles is to create, through the introduction of economies of scale, a product that is accessible to everyone with a convenient price and easily findable in supermarkets or specialty shops.

With the creation of a premium product there would not be the same mass distribution that would achieve the desired environmental results. Sales will therefore be carried out in the next future stages of the launch not only through the online shop but also through the introduction of retail channels in the United States. That market appears to be ready for this type of product, as it is easier to access in terms of national food culture.

Another of the ideas that emerged during the strategic planning phase regarding market penetration of Juicy Marbles in Italy and Europe was the opening of a production site directly in Italy. The startup team would have identified numerous opportunities arising from Italy's strong tradition and ability to produce high quality, delicious food, since our country is the one with a most developed and widespread food culture among the population.

From what we can tell from the interview, Maj Hrovat thinks that, despite the fact that Italian consumers do not yet have much experience in this field, they are quite ready for the introduction of this type of product in certain kitchens in the north of the country.

So, because of the proximity between Italy and Slovenia, their new production site would have many plus points, both in terms of business and in terms of reputation.

As for the 3D-printed production of salmon and seafood presented by Revo Foods, also in this case the biggest challenge is to recreate the same texture as a real fillet and the same taste as freshly harvested salmon.

The smoked salmon slices are made from just 11 ingredients and the team is highly satisfied with the nutritional content achieved by the product. Of course, their salmon does not contain any traces of heavy metals, microplastics, antibiotics or other waste materials usually found in salmon from industrial aquaculture. Sea conditions are increasingly deteriorating, leading to a decline in the quality of the fish that reach our dishes, increasing at the same time the risk of contamination with substances harmful to our bodies. At Revo Foods there is a very clear vision of the future: overfishing is a characteristic of the past, today we need innovative solutions to guarantee a more sustainable future. The company has also developed a smoked salmon cream spread that is rich in protein and omega 3, difficult to be found in other cream spreads made from real fish.

They are also working on trying to create the possibility of reproducing different qualities of salmon coming from different parts of the world.

On 6 March 2021, the world's first version of vegetable 3D printing was unveiled on an experimental basis. The vegan food technology company presented 'Salmon With Attitude', its 3D-printed smoked salmon. The event was held at the Budapest Bagels in Vienna during which there was a tasting for a limited number of people. The new technology based on 3D food printing is able to give the food its true appearance with the texture and appearance of real seafood.

More than 1,000 people have tested their products to date and the feedback received has been very positive, showing great interest and enthusiasm from people.

Before the test phase, people often asked if the salmon that the company was offering was as healthy as conventional animal salmon, but after trying it they found that Revo Foods' vegetable salmon was even healthier, rich in protein, omega 3, dietary fibre and vitamin B12.

Unlike Juicy Marbles' strategy for filet mignon, in this case the price has not yet been defined as they have not yet been officially introduced to the market, but they are certain that it will be a premium product with a high price in order to cover production costs.

In conclusion, we can say that the world is changing and the food regime for the future will be based on foods with similar characteristics to those found in nature, but healthier and more sustainable.

Conclusion

Two different directions in FoodTech ecosystem

This thesis has attempted to provide a thorough overview of the phenomenon of climate change that we are currently facing, identifying the food sector as a major contributor to the degradation of the world's ecosystem. For this reason, the focus of the research was mainly on the identification of a new system of food production, consumption and distribution that would increase the sustainability and efficiency of a continuously expanding sector.

On the basis of what has been presented in the previous chapters, when we talk about environmental degradation we refer to the serious consequences affecting our Planet: global warming, animal extinction, air pollution, death of flora and other negative impacts. However, environmental changes caused by human misbehaviour are also the cause of other equally serious catastrophic effects such as economic instability, conflict, large-scale migration, food shortages and the potential collapse of socio-economic systems.

Technological innovation can therefore help and stimulate the transformation of current food systems in order to make the processes used more sustainable, both in terms of environmental protection and in terms of human wellbeing. Today, the level of global malnutrition is at an unprecedented record high, many farmers have to live on subsistence income, huge amounts of food is wasted and bad agricultural practices are causing irreversible damage to the environment.

The achievement of the sustainable development goals, proposed by the United Nations through the introduction of 17 SDGs related to the implementation of the 2030 Agenda, will require the transformation of food systems in order to ensure greater inclusion, sustainability, efficiency and nutrition.

This process will imply a better environmental policy, through the definition of greater economic investments associated with adequate infrastructures. It will also provide all the necessary elements for the stakeholders involved to develop a culture and behaviour aimed at improving the management of the resources used. Whilst until only recently, the food and agriculture sectors have been slow in the adoption of the technologies

driving the fourth industrial revolution, such as the Internet of Things, artificial intelligence and blockchain, we are now facing a situation where innovation is playing a crucial role in the expansion of FoodTech. Although the new ecosystem is still at an early stage of development, it could have a significant positive impact on food processing by 2030. Indeed, if consumers were able to replace between 10% and 15% of the meat they consume with alternative proteins, by that time, total greenhouse gas emissions from agriculture would be reduced by between 5% and 8%, freshwater withdrawals used to irrigate crops for animal feed would be reduced by between 7% and 12%, and around 5% to 10% of the total land used for agriculture would be freed up for other uses.

In the light of all of this, it can therefore be said that the introduction of FoodTech has brought, and will continue to bring in the coming years numerous changes in all six ecosystems of which it is composed.

According to what has been analysed in the last chapter of the thesis, the AgTech and Next Gen Food & Drinks ecosystems are the two main future challenges able to significantly change the traditional forms of production, while maintaining the quality of the goods.

If we consider the most relevant aspects of the two types of ecosystems and the information received during the interview previously made, we can say that the conclusions of this analysis take different shades of thought as they belong to two different sectors: agriculture and livestock farming.

From what has emerged in the previous chapters and the interviews conducted with ONO Exponential Farming, Agricooltur and Dashfrm, we can conclude by saying that as far as the AgTech ecosystem is considered, the greatest innovation in terms of a more sustainable cultivation is the one resulting from lean production and verticalization of processes. Through the development and implementation of areoponics, an extremely efficient technique for growing plants without the direct use of soil, it is therefore possible to guarantee cultivation even in places with the most difficult weather conditions.

Therefore, considering aeroponics as an alternative form of cultivation of plants, vegetables and fruits that does not require the use of soil or water, it is now possible to obtain a genuine product produced by nebulising a nutrient solution containing water

and useful substances for development.

These are delivered to the roots by means of a special tool, which allows the reduction of water used in the process.

In support of this new technology, there are a number of strengths that make it so successful. The first advantage is the increased efficiency and cleanliness of the cultivation environment, which is able to guarantee excellent and flourishing harvests in a short period of time without any waste of resources. Another important advantage is that it results from the low risk of contamination of plants from diseases and bacterial infections that can have a negative impact on the quality and availability of the finished product. In this way, the total absence of pesticides used during the cultivation phase is guaranteed.

In contrast, looking at what has emerged from the startups under consideration, we can however identify the presence of some disadvantages. The first one is the rather high cost of implementation and purchase of technological processes that an agricultural business has to bear. In fact, on the basis of the difficulties encountered in raising finance, the first economic cycle proved to be very expensive in monetary terms, ensuring sufficient profits to cover the initial costs only later on. This implies the need to raise funds from private entities or credit institutions in order to ensure survival during the first months of business. Moreover, the second disadvantage stems from the need to have a dedicated indoor area in which the aeroponic system can be developed. In order to guarantee a sufficient quantity of product necessary to satisfy market demands, it is therefore essential to allocate specific areas to this type of cultivation. Today, however, thanks to patented technologies proposed by the startups considered, it is possible to minimise the amount of waste and overproduction through an independent room management of the aeroponic system.

Based on current phenomena and the observation of future AgTech trends, it is possible that forms of new cultivation systems will increase in popularity over time, becoming a production method available not only in industrialized areas, but also increasingly in restaurants, homes and urbanised areas. What is certain is that, due to climate change and human unregulated action, the quantity of soil available for crops will tend to decrease and its quality will continue to deteriorate. Therefore, more and more people

will seek to produce healthy food while respecting both the organoleptic qualities of the plant and the ecosystem itself.

Thanks to the introduction of FoodTech, aeroponic gardens and vegetable gardens will therefore be able to provide the right answer to these growing needs.

Furthermore, if we consider the safeguarding of Made in Italy products in the agricultural sector, we can see that thanks to the special technologies patented by the startups in question, there is the possibility of faithfully reproducing the characteristics of individual products, guaranteeing in the future recognition through food certifications. Indeed, Italy is the European country with the highest number of agri-food products with designation of origin and geographical indication recognised by the European Union.

This is a further demonstration of the great quality typical of the food productions, but especially of the strong link that links Italian agricultural and food excellence to its territory of origin.

The EU Geographical Indications system, in effect, favours the production and economic structure of the territory and at the same time supports the social cohesion of the entire community.

Italy is in fact the only country in the world that can boast a total of 307 geographical indications recognised at EU level for food products (170 PDO, 134 PGI and 3 TSG), 34 for spirits and 525 for the wines sector. In addition to these goods, registered at EU level, there are 5,266 traditional agri-food items recognised by the Italian regions.⁶²

This result is made possible by the great biodiversity of the plant and animal heritage, with 7,000 species of plants on national territory, 58,000 species of animals, 504 varieties registered in the vine register (compared to 278 in France) and also 533 varieties of olives compared to 70 in Spain.

Thanks to all these factors, over half (55%) of exports of Made in Italy agri-food products in 2020 were directed towards the European Union, with Germany ranking as the main customer with 7.73 billion, up 6%. In second place there is France with 5.08 billion, which remains stable, followed by Great Britain with 3.6 billion (+2.8%), which then left as a result of Brexit.

⁶² Ministero delle Politiche Agricole alimentari e forestali, *“Ventunesima revisione dell'elenco dei prodotti agroalimentari tradizionali”*, 2021

Outside the European borders, the United States is Italy's main trading partner with 4.9 billion euro in agri-food exports, which, according to Coldiretti, has increased by 5.6% despite the additional duties introduced by former President Donald Trump.

Among the most successful exports we can easily find canned tomatoes (+17%), pasta (+16%), olive oil (+5%) and fruit and vegetables (+5%), which reached an all-time high in value terms.

So, if we consider the export statistics and the fact that Italian excellence is highly recognised worldwide, it can be said that although future trends suggest the introduction of new out-of-land cultivation systems, the tradition and taste of Italian products would not be changed in any way. The new figure of the farmer that is emerging is today more focused on the possession of computer, chemical and engineering knowledge. It is precisely because of this that we have systems that guarantee the exact reproduction of the natural environment necessary for plant growth, but through a more sustainable process. In this way, it is possible to guarantee both the Italian certifications and the preservation and conservation of the food culture which makes Italy famous all over the world.

For the AgTech ecosystem, it is therefore of vital importance to balance the satisfaction of consumer needs through an ethical production system that exploits neither human labour nor the natural resources employed. Only in this way will it be possible to achieve a complete improvement of the environmental conditions without compromising the true and genuine taste of the products.

If on the one hand for the agricultural world the creation of technological solutions proves to be easy to apply even in the Italian context, on the other hand the Next Gen Food & Drinks ecosystem presents some negative externalities that are in conflict with the national culture.

As previously seen, according to FAO estimates, the demand for meat could grow by more than 50% over the next 30 years, expanding from 258 million tonnes in early 2007 to 455 million tonnes in 2050, thereby feeding 9.8 billion people.

The production of artificial meat in the laboratory could therefore meet the challenges posed by this data, while also contributing to solving the delicate and controversial problem of malnutrition that affects specific areas of the planet.

From an ethical point of view, the most important aspect of the production of cultured meat in a laboratory is the elimination of the need to breed and slaughter animals.

On the other hand, from an environmental point of view, there would be a massive reduction in non-renewable resources used in traditional farming methods. Indeed, for each hectare used for the production of cultivated meat, between 10 and 20 hectares of land employed for the growing of animal feed could be freed up, which is added to the saving of large amounts of water and energy required for their production.

Furthermore, traditional livestock farming is now responsible for the emission of significant amounts of greenhouse gases that would be reduced by the creation of laboratory-cultured meat.

Among the many advantages mentioned above, there is also a disadvantage connected with the currently very high cost of producing artificial meat. These new production techniques require specialised equipment, which are responsible for higher production costs and subsequently higher selling prices. It would be only possible to obtain a competitive selling price compared to those on the real meat market by creating economies of scale, which would cut costs and make the product available to all consumers.

The growing demand for alternative protein sources to the meat and fish industries is driving startups like Juicy Marbles and Revo Foods, large multinational food corporations and international investors to develop innovative high-tech solutions.

In response to increased ethical and environmental awareness among consumers, three common drivers have emerged. The first one is to produce meat and fish through the use of 3D printing or extrusion methods, without raising and slaughtering animals. The second is to replace conventional products with plant-based foods, simulating their nutritional properties, taste, appearance and texture. The third is to identify alternative forms of protein in novel foods that can be introduced on the market. These are very different strategies, but they can prove to be complementary and to represent a transition phase leading from the current food regime, mainly based on animal farming,

towards new food styles and production models that are more sustainable and more sensitive to nutritional biodiversity.

The process of approving and introducing cultured meat to the market is a long and difficult one, with many countries not yet ready for this innovation.

Singapore is, to date, the first country in the world to have approved the sale of lab-grown meat through specific legislation. The legislation issued - dated December 2020 - is the first worldwide on artificial meat not from slaughtered animals.

The situation is completely different in Europe, where there are still many economic, ethical and regulatory obstacles to the development of this product. In addition, here, the first major and real scepticism towards an innovative idea comes directly from the farmers who fear the closure of their businesses over time. A similar scenario can be observed in Italy, where there is a different perception and conception of food, since it is not only based on a purely nutritional concept, but more on the factor of taste and culture.

One of the biggest challenges in the reproduced meat sector is to recreate the right fat consistency and the appropriate marbling and in Italy this aspect appears to be indispensable in order to meet the expectation of the final customer. In the Italian market, in fact, there are at least six major "families" of bovine animals destined for the slaughterhouse and whose high quality is recognised all over the world.

These are the Chianina meat with its prime quality, lean and tasty meat, boasting tenderness and fineness of fibre. These determine excellent organoleptic characteristics: among the most renowned cuts, it is necessary to mention the Florentine steaks to make meat lovers experience a real emotion.

Then there is the Marchigiana, Romagnola, Maremmana and Podolica and finally the Piemontese, which includes the Fassona variety. One of the distinctive features of this meat, which proves to be inimitable and never faithfully replicated by any kind of new technology, is the double haunch, a muscular hypertrophy that guarantees a product low in fat, therefore lean and with little impact on cholesterol, while maintaining a pleasant taste. Thanks to its particular characteristics, this meat is one of the most prized in Italy, and it has also been awarded recognition as a Slow Food Presidium.

The list of foreign cattle breeds is much more extensive, including Angus, Hereford, Simmental, Japanese Wagyu and so on.

Based on the factors listed above, we can therefore conclude that although the Next Gen Food & Drinks ecosystem appears to have an efficient application in terms of both ethics and environmental benefits, at the same time it also presents many more challenges and complexities compared to the AgTech ecosystem.

In the latter there is, in fact, the clear possibility of accurate reproducing of the organoleptic characteristics of the crop through the use of special technological systems, ensuring the exact same product anywhere in the world as the one coming from the land. In the reproduction of meat, on the other hand, we have a totally different scenario: it will never be possible to safeguard and faithfully recreate the Made in Italy label in this sector. Although production techniques will become increasingly refined in the future, it will never be possible to obtain an exact recreation of a particular quality of meat recognised by food certification, as it will never be composed of real fibres but always plant alternatives.

Regardless of the fact that Italy is one of the largest suppliers of soybeans destined for the production of future foods, thus making it a profitable country for investment in the Next Gen Food & Drinks ecosystem, its population is not yet ready to accept this new type of market.

In general, our country is based on a lack of information on food biotechnology and poor disclosure even by those who produce processed meat. There is a cultural gap made up of mental barriers concerning the acceptance of what is destined to become the meat of the future. It will be a very slow process, but it will be characterised by the presence of emerging generations who will base their choices on more ethical aspects and who will be more involved in changing their current food regimes. They are actually more open to new innovations and in the future these new alternative foods could penetrate metropolitan cities. This could be made through large marketing operations that allow the product to be perceived in a premium way by means of real experiences for the final consumer. Only in this way will the Italian food sector succeed in entering a market that is diametrically opposed to its culture.

In conclusion, we can now say that FoodTech is, in general, a fundamental element in the food sector in order to guarantee the survival of our ecosystems and to ensure a better world for future generations. We are currently in the midst of a food revolution that will dramatically change the way we cultivate, produce, transport and consume food.

It is a megatrend that cannot be ignored, born in response to a number of factors, such as increased sensitivity to what we eat, to technological innovation, but also to the prospect of food shortages on a planet with an expanding population.

For this reason, the change we will face will be indispensable and it will be the result of choices that should be made from the very beginning. Broader education of the population and a greater awareness of what we are up against in 2050 will prove to be the real turning point in a situation of no return.

The revolution is inevitable, since the traditional food production system is recognised as unsustainable for a planet with a growing population to feed. The transition from today's food regimes and habits will certainly be a slow and steady process, and at the same time challenging both for cultural factors and for the preservation of the product quality.

"We cannot solve our problems with the same thinking we used when we created them."

– Albert Einstein

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Appendix

Appendix 1

Startup: ONO Exponential Farming – Thomas Ambrosi

1- Come è nata l'idea di aprire questa startup? Quali sono stati i principali motivi che vi hanno spinto a credere in questo nuovo progetto? E in cosa consiste?

Siamo una azienda che inizialmente si occupava di tecnologia e di automazione industriale. Automatizzavamo i processi che prevalentemente riguardavano noi stessi, le nostre attività. L'idea di andare a svilupparci verticalmente è nata in seguito ad una necessità interna che era quella di creare un sistema di magazzini in verticale e di ottimizzazione degli spazi in verticale per posizionare oggetti meccanici inanimati (oggetti che servono per le loro macchine).

E' nata di conseguenza l'idea di poter utilizzare questo brevetto internazionale che abbiamo ideato, non solo per stoccaggio di materiale ma anche per altre applicazioni ossia il farming.

Un paio di anni fa abbiamo scoperto l'esistenza del vertical farming e da lì son nate tutte le relazioni con i temi del 2050 e del tragitto che ci porta a quel momento. Bisogna infatti iniziare a capire che è un qualcosa che bisogna affrontare ben prima del 2050 e non solo da quel momento in poi. Abbiamo identificato il vertical farming come qualcosa di interessante da applicare all'interno del nostro modulo verticale e da lì abbiamo iniziato ad inserire diverse tecnologie che potessero aiutare il settore della coltivazione (tutto questa era solo stato sviluppato a livello di idea fino a quel momento).

Successivamente, dopo aver riordinato le idee e pensato un primo progetto di implementazione abbiamo avviato un founding di angels che ci ha permesso di andare a realizzare la macchina vera e propria. Inoltre, grazie alle conoscenze alla rete di network che ho creato (Sig. Ambrosi) negli anni precedenti sono riuscito a coinvolgere diversi imprenditori che hanno apportato diverse tecnologie, macchinari, componenti, esperienze, ecc. Abbiamo realizzato dapprima diversi prototipi fino ad arrivare poi alla creazione della prima "farm zero". E' stata la prima farm localizzata a Verona nella quale abbiamo fatto e continuiamo a fare tutt'ora diverse sperimentazioni relative a vegetali

per il consumo umano (cibo) e sperimenti relativi alle colture di piante per la farmaceutica e cosmesi. Queste ultime sono piantagioni che hanno bisogno di una totale e completa tracciabilità; coltivare in campo o in serra presenta invece in questo caso delle limitazioni di tracciabilità in quanto non si ha bene idea di cosa sia passato sopra alla pianta, che cosa contenga la falda acquifera utilizzata per l'irrigazione, se ci sono stati dei cambiamenti climatici o di biodiversità, oppure cosa può arrivare dalla pioggia. Grazie al farming indoor e alla CEA (Controlled environment agriculture), e quindi ai sistemi di coltivazione in ambienti controllati come una sorta di laboratorio, si ha la possibilità attraverso un sistema tecnologico di controllare ogni parametro della pianta quali l'umidità, la temperatura, la saturazione dell'aria a livello di CO₂ e le componenti nutritive. Attraverso i nostri sistemi si ha un consumo di CO₂ e non una produzione della stessa. Gli ambienti totalmente chiusi basati su specifici brevetti permettono una continuità di produzione attraverso un posizionamento dei sistemi di coltivazione uno a fianco dell'altro. In questo modo si possono coltivare contemporaneamente piante diverse con diverse tecniche.

In questo momento ad esempio stiamo coltivando il basilico e in contemporanea quelli che sono chiamati i micro-greens (micro ortaggi); se il basilico sta bene a 25°, i micro-greens si sviluppano meglio a 20° e se fossimo in una serra unica non si potrebbero fare entrambe le coltivazioni contemporaneamente. Quindi grazie alle tecnologie sviluppate e alla creazione di ambienti condivisibili si ha un ambiente con doppia temperatura e guidati però dallo stesso sistema informatico.

2- Come si è evoluto il settore dell'AgTech in questi ultimi anni? Avete visto notevoli cambiamenti in questi 5 anni?

Cinque anni fa sembrava di parlare per soluzioni per Marte. Quando abbiamo iniziato con questo progetto non abbiamo guardato né all'Europa né all'Italia ma quanto più a cosa si stava sviluppando in America, in quanto era il Paese con la più forte spinta e la più forte comunicazione in merito a questo settore. Oggi l'Italia, soprattutto Veneto e Verona, sono molto coinvolte in questo ecosistema. Inoltre, sta cambiando anche la terminologia nel parlare di agritech o dei processi legati a questo ambito, portando così alla necessità di assecondare questo cambiamento in quanto si sta raffinando sempre di più questo concetto. Quello che ONO Exponential farming fa ha tutt'ora e tutt'oggi un vantaggio competitivo notevole rispetto ai competitors poiché siamo riusciti a creare un

sistema e una piattaforma che sta diventando e vuole diventare democratica nei confronti dei coltivatori. A differenza di un sistema che è partito dagli stati uniti e molto geloso delle proprie expertises, con la presenza di aziende che hanno raccolto fondi inverosimili e che però hanno ritorni molto bassi poiché continuano a svolgere il ruolo dei coltivatori, il nostro sistema si basa su un concetto totalmente diverso. Se in America i nuovi coltivatori sono assolutamente gelosi dei loro “campi” e di come fanno le tecnologie, dall'altra parte quello che ONO Exponential farming fa è invece quello di introdurre il lean farming cioè un upgrade dei sistemi agricoli correnti.

Il lean farming si basa su una produzione dove serve, quando serve e nella giusta quantità. Ha le sue origini nel mondo dell'industria e dai sistemi di lean production, mentre nel sistema agricolo non è ancora stato introdotto.

Il cambio di paradigma che si sta verificando sta portando dunque al CEA ed è per questo motivo che loro hanno introdotto il CEA Platform. Questo significa che ci troviamo davanti a un nuovo modello di produzione che si differenzia da quello delle aziende che stanno puntando a creare delle giga farm caratterizzate da produzioni in enormi quantità. Ci si trova così in questi casi alla dover scaldare o raffreddare ambienti di grandi dimensioni con lo stesso tipo di coltura in quanto non permettono di rendere indipendenti le singole aree di coltivazione e regolare differenti temperature per differenti tipi di prodotto. Questo comporta la presenza di grandi quantità di prodotto coltivato al fine di abbassare il costo e renderlo fruibile a un prezzo che sia accettabile ma conseguentemente crea enormi sprechi di risorse alimentari e non.

La lean production è invece un sistema di produzione che combatte questi gli sprechi; siccome oggi bisogna cercare di limitare e ridurre le emissioni di CO₂, sprechi alimentari (oggi 30% di cibo viene sprecato). Dunque, al posto che produrre il 30% in più rispetto alla domanda di mercato e poi buttarlo, attraverso le tecnologie ONO Exponential Farming si produce invece solo quello che serve ed esattamente nella quantità richiesta. È un tipo di produzione tirato dalla domanda e non pull by the market. Se immaginiamo la produzione come una catena, possiamo vedere che se la spingiamo da dietro la catena diventa un groviglio, se invece la tiriamo da davanti rimane in ordine. Questo accade nella produzione lean, dove tutto riga dritto e fila liscio. Non spingere al consumo ma tirare in base alle esigenze di quel momento. Attraverso i nostri sistemi di produzione si riescono a creare involucri modulari che consentono di scalare man mano che c'è una richiesta. Sono basati su una tecnologia che permette di essere gestiti in maniera

indipendente e di essere spenti a aree per risparmiare luce ed energia.

C'è un cambio verso una agricoltura sostenibile e che sia corredata da sistemi altrettanto sostenibili. Oggi si va a verificare il processo per cui per creare qualcosa di sostenibile si va ad inquinare in altro modo. Bisogna evitare questo. Bisogna cercare di debellare il concetto della sovra produzione poiché se uno crede che produrre in grandi quantità significhi abbattere i costi tramite economie di scala, si sbaglia. Infatti questo comporta un effetto negativo inverso con ingenti costi derivanti dalla gestione dei rifiuti. Il fatto di trasportare gli sprechi in un centro diverso di produzione magari attraverso mezzi di trasporto aerei (esportazione) o di spostarli internamente all'azienda, il fatto di creare CO2 per raffreddare/scaldare delle aree che vanno poi a produrre sprechi, lì salta il concetto di agricoltura sostenibile di precisione e di conseguenza il senso di vertical farming. Il vertical farming è produrre localmente per consumare localmente proprio per evitare spostamenti di merce da un paese all'altro.

3- Il vostro sistema è di tipo più industrializzato o si basa sulla presenza anche di orti urbani?

Il nostro sistema è un sistema più industrializzato anche se presenta la possibilità di essere inserito in contesti casalinghi e urbani poiché il più piccolo ha dimensioni 5*5*4m. La struttura può essere posizionata ovunque, anche se ovviamente avrà una produzione tale che il bacino attorno deve essere in grado di recepire e consumare. In questo periodo si sta verificando un cambio di area AgTech, basato sempre più su una componente di giovani startupper che si stanno cimentando nella produzione di orticole in garage/appartamenti o aziende di piccole dimensioni. Nuove tecnologie stanno emergendo e loro stanno creando il passaggio che consente di arrivare ad un settore completamente automatizzato nei prossimi anni. Quindi l'inserimento di questo nuovo metodo di coltura non è solo per diminuire l'impatto ambientale ma proprio per andare a migliorare il lavoro dell'uomo e renderla una cosa "normale". I nuovi farmer dovranno adottare questo tipo di agricoltura come se fosse una vera e propria azienda, e non solo un qualcosa da collegare alla terra. E' talmente innovativa e talmente tecnologica che si creeranno coltivatori con la camicia che con la terra non hanno mai avuto a che fare.

4- Come viene visto il mondo del FoodTech ed in particolare dell'AgTech in Italia?

Avete riscontrato delle difficoltà nell'aprire questo tipo di startup essendo un Paese basato sulla coltivazione della terra e sul lavoro manuale dei contadini?

Come rispondono le realtà locali alla proposta delle vostre nuove innovazioni?

I contadini sono stereotipati oggi giorno. Quelli più giovani sono comunque attenti alla tecnologia e le applicano quotidianamente in campo tramite l'utilizzo di droni, sistemi di irrigazione di precisione, satelliti che monitorano i terreni. L'agricoltore oggi è abbastanza tecnologico e sono pochi quelli che non la adottano. In Italia comunque rimane molto difficile rompere il ghiaccio e penetrare completamente il settore agricolo con l'indoor farming. Nelle serre si coltiva già fuori dalla terra le fragole e i piccoli frutti e noi consumatori non ce ne rendiamo nemmeno conto. Sta cambiando l'approccio tant'è che i millennials e le nuove generazioni non sono più interessati alla coltivazione nella terra ma sono attenti alla sostenibilità e hanno una cultura radicata differente. Per il consumatore oggi l'importante è sapere che quello che mangia risponde a un ciclo sostenibile per il pianeta. Il cambio di mentalità sta avvenendo anche in maniera più diffusa grazie al Covid rispetto a quello che ci si poteva aspettare.

Il punto quindi è che le nuove generazioni vogliono la garanzia della sostenibilità e non gli interessa di dove viene prodotto, se in laboratorio o in terra. Tecnicamente, la pianta possiede già nel suo DNA tutte le caratteristiche per poter crescere in maniera naturale siamo noi che negli anni passati abbiamo iniziato a dare pesticidi, booster, acceleratori per creare un prodotto apparentemente migliore in poco tempo e andando così a rovinare l'ecosistema. Adesso l'ecosistema, come abbiamo visto anche in pandemia, si sta rigenerando in maniera veloce ed è quindi importante fargli fare il suo progresso in maniera tranquilla. Grazie ai nuovi sistemi indoor e al controllo dell'ambiente si ha minor impatto nella natura, si va a diminuire totalmente la presenza di pesticidi e booster e si va ad assecondare le esigenze e le condizioni naturali della pianta affinché possa crescere al meglio. Il Bio per esempio è già stato sdoganato e ci sono commissioni europee che stanno lavorando al fine di riconoscere questa nuova tipologia di produzione e identificarne le caratteristiche. Quando si parla di BIO si parla anche di bassi residui e residui zero. In questo nuovo metodo di coltivazione CEA il residuo non c'è perché non si parte da una base di pesticidi da andare a ridurre ma non esistono proprio.

5- I finanziamenti, se ne avete avuti, sono stati facili da ottenere? Le banche hanno subito creduto in voi? E stato più facile ottenere finanziamenti da parte dell'Italia o eventualmente dell'Europa?

In Italia è molto difficile cercare di ottenere finanziamenti da parte di istituti di credito. Loro sono una delle aziende italiane che hanno raccolto di più in quanto sono stati in grado di ottenere più di 1.000.000€ da angels e investitori/imprenditori mici. Non è stato difficile nel senso che dietro la creazione di questa azienda c'è lui e un gruppo di altri imprenditori che non hanno un background da startupper ma hanno accumulato esperienza e credibilità durante gli anni. Hanno aziende solide alle spalle con grandi successi. Per un giovane invece risulta più difficile essere creduto perché dietro non ha delle garanzie su cui basarsi. Non è stato difficile per quel motivo lì. In Italia è comunque molto difficile, in Europa invece bisogna essere attrezzati con studi che ti permettono di andare a definire e intercettare i vari horizon. Se si guardano le statistiche però sono davvero poche le startup che sono in grado di cavalcare l'onda e riuscire ad emergere. Bisogna mettere in questo caso nel piatto troppo knowhow e c'è il rischio che qualcuno di esterno se ne vada ad appropriare. Loro hanno ricevuto finanziamenti da ex imprenditori italiani che sono emigrati all'estero che vedendo un'iniziativa italiana altamente competitiva rispetto a quella statunitense hanno deciso di investire e fare funding per loro.

6- Attraverso questo tipo di coltivazione si riesce a preservare la qualità e la particolarità i prodotti italiani (ex: Pomodoro pachino) o si ottiene un prodotto dalle qualità unificate in tutto il mondo? Un consumatore italiano che apprezza il Made in Italy riesce comunque ad apprezzare questo tipo di prodotto? Il prodotto viene accettato in ugual modo o in maniera differente?

Il pomodoro ha un tempo di crescita che non è totalmente profittevole all'interno di una vertical farm. Tutti i prodotti possono essere replicati e fatti crescere in maniera naturale in tutti i paesi del mondo. Nell'ultimo periodo stiamo dialogando con una delle migliori scuole italiane di cucina che ha capito che non è importante andare ad insegnare a chef mondiali a cucinare con i nostri prodotti made in Italy, ma che è necessario metterlo nelle condizioni di avere lo stesso tipo di prodotto con le stesse condizioni e lo stesso seme di quello Italiano ma prodotto nel suo Paese. Lì fai crescere e trasportare il made in Italy nel mondo.

Queste macchine consentono di replicare esattamente il gusto, le proprietà organolettiche e nutrizionali che non sono di solito legate alla terra ma all'ambiente di quel posto, quali i sali minerali presenti nel terreno, l'aria e l'irraggiamento solare presenti in quel determinato terreno. Tutti questi parametri sono perfettamente riproducibili all'interno delle farm tecnologiche.

Preservare il made in Italy è uno dei principali fonti di profitto italiano ed è per questo che le caratteristiche dei loro sistemi cercano di permettere l'inserimento delle caratteristiche particolari del terreno e di assecondare le esigenze e il percorso di crescita del prodotto specifico (basilico di Albenga). Attraverso questo tipo di innovazione si ottiene anche una qualità migliore dei prodotti proprio perché basati su una continuità e una stabilità di condizioni climatiche che altrimenti non si avrebbero (non esistono temporali, tempeste,..). Potendone controllare tutto il percorso di crescita si ottiene una massima resa della produzione e un'ottima qualità; alcuni chef che si basano proprio sulla standardizzazione della qualità del prodotto preferiscono questo tipo di raccolti rispetto a quelli derivanti dalla terra perché son costati nella consistenza e nel gusto.

7- Andando ad analizzare la mappa italiana ci sono delle differenze di concentrazione di startup in quanto al nord ci sono nuovi metodi di coltura e al sud ci sono nuovi metodi manageriali per la gestione della terra. Ci sono differenze di cultura o è casuale?

Basandoci sulle nostre conoscenze e esperienze, possiamo dire che nel sud del paese per quanto riguarda coltivazioni nel mondo del pharma si ha un'adozione di misure Agtech proprio perché necessarie per garantire la crescita delle piantine mantenendo immutate le caratteristiche del prodotto. Posso però immaginare che questa diversità tra nord e sud Italia riguardo la presenza di startup sia in parte dovuta anche dalla presenza maggiore nel nord Italia di una rete industriale maggiormente sviluppato anche nel settore meccatronico e meccanico. Questo favorisce così uno sviluppo di queste realtà agricole, mentre al sud manca come tessuto e come concetto generale.

Questo però non vuole dire che al sud non ci sia innovazione, infatti là sono maggiormente presenti aziende che hanno creato dei distretti nel settore dell'aerospazio molto forti e importanti tecnologicamente parlando. Sono però delle realtà clusterizzate e non diffuse come al nord, caratterizzato invece dalla presenza di cordoni di aziende

lungo tutte le principali strade.

Per questa ragione è difficile che una startup al sud riesca a trovare una cordata così forte che investa su di lui (come accaduto a Ono Exponential farming) comportando una riduzione degli stimoli nell'aprire attività.

Appendix 2

Startup: Agricooltur – Bartolomeo Marco Divià

1- Come è nata l'idea di aprire questa startup? Quali sono stati i principali motivi che vi hanno spinto a credere in questo nuovo progetto?

La nostra idea è nata come per tutte le idee per caso, attraverso un progetto stretto in collaborazione con Auchan in Corso Romania a Torino, all'interno del quale si intendeva riprodurre in maniera innovativa tutte le aree e i processi produttivi coinvolti nel supermercato: un forno all'interno dell'area dedicata al panificio, un area che ricordasse il birrificio, e così via. Si è quindi sviluppata l'idea di proporre un progetto di coltivazione indoor per riprodurre all'interno dei supermercati la coltivazione di frutta e verdura. Da qua è nata un'idea creativa di aprire questo tipo di startup, dopo esserci a lungo interrogati su quale fosse il valore aggiunto di questo progetto basato sulla coltivazione di prodotti a km zero. Infatti il vero interrogativo era come differenziarsi e come far emergere la diversità di coltivazione dal momento che questi sarebbero poi potuti essere recepiti dai consumatori come prodotti freschi ma pur sempre trovati sui banchi di un supermercato.

E' proprio allora che è nata l'idea che poi è stata all'origine di uno dei nostri 3 brevetti, cioè quello di portare il prodotto vivo in vendita. Siamo quindi nati con l'idea di andare a sviluppare ulteriormente una tecnologia esistente, quella dell'aereoponica, che risultava essere estremamente più versatile rispetto alle altre coltivazioni del fuori suolo, dava la possibilità di essere installata ovunque e con un 98% in meno di consumo di acqua. Quindi abbiamo iniziato a coltivare e sviluppare questa tecnologia che permette di far crescere piante che vengono successivamente portate al consumatore attraverso degli espositori aereoponici. Il nostro posizionamento si basa su un mercato principalmente nel mondo RE.CA (ristoranti e catering), nel mondo del retail, negli uffici all'interno delle mense aziendali, garantendo anche un concetto di welfare per il dipendente che ha la

possibilità di portarsi a casa un prodotto sostanzialmente raccolto sul momento e consumato vivo.

A casa si può infatti mantenere vivo attraverso dell'acqua in un bicchiere.

Questa innovazione ha aperto un mondo nuovo rispetto a quello delle catene di prodotti reperibili sul mercato in quanto non viene precedentemente reciso e immesso sul mercato ma viene mantenuto vivo fino al momento esatto del consumo.

Stiamo cominciando adesso un nuovo progetto delle esportazioni di questo prodotto sulle GDO attraverso quattro punti vendita Coop attraverso l'introduzione di un metodo di conservazione diverso da quelli correntemente usati, garantendo un prodotto non derivante dall'idroponica ma impacchettato in un sistema di produzione basato sul mantenimento delle radici umide.

Il nostro target è quello di creare un nuovo mestiere del contadino di città.

A tal proposito abbiamo sviluppato due aziende: la prima si chiama Agricooltur, la startup innovativa che detiene i tre brevetti. E' una società che è nata con un capitale sociale di 10.000 e che nel giro di sei mesi è passata a 510.000 di capitale sociale. La seconda è una società agricola con 200.000 di capitale sociale che adesso sta per essere sottoscritto da parte di importanti aziende (ancora in fase di contrattazione finale). Uno di questi partner coinvolti sarà l'istituto di Maria Ausiliatrice dell'Istituto Salesiano con il fine di formare giovani atti a condurre questo tipo di attività in siti cittadini.

Inoltre, il progetto di coltivazione urbana presente nelle grandi città si sta sviluppando in questo momento attraverso la costruzione di un sito di produzione cittadino presso Milano City Life. Questo permetterà di testare un nuovo format di vendita attraverso un canale B2B e B2C che avverrà tramite appositi container di coltivazione di prodotti vivi al fine di riprodurre un orto di terra a tutti gli effetti. Lo stesso punto lo stiamo sviluppando su Genova nella zona del porto antico dove posizioneremo un container di produzione. Stiamo approcciando quindi attraverso queste nuove tecnologie ad un nuovo tipo di interlocutore, un target differente.

Questo progetto infatti non è mirato al contadino ma all'imprenditore o il giovane che intende sviluppare questo nuovo tipo di mestiere orientato nel settore dell'Agrifood business.

Nonostante i contatti intrapresi con la Coldiretti stiamo dunque cercando di creare una nicchia di mercato differente, che non andrà a rubare quelle coltivazioni tradizionali che saranno, oggi e per sempre, basate su processi di coltivazione tradizionale ma quanto

più portando la coltivazione più vicina al consumatore e più accessibile anche in aree dove una volta non era immaginabile (centro città).

Grazie a questo sviluppo di nuove colture si è resa necessaria la definizione di un disciplinare per i prodotti. Infatti, sia a livello italiano che europeo, ad oggi non è presente una regolamentazione dei prodotti fuori suolo, che non possono né essere definiti né essere considerati come alimenti biologici. Abbiamo creato quindi un disciplinare che si chiama “gamma zero”, un brand in fase di certificazione che immettiamo sui nostri prodotti e che racchiude 10 principi di sostenibilità applicabili nelle nostre coltivazioni. Questo permette di avere un marchio distintivo sui cibi.

I dieci principi sono legati alla:

- Sostenibilità ambientale: meno acqua, meno concimi, prevenzione dei trattamenti in quanto le coltivazioni avvengono in un ambiente protetto e dove si è in grado di prevenire eventuali situazioni dannose, residuo zero nei prodotti attraverso un’analisi multi-residuale che deve essere al di sotto dei valori di lettura della strumentazione, sistemi alimentari basati sull’utilizzo di energia rinnovabile, prodotti riciclabili attraverso sistemi di recupero dei cestini di plastica utilizzati per la vendita finale, prossimità di coltivazione e quindi a km zero, recupero di aree urbane prima dismesse.
- Sostenibilità sociale: impianti e sistemi privi di barriere architettoniche e quindi fruibili anche da portatori di handicap, formazione e generazione di nuovo lavoro.

Questo disciplinare racchiude quindi principi non solo basati sulla salvaguardia alimentare ma anche sociale.

2- Su che tipo di tecnologie si basa il vostro sistema di agricoltura?

Nei nostri sistemi agricoli, la tipologia aeroponica è meno sviluppata rispetto a quanto accade in altre realtà, poiché è caratterizzata da una tecnologia più complessa che vede a monte la presenza di sistemi molto più complicati che non vengono percepiti dal fruitore finale. Lo sviluppo tecnologico su cui si basa il nostro processo si basa principalmente su un’analisi e uno studio di un anno intero di produzione di prodotti che ha successivamente permesso la definizione di algoritmi in grado di controllare e gestire la presenza della luce, dell’umidità, delle condizioni ambientali, delle temperature, del livello di accrescimento del prodotto e della tipologia di nutrimento che

necessita la pianta. Quindi il nostro è un sistema totalmente automatizzato con un cuore centrale che dialoga con dei moduli di coltivazione attraverso un sistema di comunicazione tra i componenti. C'è un sistema plug&play dei sistemi che si vogliono andare ad integrare attraverso un sistema di rilevazione e gestione di essi.

Abbiamo fatto molto lavoro a livello tecnologico per consentire al fruitore finale cioè al cliente che utilizza il sito di produzione di avere un sistema automatico controllato da remoto attraverso una control room che permette il monitoraggio e l'eventuale correzione di parametri di gestione.

L'altro vantaggio che presenta il nostro sistema rispetto a quello dell'aeroponica è che il soggetto riesce in forma puntuale e in maniera diversificata a dare nutrimento a diversi prodotti contemporaneamente, cosa che con i modelli classici risulta impossibile dato l'elevato utilizzo di acqua. Oggi tecnologie aeroponiche ne esistono abbastanza ma noi stiamo cercando di portarlo veramente a dei livelli fruibili da tutti. Questa è stata da sempre la nostra sfida e stiamo cercando di attuarla attraverso l'apertura di questi nuovi siti che saranno dati in mano a persone che non hanno mai fatto gli agricoltori.

3- Come viene visto il mondo del FoodTech ed in particolare dell'AgTech in Italia?

Avete riscontrato delle difficoltà nell'aprire questo tipo di startup essendo un Paese basato sulla coltivazione della terra e sul lavoro manuale dei contadini?

In passato abbiamo attraversato dei momenti caratterizzati da richieste da parte di aziende interessate a iniziare le proprie attività con il nostro progetto, caratterizzato da brevetti che tutelano in parte le particolarità delle nostre tecnologie e parte dei nostri processi.

Sicuramente in questo nuovo ecosistema ci sono aziende che si stanno sviluppando in maniera importante e che sono basate per lo più su una mono coltivazione e quindi una mono produzione (solo pomodori, solo insalata o coltivazioni con caratteristiche più semplici da riprodurre e ottenere). Questi stanno quindi facendo prodotti massivi alternativi alle tradizionali colture.

Noi invece stiamo cercando di entrare in una nicchia di mercato diversa; a noi non interessa fare i quintali di pomodori e non ci interessa nemmeno venderli con delle caratteristiche di prezzo regolamentate dal mercato italiano alimentare. Abbiamo avviato il progetto con una nuova vision rispetto a quella delle altre startup, che è poi quella che deriva dalla mia esperienza nell'automazione industriale dell'automotive e

che abbiamo deciso di trasferire in questo settore.

I prodotti che vendiamo si collocano a un prezzo medio rispetto ad un prodotto biologico. Se consideriamo per esempio una pianta di basilico, questa viene venduta da noi a 1.70€, che se confrontata con un prodotto reciso coltivato in pieno campo risulta avere un prezzo più caro, ma se viene confrontata invece con un prodotto biologico in mazzetto il prezzo è quasi uguale e varia di pochi centesimi. Siamo quindi abbastanza allineati al mercato biologico. Il nostro è un sistema basato sulla lean production che permette di produrre in piccole quantità in base alla domanda, facilmente accessibile dal consumatore. Non vendiamo un prodotto ma una filosofia perché ci deve essere il gusto, ci deve essere il sapore.

4- I finanziamenti, se ne avete avuti, sono stati facili da ottenere? Le banche hanno subito creduto in voi? E stato più facile ottenere finanziamenti da parte dell'Italia o eventualmente dell'Europa?

Ci siamo autofinanziati questo progetto tramite capitale proprio e quello apportato da investitori privati, successivamente entrati in società. Abbiamo inoltre ottenuto un bando che adesso è in fase di erogazione da parte della regione Piemonte per 400.000€ a fondo perduto. Questi sono comunque delle somme che avevamo già precedentemente speso e investito e che derivavano da risorse proprie (private). Da parte dell'Europa però non c'è stato nessun tipo di sostegno.

5- Attraverso questo tipo di coltivazione si riesce a preservare la qualità e la particolarità i prodotti italiani (ex: Pomodoro pachino) o si ottiene un prodotto dalle qualità unificate in tutto il mondo?

La nostra produzione ha molta cura di quella che è la gestione della coltivazione stessa dei prodotti e grazie alle tecnologie riusciamo impiegate ad ottenere le migliori qualità organolettiche per ogni prodotto. Ad esempio, abbiamo da poco chiuso una partnership con Eataly di Genova dentro il quale il ristorante il Marin utilizza il basilico proveniente dalle nostre coltivazioni, dato il profumo e un gusto eccezionale. Abbiamo una gamma di prodotti molto ampia e chi li assaggi rimane a bocca aperta sia per la qualità che per il sapore. Tra gli altri ristoranti che hanno adottato i nostri prodotti possiamo trovare Piano 35, Piccolo Lago e altri ristoranti stellati, proprio perché gli permettiamo di avere un orto all'interno della propria cucina garantendo un approvvigionamento diretto e di

altissimo livello.

Adesso in coltivazione si possono trovare 7/8 tipologie diverse di prodotto, e per ognuno di essi abbiamo ricreato ad hoc il macro ambiente migliore per ogni tipologia fornendo così il giusto nutrimento necessario per la corretta crescita e maturazione. Questo serve per andare simulare le condizioni più idonee per ogni singolo prodotto. Le nostre coltivazioni presentano una gamma molto vasta di prodotti che vanno dallo zenzero allo zafferano, i mirtilli, piante aromatiche di qualsiasi tipo, il genepy, melanzane bianche, cetrioli, peperoni, le classiche insalate, le fragole che ricordano le fragoline di bosco. La caratteristica che sicuramente ci diversifica dai prodotti coltivati localmente è che noi, portando la coltivazione al consumatore, formiamo un prodotto ancora vivo e quindi un prodotto che non subisce nessun tipo di declinazioni sulle qualità organolettiche. A volte capita nelle grandi industrie e nelle grandi distribuzioni che il processo di maturazione avvenga direttamente nella fase di trasporto, privando così alla pianta il giusto fabbisogno di nutrimenti.

Adesso stiamo provando a fare delle varietà autoctone come per esempio una particolare fragola di bosco, caratterizzata da uno shelf life troppo breve per essere normalmente raccolta, trasportata e venuta. In questo modo si risolverebbe questo problema. Altro esempio è la fragola tortonese, sviluppata in un sito di coltivazione a Tortona; stiamo cercando di far rientrare questo prodotto in uno coltivato sul territorio attraverso la perfetta ed esatta riproduzione del terreno di coltura, sperando così nel riconoscimento della denominazione del prodotto.

6- Si riesce quindi a mantenere invariata la certificazione alimentare per i prodotti o si hanno delle complicazioni in quanto non effettivamente derivanti dalla terra?

E' una cosa su cui stiamo ragionando. Il nostro partner salesiano ha infatti fatto un suo sito di produzione presso il proprio istituto all'interno del quale stiamo producendo la fragolina di Tortona e stiamo cercando di capire come attraverso questo tipo di tecnologia mantenere la denominazione di origine del prodotto.

Appendix 3

Startup: Dashfrm - Stefano Boaretto

1- Come è nata l'idea di aprire questa startup? Quali sono stati i principali motivi che vi hanno spinto a credere in questo nuovo progetto?

L'idea di costituire V-frm è nata alla fine del 2019, a seguito di un evento dal titolo Food Sense - Il vertical farming a supporto della città sostenibile. Lì abbiamo capito immediatamente dov'era il luogo ideale per portare le nostre competenze, conoscenze, capacità e tecnologie: nel mondo, apparentemente più lontano dal nostro, il mondo dell'Agricoltura. V-frm srl è una startup innovativa, incentrata sullo sviluppo, la produzione e la gestione di impianti industriali aeroponici per la produzione e la coltivazione in verticale di piante anche bio-fortificate.

2- Come si è evoluto il settore dell'AgTech in questi ultimi anni?

L'Agenda 2030 per lo Sviluppo Sostenibile in particolare per gli obiettivi relativi a:

- a. 3 Salute e Benessere
- b. 11 Città e comunità sostenibili
- c. 12 consumo e produzione responsabili
- d. 13 lotta contro il cambiamento climatico

Il settore dell'Agtech è in forte espansione innanzitutto per:

- I sistemi agro-alimentari determinano fino al 25% delle emissioni di gas-serra; Secondo la FAO la situazione attuale del dissesto idrogeologico a livello globale è ormai un problema molto grave: il 33% dei suoli mondiali sarebbe fortemente degradato e la metà dei terreni abitabili nel mondo sono destinati all'agricoltura. Nel solo contesto italiano da ricerche di Ispra è venuto fuori che nel 2019 si sono consumati 57 milioni di metri quadri di suolo, al ritmo di 2 metri al secondo.
- I sistemi alimentari rappresentano circa un quarto delle emissioni di Gas Serra antropogenici (GHG) e la produzione agricola per il 70% dei prelievi globali di acqua dolce.

A livello globale quello dell'indoor farming è un business su cui stanno puntando molti investitori. Basti pensare che negli ultimi anni molte startup hanno chiuso round di investimento importanti.

- 2,9 miliardi di \$ mercato del verticale Farming 2019
- 11,7 miliardi di \$ nel 2027
- 31,7 miliardi di \$ mercato dell'Indor Farming 2019
- 49,6 miliardi di \$ nel 2025

3- Su che tipo di tecnologie si basa il vostro sistema di agricoltura?

Il sistema si basa sulla nebulizzazione ad alta pressione direttamente sull'apparato radicale. V-firm è la prima azienda in Italia e nel mondo che si pone l'obiettivo di sviluppare e installare impianti produttivi aeroponici che, pur mantenendo sempre la stessa tecnologia e funzionamento, possiedono una struttura dimensionale configurabile in base alle diverse esigenze di spazio e di colture del cliente.

Gli impianti che facciamo sono scalabili, cioè modulari. Possono quindi andare a rispondere a diverse esigenze attraverso piccoli impianti con 50 vasche e possono crescere fino a larghe quantità di prodotti. Si riesce quindi a combinare sia la lean production che la domanda in larga scala. Essendo un prodotto di qualità la grandissima quantità non è dunque la caratteristica principale dei nostri processi.

E' un impianto indoor adattabile a qualsiasi tipo di edificio o area, dalla serra all'edificio industriale che si vuole recuperare permettendo quindi una coltivazione in differenti ambiti.

Proprio la capacità unica dell'impianto di V-firm di espandersi in verticale in un'ottica multipiano per diversi metri grazie alla bassissima quantità di acqua presente nelle vasche, rappresenta un elemento di innovatività nel mondo dell'aeroponica dove operano aziende che costruiscono semplici serre o possono espandersi in altezza solo per uno o due livelli.

Inoltre, in uno stesso impianto di V-firm si possono produrre contemporaneamente diverse tipologie di colture grazie all'utilizzo di piattaforme LED dotate di software parametrici che consentono la creazione di diversi ambienti di coltura (montana, marina).

Inoltre, l'ultimo obiettivo della start-up è quello di creare una coltivazione "Free from-Rich in", dedicata ai consumatori finali: tramite la nebulizzazione dell'acqua è infatti possibile controllare in modo puntuale tutti i nutrienti dati alla pianta. Questo controllo fa sì che si possano eliminare quegli elementi non tollerati aggiungendo al contempo nutrienti utili alla salute e al benessere delle persone trasformando così le piante in veri e propri integratori.

4- Come viene visto il mondo del FoodTech ed in particolare dell'AgTech in Italia? Avete riscontrato delle difficoltà nell'aprire questo tipo di startup essendo un Paese basato sulla coltivazione della terra e sul lavoro manuale dei contadini?

E' ancora presto per una valutazione oggettiva, l'impressione è che possa essere molto positiva soprattutto per i profumi ed i sapori e l'ottima qualità che le piante riescono a produrre in questo ambiente con bassissimo utilizzo d'acqua. L'assoluta assenza poi, di metalli come il nichel, la produzione senza l'utilizzo fitofarmaci, erbicidi e antifungini, in questo periodo storico, sono elementi che alcuni cluster di popolazione soprattutto più giovani cercano.

5- Come rispondono le realtà locali alla proposta delle vostre nuove innovazioni?

In questa fase c'è moltissima curiosità ed attenzione. Nell'impianto "demo" che stiamo costruendo a Rovereto i contadini avranno la possibilità di testare direttamente le proprie produzioni e valutarne direttamente la velocità dei tempi di produzione, la qualità del prodotto, i sapori e profumi e la possibilità di raddoppiare i cicli di crescita creando un prodotto con un livello qualitativo costantemente "replicabile" per tutto l'anno.

6- I finanziamenti, se ne avete avuti, sono stati facili da ottenere? Le banche hanno subito creduto in voi? E stato più facile ottenere finanziamenti da parte dell'Italia o eventualmente dell'Europa?

Stiamo partecipando ad alcuni bandi sia italiani che europei, ad oggi dopo un anno di vita stiamo finanziando direttamente la società attraverso fondi privati. Banche non pervenute.

7- Attraverso questo tipo di coltivazione si riesce a preservare la qualità e la particolarità dei prodotti italiani (ex: Pomodoro pachino) o si ottiene un prodotto dalle qualità unificate in tutto il mondo?

Grazie alle tecnologie utilizzate possiamo replicare modelli ambientali (temperature, umidità, Co2, radiazioni etc..) oltre ovviamente al suolo. Questo permette assolutamente di ricreare qualsiasi prodotto di qualsiasi zona d'Italia in qualsiasi parte del mondo e viceversa. Possiamo creare ambienti diversi anche all'interno dello stesso impianto.

8- Un consumatore italiano che apprezza il Made in Italy riesce comunque ad apprezzare questo tipo di prodotto? Il prodotto viene accettato in ugual modo o in maniera differente?

Non abbiamo ancora dati certi derivanti da un controllo e un monitoraggio del consumatore finale però, considerando i giudizi degli chef che hanno adottato questo tipo di prodotto, possiamo dire che permette di garantire alti standard qualitativi e un approvvigionamento costante e continuo.

Appendix 4

Startup: Juicy Marbles – Maj Hrovat

1- How did the idea of opening this startup come about? What were the main reasons that led you to believe in this new project?

We started working in this industries in late 2018. There was a hackathon, a technological event of a week and one of the challenges was to find a more sustainable solution for the beef sector, so we started to collect all the information regarding the use of water, land, gas emissions, and how big the challenge of the industrial product really is. The solution we proposed was not only regarding the creation of vegan products such as tofu, seitan, tempeh or similar but try to modify them and transform them into something more attractive for meat lovers.

This idea, deeply developed through fermentation technology, won the challenge and the hackathon and this was the beginning of our trip in this sector. After that we had the possibility to commercialize our plant based burger. In fact, at the same time, we were

working with a fast program with international retailers. The reason why we decided also to participate to the challenge was because while we were launching the product also other supermarkets or retailers (Lidl) started to sell those goods in a cheaper way. The competitions started to be less sustainable and for this reason we decided to focus on and create something completely new for the market. We wanted to find something difficult to be replicated, full of technology and with a specific issue to pursue, not only the want to enter in the international food sector.

After that, we participated in the Good Food Conference in San Francisco and we were quite intrigued by the growth of the foodtech community, in particular in this ecosystem. We finally found the biggest challenge: try to replicate the texture and the fibres and the structures of chicken/beef or in general meat products. We didn't believe in 3d printing as a useful technology solution. Even some startups started to think about it and we found more valid solutions. There was a very long study process consisting of the reading of much scientific literature in order to understand the technology under these processes. We found some interesting concepts and in particular one was characterized by the use of devices needed to deform the protein because of their natural composition. Considered as an alternative technology solution, the extrusion of protein could be made by the use of some specific machines that cost 1.000.000\$ each, so we started using for the first prototype the bar machines of a small entrepreneur paying him 6 packs of beers. After that there was a lot of prototyping, a lot of testing and covid appeared. We used this time to improve their recipes, their ingredients, and their combinations, and slowly it became more and more realistic. The product was not anymore a reproduction of protein but a "real" steak. With the steak product we apply to the wide company merger. Since the time of planty burger we (Maj and his friends) had a lot of interest in entering accelerator programs and founding in order to enter in the bigger scale. We faced this change and now we are growing and growing. The production floor is getting smaller so we will move to another building.

**2- On what kind of technologies is the creation of meat in the laboratory based?
(not a very specific answer in respect to the parents).**

No 3D printer but something made by fermentation and extrusion process.

3- How has the Next Gen Food and Drinks sector evolved in recent years? Did you face many challenges?

The whole protein sector increased its hype and after the IPO of beyond meat everybody started to be interested in this field. There are thousands worldwide startups producing plant based burgers and this traditional plant based meat are really competitive on the market and there are a lot of not really delicious burgers out there. Definitely there has been a lot of money going into the innovation of things, like for instance laboratory meat that recently have reached huge financial investment. It is really interesting to see how in these two years these few alternatives of meat or half protein in general increase their importance both in a technological sense but also in a way of consumer perception. We now have a better understanding of why consumers actually buy the products and it's somehow like a huge bubble in which everybody tries to do stuff in and gets really excited about it. You just have to do something innovative because otherwise you're just one of the many producers in the market. It was a growth quite exponentially in the way that products are now produced every day and big companies are also trying to pursue it by investing in startup sources. Nestlè has a program of plant base now and is entering the market, Unilever bought a vegetarian company.

4- Was funding, if any, easy to obtain? Who immediately believed in you?

At the beginning, we found money from local communities (basically a mentor and angel investors) that gave us a few 10.000\$ to produce the prototype. Now since we entered the acceleration program and we have been accepted by the Y Combinator standard, we raised funds because we knew the KPI in this field. The opportunity is quite immense and everybody can understand and invest in your idea. People are more pushed to invest since they start to see revenues and positive results.

The fact that definitively helps you in raising funds and being considered by big companies and accelerators is if you are a technology startup working in this sector and not only a retailer of technology. I mean, at first we were basically interested in the idea of developing machines and selling them with processes, but big corporations are now interested in investing in someone able to create the machines, create the process and sell directly its final product. They don't want to see burgers or only technology, but they want the entire startup to be able to make burgers in a better way.

5- How did the final consumer react to the idea of eating something artificial, since you entered the market one month ago?

At the beginning of this programme we were pushed in some way to commercialize early so even though we were not happy with the final product in order to give people the chance to provide us feedback. When you're selling a product that has a competitive price to beef such as 15€/kg (in Slovenia) as the launch price, at the beginning people were quite happy to pay that much. People started to come back and give them positive feedback, started to order more, and there was some interest in products without packaging. Then order started to accelerate and they arrived at 200 in one time and we decided to go sold out. We had very limited capacity at that time so we were using the machines all the time and basically this was the reason we were sold out.

We had the recommendation to make the price higher and see what people are willing to pay if it happens. In fact, for the early adopters, so people are really interested in this space and willing to pay more, we raise the price and start to sell the "value". Increasing the price also accelerated the sales because people increased their perception of quality and premium products. In the end the problem was that the product was not really something perfect in Maj's opinion and some people were a little bit disappointed about the selling price and the quality. We had the 7€ of re-purchase but the price was not sustainable anymore for the sector. We want to lower the price and make it affordable for everyone, but we need to scale the production in order to do so.

We may enter the market also through retailer shops in the US and not only by their e-commerce because it is a market already ready for these products, with other cultures and we have national distribution channels easier to access. People are really hype about this product so they are very interested in buying it. The goal is to enter retail possibly at the end of the year.

6- Does this type of production preserve the quality and distinctiveness of the products or does it result in a product with unified qualities throughout the world?

This is the goal, the one to be able to manipulate all the single aspects of this product. Try to replicate different types of beef coming from all over the world.

7- What is the taste of the product? Are they similar to meat one or completely different? Are they near to the one of veggie burger?

Natural flavours we are trying to reproduce in the hardest thing of this challenge. The thing is that the beef out the all meat has the hardest flavour to be reproduced, because it has a very particular structure difficult to be create. At the same time its meatiness it is not so difficult to be replicate and this is the reason why we are trying to make it as realistic as possible, still leaving something completely different. It is also interesting to see the reaction of consumers: meat lovers say that that it can be definitively reconnect to the little part of actual beef with some changes, whilst some plant based people say that it remember the meat without differences. We are trying to target those consumers in order to understand for whom the product is good enough and provide them the best experience. For meat lovers it will be necessary to make some improvement both in the structure and in the flavour. The flavour department is going to develop something new since it is very complex to replicate.

8- How do you think this kind of startup could be seen in Italy, considering that it is a country with a very strong food and land culture?

One of the ideas that we also had and that might be achievable in the future, was to establish a production city in Italy since they are near Slovenia and just take advantage of this Italian tradition and capability to produce high quality and delicious food. I think for Italian consumers although we don't have much experience they are quite prepared to plant based meat tofu, and vegan alternatives. So the production will be based in Italy this would be a plus point for their business and reputation. Italy is also the greatest provider of soybeans and this could be a major reason to invest in Italy. Maybe not everyone is ready for this market but there are numerous flavour explorers in Italy. One of the owners of an Italian restaurant chain in Slovenia is setting to open a restaurant chain in Milano and one of the ideas was basically to have a normal menu take away of Italian food but also a normal menu with dishes based on plant based. There are many young people starting to change their food regime, open to new innovation for them.

Appendix 5

Startup: Revo Foods – Robin Sisma

1- How did the idea of opening this startup come about? What were the main reasons that led you to believe in this new project?

The Oceans sustainability and the environment are the main aspects that pushed us to create new technology. In fact the sea has a lot of problems related to overfishing and we think we need to offer better alternatives for consumers to still like the fish and consume it.

2- On what kind of technologies is the creation of seafood in the laboratory based?

Plant based product printed with 3d printer. The protein powder mixed in water and joined with the other ingredients. At the end it is put in the 3d printer that through a process of extrusion creates the salmon. We have full control of the shape and it is amazing. We are now focused mainly on slices of smoked salmon and not on the creation of the entire piece of filet. The other kind of product is sashimi.

3- How has the Next Gen Food and Drinks sector evolved in recent years? Did you face many challenges?

The sector is going better with more companies understanding this growing field with a lot of money involved and able to create a lot of money and revenues. There is a huge development, in fact five years ago there were not so many companies and now it is exploding with more and more companies that entered the market. There will be an amazing increase of products that will also become more and more better than now. Most people are interested most in the meat and chicken one rather than in the seafood sector, but there is a puck of seafood players that are starting now to operate in the field and it is fantastic. This allows the sharing of knowledge and the improving of knowhow causing a huge development. They are concentrated all over the world.

4- Was funding, if any, easy to obtain? Who immediately believed in you?

It was difficult to find funds at the beginning and also the infrastructure was not so friendly and available for investing in it. Our business was very innovative and we had no history so it was difficult to convince people. In the United States the food sector was

more developed and there were more investors. We needed to fight hard in comparison with other American startups but finally we received money and now everything is going better. Now, we received funds both from Vienna and from government and institutions, also Europe is going to invest in it spending a lot of focus on this sector.

Risk capital companies are those who invested in our ideas and risky investors. We also received public funding from Austria.

5- Does this type of production preserve the quality and distinctiveness of the products or does it result in a product with unified qualities throughout the world?

There is the possibility to create different qualities of salmon but we actually don't do it. Maybe in the future we will develop something new.

6- How do you think this kind of startup could be seen in Italy, considering that it is a country with a very strong food and land culture?

Our products have been tested by more than 1.000 people and their feedbacks were very positive. They loved it and were very enthusiastic. The price has not been defined yet because we are not on the market. We are sure it will be a premium product with a high price in order to cover production cost. We would like to enter the market at the end of this year in specific shops and not in supermarkets.