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Artificial Intelligence for improving sustainability performance in the agri-food chain: The Regusto platform case

Supervisor

Ch. Prof. Silvia Panfilo

Graduand
Carlo Rossignoli
Matriculation Number
872245

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Introduction

"The term 'sustainable artificial intelligence' encompasses two distinct yet complementary approaches. The first is AI for sustainability, which involves applying artificial intelligence to promote and seek solutions for a sustainable future, for instance, by optimizing processes and identifying innovative solutions for environmental and social challenges. The second approach is the sustainability of AI, which focuses on reducing the environmental impact of AI-based technologies. The future of sustainability and AI depends precisely on balancing these two approaches". (Nieto-Rodriguez & Vargas, 2023).

Artificial Intelligence is playing a key role in improving sustainability and business performance, with a major improvement in the agri-food sector (EPRS European Parliamentary Research Service, 2023). Artificial Intelligence is the main technology that enables companies, under increasing pressure to reduce waste and greenhouse gas emissions, to equally address the eco-sustainable challenges of this century. Globally, companies therefore see AI as the only technology that can help business management by making it more effective and sustainable during production processes.

The agri-food industry is characterized by well-defined production processes and complex supply relationships. This industry has a major impact on the environment and society, uses many natural resources, including land and water, and accounts for about a third of global greenhouse gas emissions. For this reason, it is now essential to employ cutting-edge technologies that can address emerging sustainability issues, which have so far seen little effort and results.

By integrating AI into the supply chain, it has been possible to have more accurate monitoring of processes, with a consequent advanced data analysis improving the entire management of resources for companies. For example, AI has been used to predict and manage market demand, thus reducing overproduction and food waste, helping groups to optimize and estimate in advance possible changes in the sector which, if not kept under control, could lead to significant problems for productivity. These applications, therefore, not only promote environmental sustainability, but also improve the economic performance of companies, creating significant added value. Finally, AI

enables the adoption of circular economy practices, allowing companies to reuse by-products and reduce negative impacts on the ecosystem.

The Environmental, Social, and Governance (ESG) pillars must also be taken into account when discussing production chains and business sustainability. These three aspects serve as crucial benchmarks for assessing, quantifying, tracking, and bolstering an organization's or company's sustainability commitment. This strategy incorporates investments focused on governance, social, and environmental concerns, all of which are critical for accountable and sustainable management.

Artificial intelligence, in this case, can accelerate the improvement of companies' ESG performance thanks to the automation of decision-making processes based on data relating to the monitoring of ESG factors. Given the complexity and the growing focus on this principle, artificial intelligence can greatly implement the study and analysis of these data, which often prove to be crucial for the success of a company's sustainability performance. AI can then be used for machine learning models through which to have dashboards to understand and monitor ESG risks or to identify areas of activity where there are hidden spaces for improvement.

With an emphasis on the adoption and tracking of sustainable practices, the goal of this effort is to investigate how artificial intelligence may enhance sustainability performance in the agri-food industry. AI has the power to completely transform how businesses run, easing the shift to more environmentally friendly company models and enhancing both financial and environmental results. This experimental thesis aims to investigate how AI technologies can be used to monitor, optimize and make production processes more efficient, thus contributing to the reduction of carbon emissions, saving resources and minimizing waste.

At a time when sustainability is not only a regulatory obligation, but a determining factor for corporate competitiveness, this research fits into the global debate on the role of new technologies in supporting companies in achieving the Sustainable Development Goals (SDGs). The importance of such an investigation is reinforced by the growing pressure that companies face to reduce their environmental footprint and adopt circular production models. Consequently, this study aims to provide a theoretical and practical basis for the implementation of AI solutions within companies in the agri-

food sector, proposing innovative models to increase the efficiency and sustainability of their operations.

In summary, the research intends to demonstrate how AI can not only facilitate the sustainable transformation of the agri-food supply chain, but also improve the economic performance of companies, answering key questions on how AI can be integrated into business processes and how it can help monitor sustainable practices.

The whole study starts from a sample of about 40 articles that have as a common theme the presence of the 19 objectives of the 2030 agenda.

Therefore, in the first chapter we will delve into the very recent literature on AI and see how this tool has evolved over time; we will then discuss the ESG topic and evaluate how this principle is becoming central in many companies. We will also delve into the SDGs and the 2030 Agenda, focusing in particular on five issues related to artificial intelligence, namely the importance of AI:

- ✓ in corporate sustainability,
- ✓ for improving operational performance,
- ✓ for reducing waste,
- ✓ for traceability in circular supply chains,
- ✓ for achieving the SDGs.

Finally, we will close the chapter with the methodology that we will apply in our study.

In the second chapter, we will analyze how the Regusto platform uses artificial intelligence to help companies reduce food waste and improve their sustainability performance. Thanks to the tools offered by Regusto, companies can not only reduce the amount of discarded products, but also increase operational efficiency, that is, carry out activities more quickly and precisely, saving resources and reducing costs.

In the third and final chapter, we will analyze how three companies in the agri-food sector, Parmacotto, Rovagnati and Esselunga, use the Regusto platform to achieve the five objectives discussed in the previous chapters. We will try to understand whether, despite operating in different contexts and with specific objectives, both companies manage to obtain similar results in terms of efficiency, waste reduction and improvement of sustainability. In other words, the analysis will try to highlight whether the use of Regusto leads to comparable results, even if the companies may be different

in size, type of product and initial approach. All this will be done through the analysis of their sustainability reports and financial statements. Finally, in the conclusions we will draw the conclusions of our study and the results obtained. The objective will be to understand if the adoption of artificial intelligence has led to improvements in the sustainability performance of the companies, whether these improvements have followed a common trend or whether there are differences due to the specific characteristics of each company. By analyzing the data, we will try to understand if, using Regusto, companies obtain more efficient results in terms of waste reduction, improvement in traceability and resource optimization.

In conclusion, the analysis will attempt to ascertain if organizations' sustainability performance has improved, deteriorated, or stayed the same as a result of artificial intelligence, and whether the use of Regusto has improved their operations and financial outcomes. This will enable us to make inferences about the possibilities and difficulties associated with integrating digital technology within the framework of business responsibility.

Chapter I
Sustainability Development Goals and AI

1.1 Bibliometric analysis of the literature review on SDGs studies

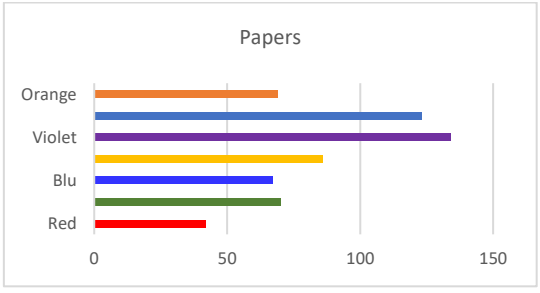
This work starts from the analysis of a sample of about 40 articles related to the agri-food world, which refer to one or more of the 17 sustainable development goals of the 2030 Agenda.

Our analysis started from a database of Excel including 573 papers in the management and business administration area, related to the period between 2020-2024.

The papers were classified within 7 clusters that identify the different topics covered; in detail:

1. Red (tourism, developing countries, hospitality, stakeholders, covid;)
2. Green (reporting&SA);
3. Blue (planning, supply chain, business models);
4. Yellow (governance, financing, investment, ESG, risk assessment);
5. Violet (decision making, partnership, MNEs, barriers and drivers, sustainable cities, economic impact, grant challenges);
6. Turquoise (CSR, environmental protection, gender equality, social impact);
7. Orange (circular economy, industrial development, manufacturing, innovation, performance assessment).

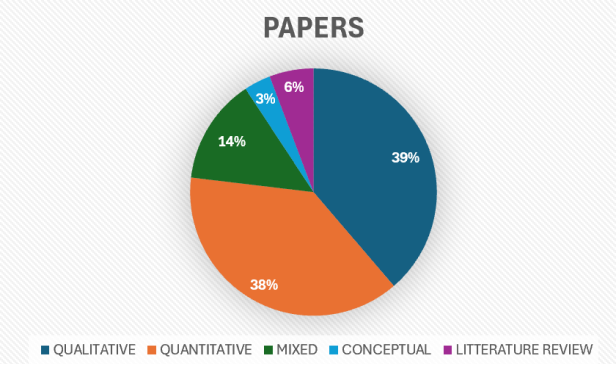
Graph 1.1 Analysis of DB papers: No. by topic category



From graph 1.1 we see that most of the papers analyzed belong to the categories (yellow, violet, turquoise and orange) that more closely address issues related to sustainability.

The methodology used for each paper was then identified, determining whether the studies adopted qualitative approaches (e.g. interviews or survey), quantitative approaches based on statistical analysis, mixed, conceptual or literature reviews.

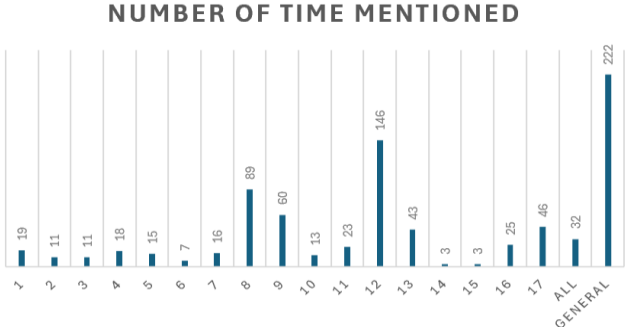
Graph 1.2 Analysis of DB papers: No. by methodology applied



Graph 1.2 shows that more than 50% of the papers deal with studies with statistical analysis and quantitative or mixed methodology highlighting the need for more qualitative investigations.

The last step, fundamental for this work, was to identify for each paper present which of the 17 SDGs of the 2030 Agenda it referred to.

Graph 1.3 Analysis of DB papers: No. by SDGs covered



Graph 1.3 shows that the most mentioned SDG was the 12th, the sustainable development goal that refers to responsible consumption and production. More than 200 papers, however, do not refer to any specific SDGs while 32 of them refer to all of them.

Building on this selection, about 40 papers (see Appendix) were identified that deal with the topic of the use of artificial intelligence also applied to the improvement of sustainability performance or that deal with sustainability within the agri-food supply chain.

From the analysis of the literature, it clearly emerged that the interest in the application of AI in the field of sustainability related to agri-food supply chains is growing strongly; however, there are still important gaps especially regarding the use of AI for the improvement of supply chains and circular supply chains. For this reason, the current work aims to shed a little lighter on these issues and tries to delve into how the implementation of intelligent supply chains and the use of AI can improve long-term sustainability in the corporate world, particularly in the agri-food supply chain, which is responsible for a third of global greenhouse gas emissions.

1.2 AI and its application for green production

Artificial intelligence (AI) is a branch of computer science that deals with the creation of systems capable of performing tasks that would require human intelligence, such as speech recognition, natural language understanding, logical reasoning and machine learning.

In short, we could say that artificial intelligence is the ability of a machine to show human skills such as reasoning, learning, planning and creativity. AI, therefore, is not a single technology, but a set of techniques and algorithms that allow a machine to learn from data and information and adapt to constantly evolving situations.

The concept of "simulated human intelligence" was first discussed in 1956 at a meeting at Dartmouth College in New Hampshire. Some of the leading figures in the field at the time, including Nathaniel Rochester and John McCarthy, gathered to discuss innovative ideas for such systems. One of McCarthy's many proposals was to build a machine that could replicate every aspect of human intelligence and learning. Professor McCarthy had two months and a team of 10 collaborators to implement cutting-edge simulated intelligence systems. But a rival project by Allen Newell and Herbert Simon,

who had already created a computer called Logic Theorist that could prove theorems based on principles of college mathematics, undermined McCarthy's plan.

The development of the General Problem Solver (GPS), a computer that imitates human problem-solving techniques using the so-called "heuristic means-analysis" was made possible by the Newell and Simon program, which represented an important advance in this field. This analysis involves solving a problem with the help of humans and simulated human intelligence systems at the same time. We start from the so-called "current state", that is, the starting situation, to then arrive at the objective state, the final target to be reached. If the computer sees that the two states match, it will not initiate any action, otherwise it will have to find an action to reduce the distance between the two states. A good example is that of modern street navigation apps, where the system takes into account the position in which you are and immediately after having entered the address of the position of where you want to go, the app calculates the route and therefore the action to be performed. All these aspirations soon ran into significant obstacles, however, such as the robots' inadequate ability to reason beyond simple syntax manipulation and their lack of semantic expertise in the topics they were dealing with. The United States government stopped supporting the creation of these machines in 1966 due to restrictions.

Artificial intelligence has grown more quickly with the introduction of large data and the advancement of computing power, particularly in the domains of machine learning and artificial neural networks. Systems gain performance over time by studying vast volumes of data. Due to these advancements, AI is now a strong and adaptable instrument that is applied in a wider range of intricate domains.

Fosso Wamba, Queiroz and Trinchera (2024) encompass the concept of AI versatility and explain very well how this can be, if properly exploited, decisive for the competitiveness of a company. The authors address three aspects in particular: the first is the enabled dynamic capabilities of AI where business skills help organizations to use artificial intelligence to quickly adapt to market changes, a central feature of the dynamic capability theory that highlights how companies develop capabilities to react and thrive in turbulent environments. Previously, AI was used as a process optimization tool, now, instead, it is a real enabler that allows to analyze large amounts of data, to make fundamental predictive forecasts and allows to reduce risks considering various

strategic aspects of the sector. In doing so, this tool has allowed the transition from a use merely oriented to operational efficiency to a use of resilience and innovation. The second theme addressed by the authors concerns the fundamental transition from a culture based on adaptations dictated by intuitions and subjective experiences to a "Data-driven" culture. Previously, it was thought that the subjective thinking of management and the experiences of managers were the cornerstone for developing business adaptations within the economic sector, but as the theory of “homo economicus” explains, people have a limited capacity for analyzing and re-elaborating information, leading to a high probability of making mistakes. With the advent of artificial intelligence, however, we have moved to a more scientific approach that allows us to conduct a much more detailed analysis, taking into account many more factors, thus greatly reducing the possibility of stumbling into errors. The last topic addressed by the authors concerns the possibility of integrating AI into a nation, to facilitate political and social choices; in particular, some states are culturally more favorable to risk than others, and it is here that AI can favor government regulations and incentives and social interventions towards change. In short, AI is no longer a simple support technology but a set of evolutionary capabilities influenced by cultural, environmental and organizational factors that allow us to guide business or government decisions and to innovate and promote performance improvements. In addition to the various possible areas of application of AI, there are a rich series of situations where AI is integrated within supply chains. As highlighted by the authors Hao and Demir (2024), the TOE (Technology-Organization-Environment) model explains well how the multifactorial nature of artificial intelligence is integrated, analyzing the technological capabilities, organizational readiness and environmental pressures within the supply chain. Then, by crossing the TOE model between various sectors, can obtain important information that would certainly improve the supply process and the functioning of the chain itself. According to the authors, there are three very important phases that must be exploited if you want to have a successful strategy. The first is the pre-development phase where you need to take into account many variables and break down the problem into many small parts, so as to be able to have a broader vision of the individual processes that will be implemented. The second phase is the actual development phase where the theory will be put into practice to test whether a solution has been found for each problem.

Next comes the post-development phase, in this case you want to measure whether what was expected actually corresponds to the results obtained in the field.

In the paper by Hao and Demir (2024), six key elements for the pre-development stage of supply chains' use of AI are outlined in the research. These themes make it abundantly evident how crucial it is to take a proactive rather than reactive stance in order to guarantee successful AI integration. In the context of work psychology and business organization, proactivity is defined as an anticipatory mindset that is focused on change and self-initiative in certain work scenarios.

Starting from the first of the six topics, “anticipating technological constraints”, companies are required to start by predicting potential technological problems, which could concern IT infrastructure, data quality and the availability of computational resources. By identifying these factors in the pre-development phase, companies can more effectively allocate investments and technological solutions to overcome these challenges, preventing delays that will arise in the optimization phase. The second topic is improving decision-making procedures, where AI should not be limited to merely identifying a priori the unexpected events that could affect the supply chain but should be able to calculate the necessary resources that will need to be available to deal with such issues. This topic focuses on the notion that AI should, through forecasting, speed up operational decisions rather than responding only to unforeseen circumstances. To use this system, organizations will first have to identify the weaknesses in their current processes and then improve them. The third element is risk mitigation. To take a proactive stance, where the company is already prepared in advance to deal with difficulties, as opposed to a reactive stance, where the company only responds when the danger is already underway, companies must recognize any issues that may impede the adoption of AI; such as cybersecurity vulnerabilities or lack of adequate regulations. It is essential to develop mitigation methods to manage these risks during the pre-development phase, as well as ensuring that infrastructures are prepared and that sufficient security measures are in place to safeguard data and AI systems.

The fourth theme refers to cross-functional collaboration where promoting collaboration between different departments within the organization cannot be confined to a single department, but requires the active participation of all business functions,

from marketing to human resources, to ensure that the adoption of simulated human intelligence (AI) meets the overall needs of the value chain.

An examination of the strategic alignment between company plans and the possibilities of artificial intelligence is the topic of the penultimate theme.

From the very beginning, businesses need to determine how artificial intelligence may help them achieve their long-term strategic objectives, such as increasing their operational agility, enhancing their sustainability, or expanding into new markets.

The possibility of incorporating intelligent systems into business planning, as opposed to viewing it as an ad hoc or independent solution, is the subject of this discussion.

Finally, there is cultural and training preparation, a crucial topic that concerns the preparation of human capital for the adoption of AI. Organizations must be ready to manage the cultural change that AI integration entails. This includes training programs, change management, and the construction of a corporate culture open to innovation and experimentation with new technologies.

There are different ways to prepare resources for change; according to the TOE theory, one of these is the socio-technical system that, by creating interdisciplinary teams, where AI experts and industry experts collaborate to find practical solutions, transforms the constraints present in the processes into enabling factors.

Another way is upskilling or rather the development of talents; in this case, resources are fully trained on technologies and above all on the importance that these have for the company. It is a solution that starts further upstream, in fact, without adequate training and the right skills, the adoption of AI can be slowed down. Creating an AI-ready workforce is therefore an essential element pto transform constraints into enablers. Without this, there would be no possibility of having adequate personnel to deal with problems and find solutions.

These six themes are central to ensuring that the adoption of simulated human intelligence (AI) does not occur reactively, responding only to problems as they arise, but rather proactively, anticipating and planning constraints and opportunities.

The main role of technological, organizational and environmental dynamics is to directly influence success in each phase, and the understanding of how constraints in one phase can become enablers in another.

In essence, it can be said that AI has undergone a significant acceleration with the advent of Big Data. This acceleration has become a fundamental factor in terms of sustainability, allowing public and private stakeholders to intervene correctly and pervasively in choices aimed at improving sustainable development goals without losing sight of either economic or environmental objectives. These objectives are not binding for companies but there is still an invitation to pursue them for all actors in the system, including governments, organizations and the private sector.

However, we must not overlook the regulatory concerns and intense emphasis that the advent of AI has brought. A case in point is the regulation on artificial intelligence and self-employment in food-delivery platforms approved by the Council in May 2024 after being ratified by the European Parliament in the same year. The goal is to make AI systems safe, transparent, traceable and environmentally friendly.

According to the regulation, AI systems are categorized according to their degree of risk: those with "unacceptable risks", such as social manipulation, are prohibited unless there are exclusions dictated by parliament; those with "high risks", which apply to topics such as product safety and fundamental rights, must be subjected to rigorous evaluation and registration procedures by arbitrary bodies. Workers on platforms such as Delivero, Glovo and Justeat have had to face a long struggle against the institutions. The latter, when this regulation had not yet been promulgated, were exploited and made to work in demotivating conditions. Suffice it to say that they were not defined as employees or self-employed workers so they could not benefit from either of the two protections deriving from these positions. However, when using AI, there are additional dangers to consider, one of which is data privacy, since examining huge amounts of data could lead to access to sensitive information.

Another important issue is the bias of algorithms, which can derive from the prejudices of those who designed them or from the data used for training.

These "discriminations" are divided into direct and indirect. The first occurs when the bais of the algorithm is directly linked to the discrimination situation, for example a company uses a scouting system to hire workers via a platform but the

platform uses an algorithm that discards all the CVs of women with two children; the second occurs when the bais is indirectly linked to discrimination.

Still referring to workers on the platform there is an important example regarding the Glovo case where workers who gave non-continuous work availability on the platform passed behind workers who had worked without periods of rest, this can derive from how the algorithm was designed or from the prejudices of those who designed it. However, European regulation is trying to provide greater clarity and transparency on these delicate issues, with the aim of preventing ambiguity.

It is clear how this area is still little explored and how strong its impact is in today's society.

1.3 The ESG pillars/dimensions of sustainability

The acronym ESG represents three fundamental areas namely Environmental, Social and Governance. Each of these pillars concerns specific sustainability criteria such as commitment to environmental sustainability, respect for corporate ethical values and operational transparency. ESG criteria usually take the form of a score that evaluates the company's risk for investors, based on data and metrics related to the organization's intangible assets. In fact, investment decisions are increasingly not based only on financial performance, but also consider environmental impact and responsible corporate management.

Milton Friedman, an economist, said, in the decades between 1960 and 1970, in response to the increased emphasis on philanthropy, that social responsibility was detrimental to the financial success of corporations and that government controls were detrimental to the economy.

For a large portion of the 20th century, his idea that corporation valuation should be nearly entirely based on financial outcomes and that social responsibility expenses were not necessary had an impact on economic thought.

Towards the end of the century, however, a contrary theory emerged. In 1988, James S. Coleman published the article "Social Capital in the Creation of Human Capital", challenging the predominant concept of "self-interest" and introducing social capital as a new measure of value. At the same time, the strict separation between finance and the environment began to be overcome.

In 1998, journalists Filbeck and Preece published the "Fortune 100 Best Companies to Work For", a book that listed the best-performing companies in the United States in terms of corporate social responsibility and how their financial performance was affected. It turned out that improving procedures and expanding corporate responsibilities did not negatively affect the company's financial performance, but rather maximized productivity, ensured business efficiency, and led to the procurement and use of top management talent.

This concept is taken up by Delgado et al. (2023) who develop the concept of "double materiality"; it refers to the ability of companies to consider two aspects of materiality, that of internal stakeholders, therefore a focus on the financial aspect, and that regarding issues that have a significant impact on external stakeholders, such as customers, employees, suppliers and society in general. In fact, issues that are included such as human rights, diversity and inclusion, or environmental sustainability, highly relevant topics for an external analysis focused on sustainable goals. At the same time, there is also financial materiality that focuses on sustainability aspects that affect the financial performance of the company. For example, a company that reduces carbon emissions could improve its reputation and, consequently, attract investors or customers, increasing profits. Connecting these two aspects allows companies to address sustainability challenges not only from an ethical point of view, but also with an eye on long-term financial and strategic effects.

Responsible investments based on ESG criteria have reached a phase of global expansion, favored by COP21 – the Paris Climate Conference – and the United Nations Sustainable Development Goals for 2030 (SDGs). COP21 was held in Paris in 2015 as the twenty-first annual session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (1992) and the eleventh session of the Meeting of the Parties to the Kyoto Protocol (1997).

The 196 signatory nations pledge to severely cut greenhouse gas emissions and keep the rise in global temperatures well below 2°C over pre-industrial levels. ESG has established itself firmly in the financial industry as a result of sustainability agreements being supported on several levels. Indeed, global ESG assets are expected to surpass $53 trillion by 2025, accounting for almost one-third of the estimated $140.5 trillion in total assets under management, according to Bloomberg.

The EU has a leading position in the sustainable fund market with 84% of global assets in this sector. Furthermore, it is the most advanced and diversified market for ESG investments. In comparison, the United States, which follows at a distance, represents about 11% of these global assets of sustainable funds (EPRS | European Parliamentary Research Service, 2024)

It is known, as also confirmed by the study by Zampone et al. (2024), that a good sustainability performance, especially in the environmental and social fields, leads to a greater disclosure of the SDGs by companies. Their study aims to understand whether companies' SDG disclosure practices actually reflect their sustainability performance and whether such disclosure is useful for investors and other stakeholders. The study covers a time period from 2016 to 2020 and includes 635 companies from 45 countries and 8 different industrial sectors. Based on their activity and progress responses, companies submitted information on the methodology with which they disclose the SDGs through a transparency index. Using a database, companies provide a comprehensive and unique assessment of environmental, social and governance aspects through which ESG performance is then measured. Subsequently, it is identified whether the analysis of ESG performance influences SDG disclosure and, consequently, whether it leads to the attraction of new stakeholders. The results of the study indicate that there is a positive relationship between ESG and SDGs. In other words, companies that score higher in ESG indicators are more likely to voluntarily provide information on their progress towards the SDGs. All this leads to an increase in interest from external stakeholders in investing in the company's activity. Dictated by the fact that the latter recognize greater transparency and trust towards the company, they perceive greater differentiation and lower risks in the long term given the strong coherence between declared objectives and real results and finally greater access to sustainable capital as a consequence of the fact that institutional investors and ESG funds favor companies that share high standards of transparency. Other authors such as Tyan et al. (2024) also support these analyses. Their research examines how the corporate governance framework and the execution of the ESG strategy influence the achievement of the Sustainable Development Goals.

Focusing on important areas such as the role of ESG, corporate governance structure, embeddedness idea, and integration of ESG strategy into corporate operations,

the study draws attention to the discrepancy between companies' intentions and actual implementation of SDGs. Information from 552 publicly listed enterprises in Taiwan was used to assess the above.

The study results show that a correct ESG implementation is fundamental to transform strategic intentions into tangible results. Dictated by the fact that a deep-rooted strategy focused on innovation leads to an orientation towards the improvement of obsolete operating practices, subsequently the so-called "multiplier effect" is created which sees companies oriented towards sustainable practices make agreements with partners who share very similar visions generating an incontrovertible change towards a green supply chain and finally a reduction in costs resulting from the reduction of waste and increased efficiency in the supply chain.

In the agri-food sector, one of the main challenges is the need to have reliable and accurate data along the entire supply chain, starting from the field, to demonstrate the ability to support responsible and sustainable production. Data collection and mapping, together with the measurement and comparison of ESG ratings, are issues of increasing relevance for all actors in the supply chain.

Lee (2023) conducted a study on about 500 of the largest companies in the world and highlighted how, through an index based on the SDGs, corporate interconnectedness can be predictive of CSR (corporate social responsibility) practices. In this case, the index based on the SDGs, through a linear regression, was used to understand whether the dependent variable, i.e. CSR, is influenced by the independent variable, i.e. corporate interconnectedness. Corporate interconnectedness refers to the fact that there are links between two or more companies; the most appropriate example is when the CEO of another company is present on the board of directors of a company. It was possible to see that corporate “centrality” is a good predictor of CSR practices. In other words, a good interconnectedness between companies can favor governance practices that are more oriented towards sustainability. However, this is not always the case. Some SDGs, such as those related to climate change or gender equality, are more subject to external influences and pressure from networks. SDG 13, in fact, benefits from the exchange of know-how and sustainable practices between interconnected companies and SDG 5 is driven by shared policies in sectors with strong interconnection. Other SDGs, however, such as those related to poverty or responsible consumption, could

depend less on direct interconnection and more on factors internal to the company, such as the local context or independent company policies.

If we shift the focus to companies in the agri-food supply chain, therefore, it is easy to understand that a well-centralized management of the supply chain can lead to the improvement of sustainable performance along the entire supply chain. Then, considering environmental parameters, social regulations and corporate governance, we can get to obtain a sector that self-implements to achieve an eco-friendly production system.

Given the importance of the agri-food supply chain at a global level, both for its contribution to the local economy in terms of employment and for its general economic impact, ensuring ESG compliance proves to be a decisive element for the future of this sector (European Commission Agriculture and rural development, 2023)

On the environmental front, agri-food companies committed to sustainability are adopting environmentally friendly agricultural practices, promoting biodiversity, reducing the use of pesticides and chemical fertilizers and working to reduce the carbon footprint throughout the production and distribution chain.

From a social perspective, great attention is paid to working conditions in the fields and supply chains, to the promotion of in food safety and supporting local communities. This can include initiatives aimed at improving the quality of life in rural areas, ensuring fair working conditions and encouraging diversity within food supply chains.

In terms of governance, ESG-oriented companies adopt ethical and transparent management practices. This includes the correct disclosure of information, the implementation of anti-corruption policies and the promotion of responsible and ethically oriented corporate leadership. The set of these commitments that each company within the supply chain takes on leads to an improvement for all the actors involved in the current production and sales process. Therefore, a little extra attention can ensure that the resulting benefit maximizes not only the utility of individual companies, but also the well-being and health of all.

Adomako and Nguyen (University of Economics and Finance in Ho Chi Minh City, Vietnam 2024) studied the relationship between corporate social responsibility (CSR) and green supply chain management (GSCM) can lead to sustainable

consumption and production patterns. Using a quantitative analysis, the experts collected data from managers of food companies. It emerged that there is a strong positive correlation between CSR and GSCM, which predicts that the use of eco-friendly materials and the reduction of waste increases the probability of achieving sustainable development goals. Subsequently, it was seen that corporate social responsibility seen from an internal perspective leads to improving the efficiency and motivation of employees, while from an external point of view it strengthens the reputation and the relationship with stakeholders. All this makes it clear that these practices move eco-sustainable practices on a larger scale and favor their growth.

Principato et al (2024) argue that blockchain technology can help solve the problems of food waste and insecurity, both of which have been worsened by the COVID-19 outbreak. In this study, data from the Italian platform Regusto, which tracks and redistributes surplus food, is examined. The application of advanced statistical analytic methods is utilized in order to investigate the efficacy of the Regusto platform in terms of increasing the availability of meals to individuals who are already living in poverty. It has been discovered that the distribution of surplus food through food retailers can be comfort to low-income families and communities who are struggling by decreasing the level of insecurity that they experience. Furthermore, it examines how blockchain technology ensures transparency and traceability in the distribution process, thus facilitating more equitable access to healthy food. In conclusion, the study raises the possibility that blockchain technology can be a useful tool to ensure that everyone has access to basic necessities, encouraging further investigation into ways to reduce food waste and poverty.

We can certainly say that ESG practices are not recent but, as we have seen, have much more structured roots in history; however, a concrete and real commitment in this direction is emerging only in recent years in which we find many companies that are focusing on green production. This dedication is becoming even more crucial as research shows that businesses may achieve both sustainable and profitable outcomes. In the end, implementing green and sustainable manufacturing methods not only addresses the environmental issues of the present but also serves as an investment in a more accountable and competitive future.

1.4 2030 Agenda and the Sustainable Development Goals (SDGs)

The 2030 Agenda is a global action plan adopted by the United Nations in 2015, which highlights several interconnected objectives, underlining the fundamental link between human well-being, the health of natural systems and the common challenges that all countries must face. The 17 Sustainable Development Goals (SDGs) aim to address a wide range of issues related to economic and social development, including poverty, hunger, the right to health and education, access to water and energy, decent work, inclusive and sustainable economic growth, climate change, environmental protection, urbanization, sustainable consumption and production patterns, social and gender equality, justice and peace.

In addition, starting from the 17 interconnected goals of the 2030 Agenda, many United Nations Member States have launched various initiatives intended to unite young minds from various countries, promoting concrete collaboration for change through the creation of sustainable solutions.

Among the most important initiatives related to Agenda 2023 and of interest to our work are:

- ✓ **UN Global Compact** which is a United Nations initiative that involves private companies, inviting them to adopt sustainable policies in line with the SDGs, in areas such as human rights, the environment, anti-corruption and work;
- ✓ **Zero Hunger Challenge FAO** initiative to eliminate hunger and improve food security through sustainable agricultural practices, support for small farmers and reduction of food waste;
- ✓ **The Italian Network for Sustainable Development** (ASviS) which is a network of over 300 Italian organizations that promotes and monitors progress towards the SDGs in Italy, proposing sustainable policies and solutions.

In short, the 2030 Agenda aims to transform the world by improving the quality of life, protecting the environment and building more just and resilient societies, where no one is left behind. Let's look at the 17 goals of the 2030 Agenda in more detail.

1.4.1 Goal 1 – No Poverty

The first goal of the United Nations 2030 Agenda aims to eliminate extreme poverty by 2030. Despite significant progress in recent decades, during which extreme poverty has been reduced compared to the 1990s, more than one in five people still lives on less than $1.25 a day. This amount is now considered insufficient to guarantee a dignified life; the UN suggests raising the threshold to $5 a day. Poverty goes beyond the lack of income, also including the absence of essential services such as health, education, security and the right to participate in decision-making processes. As highlighted in the study by Chegini, Pakravan-Charvadeh, Rahimian and Gholamrezaie (2021), which examined a region of Iran, there is a huge connection between income inequality, household well-being and food security especially in rural areas of developing countries. Using data extracted from the research, it was seen that only 40.79% of the analyzed households are food secure, while the others are facing high levels of food insecurity. Furthermore, families with greater income inequality appear to be more vulnerable. This shows how urgent it is to implement specific policies, such as building affordable homes and offering long-term loans for the purchase of goods and resources. This study is useful as an example to explain a trend common to many areas of the world. By increasing the development of less favored areas and bringing economic well-being more uniformly, a significant reduction in poverty and an increase in access to primary resources can be achieved. All this must be achieved with the collaboration of already developed countries that have strong economic power.

1.4.2 Goal 2 - Zero Hunger

Goal 2 of the 2030 Agenda aims to eliminate hunger and malnutrition by 2030, focusing on the promotion of sustainable agricultural practices and increasing productivity, especially for small farmers, including women and indigenous peoples. It aims to ensure food security, improve soil quality and reduce food waste, which is a significant problem. Currently, approximately one in nine people suffers from malnutrition, with children suffering the most serious consequences: malnutrition is responsible for 45% of deaths among children under the age of five.

As the authors Yu et al. (2024) explain, poverty exists when people cannot directly access food resources, therefore they do not have security on meals and this generates serious problems especially when we are talking about a third of the world's population including women and children. To improve accessibility to food, in a complex world like ours, we must resort to the use of new technologies.

In recent years, a platform called Regusto has been created that helps companies reduce waste and reallocate surplus food production. By doing this, the multifunctionality of artificial intelligence can be exploited to maximize efficiency and reduce waste, bringing significant access to food resources to the most vulnerable countries. The blockchain method, therefore, as underlined by the authors, can ensure that food insecurity is reduced in the long term and thanks to its tracking and transparency system, this challenge can be faced in the long term so as to reduce the number of people who are still in poverty today. In the second chapter of this work, we will discusse the application of AI to the service of food reuse and waste elimination.

1.4.3 Goal 3 - Good Health and Well-being

The third objective of the 2030 Agenda is to emphasize the promotion of good health and well-being, with the objectives of lowering the rates of newborn and maternal mortality and ensuring that everyone has access to high-quality medical care.

Particularly, it seeks to lower the rate of infant mortality by establishing a target of no more than 25 deaths per 1,000 live births, but, however, it is possible that more than sixty nations may not be able to achieve this objective until 2030.

Regarding maternal mortality, the goal is to reduce it to less than 70 deaths per 100,000 live births, however, despite a 37% drop in this rate from 2000 to 2015, approximately 303,000 maternal deaths are still recorded each year, many of which could be avoided.

According to the authors Junaid,et al (2023), dynamic supply chain capabilities in healthcare organizations around the world are essential to ensure excellent health and well-being. This study is the result of the challenges that arose with the advent of COVID-19. According to the research, healthcare companies that possess the capacity to learn, organize, and respond quickly to changes may effectively handle production disruptions and transform uncertainty into opportunity. The study also demonstrates that

improved and more efficient management of the supply chain can result in significant benefits. However, when even developing nations have a functional and effective medical system, global progress may be made. These findings underline the need to adopt supply chain management strategies that support the achievement of global health, demonstrating how resilience and integration are essential for the continuous improvement of the quality of healthcare services.

1.4.4 Goal 4 - Quality Education

The Sustainable Development Goal 4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all by 2030. This goal is not limited to primary education, but emphasizes the need to ensure equity and quality in all levels of education, including vocational training and lifelong learning.

This fundamental theme is also addressed by Alromaihi et al. (2023); the authors highlight that the use of learning management systems, student assessment and classroom interaction have a significant impact on the quality of education in a digital context. These elements are essential to ensure that all students have access to high-quality education, including online.

Furthermore, the support provided by international accreditation bodies is crucial in maintaining educational standards during the transition to digitalization. Their influence helps institutions overcome the challenges associated with digital teaching, thus contributing to more equitable education.

1.4.5 Goal 5 - Gender Equality

Achieving gender equality is the main objective of Goal 5. However, there are still significant obstacles, such as gender-based violence, economic inequality and low female political recruitment. The mission is to try to end all types of violence and discrimination against women, put an end to macabre customs such as genital mutilation and forced marriage and recognize the importance of unpaid domestic work. The investigation by Daniel-Vasconcelos et al. (2022) on the relationship between gender diversity and corporate social responsibility is a very compelling study. According to this research, the existence of CSR committees is linked to more effective and targeted

dissemination of the Sustainable Development Goals. It was found that companies with women on the corporate social responsibility board generally take into account a wide variety of points of view, which translates into more sustainable and inclusive business practices.

These findings suggest that companies not only comply with social regulations but also optimize their sustainability performance. In this way, it is highlighted that gender equality is not only a matter of social justice, but can also be a crucial strategy for the sustainable success of companies.

1.4.6 Goal 6 - Clean Water and Sanitation

The Sustainable Development Goal 6 aims to ensure the availability and sustainable management of water and sanitation for all by 2030. This goal goes beyond simple access to drinking water, also including the protection of aquatic ecosystems, responsible management of water resources and the improvement of water quality.

A key aspect of this goal is the implementation of integrated water management at national and international level, promoting cooperation between countries to ensure sustainable use of water resources. Finally, Goal 6 promotes international cooperation to help developing countries better manage water and cleanliness, encouraging the use of innovative technologies and the active participation of local communities in water control.

1.4.7 Goal 7 - Affordable and Clean Energy

Sustainable Development Goal 7 aims to ensure universal, safe and sustainable access to affordable energy for all by 2030. Currently, around 1.6 billion people do not have access to electricity, which limits progress towards other development goals, such as eradicating poverty and improving health and education. The mission here requires a strong increase in the share of renewable energy, which must translate into universal access for all those who cannot benefit from it. Doubling the rate of improvement in energy efficiency is another top priority. Today, energy loss rates from all those renewable energy generation systems such as wind, hydroelectric and photovoltaic are still too high. The goal therefore calls for investments in more efficient clean energy

infrastructure and promotes global cooperation to make energy more accessible. With an emphasis on the least developed nations where cooperation from the most advanced states is needed.

1.4.8 Goal 8 - Decent Work and Economic Growth

Sustainable Development Goal 8 aims to promote inclusive and sustainable economic growth, accompanied by full and productive employment and decent work for all. Currently, over 200 million people in the world are unemployed, with a particular incidence among young people. The goal is structured around several key measures: supporting economic growth per capita, looking for an annual increase in GDP of at least 7% in the least developed countries; enhance productivity through innovation and diversification and promoting policies that favor entrepreneurship and the creation of decent jobs.

To separate environmental degradation from economic progress, the importance of efficient resource allocation and environmental sustainability is emphasized. This requires strengthening financial institutions and expanding access to financial services to all who need them, subsequently establishing more stringent regulations for sustainable tourism and ensuring safer working environments. Consequently, another important mission that has been established by the eighth goal is to increase trade aid to developing nations by established nations, ensuring uniform growth of world economies so as to create a stronger developed market on a global scale.

1.4.9 Goal 9 - Industry, Innovation, and Infrastructure

SDG 9 has as its objectives the construction of resilient infrastructure, the development of sustainable industrialization and innovation. For these, it is considered essential to invest in scientific research and sustainable infrastructure in order to promote economic growth and create jobs. This goal also focuses particularly on less developed nations. In support of small and medium-sized enterprises, it also seeks to facilitate the obtaining of financial services at reasonable prices.

Finally, Goal 9 highlights the importance of increasing access to information and communication technologies, ensuring universal access to the Internet in the least developed countries. All these measures are essential to promote sustainable economic growth and ensure that the benefits of development reach every segment of the population.

1.4.10 Goal 10 - Reduced Inequality

Sustainable Development Goal 10 aims to reduce inequalities both within and between countries, recognizing that global inequalities hinder sustainable development and efforts to reduce poverty. In recent years, income inequality has increased, limiting the opportunities for social and cultural participation of the most vulnerable segments of the population. Therefore, the goal focuses on increasing the income of the poorest 40% of the population at a rate above the national average, while promoting the social, economic and political inclusion of all, regardless of age, gender or economic status. To achieve these goals, it is crucial to eliminate discriminatory laws and practices and adopt tax and wage policies that promote greater equality.

A relevant aspect is the regulation of global financial markets to ensure greater accountability and legitimacy of international economic institutions. Special measures are foreseen for developing countries and support for financial flows, such as foreign direct investment, in the regions most in need. Finally, the aim is to reduce migration costs to less than 3% by 2030, thus contributing to greater equity and opportunity for all.

1.4.11 Goal 11 - Sustainable Cities and Communities

Urbanization is one of the most important developments of the twenty-first century: more than half of the world's population now lives in urban areas and urbanization is expected to grow to 70% by 2050. 80% of global economic activity is generated by cities (they occupy only 3% of the Earth's surface), which consume 75% of resources and produce roughly the same amount of emissions, thus representing a significant environmental impact.

Sustainable Development Goal 11 aims to create inclusive, safe and sustainable cities and human settlements. It also aims to eliminate slums by 2030, working to ensure that everyone has decent housing and basic services. As a third goal it aims to promote development of safe transportation infrastructures.

Lastly, it provides assistance to the least developed nations in developing sustainable structures and promotes the adoption of policies for climate resilience.

1.4.12 Goal 12 - Responsible Consumption and Production

Global consumption currently exceeds the capacity of ecosystems, making substantial changes in production and consumption patterns necessary to ensure sustainable development. Goal 12 aims to promote sustainable consumption and production patterns, implementing the ten year framework for programmes on sustainability. By 2030, it is planned to manage natural resources and reduce food waste, decreasing losses along production and supply chains.

In addition, the goal includes the environmentally friendly management of chemicals and waste, with the aim of significantly reducing their release into the environment. The goal therefore aims to reduce waste and pollution through efficient use of resources and a responsible production cycle.

1.4.13 Goal 13 - Climate Action

Climate change is considered a major obstacle to sustainable development; it puts infrastructure and certain economic sectors at risk in developed areas and threatens livelihoods in developing nations. Forest areas and agricultural lands are strongly influenced by changes in temperature and precipitation cycles, which have caused global increases in carbon dioxide (CO2) of about 50% between 1990 and 2012.

Goal 13 calls on nations to work together on environmental issues and include climate protection measures in their national policies, as regulated by the United Nations Framework Convention on Climate Change.

It stresses in this context that it is essential to increase resilience to natural disasters and reaffirms the commitment of the developed world to allocate 100 billion dollars per year to help developing countries overcome the effects of climate change.

1.4.14 Goal 14 - Life Below Water

Pollution and overexploitation of the oceans are causing serious problems, such as biodiversity loss, ocean acidification and increased plastic waste. Climate change and the growing world population are further intensifying the pressure on marine resources. Goal 14 aims to conserve and sustainably use the oceans and marine resources, significantly reducing pollution by 2025 and protecting ecosystems to avoid negative impacts.

Goal 14 seeks to protect at least 10% of coastal and marine regions from overfishing and abuse of the environment, by 2020.

Other goals include a commitment to ban subsidies that fuel overfishing and to use more sustainable management of marine resources to protect small island developing nations. International law itself promotes the conservation of oceans and marine resources and their sustainable use for the benefit of both the environment and communities.

1.4.15 Goal 15 - Life on Land

The conservation and sustainable use of biodiversity are essential for social and economic progress and for the survival of the human species. However, biodiversity continues to suffer a worrying decline, with serious consequences for food security and human health, particularly in rural and indigenous communities.

Goal 15 deals with the conservation, restoration and sustainable use of terrestrial ecosystems and sets the goal of halting deforestation by 2020. By 2030 it sets the goal of halting desertification and rebuilding damaged areas.

This objective requires measures and rapid action both to stop poaching, to combat trafficking of protected species, and to slow the spread of invasive species. It is considered necessary to protect mountain ecosystems and to strengthen the importance of biodiversity in local and national planning choices.

It is essential to mobilize financial resources for the conservation and sustainable management of forests, also promoting an equitable distribution of benefits arising from

the use of genetic resources. Finally, the goal aims to strengthen global support in the fight against poaching, creating sustainable livelihood opportunities for local communities.

1.4.16 Goal 16 - Peace, Justice, and Strong Institutions

Sustainable development benefits from effective governance and inclusive and peaceful communities. In fact, strengthening peace institutions has helped many nations achieve the Sustainable Development Goals, while nations affected by conflict are farthest from achieving this. Therefore, Goal 16 has set a target by 2023 to try to reduce organized crime, torture and other types of violence, arms trafficking, illicit money flows and corruption and, in turn, promote an inclusive and peaceful society.

To ensure peace, the goal includes promoting the rule of law and access to justice. Specific actions include reducing violence, eliminating child abuse, strengthening institutions and including all in decision-making. It is expected to ensure a legal identity for all and access to public information. In addition, the goal supports the capacity of national institutions to prevent violence and combat terrorism and promotes non-discriminatory laws for sustainable development.

1.4.17 Goal 17 - Partnerships for the Goals

The successful implementation of SDG 17 depends on a strong global financial framework that goes beyond the traditional commitments required for the other goals. The mission in this case requires the most developed countries to dedicate 0.7% of their gross national income to assisting and strengthening the countries most in need. This includes improving fiscal management and public debt for each foreign state through policies aimed at maintaining sustainability in the long term. In the field of technology, the goal is to promote cooperation between different geographical areas to facilitate access to learning and innovation. In terms of trade, goal 17 supports a fair and open trading system and aims to double the share of world exports of poor countries by 2030, ensuring quota-free market access. At the political level, it is intended to improve macroeconomic stability through multilateral and multi-stakeholder partnerships, which are essential to mobilize the knowledge and resources needed to achieve the

Development Goals. Finally, by 2030, a global data collection is planned, covering these topics, essential to monitor progress towards achieving the missions.

1.5 AI to support sustainability in the agri-food supply chain

Artificial intelligence (AI) can play a crucial role in supporting sustainability in the agri-food supply chain, helping to optimize various aspects of the production process, reduce waste and improve overall efficiency. However, in the regulatory landscape of sustainability, it is essential to be careful as regulations are becoming increasingly complex and stringent. AI can support companies in adapting to this ever-changing regulatory environment, reducing the risk of sanctions and facilitating compliance. European Union legislation aims to regulate AI to ensure safe and beneficial development, promoting benefits in areas such as healthcare, sustainable transport and production efficiency.

Research by Fosso et al. (2024) shows that AI and its dynamic capabilities improve an organization's environmental performance; this is also the case with research developed in the United States and France using structural equation models, or SEM, to analyze data collected by supply chain managers, which determined an improvement in environmental performance in both nations despite their different cultural traits. In conclusion, artificial intelligence can improve corporate sustainability.

Below, we look at some of the ways in which AI is expressing its potential for sustainability in the agri-food industry.

1.5.1 Precision agriculture

Artificial intelligence applied in agriculture allows for better management of natural resources: soil, water and nutrients, proposing itself to support cutting-edge technologies such as sensors and drones. This strategy aims to increase agricultural productivity while reducing the excessive use of resources and chemical elements such as pesticides and fertilizers. The starting data relating to soil conditions, crop health and humidity levels can be easily monitored through "IoT" sensors or with the help of drones with machine learning algorithms.

By analyzing this data, AI can more accurately predict when and how to intervene with fertilizers or irrigation, significantly reducing waste. The algorithms can also precisely analyze meteorological data, soil moisture levels and other environmental factors to optimize agricultural systems, avoiding the excessive use of water, an increasingly scarce resource. Finally, AI can contribute to the early diagnosis of plant diseases or pest infestations, allowing for treatments that reduces the need of chemical elements and minimizes their impact.

1.5.2 Optimizing production and logistics

AI can improve the management of the entire supply chain, from producer to end consumer, optimizing production processes and minimizing food waste. This can be achieved through demand forecasting, transportation and distribution optimization, and the creation of intelligent supply chains. In fact, AI, through predictive algorithms, can analyze consumption patterns and seasonal fluctuations in demand, optimizing agricultural production and minimizing excess production that can lead to food waste. This is partparticularly useful for the management of fresh crops, which have a limited shelf life. Furthermore, the use of machine learning to analyze routes, traffic conditions and market demand can improve transport logistics, reducing fuel consumption and CO2 emissions related to the transport of food. Finally, AI can improve traceability throughout the agri-food supply chain, ensuring that products are distributed efficiently, reducing waste and improving consumption management.

As reported in the article by Goralski and Tan (2024), AI can act as both a disruptive force and an enabler for existing business models. Thanks to these technologies, companies can rethink their operations and strategies to align with new emerging technologies. Artificial intelligence, through its deep learning and automation capabilities, is revolutionizing business processes, increasing efficiency and productivity, which translates into a direct impact on the performance of companies. Furthermore, AI plays a key role in the pursuit of the United Nations Sustainable Development Goals (SDGs), in particular in terms of resource management and the optimization of company models, with the aim of becoming eco-friendly. However, there are uncertainties regarding how AI could influence the future: it could accelerate

the path towards greater sustainability or, on the contrary, generate economic and environmental instability.

The paper analyses three case studies in order to learn more about these impacts and draws preliminary conclusions on the importance of business leaders and managers education to rapid technological and social changes. The survey highlights the need for leaders able to catch the opportunity of exploiting AI to improve business performance and promote global sustainability. AI proved good results in the agri-food sector as well: according to Studies in this area, AI improves the traceability of products along the entire supply chain, enhance transparency and optimizes resource management. Combining blockchain technologies with AI, allows companies to monitor the path of products from field to table, thus spreading application of sustainable practices throughout the production chain. These systems promote optimized management of resources, ensuring that operational efficiency turns into reduced costs and improved environmental performance.

1.5.3 Reducing food waste

One of the greatest environmental impacts resulting from the agri-food supply chain is represented by food waste, both at the production level and along the distribution chain. Artificial intelligence can be used to monitor the freshness of food products and predict when products might deteriorate, optimizing warehouse management and reducing the number of discarded products. In fact, sensors and machine learning models can monitor the quality of food during transport and storage, promptly suggesting actions to avoid deterioration, such as transfer to conservation areas or redistribution to nearby markets. Furthermore, AI algorithms can analyze food consumption data and propose more precise portions for consumers, reducing waste at the household level. Finally, the use of AI in automated warehouses allows for the optimization of food stock management, reducing products that end up unused and are therefore discarded. This work will focus in particular on the topic of reducing food waste within the chain.

The study by Cane and Parra (2020) focuses on reducing food waste as a crucial challenge; in fact, according to the authors, this challenge is managed also using digital

platforms that ecourage the redistribution of food excesses. AI allowes to improve the effectiveness of these platforms, thanks to advanced predictive analysis and optimization systems. In fact, machine learning algorithms can accurately anticipate seasonal demand for various goods, providing data to drive reduction of overproduction and consequently minimizing waste. Furthermore, AI can be applied to artificial vision for continuous monitoring of food quality, intercepting in real time products close to expiration date and even promptly notifying their availability for redistribution to local organizations.

1.5.4 Reducing the Carbon Footprint in the Supply Chain

The carbon footprint is a measure of the total greenhouse gas emissions, in particular carbon dioxide (CO_2) and methane (CH_4), generated directly or indirectly by an individual, an organization, an event or a product throughout its life cycle. It is expressed in tonnes, which standardizes the environmental impact of different greenhouse gases into a single value, based on their global warming potential. The carbon footprint is calculated by adding up all the sources of greenhouse gas emissions linked to an activity, product or service, from its beginning to its end. This approach takes into account the entire life cycle, including production, distribution, transportation, use and disposal.

AI can help optimize energy use on farms and in food processing plants, thereby reducing the carbon footprint associated with these activities; for example, by adjusting lighting, irrigation and heating to use energy only when it is actually needed. It can then also analyze environmental and climate data to suggest crops that are more suitable and resistant to local conditions, reducing the need for high energy and chemical inputs and ensuring more sustainable production.

Saeed et al. (2024) study explores copycat behavior among Thai listed companies, with the aim of contributing to the UN SDGs. The analysis covers the period from 2009 to 2019 and shows how companies monitor and follow their competitors' initiatives to improve their environmental performance, mainly by reducing emissions,

innovating in products and limiting the use of resources. This behavior allows to improve market reputation and attract investors sensible to environmental care.

This concept can also be applied to the agri-food supply chain, where companies can adopt emission reduction practices influenced by competitors' behavior and sustainability expectations. In a context where green reputation is increasingly valued, the imitation effect can incentivize the adoption of concrete measures to limit emissions in this sector too, thus contributing to higher environmental standards along the entire supply chain.

1.5.5 Traceability and Transparency of the Agri-food Supply Chain

AI can analyze and organize data collected along the entire production chain, creating a digital "history" of the product, which allows us to know where it comes from, how it was treated and how it was distributed. This system can help consumers choose sustainable products and allow producers to guarantee quality and compliance with environmental standards. Furthermore, by combining AI with blockchain technology, it is possible to ensure transparency along the supply chain and verify that agricultural practices comply with sustainability standards. This combination also allows us to detect any fraud and ensure that consumers have access to verified and certified information.

1.5.6 Support for Research and Innovation in Sustainable Practices

With artificial intelligence, it is possible to analyze huge sets of genetic data to identify the characteristics that make some crops more resistant to climate change or pests, thus supporting the selection of more sustainable and resistant agricultural varieties.

It also allows us to analyze research data and suggest innovative solutions for sustainable agricultural practices, such as the use of cover crops that protect the soil or crop rotation to preserve its fertility. Cover crops refer to the fact that plants are sown between one main crop and another, without the aim of being harvested for consumption, but only with the aim of improving the quality of the soil, whereas crop rotation consists of alternating different types of plants on a given terrain based on pre-established annual cycles, so as to improve its productivity.

Therefore, thanks to these technologies, it is possible to promote a food production model that respects the environment, responds to demand without excesses and contributes to a more ethical and responsible supply chain.

Chapter II

Regusto Platform: AI at the service of sustainability in the agri-food supply chain

2.1 Regusto: digital platform for sustainability

Regusto is a platform, developed by the innovative start-up Recuperiamo srl, which uses AI to improve the impact of companies in terms of environmental sustainability. Regusto's mission is twofold: on the one hand, to optimize the redistribution of surpluses from production to charities and non-profit organizations, and on the other, to promote a responsible and eco-friendly consumption model in line with the Sustainable Development Goals (SDGs).

Through the use of Artificial Intelligence and advanced technologies such as blockchain, the company guarantees transparency and traceability along the entire supply chain. The platform uses machine learning algorithms, analyzing a large amount of data, finding useful patterns to predict and optimize the flows of surplus food, improving the efficiency of operations and reducing the volume of wasted food. In this way, Regusto not only solves an environmental issue, but also addresses a social problem, making discarded food available even to countries that are experiencing food insecurity.

This platform represents a concrete application of the theoretical principles analyzed in the first chapter of the thesis. Resuming the themes discussed in the first chapter, Regusto helps in the calculation of the materials needed for a more eco-friendly precision agriculture, uses intelligent algorithms to study a large amount of data,

predicting any problems and making production and logistics processes more flexible and integrated. Furthermore, Regusto improves food waste by trying to calculate the production surpluses of partner companies as precisely as possible, redistributing them to areas in the world where poverty and food shortage rates are above the threshold. Another mission promoted by Regusto is to reduce the carbon footprint by exploiting a chain effect that sees the competitors of its partner companies forced to resort to greener methods in order to be more competitive. It is clear that these new tools for sustainability help to create a real driving movement that, starting from companies and spreading to the rest of society, shifts the focus towards an economy that is less destructive for the environment.

2.2 Regusto and the impacts on the SDGs of the 2030 Agenda

Regusto is a brand of the start-up Recuperiamo s.r.l., founded in 2016 by Marco Raspati and Paolo Rellini with the aim of proposing concrete solutions to prevent and reduce food waste, in the profit and non-profit sectors, acting according to the logic of the circular economy. Regusto, through the experience gained in the fight against food waste, introduces an innovative “food sharing for charity” model at European level.

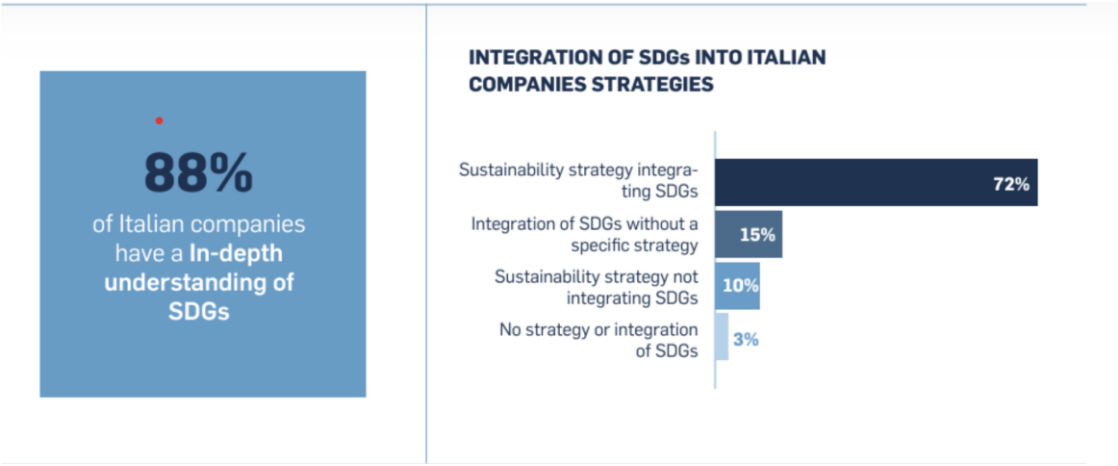
The Regusto platform connects companies and non-profit organizations to manage product stocks and is the first to introduce blockchain technology and the use of AI in the fight against waste, to ensure digitalization and traceability of economic and product flows, monitoring and certifying the positive social and environmental impacts generated. Through the Regusto platform, food and non-food companies can donate and sell their products, digitalizing and tracking all flows in a transparent manner. For each transaction, the benefit obtained at a social and environmental level in the territory is calculated and monitored.

Through specific algorithms, the data generated is converted into "impact tokens" developed according to international calculation standards, certified in blockchain and by RSM International. Impact Tokens certify the positive social and environmental impact generated in the Italian territory expressed in terms of equivalent meals distributed, CO2 avoided, water and soil saved thanks to the non-rejection of donated and redistributed products.

It is important to underline that Regusto's activity is in line with the United Nations development goals for the 2030 agenda. In fact, Regusto has a significant impact on the following SDGS:

- ✓ 1 (zero poverty),
- ✓ (zero hunger),
- ✓ 10 (reduce inequalities),
- ✓ 11 (sustainable cities and communities),
- ✓ 12 (responsible consumption and production),
- ✓ 13 (act for the climate),
- ✓ 15 (life on land).

Graphic 2.1 integration of SDGs in italian companies strategies (Regusto Sustainability Report 2022)



As for food waste, according to the International Observatory on Food and Sustainability (Waste Watcher), in 2023 the economic value of waste in Italy was equal to 9 billion euros (600 billion euros worldwide). In fact, during 2023, over 4 million tons of food were lost in the Italian supply chain (4,240,340 tons to be precise), for a total value of 9,301,215,981 billion euros. Food recovery for solidarity purposes is becoming a consolidated practice also because the demand is growing, creating a growth in this market, in fact in Italy there are 6 million people in a state of absolute poverty and this represents a real problem.

Furthermore, everything that derives from the non-workable goods of production has a considerable impact on global pollution. According to the World Organization for

International Relations (WOIR), the global surplus is responsible for 4.8 billion tons of greenhouse gases emitted into the atmosphere and 180 billion cubic meters of water consumed. In addition, food waste causes other negative effects on the environment and society, such as deforestation, loss of biodiversity and world hunger. This also leads to economic loss and loss of natural resources, such as soil, water and energy. These impacts particularly affect the poorest and most vulnerable populations, increasing social and economic inequalities.

Graphic 2.2 Top 3 SDGs on which italian companies act (Regusto Sustainability Report 2022)

Even in 2023, Public Administrations and the Third Sector have been subjected to increasing pressure linked to requests for food support and more. Precisely for this reason, the support provided by Regusto to the third sector, to companies and to the various territories covered by the service has been even more valuable. Therefore, monitoring the impacts generated at a social, environmental and economic level alongside the digitalization and reporting of all economic and product flows, today becomes even more strategic for all interested parties: companies, non-profit organizations and Public Administrations.

2.3 Regusto Business Model

Regusto is based on an innovative business model that combines sustainability, technology, AI and social inclusion, making it a pioneering example of circular economy. According to the concept, food businesses like supermarkets, wholesalers, or

producers are required to enter data pertaining to surpluses onto the platform, during which they must identify the number and kind of excess.

A machine learning algorithm does data analysis in order to compare supply to demand from non-profit organizations in real time. This is done in order to ensure that there is prospective interest in acquiring resources.

Through the use of logistics optimization algorithms, the platform helps charities pick items that meet their requirements, and then it optimizes delivery routes in order to decrease both costs and the impact on the environment.

Each transaction is recorded on a blockchain network, ensuring complete traceability of food along the supply chain. AI applied to the platform data allows it to play an important role in optimising the process of managing and distributing food more effectively, particularly in the predictive and process optimisation fields.

In this chapter we will see in detail how the platform works and the impacts of AI within it.

Recuperiamo S.r.l. integrates common benefit objectives into its statute, committing to operate in a sustainable and responsible way towards people, communities and the environment, in addition to economic profit. Unlike many traditional companies, it balances the interest of shareholders and the social/environmental impact resulting from its activity.

Given the present environment, the implementation of business models that are both sustainable and creative is a top goal for a great number of firms.

Recuperiamo S.r.l. established the Regusto brand and developed the "Impatto Positivo" platform with the intention of monitoring and improving the recovery of food that is at danger of being wasted. Both of these initiatives were accomplished by the utilization of cutting-edge technology.

2.3.1 The Impatto Positivo platform

In a world where approximately one third of the food produced is wasted, and where every action counts in the fight against climate change, the need for effective solutions has become increasingly urgent. Impatto Positivo was born from the desire to transform the problem of waste into a resource, not only by recovering products at risk,

but also by converting these acts into quantifiable and traceable benefits for the environment and society

The goal of Impatto Positivo, therefore, is to resolve these issues first by tracking products at risk of waste through the use of blockchain technology. In fact, the platform guarantees precise and unfalsifiable documentation of the quantities of recovered products, providing a reliable database for certifications and sustainability reports.

The second goal concerns the fact of incentivizing environmental and social sustainability through the issuance of Impact Tokens (these are digital assets that represent the positive impact of a project or investment on social and environmental objectives).

The blockchain represents a digital register where information is saved in blocks and each set is connected so that the information present cannot be deleted. Each grouping of data has an identification code that certifies its uniqueness, so that there are no duplicates.

Each unique code, called hash, is contained in the reference group and in the group that follows it. This link guarantees the integrity of the data, making it extremely difficult to alter or manipulate the information once recorded, because if the code were altered the next block would no longer recognize it and therefore would no longer exchange the information creating a chain effect with all the groups present in the network.

Decentralization is, therefore, a fundamental aspect of this tool. Unlike a traditional database, which has centralized management, the blockchain is distributed across a network of nodes that participate in the verification and validation of transactions. This makes this element highly resistant to failures and attacks, as well as promoting the transparency and reliability of information.

This technology offers a series of key advantages:

- Transparency for each transaction or activity recorded, ensuring a clear representation of the operations without there being a way to alter the data;

- Security guaranteed by cryptographic protocols that protect the data from any manipulation, ensuring that each record is permanent and immutable.

- Verifiability is when stakeholders can independently verify the authenticity and accuracy of what is recorded, which is crucial to building trust among consumers, businesses and regulators.

Implementing blockchain technology is not just a technical issue, but it is an important change that allows addressing common problems through new business models. Positive Impact aims to be a model for the industry, demonstrating how technology can be used to achieve real and measurable benefits, improving corporate sustainability. With the support of concrete and relevant data, it wants to inspire other companies to undertake similar initiatives, amplifying the impact of an ecological transaction.

In the following paragraphs we will analyze how, thanks to blockchain and the quantity of data, Regusto uses AI to predict and optimize redistribution processes.

2.3.2 Impact Tokens

Impact Tokens are at the heart of the platform's incentive and tracking mechanism, acting as a tool to quantify and validate the efforts made by companies and individuals. These are automatically generated by the platform every time a qualifying action is recorded. The process begins when a company reports the recovery of materials at risk of waste through the system, which in turn verifies the actual recovery action (each recovery action is first checked to ensure that it meets the pre-established admissibility and integrity criteria), subsequently the impact is calculated based on predefined metrics, such as the amount of CO2 saved, water conserved or waste avoided.

Once the company's impact on the environment has been calculated, Tokens are issued directly to the account on the platform.

All this allows the company to view how it is performing in real time through an interactive dashboard on the site, this dashboard contains the set of all the small commitments that the company has made to reduce its effect on the environment.

Impact Tokens not only serve as quantitative proof of a company's commitment to sustainability, but can also be used:

- to obtain environmental certifications that attest to the company's commitment to reducing its environmental impact, increasing stakeholder interest;

- to exchange or sell these tokens on dedicated marketplaces, providing a direct economic incentive for sustainable practices.

Positive Impact is also designed to be easily integrated with other business management systems, allowing companies to seamlessly connect the actions carried out daily with the platform. This ensures that monitoring is as accurate and easy as possible, helping the large-scale adoption of these systems. In short, the company offers a solid and transparent approach to quantifying and incentivizing environmental and social sustainability.

Before getting to the calculation of the metrics related to Impact Tokens, it is necessary to understand the process that leads to the generation of these tools. The first step to follow is data collection, as soon as a purchase of material occurs, the platform receives the order in real time and notifies it. Next, we proceed with the verification and validation of the data, then Regusto checks that the company requesting the goods belongs to the platform, that there are no errors in the request of any kind, that there are actually goods in stock and only then accepts the order.

From here we proceed with the application of the metrics, through which the platform calculates the number of Tokens due based on the resources saved and the impact generated. The formula used ensures that each token issued has a corresponding environmental and social benefit that is issued to the account of the benefactor company.

Finally, we proceed with the organization of logistics, in this case the platform manages the information and delivery addresses of the stocks by sending them directly to the couriers responsible for transport with consequent transfer to the end customer.

Now, the question arises spontaneously as to how the metrics for the evaluation of green certificates are actually calculated. The main objective is to guarantee the most accurate and precise calculation possible, therefore standard metrics are used based on data collected from studies on the environment and the population. And for example, a first metric used is that of meals saved, that is, the value of meals that would have been lost, but instead were recovered and redistributed. To give an idea, the value of a token represents the equivalent recovery of 2 meals.

The second metric used concerns CO2, in this case an impact token is equivalent to 1 kg of carbon dioxide not emitted into the atmosphere.

The third metric, however, refers to the fact that for every 2 cubic meters of water saved, a token is emitted, and finally the fourth calculates a token as corresponding to 3 square meters of soil saved.

To conclude this paragraph, we want to underline the fact that to increase the effectiveness of these powerful tools, all the individual steps must be carried out in synergy with each other because to obtain a real benefit, everyone's contribution is needed, without it, the efforts would not give the same result.

2.3.3 Front-End/Back-End Development and Public Registry

The front-end of the Positive Impact platform and its public registry are essential components that not only facilitate user interaction with the system but also ensure transparency and accessibility of information related to the environmental and social impact generated. React (a javascript library developed by meta ex facebook, to efficiently update the parties involved when data changes on the platform) was chosen as the framework for the front-end development thanks to its flexibility and ability to build dynamic and highly interactive user interfaces.

This technology allows for efficient management of the application state and immediate responsiveness to user actions, which are essential for a platform that manages complex, real-time data. The front-end architecture was designed to be intuitive and user-friendly, facilitating users in accessing information and navigating between the various features.

Particular attention was paid to the scalability of the interface, to ensure that the system remains high-performance even as the number of users and transactions increases.

The site communicates directly with the Quadrans blockchain, i.e. Regusto's digital diary, to retrieve different types of information such as details of issued or registered certificates, data on participating companies that adhere to the system and aggregate statistics on activities that show the summary of the actions carried out by the companies. It is understood that the more information is present in the diary and the greater the participants, the greater, in turn, the power and portability of the site itself will have to be.

To do this, the company uses different strategies:

- Decentralized architecture: the data is distributed across multiple nodes based on how many participants there are so as not to congest the flow of information on a few blocks;

- Efficient smart contracts: i.e. the company uses intelligent programs to minimize human intervention even in the event of problems;

- Optimized transaction management: each transaction is validated quickly while maintaining consistency between all the nodes of the system, so in the event of problems found in a block the platform does not approve the transaction;

- Selective storage, in some cases the heaviest information can be saved on external hard drives, with which the blockchain system can communicate quickly;

- Parallel processing, parallel systems such as Golang are used (a super-fast assembly line, where thanks to different processes you can quickly obtain information on any field).

After having carried out this first analysis, let's now see how the platform is structured and what are the main tools used in the front-end. Recuperiamo Srl collaborates with MySQL, a relational database management system, which stores the platform data in a structured way, manages the information application logic and orchestrates operations with the database in a safe and high-performance way.

The choice of MySQL lies in its reliability, scalability and its versatile application that makes it perfectly compatible with the analysis of large amounts of data and transactions.

Subsequently, the platform uses Amazon Web Services (AWS) as hosting to manage IT resources and ensure that everything works smoothly.

AWS offers a wide range of cloud computing services that support the application in terms of computational capacity, storage and security. The platform benefits from AWS elastic scalability, which allows you to adapt resources depending on the workload and user growth, ensuring that the service remains optimal even during periods where there are peaks in access to the platform.

Amazon Web Services also provides numerous tools and protocols for data security, including firewalls, barriers that control incoming and outgoing traffic, encryption of the Financial Statements (the process that transforms data into an indecipherable code that is impossible to read for anyone who does not have access to

the data), encryption of data in transit and at rest (a practical example when a password is entered on a secure site, it is encrypted while traveling from the computer to the server, so that it cannot be intercepted) and finally configurations for compliance with international regulations on privacy and data protection.

These tools help protect the platform from unauthorized access and other cyber threats, ensuring the security of users' sensitive information and the operational continuity of the platform.

For a deeper understanding, think about these three tools like a restaurant. Go is the chef who receives and processes customer orders, MySQL is the order and reservation book that keeps track of all the movements and the various activities that will be carried out as well as the workloads managing periods where demand is reduced to periods with seasonal peaks and finally AWS is the actual structure so without it the activity could not be carried out.

2.3.4 Implementation of the Public Registry on the Quadrans Blockchain

The public registry plays a crucial role in providing tangible proof of companies' commitment to sustainability. It transparently shows the participating companies and the impact certificates issued, offering verifiable proof of environmental and social impact declarations.

Using the Quadrans blockchain, the platform ensures that all recorded information is immutable and permanent. Once the data is written to the blockchain, it cannot be altered or deleted, ensuring a high level of security and reliability.

The public register is accessible online to anyone, without the need for special permissions, which encourages greater transparency and allows consumers and stakeholders to directly verify the green credentials of companies.

The public register interface has been designed to be simple to use, allowing users to easily search and view information.

It provides advanced search functionality to filter data by company, type of impact, data required and other relevant variables. Therefore, the development of the front-end and implementation of the public register are critical to the success of the Positive Impact platform.

2.3.5 Back-Office and Certificate Generation

The back-office represents the area reserved for operators and administrators of the platform, which allows you to manage and monitor all activities related to the recovery, distribution and traceability of resources saved on the site.

Administrators can insert, update and monitor the recovery activities of products at risk of waste. The main functions performed by the back office concern:

- ✓ Management of users and companies by registering participants in the platform register with the consequent assignment of the role and permissions for operations carried out on the site;
- ✓ Monitoring of transactions consisting in viewing the recovery movements and the redistribution of resources in real time, ensuring maximum efficiency;
- ✓ Assignment of Impact Tokens and therefore calculation of tokens based on the impact generated by each individual company;
- ✓ Integration with the Quadrans blockchain, as seen previously, guarantees direct contact with the digital register of the platform;
- ✓ Management of donations and orders allows you to make requests for the recovery and redistribution of goods;
- ✓ Reporting and data analysis allows you to make reports and statistics on the impacts for each individual participant;
- ✓ The Back Office is therefore essential to maintain the system efficient and transparent, allowing users to track each operation in a clear and measurable way without having to resort to the use of other systems.

Thanks to this technological structure, Regusto facilitates the recovery of resources and the creation of a positive social impact.

2.3.6 Future Perspective

The Positive Impact project has effectively demonstrated the revolutionary potential of blockchain technology, combined with artificial intelligence, in the field of sustainability by helping companies achieve the sustainable development goals efficiently.

Looking to the future, Recuperiamo SRL is determined to expand the scope of the Positive Impact platform with the aim of involving an ever-increasing number of companies and sectors, thus extending the use of its tools towards more complex and motivating challenges. Through workshops, strategic partnerships and awareness campaigns, the company aims to promote a wider adoption of its innovative practices and technologies.

A crucial aspect for the future will be the incentive for companies to participate in the initiative, including not only the promotion of ethical and environmental aspects, but also the demonstration of tangible economic benefits. Through the potential monetization of Impact Tokens and their use in regulated exchanges and markets, companies could be motivated to implement more sustainable practices thus becoming increasingly attractive to external and internal shareholders.

However, despite the successes, the path of Impatto Positivo will be characterized by several challenges, one of these is the technical complexity, that is, the need for continuous training on cutting-edge technologies and the resistance to change which will act as a deadweight especially if there is an opening towards foreign markets that will require greater efforts for a deeper understanding of local cultures and labels. In any case, these challenges also represent important opportunities for innovation and affirmation in the field of digital sustainability, making the Perugian company a fundamental cornerstone of this sector. Finally, by continuing to invest in development, the company is committed to shaping a future in which technology and ethics go hand in hand towards the creation of a greener and low environmental impact world. In conclusion, the Impatto Positivo project represents an exemplary model of how technological innovations can and must be used to address some of the most urgent global challenges, Recuperiamo SRL is in fact determined to continue on this trajectory, improving and expanding its know-how for the protection of the planet.

2.3.7 The platform process flow

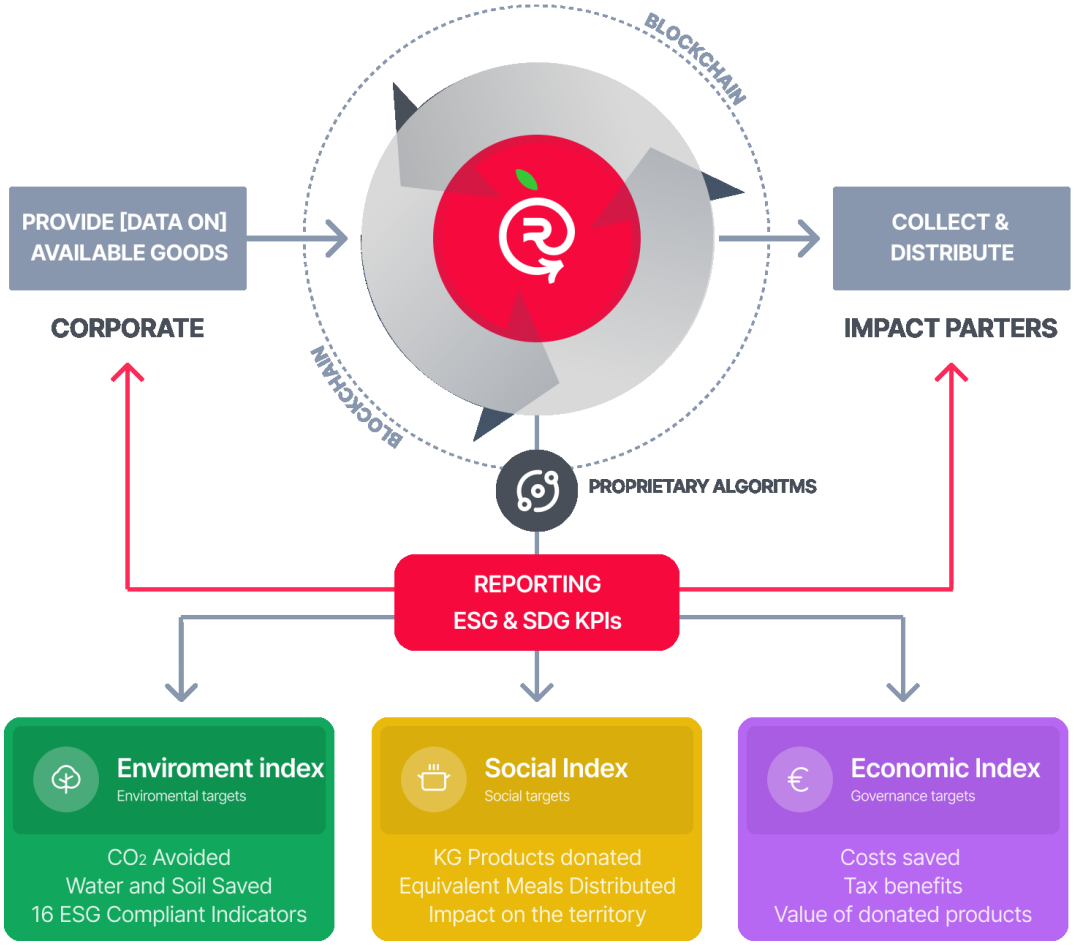
The Regusto platform follows a well-defined process for the relocation of surplus food that is divided into different phases:

- ✓ Acquisition of surplus products,

- ✓ Matching supply and demand,
- ✓ Logistics and redistribution,
- ✓ Monitoring and certification.

For surplus food, agri-food companies, supermarkets, restaurants and local producers upload the data relating to the products directly to the platform, often automating the processes through the integration of software or other intelligent devices capable of reducing errors.

Graphic 2.3 General overview of how Regusto works (Source: Regusto Sustainability Report 2022)



The platform collects detailed information on available products, such as quantity, type, expiration date and storage location.

Immediately after, the blockchain technology integrated into the platform tracks each product, ensuring transparency and reliability.

Thanks to all this, registered charities and non-profit organizations can access the list of available products in real time and can request what they need.

The task of the company is to optimize the supply chain by reducing transportation times and costs.

Each transaction is then recorded in blockchain, facilitating production traceability for companies and external partners.

2.3.8 Acquisition of surplus products and matching supply and demand

The acquisition of surplus products is part of Regusto's core business. Surplus food refers to all those products that, while still perfectly consumable, risk being wasted due to production surpluses, packaging errors or simply because they are close to expiration. These products can come from different sources, such as:

- Food production companies,
- GDO (large-scale retail trade),
- Restaurants,
- Farmers and local markets.

Regusto has also developed specific tools to allow donors to register their surplus material and automatically calculate the volumes and types of products, allowing them to categorize and facilitate distribution.

All this uses artificial intelligence algorithms to analyze information on available products, evaluating their freshness, type and potential use. This helps to increase the meeting between supply and demand, which occurs in real time every time a beneficiary organization accesses the platform to request material.

This meeting between the two variables is constantly improved through the study of some factors such as:

- ✓ Type of food requested or available, compatible with those that are the stocks in the warehouses of the companies;
- ✓ Geographical position, therefore based on the location of the company the best match is studied that optimizes the distribution times and reduces the environmental impact;

- ✓ Delivery times, the platform through intelligent learning selects the closest couriers and the least busy routes for the logistical organization of transport.

The matching algorithms, therefore, compare the collected data and create optimal matches based on these criteria.

Once a match is found, both parties are notified via automatic messages allowing them to manage the orders in an optimal manner.

2.3.9 Logistics and transport management

Once a beneficiary organization confirms the request, Regusto starts the transport assignment process using an intelligent logistics optimization system.

The software manages the matching between donor and beneficiary based on the geographic location and the needs of the organization and subsequently manages the collection by an authorized courier from the platform's certified network.

The second step is fundamental and refers to the optimization of routes to reduce costs, delivery times and risks of deterioration of the products, which could deteriorate if not delivered on time.

After these first two steps, the assigned couriers receive instructions via mobile app or GPS system and proceed with the collection of the products from the donor.

The subsequent offerer can monitor the tracking of the goods via the GPS installed on the vehicle, allowing the status of the shipment to be supervised in real time.

Any anomalies, therefore delays, temperature problems or need for a route diversion, are automatically reported, this helps the actors involved to act promptly, allowing the resolution of errors and the consequent final delivery of the goods to the recipients. The penultimate step concerns the verification of the receipt of the goods by the beneficiaries through the digital signature or scanning of the QR code generated by the platform which guarantee the safety and immutability of what happened.

Only after the products are verified to ensure that they are in suitable conditions for distribution to the final consumer, the receiving entity has the right to send feedback on the quality of the food brought, thus improving the management system of future donations.

Finally, as a last step, reports are drawn up for the traceability of the products which act as a guarantee regarding transparency and compliance with current regulations. These documents contain information referring to:

- Quantity and type of food redistributed;
- CO_2 emissions saved thanks to logistics optimization;
- Monitoring of deadlines and reduction of waste.

Everything will then be analyzed and inserted into the platform reports to update in real time its operational activities publicly visible on the website of the same.

2.3.10 Distribution and final destination

Once the food reaches the beneficiary organizations, the Regusto platform ensures the management and registration of all the procedures necessary for the allocation of resources. Once everything is delivered, the platform, thanks to metrics that will be analyzed in the following paragraphs, publishes the data relating to the waste and savings of resources generated.

Each recovered product is accompanied by an information sheet that includes information on its origin, storage conditions and expiration date, to ensure that the food arrives in the right hands and in optimal conditions.

Another distinctive element of Regusto is that it provides detailed reports to both donors and charities. These reports can include information on:

- ✓ Quantity of food recovered
- ✓ Number of people reached by donations
- ✓ Social and ecological impacts of food recovery
- ✓ Economic value of food recovered
- ✓ Percentage of food avoided from waste.

This reporting system not only allows for process optimization but also provides donors and organizations with a clear and measurable view of the impact of their actions.

2.3.11 Benefits for stakeholders

For companies that join Regusto there are several advantages. First of all, by engaging in eco-friendly actions they improve the image of the company and therefore

become more attractive in the eyes of potential external stakeholders. Furthermore, the platform offers companies a simple and practical way to manage the redistribution of excess food, without having to worry about all the bureaucratic and limiting aspects that can arise from these activities.

Nonprofit organizations benefit from the possibility of having access to free food , which can be used to help people in need, without having to submit to the disadvantageous conditions of the market. This represents a significant economic saving for all participants, who can focus on carrying out their activity.

2.4 Regusto corporate performance metrics in relation to the SDGs

2.4.1 Social Indexes

The Regusto platform uses various metrics to measure the effectiveness of its operations and to evaluate the impact on the Sustainable Development Goals, in particular it evaluates the quantity of food recovered by monitoring the kilos of food saved in reference to SDGs 12-3. All this occurs through a simple subtraction between the total food recovered minus the total food discarded, making it a percentage you get the weight of the food saved on the total. Over the past year, over 4 million tons of food were wasted in the Italian supply chain, for a total value in the food supply chain of €9,301,215,981. Food waste in the supply chain weighs 26% in agriculture, 28% in industry and 8% in distribution. It is noted that by redistributing the surplus, one of the main problems of the 2030 agenda, namely food insecurity, can be addressed.

Another indicator concerns the number of beneficiaries supported to generate food security, i.e. the charities and non-profit organizations that receive food and the people served by these organizations (SDG 2).

All this can be calculated with the so-called Distribution Frequency index (which quantifies deliveries and food distributed in relation to periods of greatest need); just multiply the number of participating organizations and the meals redistributed for each individual organization. Thus, giving the weight of the social impact of the platform which saw a total of over 3,830,000 meals distributed in 2022.

2.4.2 Environmental indices

Then there is the third indicator dealing with the topic of environmental impact (CO2 emissions) calculated by multiplying the quantity of food recovered by the average emission factor for food waste disposal (SDGs 12-13). This indicator also includes all those cost and emission savings resulting from the production of new foods, the decomposition of food into waste and its disposal by donor companies. It is clear that the benefit generated is great, just think that according to the World Organization for International Relations, food waste in the world is responsible for 4.8 billion tons of greenhouse gases emitted into the atmosphere and a water consumption equal to 180 billion cubic meters.

Furthermore, food waste causes other negative effects on the environment and society, such as deforestation, loss of biodiversity and world hunger. Therefore, the use of platforms such as Regusto is essential to prevent this from happening.

The second environmental index used by Regusto focuses on the total amount of water and soil used. Every year, a large amount of food is thrown away throughout the food chain. This waste involves the unnecessary use of natural resources such as water for irrigation of crops and soil for agricultural production. To calculate the impact of waste, estimates are used based on the average water and land consumption for the production of certain foods.

Meat production requires enormous quantities of water; in fact, approximately 15,000 liters of water can be used to produce one kilo of meat. On the contrary, foods such as fruit, vegetables and legumes require a much smaller quantity of water. In this case, we are talking about the amount of water needed to grow the vegetables up to the last step of the chain, i.e. the consumer.

Therefore, when food is recovered, new foods are not produced, thus saving resources that would otherwise have been consumed. Studies suggest that each ton of recovered food could save up to 1,500 m^2 of agricultural land. In this way, through the recovery and redistribution of food, a significant contribution is made to reducing the pressure on natural resources, promoting more sustainable management of the planet.

2.4.3 Economic Indices

Food recovery, in addition to helping reduce food waste and promoting sustainability, brings with it significant economic benefits for companies that join the platform, including savings on disposal costs and tax benefits resulting from food donations.

Companies often face considerable expenses for the disposal of unsold or no longer saleable products, these costs can include transportation, treatment and disposal of waste, which however fall on the company that generated them. The recovery of these products and their redistribution to non-profit beneficiaries allows companies to reduce these expenses and to place the company on an eco-sustainable level of business activities so as to make the company more attractive in the eyes of potential investors.

Furthermore, donating excess food can also reduce operating costs related to warehouse management, reducing the volume of unused goods and transforming that cost into a potential profit opportunity. As we well know, on an economic level, the more goods are stored in the warehouse, the greater the incidence of operating costs on the company's profitability. It is easy to understand how this becomes a fundamental aspect, which must be kept under control, if the company wants to perform at its best.

In addition, Law 166/2016, known as the "Law against food waste", offers tax benefits to companies that donate food for solidarity purposes. The provision provides tax breaks for companies that donate food to charity, reducing corporate income tax (IRES) and other direct taxes. Donations are considered tax deductible, which means that the company can reduce its taxable income based on the value of the donated food. This provides a significant advantage to companies, as it allows them to recover part of the costs incurred for the production and disposal of goods, while at the same time carrying out a socially responsible action.

These economic benefits are therefore a fundamental driver to promote not only the impact of companies on the environment but also to promote an economy more focused on innovation.

Finally, there is a final indicator that measures the economic and social value that takes into account the impact tokens generated and the economic value of the donation (SDG17). The latter is calculated by multiplying the quantity of food donated by the average market value of food, providing information in terms of the economic

value of donations, useful for companies' tax reporting and for measuring the economic effectiveness of the platform. In fact, there are numerous companies supported with over €200,000 of funds distributed to non-profit organizations through Spesasospesa.org and Regusto for the purchase of products from companies in the national territory (overall over €1,100,000 disbursed since the start of the project) in 2022 alone.

2.5 Regusto and AI

The Regusto platform therefore uses AI in every step of its process in a widespread manner. In fact, the platform optimizes the recovery, management and distribution of excess food with trained algorithms, thus helping to combat food waste. As seen in this chapter, AI is used for different purposes such as Predictive analytics, that is, using machine learning algorithms to analyze historical data relating to donations and requests for food by beneficiary organizations. In this case, artificial intelligence predicts future demand, anticipating possible choices of interested parties and allowing the amount of food to be recovered to be optimized, in order to reduce waste and ensure more effective distribution.

A second aspect refers to logistics optimization when the site helps optimize delivery routes, considering various factors such as the location of donors, that of recipients, traffic conditions, courier costs and possible strikes or weather problems, allowing food transportation to be planned in such a way as to minimize the impact of each individual logistics action.

A third aspect refers to intelligent matching, therefore the match that is created, thanks to artificial intelligence, in the process of matching donors (supermarkets, restaurants, producers) and beneficiaries (charities, soup kitchens, etc.).

AI algorithms evaluate the specific needs of organizations and the characteristics of donations (type of food, quantity, etc.) to create more precise and efficient matches. AI also takes into account the seasonality and possible cyclicality of requests from organizations in order to predict what they will require in the future, thus anticipating matching issues.

Tracking and management of expiration dates: Regusto applies artificial intelligence to monitor the status of donated food in real time, ensuring that it is stored

correctly and that expiration dates are respected. AI can warn when food is about to expire, in order to allow timely redistribution and avoid waste.

Optimization of warehouse management: AI is also used to manage warehouses, facilitating the control of stocks and the management of food flows, to avoid accumulations of unused or excess products.

These are just some of the main uses of AI on the Regusto platform, which contribute to improving efficiency and reducing food waste, creating a smarter and more sustainable food recovery and redistribution system.

2.6 Regusto Economics

As discussed in this chapter, Regusto has introduced the first donation management portal in Italy based on an innovative sharing for charity model that uses blockchain technology and AI to ensure transparency and traceability in the management of money and goods flows. Through the platform, food and non-food companies can donate and sell their products, digitalizing and tracking all flows in a transparent manner.

For each transaction, the benefit obtained at a social and environmental level in the territory is calculated and monitored. Through specific algorithms, the data generated is converted into Impact tokens developed according to international calculation standards, certified in blockchain and by RSM International.

Impact Tokens certify the positive social and environmental impact generated in the Italian territory expressed in terms of equivalent meals distributed, CO2 avoided, water and soil saved thanks to the non-rejection of donated and redistributed products. The combination of technology and innovation gives rise to the opportunity offered by Regusto, for companies, to document and measure their investments in sustainability and contribute to carbon neutrality.

The ecosystem that uses the Regusto platform is the most important at national level for the prevention/management of waste and is composed of:

- ✓ over 500 food and non-food companies (including Rovagnati, Esselunga, Bennet, Sammontana, Camst, Amadori, Cir Food, in the food sector and Leroy Merlin, Moleskine, Samsung, Henkel in the non-food sector);

- ✓ over 750 non-profit organizations (including the Italian Red Cross, Caritas, Banco Alimentare, Terre des Hommes, Progetto Arca, etc.).
- ✓ To date, Regusto has already achieved important results:
- ✓ 5.1 million kg of products at risk of waste recovered;
- ✓ 10.2 million equivalent meals distributed (1 eq meal = 0.5 kg of food);
- ✓ +7 million kg of CO2 avoided;
- ✓ +9.7 million cubic meters of water saved;
- ✓ +410,000 Impact Tokens sold.

Every month, thanks to Regusto, over 200 tons of food and non-food products are donated and sold.

In the early years, Regusto had a business model similar to that of the now well-known and innumerable platforms that allow users to purchase expired food at reduced prices, such as Too Good To Go, but after having better analyzed the needs of the market and the subjects it addressed, it decided to take a different path.

As explained in the previous paragraph, Regusto has a dual function, on the one hand it allows the meeting between companies producing goods at risk of waste and non-profit organizations, which can, through the portal, book the products published by the producing companies; on the other, it sells Impact Tokens, or tokens generated through proprietary algorithms thanks to the transactions that took place between the first two entities, to companies of any type and sector interested in generating a positive impact on the territory.

Non-profit organizations can book the goods available for donation or sale. If the company accepts the booking by the organization, the transaction is closed. In the case of products for sale, payment is managed independently between the two entities involved. Tokens are generated from each transaction.

Once the Impact Tokens are generated, they remain "in the belly" of Regusto, which makes them available to companies interested in generating a positive impact on the Italian territory. Furthermore, thanks to the use of blockchain and AI, the company that purchases the Tokens will be able to know all the information relating to the transaction that generated them. The Regusto portal generates revenue through:

- The sale of Impact Tokens[1] to companies in any sector interested in contributing to a positive impact on the territory (directly, at a cost of 1 euro, or indirectly, through partners at a reduced cost); but also during sustainable events (Earth Day, Suoni Contro Vento, Spoleto Festival, Umbria Jazz);
- Accessory services designed for companies that are partners of the platform (mainly focused on sustainability and communication issues) such as the personalized dashboard (for immediate reading of data) or the exclusive impact report with the summary of donation activities, statistics and benefits achieved by the company;
- Custom projects for companies that want to carry out communication campaigns.

Companies that purchase Impact Tokens contribute to generating Positive Impact and allow the use of the Regusto platform to remain free for all those involved, thus amplifying the environmental, social and economic impact generated

The goal of Recuperiamo s.r.l. is very clear, by 2025, the company intends to involve international entities to track donations globally and achieve important social and environmental impact goals together:

• 50 million meals distributed;

• 20,000 tons of CO2 avoided;

• 40 million cubic meters of water saved;

• 60 million square meters of land saved.

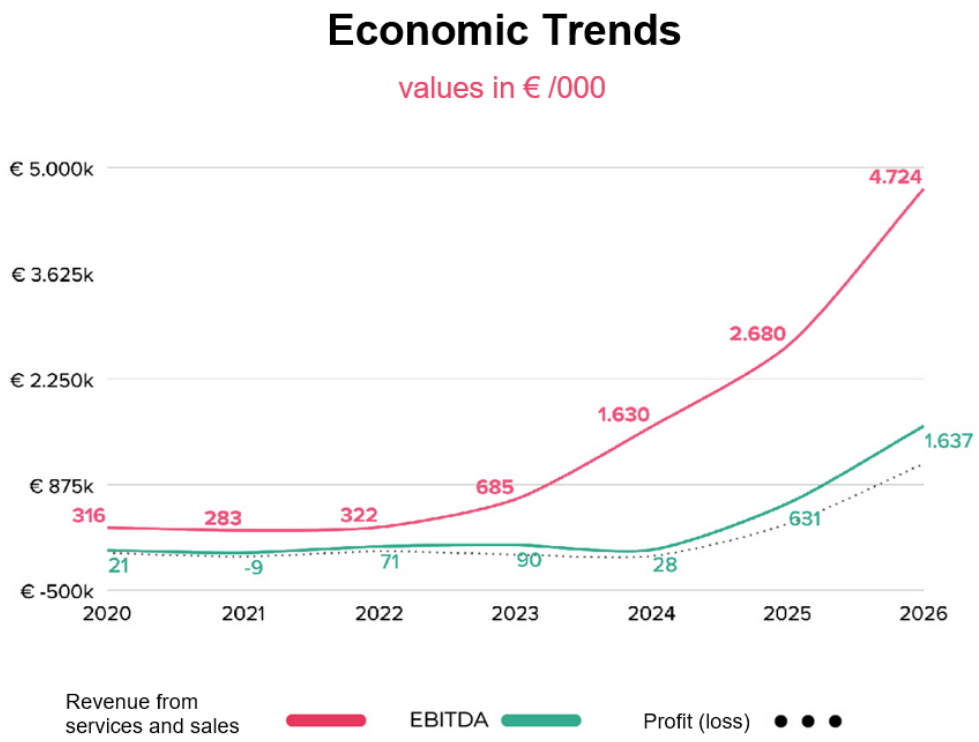
While regarding income and performance goals, Recuperiamo s.r.l. estimates it can achieve:

- A turnover of 4 million euros;
- EBITDA of at least 1 million euros;
- Distribute profits;
- Internationalization.

[1] Impact tokens: the characteristics of Regusto's "Impact Tokens": through specific algorithms, the data generated by the platform are converted into Impact Tokens, tracked in blockchain and uniquely identified in the form of NFTs. The Impact Token certifies the positive impact generated by each transaction (between non-profit organizations and companies with products at risk of waste) that takes place through Regusto. In fact, the Impact Token was created with the aim of certifying the impact generated thanks to the virtuous cycle of donation, recovery and redistribution of products at risk of waste

Regusto's 2023 budget saw a production value of approximately 680,000 Euros, with a projection in 2024 of approximately 1.4 million Euros and over 4 million in 2025.

Graphic 2.4 Regusto Development Plan (Source wearestarting 2023)



2.7 Regusto Awards

In recent years, Regusto has distinguished itself as an innovative reality with a great impact on society, capable of addressing the challenges posed by climate change and the 2030 agenda. This commitment has been recognized through prestigious awards and collaborations with important foundations and initiatives at national and international level. Below we will examine in depth the awards that Regusto has received, representing the testimony of its dedication and its success towards a more sustainable economy.

2.7.1 Louis Bonduelle Awards 2022

The Louis Bonduelle Awards, awarded in 2022, represent an important global recognition for innovative and sustainable projects in the food sector. Regusto was awarded for its role as a partner in the SpesaSospesa project, an initiative that aims to reduce food waste through the use of digital technologies and the construction of solidarity networks for the redistribution of meals. This award highlights Regusto's ability to combine technological innovation and ethical commitment, creating an important model of circular economy that involves companies, public bodies and citizens. The support of the Louis Bonduelle Foundation highlights the relevance of the project and its ability to contribute to achieving a more equitable and sustainable food system.

2.7.2 Barilla Foundation 2020

Later in 2020, the Barilla Foundation included Regusto as an established reality in the fight against food waste. This recognition is a certificate of excellence, as Barilla itself is an international point of reference for the promotion of food and environmental sustainability. The inclusion of Regusto in this list testifies to the effectiveness of its digital solutions, such as the platform that facilitates the redistribution of food surpluses, and its significant contribution to raising awareness on crucial issues such as food waste. The ability of Recuperiamo Srl to act as a catalyst for change in the agri-food supply chain was particularly appreciated, highlighting how technology is a powerful tool for addressing globally complex challenges.

2.7.3 Only the Brave 2020

The "Brave Action for a Better World" award assigned in 2020 by the Only the Brave Foundation, created by Renzo Rosso, founder of the Diesel brand, represents an important recognition for Regusto. The organization is known for its commitment to promoting initiatives that generate a positive impact on society and for carrying out innovative strategies at a corporate level. The award was given to the company for having taken on the responsibility of finding courageous and inspiring solutions in the ecological context, consequently for having made all this its mission towards the

creation of a greener agri-food system. Through its initiatives, Regusto has demonstrated that it has the vision necessary to address complex social and economic problems, proposing concrete and replicable intervention models.

2.7.4 Earthshot Prize Milano 2021

Another recognition was the Earthshot Prize Milano 2021, an initiative that aims to reward projects with a positive impact on environmental and social sustainability. On this occasion, Regusto collaborated with highly prestigious organizations such as Terre des Hommes and the Italian Red Cross, in the context of the Hub Indifesa project. This partnership strengthened the role of the company as a key player in promoting new solutions for the distribution of essential resources to those who need them most, while helping to reduce waste. The involvement in the Earthshot Prize underlines the importance of Regusto's technologies in creating a sustainable and resilient future.

The distinctive element that emerges from all these awards is Regusto's ability to combine three fundamental dimensions, namely Technological Innovation through the use of advanced digital platforms, which have revolutionized the way in which food surpluses are monitored, redistributed and valorized.

The second element concerns Social Impact, demonstrating a strong commitment to creating value for the most vulnerable communities, the company has provided concrete help, while promoting a culture of solidarity.

These awards are not only milestones for Regusto, but also an incentive to continue in its mission. They demonstrate that the path taken is the right one and that the commitment of this organization can serve as an inspiring model for other realities.

Chapter III
Three users of Regusto platform.

3.1 Introduction

In this last part we will analyze how three companies in the agri-food sector that use artificial intelligence to improve their sustainability performance, manage to achieve their goals also through the use of the Regusto platform. Through this analysis we will try to verify whether the adoption of AI and digital platforms has actually contributed to improving the eco-friendly results of companies and how all this happened.

The main objective of this third chapter is, therefore, to analyze to what extent the Regusto platform has concretely improved company performance. In particular, the chapter aims to compare the theoretical evidence that emerged in the first two chapters with the real data extracted from the sustainability reports of three companies: Parmacotto, Rovagnati and Esselunga.

There will therefore be an analysis of which ESG investments each of the three companies has implemented with particular attention to the reduction of waste, also including the redistribution of surpluses for social purposes or to improve production efficiency. In parallel, the optimization of resources, both in terms of materials and energy, will be examined to determine whether the use of AI and technologies have generated more efficient management with economic and environmental benefits. Through the observation of companies' practices and sustainability metrics, this part intends to provide a vision of how the integration of innovative technologies can represent an enabling factor for more sustainable and effective business strategies. The results will allow us to outline general considerations, offering useful insights for the debate on the role of AI in the transition towards more sustainable and efficient business models.

Another key point concerns traceability along the production chain. The study will analyze the role of technologies in increasing transparency and control over business processes, with a focus on improving stakeholder trust and compliance with corporate sustainability standards defined by ESG criteria. All this will be considered

an essential element to ensure more responsible management of processes and greater alignment with the Development Goals.

A further element of analysis will be the overall alignment of corporate practices with the SDGs, through a structured observation of the progress made by companies in relation to key sustainability indicators.

Environmental, social and economic impacts will be taken into consideration to understand whether these concretely contribute to improving performance and responding to the challenges posed by the global context.

Subsequently, it will be seen whether the analysis of the case studies has outlined common trends, useful for understanding and drawing conclusions on the relationship between AI and the sustainability of companies.

Finally, the paper therefore aims to offer an empirical and in-depth vision of how the adoption of advanced technologies for sustainability can transform corporate management, generating tangible benefits and contributing to the achievement of global sustainable development goals.

3.2 The Parmacotto case study

Parmacotto is a well-known Italian company founded in Parma in 1978 that works in the agri-food sector and for generations has carried forward a culture based on the processing of cooked ham. Founded by Marco Rosi, the company sees its production headquarters and slicing site between Sanvitale Baganza and Marano, two small towns in Emilia Romagna. In 2001, Parmacotto acquired Parma Mec from the Barilla group, a company specialized in the production of cured meats and sliced meats. This acquisition marks the entry of the Parma-based company into the world of self-service.

After a series of acquisitions, which see the same company expand into multiple markets such as Tuscany and abroad, especially in France, in March 2018, the joint stock company was acquired by Giovanni Zaccanti, a Bolognese entrepreneur among the founding members of Saeco and Caffitaly, who will serve as president. In doing so, it will give life to what will be recognized in 2024 as the cured meats giant, established by an agreement between GranTerre and Parmacotto spa.

3.2.1 Parmacotto responsibility towards the 2030 Agenda

As reported in the 2022 sustainability report, the Parma-based company wants to focus its attention on promoting a healthy lifestyle, strong social inclusion and increasing greater protection towards the environment. The latter has focused more on some of the sustainable development objectives such as:

- ✓ Good health and well-being (SDGs 3);
- ✓ Zero hunger (SDGs 2);
- ✓ Decent work and economic growth (SDGs 8);
- ✓ Responsible consumption and production (SDGs 12);
- ✓ Climate action (SDGs 13);
- ✓ Life on Land (SDGs 15).

To do this, the company has adopted a strategy (Feelingood) based on three general guidelines, which allow for the optimization of a more circular approach to its supply chain and the implementation of its 360-degree sustainability:

- ✓ Well-being at the table;
- ✓ Well-being of communities;
- ✓ Well-being of the environment.

The first guideline concerns “Wellbeing at the table”, that is, the work that is done every day to develop products that are not only good to taste, but also capable of reconciling quality and healthy and balanced lifestyles worthy of every human being. The second guideline concerns “Wellbeing of communities”, understood as investment in culture and social responsibility, through projects and actions for employees and local communities, such as Mezano and San Vitale, which allow us to strengthen our ties with the territory.

Finally, there is the last guideline that concerns the theme of “Wellbeing of the environment”, that is, undertaking a path that through a scientific approach, analytical KPIs and monitored objectives will allow the company to reach zero emissions by 2026.

3.2.2 From guidelines to a more sustainable lifestyle

To transform the objectives determined by the three guidelines just seen into tangible results, Parmacotto has decided to implement steps to follow, accompanied by a careful selection of raw materials, a short and transparent list of ingredients that allows the optimization of production processes, attention to product safety and consumer protection. The first step concerns the careful selection of raw materials, which allows us to offer processed products taking care of the details and to guarantee customers, therefore, a consistently high level of quality.

The second step concerns the ever decreasing use of preservatives in the production of cooked ham and all cured meats; this represents a real challenge that requires greater attention and control of the process. To do this, in fact, it is essential to maintain very high food safety standards and a choice aimed at maintaining a processing that respects a natural process as much as possible in all the different production phases. As is known, preservatives in cured meats and sausages play a fundamental role and are the main pillar for long-term preservation, therefore trying to reduce their use is a continuous challenge that the company has accepted to reduce all those health risks that such ingredients can cause due to prolonged use.

The third step refers instead to products that have a high salt and fat content, hence the Parma-based company has developed innovative solutions that see a 25% reduction in salt in the production of Prosciutto Cotto di Alta Qualità iposodico and a further 3% reduction in fat in the same. The fourth point requires that there is a short and transparent list of ingredients, which aims to provide clear and detailed information, helping consumers to make informed decisions. The next step refers to a key aspect for the long-term sustainability of the company, namely the upgrade of production processes and technologies; in fact, the company constantly improves the processes and technologies used, to offer top quality products and satisfy the needs of consumers, who have shown over the years greater attention to sustainability and the origin of raw materials. As a penultimate step there is the improvement of nutritional profiles, that is, continuous research combined with scientific studies for meats and raw materials that can be processed by minimizing the possibility that after the conversion process they present substances that have a high impact on health.

To conclude, the last step concerns the use of exclusively natural flavors, all this in response to the growing need for well-being by consumers and the focus of the market that is moving towards increasingly green consumption with 100% natural flavors.

3.2.3 Carbon neutrality

As regards the objectives on which Parmacotto has focused most, there is that of the decommissioning or no longer using fossil fuels to create energy with the aim of achieving zero direct emissions by 2026. To do this, the company has joined the initiative, born from the collaboration between international institutions such as the United Nations Global Compact, the World Resources Institute and the World Wide Fund for Nature, which aims to prevent climate change and reduce greenhouse gas emissions. This project is called Science Based Targets and supports companies that want to commit to the fight against climate change; the company has joined it since 1 January 2022. Compliance with this for Parmacotto Group represents a commitment to reduce Scope 1 (direct greenhouse gas emissions) and 2 (indirect emissions) emissions by 50% compared to 2018, the reference year of the measurements, and to identify an action plan or initiative to limit Scope 3 emissions (indirect emissions of the value chain).

From here, then, the idea was born to create an ambitious roadmap to progressively reduce carbon emissions by working concretely on numerous lines of intervention. In this context, correct energy management is very important and brings with it several advantages:

- ✓ Energy savings dictated by the reduction of consumption and elimination of waste;
- ✓ Optimization of costs and times, guaranteed through the monitoring of specific tools or systems;
- ✓ Lower environmental impact due to the reduction of CO2 emissions.

For this purpose, Parmacotto group has established an "Energy Committee" composed of a CEO, a Sustainability Manager, a Technical Manager, an Administration Manager and an Operations Director, with the aim of monitoring the progress of the activities started and the consequent achievement of the established standards.

During the meetings, the results obtained are displayed and new energy efficiency and decarbonization projects are taken into consideration. The committee consults on a biweekly basis, thus maximizing efficiency in the event of problems encountered and implementing step by step objectives that could take longer to provide any benefit.

To give an idea of the group's impact, it was found that from January 1 to December 31, 2022, energy consumption was equal to 89,483 GJ, mostly related to the production activity of the core business, of which approximately 2% is based on the consumption of non-renewable fuels (Diesel, Petrol, LPG), while 51% is given by the consumption of electricity taken from the national grid. Consequently, natural gas consumption represents 47% of total energy use and direct GHG (Greenhouse Gas) emissions in 2022 were equal to 3,377.869 tons of CO2eq10, allocated to stationary combustion of fuels (about 70%), refrigerant gas leaks (about 28%) and the company car fleet (about 2%).

As regards indirect Scope 2 emissions, both calculation methodologies were used, therefore location-related and market-based.

Despite the different impacts that the company has generated during its activity, there is an important result achieved already in the short term, i.e. in 2022, Scope 2 GHG emissions calculated according to the Market-based approach were equal to 0 tons of CO2eq, all this was possible thanks to the purchase of 100% renewable electricity certified by guarantees of origin. The emissions calculated according to the Location-based methodology, however, are equal to 3,619 tCO2eq.

To conclude this paragraph, we want to delve into the last but not least step to take into consideration towards a reduction in carbon emissions.

The company is pursuing a path towards the use of sustainable and renewable materials for food packaging, which must guarantee technical and technological characteristics capable of preserving their organoleptic characteristics, must protect the product and reduce food waste.

The governance guidelines provide for an 18% reduction in the use of plastic for the wrappers of the cold cuts packages, consequently it provides for the use of thermoforming materials composed of 70% recycled PET, thus generating an equivalent to 50% of recycled PET presence on the final packaging.

Subsequently, FSC certified paper and a 100% recyclable tray will be used on the final packaging of the product in order to maintain an eco-friendly impact and finally the aluminum layers will be replaced with conversions to cardboard with a white background, further reducing the printable surface.

3.2.4 The Role of Regusto

The Parma-based joint-stock company has been adhering to the Regusto initiative for years now, thus taking its sustainability mission to another level, creating a circular ecosystem based on an innovative “sharing for charity” model where initiatives are taken that evaluate the recycling of all processing waste and allow its re-issuance in a new phase of its life. Through the technologies analyzed previously and the use of AI, we have seen how the Regusto platform guarantees transparency and traceability in the management of cash and goods flows, thus allowing affiliates to donate surplus food in a safe and verifiable way.

Through this platform, Parmacotto Group is able to digitize and transparently monitor donated surplus food. The partnership with Regusto demonstrates Parmacotto Group's deep commitment to supporting environmental and social responsibility. As evidence of this commitment, since the beginning of 2023 the group has donated approximately 56,000 kg of products to non-profit associations through the platform, contributing to the redistribution of excess food and concretely supporting the circular economy.

In a historical moment in which purchasing power is declining and there is a growing number of families in difficulty, responding concretely to the needs of the weakest groups has become a priority, and this is precisely why Parmacotto has decided to donate excess food stocks to those in need.

The group's commitment also concerns raising awareness among people and actively involving the community, to inspire a culture of conscious consumption, thus contributing not only to reducing food waste, but to strengthening the commitment to corporate social responsibility, demonstrating that private companies can also play a fundamental role in building a green future.

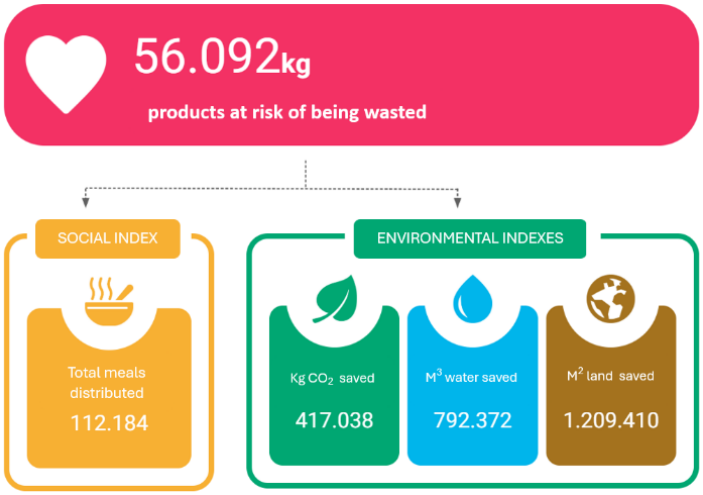
According to the World Food Programme, approximately 830 million people in the world suffer from hunger or malnutrition, at the same time, it is estimated that a third

of the food produced globally for human consumption is lost or wasted every year. Thanks to the close relationship with Recuperiamo srl, the company has been able to count on a recycling of 56,092 kg of products; just think that on average to feed an adult man in the world it takes about 365 kg of food/year consequently Parmacotto thanks to Regusto has fed 153 more people in a year. Therefore, if in the world there are more or less 400 million active companies, it would be enough for 5 million (0.01%) of these to recover the meals that the Parma company has recycled and we would come close to no longer having malnourished or food insecure people. It is clear when the effort is marginal but the gain is very important, so it would be enough for everyone in their own small way to take a step forward to help solve the problem concerning the community.

Referring to the environmental indices calculated by Regusto for the group, it is clear that the redistribution of meals has reduced CO2 emissions by 417,038 kg, there has been a saving of 792,372 cubic meters of water and 1,902,410 square meters of land saved. It has been estimated that global food waste amounts to about 1.3 billion tons per year, this has an estimated economic value of about 940 billion dollars; it is clear that the path to giving new life to products is the only possible one if you want to have less impact on the environment.

The indices that follow are calculated and generated by the Regusto platform, shared and certified in blockChain and enriched with AI for predictive purposes: the data are updated weekly.

Graph 3.1 Calculation of environmental and social impact indices and recovered meals for Parmacotto by Regusto 2023 (Regusto website)



Finally, it should be noted that these excellent results in terms of ESG are combined with a growth in the Parmacotto Group's turnover between 2022 and 2023 of approximately +7.6% (Revenues from sales 2023 112 million euros, approximately 6.6 million euros more - Source Parmacotto 2023 Financial Statements and Notes to the Financial Statements).

3.3 The Rovagnati Case study

Let's now analyze the Rovagnati, an Italian company specialized in the production of cured meats since the middle of the last century. The company was founded in Biassono, a town in Brianza located in the Province of Milan, after the Second World War by Ferruccio and Emilio Rovagnati, who were involved in the production of butter and the trade of cheese.

Since the sixties, the company began to make a name for itself in the sector after a series of alternating phases that saw it still too focused on the dairy sector, only in 1991 did the company dedicate itself to a massive advertising campaign during the program Wheel of Fortune by Mike Bongiorno. From here, the rise of the Brianza company is also consolidated by the numerous acquisitions of companies in difficulty, very often operating in activities corresponding to that carried out by the company itself.

3.3.1 Rovagnati's sustainable development plan

The company's path towards sustainability began following the creation of its own CSR commitment structure, also known as ESG Team, by launching the Rovagnati Qualità Responsabile program in 2017.

The plan sees three fundamental aspects of the group's philosophy as its supporting pillars, namely products must be "good, healthy and fair".

In doing so, the Brianza-based company has outlined its sustainability strategy by connecting the Brand Purpose, i.e. the company's general objective, and the Brand Mission, i.e. the methodology of how it wants to achieve the main objective, to a series of concrete commitments. As regards the Brand Purpose, the aim is to bring a good and healthy gastronomic offer to tables all over the world, developed with innovative

systems and according to high quality standards to remain increasingly sustainable and committed. The company's Brand Mission instead combines the experience of a long tradition with a vision focused on the future, generating value for the environment, communities and interested stakeholders.

The concrete commitments concern in the first analysis the identification of a specific corporate function with the aim of guiding the Company along the path undertaken and using the latter as a cornerstone for more sustainable development.

All this was possible thanks to the introduction of the ESG Team, which made it possible to trace a philosophical route, in an eco-friendly theme, of the company divided into different phases.

The first phase concerns the Creation of a strategy in which sustainability is synergistically integrated into the business, therefore it is no longer a mere objective to be evaluated at the end of the production year but becomes a compass that guides the company from the beginning of the process. The second phase made it possible to define the areas of commitment and concrete and coherent actions to be implemented over time, with a short, medium and long-term horizon.

Consequently, in the third phase, communication was established on various levels of environment, governance and social disseminated through appropriate internal and external channels of Rovagnati, thus generating the identification of the metrics to be used as KPIs for the evaluation of the objectives.

The areas of commitment on which the green action plan was founded will be analyzed later, referring to the potential areas of commitment and concrete commitments that the company has given itself as an improvement towards green production.

3.3.2 The steps of the Rovagnati green strategy

After having outlined the three key elements of Rovagnati's sustainable strategy, let's now see in concrete terms what are the individual steps that are taken to concretely obtain the results of good, healthy and fair. To begin with, all the products are born from traditional Italian methods and recipes, therefore they embody the made in Italy and transmit the culture of our country.

Subsequently, the cold cuts contain proteins with high biological value, an important nutritional source of essential amino acids which, as is known, combined with a balanced diet can benefit human health by bringing benefits.

A further commitment that the Brianza company has taken on is that of creating gluten-free products, thus breaking down barriers and bringing the consumption of raw materials to a wider audience.

Furthermore, the laboratories located within the company certified by Accredia and RovaLab guarantee the safety of the products by carrying out 60,000 analyses per year; in this way, possible contamination of the food or the risk of pandemics is avoided.

Everything we have seen is the fruit born from the synergy between innovation and technology in every phase of the production process, guaranteeing transparency and reliability of the Brianza supply chain.

Another important step concerns the food processing techniques capable of generating finished products without the addition of nitrites, both vegetal and non-vegetal, and guaranteeing the same level of safety established by international regulations.

Rovagnati, then, is at the forefront in the fight against food waste, due to the fact that the latter has joined projects such as Regusto to develop circular economy practices such as donation and responsible management of production surplus.

It is clear how these small steps may seem trivial but they contain key elements for a successful strategy, which sees the focus of companies in generating a non-closed-circuit economy, i.e. with a beginning and an end, but circular, therefore allowing to give new life and a better use to all those materials that would otherwise be thrown away, generating only more pollution.

3.3.3 Sustainable initiatives

The Brianza company has firmly embraced the commitment to environmental sustainability, outlining concrete initiatives in the energy, logistics and packaging sectors.

A first initiative concerns the field of cogeneration, that is, an advanced process that integrates heat recovery with the production of electricity that would otherwise be dissipated, thus significantly reducing emissions into the atmosphere. Therefore, from a

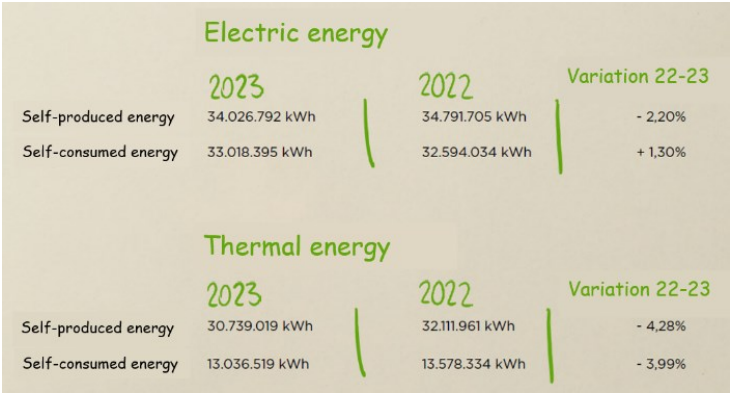
single source you can both use energy to operate machinery, lighting systems and everything else, and heat the environment directly from the same resource for a total of 4.45 MWe (meter water equivalent) generated by this system; to give you an idea, with the same energy you could power a total of more than 4,000 homes.

Graph 3.2 Energy consumed based on revenue generated (Source: Rovagnati sustainability report)

ROVAGNATI	2023	2022	Variation 22-23
Energy consumption	81.627.268 kWh	85.589.581 kWh	- 4,63%
Revenues	312.366.155 €	305.861.116 €	+ 2,13%
Energy intensity	0,26 kWh/€	0,27 kWh/€	- 6,6%

These plants represent an important step towards self-sufficiency, contributing to the company's overall energy needs; in fact, thanks to these structures, 65% of the energy needs of all the plants are satisfied. A second initiative pursued by the group refers to investments in logistics, namely a strategic partnership and adoption of eco-sustainable vehicles has been started, which allow long distances to be covered with zero emissions and keep road transport competitive with regard to international green regulations.

Graph 3.3 Energy consumption for type of energy (Source: Rovagnati sustainability report)



Electric energy	2023	2022	Variation 22-23
Self-produced energy	34.026.792 kWh	34.791.705 kWh	- 2,20%
Self-consumed energy	33.018.395 kWh	32.594.034 kWh	+ 1,30%

Thermal energy	2023	2022	Variation 22-23
Self-produced energy	30.739.019 kWh	32.111.961 kWh	- 4,28%
Self-consumed energy	13.036.519 kWh	13.578.334 kWh	- 3,99%

The commitment to innovation in the packaging sector was then intensified, with a specific focus on reducing the use of plastic, which saw an overall recycled plastic content in the packaging equal to approximately 43% of the total and for the flagship lines such as Snello, i Firmati and Gran Biscotto it reaches 55%.

Consequently, further funding for research and development led to a 38% reduction in the use of plastic packaging materials and during the period 2020-2023, with sales volumes roughly unchanged, an overall saving of 376 tons of plastic was achieved, equal to the size of 166 football fields.

Finally, the latest initiative carried out by the company refers to the implementation of various interventions aimed at optimizing water consumption and improving the management of this resource.

A significant step was taken with the installation of the PSHT pasteurizer, a machine that applies a fast and high-temperature pasteurization process by heating the liquid quickly and cooling it just as quickly, which contributed to reducing water consumption. In addition, other renovation interventions were started on the wastewater treatment plants aiming to implement a closed circuit for cooling, allowing significant water savings of 10 liters per minute for each machine, corresponding to 2.5 million liters per year.

Graph 3.4 Rovagnati Water Management (Source: Rovagnati sustainability report)

ROVAGNATI	2023	2022
Water withdrawal	617.424 m^3	614.134 m^3
Revenues	312.366.155 €	305.861.116 €
Water withdrawal per unit of revenue	0.002 m^3/€	0,002 m^3/€

3.3.4 The role of Regusto

Thanks to the use of the Regusto platform, Rovagnati has the possibility of donating surpluses to various non-profit organizations, including:

- ✓ Fondazione Banco Alimentare, which deals with the collection of food and the recovery of surplus food from agricultural production

- ✓ Pane Quotidiano, a non-profit association with the primary objective of ensuring free food every day to the poorest segments of the population;
- ✓ Maremosso, a Volunteer Organization that takes care of those who need it most by promoting good circular economy practices.

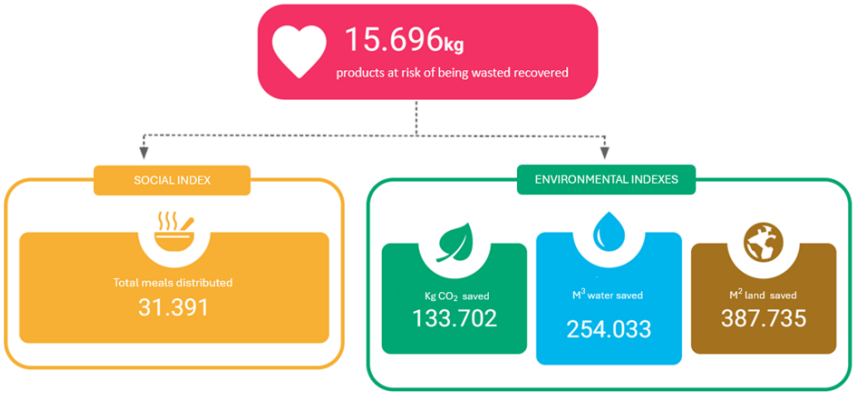
Since 2003, the Brianza-based company has continued its historic collaboration with Banco Alimentare, a program that focuses on people, organizations and companies united in the fight against food waste and in supporting communities, becoming ambassadors of the project, which aims to raise public awareness of food waste in 7 points:

1. value food;
2. look around;
3. be proactive;
4. donate food;
5. fight waste;
6. network;
7. become an ambassador.

Since the company joined Regusto, a recovery of approximately 15,695 kg of food has been recorded, with a consequent redistribution of 31,391 meals. The carbon dioxide not emitted was equal to 133,702 kg, the cubic meters of water not wasted were 254,033 and 387,735 square meters of soil were saved.

In this case too, it is clear how Regusto has played a fundamental role in safeguarding the environment and food, benefiting not only from a solidarity point of view but also from a productive one for the company.

Graph 3.5 Calculation of environmental and social impact indices and recovered meals for Rovagnati by Regusto (Source: Regusto website)



Finally, it should be noted that these excellent results in terms of ESG are combined with a growth in Rovagnati's turnover between 2019 and 2023 of approximately +7.5% (Sales revenues 2023 312 million euros, approximately 22 million euros more than in 2019 - Source: Rovagnati 2023 Financial Statements and Explanatory Notes).

3.4 The Esselunga case study

Esselunga S.p.A. is an Italian company that operates large distribution centers in northern and central Italy, including supermarkets and superstores. With over 170 stores distributed across the regions of Lombardy, Veneto, Piedmont, Emilia-Romagna, Tuscany, Liguria and Lazio, the company oversees approximately 8.7 percent of all Italian food and hypermarket sales. The company was founded by two Italian partners and Nelson Rockfeller under the name of Supermarkets Italiani S.p.a.; after a series of ups and downs, it established itself in the food sector. The big change occurred from the 1980s to the early 2000s, when the way of shopping was revolutionized through the use of online portals that helped consumers choose products and have their shopping done by superstore staff. From here, the company, which still had the Supermarket sign, changed its design towards the end of 2019 to LaEsse, which later became Esselunga.

3.4.1 The reference context

Food market volatility may be caused by potential risks associated with climate change, which could lead to disruptions in the supply of raw materials and finished products, resulting in a cost of no less than $15 on the price of products (2023 Esselunga sustainability report).

Disruptive phenomena for the supply chain system include reductions in the production of products from extreme weather events, as well as potential reductions in the supply of food and agricultural materials resulting from increasingly strong geopolitical instability.

Progress in recent years has acted abruptly on the market, seeing the 2022 Russian-Ukrainian conflict undermine the world's major cereal producers and the Israeli-Palestinian conflict create new tensions on the prices of goods traded in the border regions of the conflict. In this regard, each actor is required to propose creative solutions to address these problems. To ensure the health of the planet and human beings, it is important to eliminate production and consumption models that are less harmful to ecosystems and more sustainable. In addition to reducing its own impact on the environment and people, Esselunga works daily to increase consumer awareness of healthy and sustainable lifestyle choices. In light of this, the company is one of the original sponsors of the ten-year "Farm to Fork" project, developed by the European Commission. This addition forces the group to move towards a healthy, environmentally responsible and fair food system. Furthermore, in order to implement its commitment to a more eco-friendly system, Esselunga has joined the United Nations Global Compact, through which it undertakes to share and apply 10 fundamental principles, supporting the sustainable development goals of the 2030 agenda and reporting annually on the progress made. Below we see the objectives that involve Esselunga.

3.4.2 The sustainability policy

In order to pursue the objective of incorporating more and more sustainability factors into the decisions taken daily by the Group, Esselunga has revised its Sustainability Policy, approved by the company's Board of Directors, defining the

principles and guidelines underlying responsible and sustainable corporate management. This revision was published in the 2023 Sustainability Report.

The revision of the policy in the socio-cultural, economic, geopolitical and environmental context was caused by the latest changes within. This made it necessary to review the priorities and commitments in the area of sustainability to reflect developments in the context in which the company operates.

In the sustainable mission, the company has divided its objectives into three priority areas regarding the material issues that form the basis for commitments, objectives and strategy. As a first point, the company is aware that the people it works with are the heart of the company, represent the values and culture of the company and constitute an important channel through which to offer quality services and generate new value. By carrying out its work with passion and dedication, the company promotes innovation and best practices in social and environmental responsibility along the value chain to enhance long-term sustainability and maintain the trust of its customers. The second pillar refers to carrying out its work with passion and dedication, promoting innovation and best practices in social responsibility across the value chain to implement long-term sustainability and maintain the trust of its customers.

And finally, the third pillar focuses on the fact that the food supply chain has an impact on the environment and that working to protect the planet and fight climate change can guarantee essential resources for future generations, improving their quality of life.

Having said that, we now move on to see what steps the Milanese company has set itself to implement and how they relate to the SDGs; as described above, the group has decided to enclose its efforts in three macro containers relating to the people who work there and to the community, to its sector and to the planet. As regards people and communities, Esselunga has decided to invest in training programs and initiatives to enhance individual skills and promote professional growth.

Improve the quality of life and have a positive impact on physical and mental health by satisfying needs and preferences through welfare initiatives, creating a balance between work and affections.

Ensure employee safety by improving management systems, spreading knowledge and promoting a culture of prevention and awareness.

Consequently, in the sector sphere, the company has decided to offer high-quality products and guarantee their traceability to protect consumers from the risk of damage to health, through constant monitoring of production and supply processes. Thanks to the use of clear packaging and labels, guide consumers towards informed purchasing choices and avoid negative effects due to incorrect communication.

Promote excellence and innovation, responding to customer needs and expectations and collaborating with universities and experts, who have contributed to the continuous evolution of technologies and knowledge in the sector.

In the environmental sphere, it has decided to design a sustainable value chain and reduce the negative effects on the environment caused by its activities and along the supply chain, monitoring energy consumption and implementing technological solutions to make them more efficient, using renewable energy sources.

Managing waste means reducing waste and valorizing scraps and surpluses, reducing the negative impact on the environment, all this can be achieved through research into new methods to recover ingredients and raw materials in production processes, the creation of methods to reduce food waste in the store and the distribution of food and non-food products that have not been sold.

Maintaining the quality, safety and conservation of products, while reducing the negative impact on the environment caused by ineffective management of packaging by using recyclable, compostable or reusable packaging.

To conclude this paragraph, last but not least, Esselunga has decided to play a crucial role in donations. In fact, reducing food waste is one of the Group's strategic objectives, and this is achieved by donating excess food to charities and associations that help the neediest people.

The company can significantly contribute to the donation of meals and basic necessities because it is both a retail and manufacturing reality.

The group works on several fronts, namely it offers over 100,000 kilograms of fresh bread per year to the Pane Quotidiano Onlus and collaborates with the Fondazione Banco Alimentare to safely and systematically distribute surpluses to those in need.

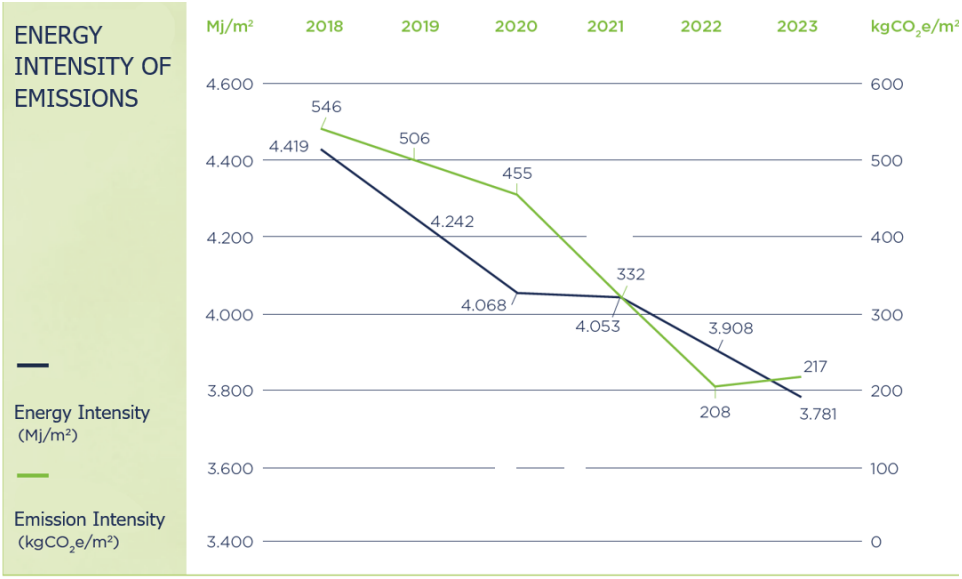
3.4.3 Group energy consumption and emissions

The group's operations involve the use of significant energy resources and involve the emission of greenhouse gases. To ensure adequate control, the activities have been reorganized in line with international standards, thus receiving certification since January 2022.

Esselunga's environmental responsibility also includes objectives to be achieved by 2025, which include:

- ✓ 70% reduction in CO2e66 emissions (scope 1 and 2) through investments in efficiency, self-production and purchase of renewable energy certified through guarantees of origin;
- ✓ 25% reduction in CO2 emissions only through efficiency and self-production, to which a specific budget has been dedicated, without taking into account the effects of purchasing energy from renewable sources.

Graph 3.6 Energy intensity and emissions of the Esselunga supply chain (Source: Esselunga sustainability website 2023)



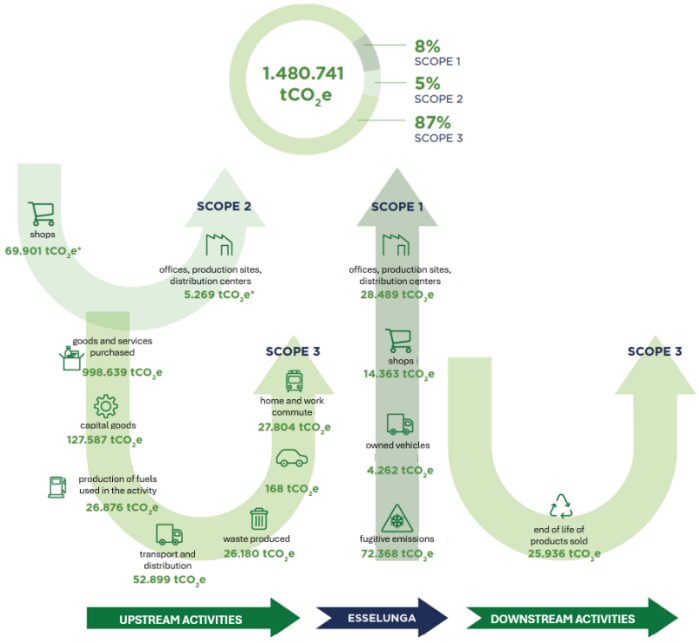
In 2023, Esselunga produced a total emission impact of 194,652 tCO2 through its consumption, with a decrease of 6.96% compared to 2022, a limited decrease also due to the increase in F-gas leaks in the refrigeration circuits.

Esselunga uses and monitors an energy intensity indicator and an emission intensity indicator based on the square meters of stores and warehouses, where online shopping is prepared, to achieve its objectives and measure progress, this is done to take into account the continuous development of the group.

The indices relating to energy performance (energy intensity) and CO2 emissions (emission intensity) showed significant improvements in 2023 as shown in the graph 3.7.

Consequently, the company has quantified its environmental impacts beyond the company's borders to report emissions related to the entire value chain. In fact, it was possible to determine the indirect emissions for the year 2023 in accordance with the Greenhouse Gas Protocol, the most well-known calculation protocol globally, which showed that logistics and store operations, as well as branded products processed or transformed within the processing centers, led to indirect emissions (scope 3) of approximately 1,286,089 tCO2, marking an excellent milestone in the fight against climate change. Another significant step has been taken when it comes to any surplus food produced that is donated by Esselunga to help the community. In an effort to provide a more balanced and complete diet to those in need, food donations include a variety of products such as bread, fruit, vegetables, dairy products, cured meats and meat.

Graph 3.7 Esselunga emissions by activity (Source: Esselunga sustainability website 2023)



When donating food for human consumption is impossible, surpluses are then directed to companies that produce animal feed in order to ensure its circular use, through a system of risk assessment and critical control points that guarantees maximum safety.

In conclusion, the company has set itself a difficult challenge such as finding a new type of packaging for its goods while maintaining a balance between the numerous business needs, including reducing environmental impact, maintaining product quality, food safety, achieving the desired shelf life, product protection, conversion of packaging machinery, availability of raw materials and cost.

Esselunga has set itself a packaging objective to synthesize and optimize all these aspects, this will allow it to adapt to the changes in the CONAI guidelines on the classification of packaging and at the same time to take environmental issues into account.

The company is committed to ensuring that at least 85% of the packaging of Esselunga-branded products produced internally or by third parties are made with recycled, recyclable or compostable materials, as indicated in the 2020–2025 Sustainability Plan.

In essence, the well-known Milan company has implemented a series of important measures aimed at promoting green development of the business and in line with the sustainability objectives described above and reported in the 2023 Sustainability Report.

The company has activated an online psychological consultancy service which is available to all employees in order to ensure maximum work-life balance.

It has also activated various collaborations in order to encourage the inclusion of people with disabilities and guarantee long-term professional opportunities.

Another important initiative is the partnership with PizzAut, aimed at supporting people's employment on the autistic spectrum through the sale of PizzAut products in stores. Esselunga also promotes projects for gender equality in STEM disciplines.

In 2023, the company awarded scholarships and collaborated with several universities to encourage female participation in these fields.

Also, for customers the company promotes a healthy lifestyle, encouraging healthy food choices through awareness and education campaigns, such as the collaboration with the Yougoody project, developed by the National Cancer Institute of Milan.

Among other actions, 100% of stores have a timed lighting schedule, 96% of lockers have night-time switching off, and 19 stores have implemented a Machine Learning service to optimize climate control. Furthermore, in 2023, a project for the disposal of used coffee capsules was launched in collaboration with Amsa and A2A Ambiente and is currently being tested in some stores, in order to offer customers an innovative and one-of-a-kind solution.

3.4.4 The role of Regusto

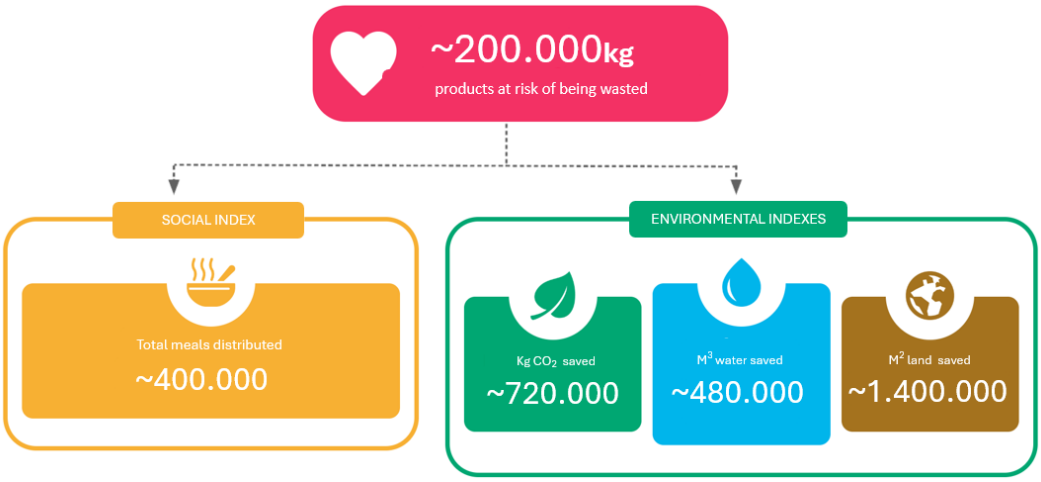
The partnership between Esselunga and Regusto has been going on for many years now and through it the company is also committed to local communities in the areas in which it operates. Through the Fìdaty Catalogue, the company has supported numerous fundraisers for Emergency, for the victims of the earthquake in Syria and Turkey and for those affected by the flood in Emilia-Romagna. Esselunga, thanks to its partnership with Regusto, was therefore able to develop a customized sustainability plan, composed of many different initiatives.

A total of 265 initiatives were carried out, which allowed over 39 million euros to be allocated to local communities, perhaps the best goal achieved to date by the Milanese spa in the green field; furthermore, in collaboration with suppliers, Esselunga made food donations for a total of over 2,000 tons of food and 4 million meals, distributed to more than 190 associations and non-profit organizations.

Consequently, the company promotes solidarity initiatives, management of public and private green spaces and promotion of sports and culture, such as, for example, the "Amici di Scuola e dello Sport" project has contributed over 135 million euros in school and sports materials to more than 14,000 schools and 7,000 amateur sports clubs since 2015, another important social goal for the company. Moreover, thanks to the collaboration with Regusto, the company has been able to further consolidate its commitment to the social and environmental field, obtaining very important results. In fact, from the work with the platform, over 4 million meals have

been donated and recovered and more than 135 million euros have been allocated to 14,000 schools and 7,000 sports clubs, from 2015 to today. Furthermore, more than one million square meters of green areas, both public and private, have been detected and managed, creating parks for families, which, otherwise, would have been built. On the sustainability front, there was an 82% increase in recycled materials compared to 2021, equal to 462 tons more, demonstrating the constant commitment of the Milanese company to promote virtuous actions, both for people and for the environment. In particular, as can be seen from the Regusto graph, the company managed to save around 200,000 kg of products destined for waste in one year, with a consequent redistribution of 400,000 meals to charities. It then recovered 480,000 cubic meters of water and 720,000 kilograms of CO2; to give an idea, the latter would need 48,000 trees to be reabsorbed. And finally, one million four hundred thousand square meters of soil were saved, corresponding to approximately 196 standard-sized soccer fields.

Graph 3.8 Calculation of environmental and social impact indices and recovered meals for Esselunga by Regusto (Source: Regusto website)



Finally, it should be noted that these ESG results for 2022 are accompanied by a turnover of approximately 8 billion euros, with a slight decrease of the same starting from 2021 of approximately 3.4%.

3.5 Comparative synthesis and analysis of Regusto Indicators

In this section, we will briefly summarize the case studies just explored with the aim of seeing if there are any theoretical trends common to the three companies in the field of sustainability and results. We will also compare the indices that each of the three companies obtained through the Regusto platform in order to compare the results of the different green policies adopted.

The sustainability strategies of Parmacotto, Esselunga and Rovagnati all focus on key aspects such as social responsibility, environmental protection and animal welfare, although they differ in specific approaches and initiatives, these companies all have in common a shared commitment to the creation of an eco-sustainable supply chain. Esselunga, in particular, adopts a Sustainability Plan based on three pillars such as people and communities, trying to promote the growth of employees from a personal and professional point of view, the Milanese company is committed to ensuring high standards of safety at work and training, also supporting more vulnerable categories. Consequently, it is committed to offering high-quality, transparent and safe products and services, favoring suppliers who adopt ethical and sustainable practices, encouraging the choice of local partners who promote typical Made in Italy materials. And finally, it invests in innovative solutions, addressing issues such as climate change, waste management, packaging and biodiversity, aiming to reduce the environmental impact of its activities by 2030, as per its objective. Furthermore, Esselunga has joined the United Nations Global Compact, committing to respect ten principles relating to human rights, work, environment and anti-corruption.

Rovagnati has developed the Corporate Social Responsibility program "Rovagnati Responsible Quality", based on three fundamental values:

- ✓ Tasty: production of gastronomic specialties according to Italian tradition.
- ✓ Healthy: use of selected ingredients and innovative technologies to guarantee high standards of food safety.
- ✓ Fair: commitment to sustainability in terms of people, animal welfare and the environment.

In particular, Rovagnati focuses on:

- ✓ People: enhancement of the professional and personal development of employees, support of local communities through philanthropic initiatives and fight against food waste.
- ✓ Animal Welfare: responsible management of production chains with attention to animal welfare and choice of local suppliers who guarantee the quality of resources.
- ✓ Nutrition: promotion of food safety through the careful selection of raw materials, continuous analysis of products and clear labeling.
- ✓ Environment: reduction of environmental impact by promoting a culture of sustainability, reduction of the use of plastic and research of innovative solutions for packaging.

Parmacotto, to address the Sustainable Development Goals (SDG 2, 3, 8, 12, 13, 15), uses a strategy called "Feelingood", which is based on three guidelines: well-being at the table, well-being of communities and well-being of the environment. The company wants to develop quality products, minimize the use of preservatives, salt and fats, promote social responsibility in its territories and achieve the goal of zero direct emissions by 2026 using this method. Consequently, the company participates in the Science Based Targets initiative and is committed to reducing direct (Scope 1) and indirect (Scope 2) emissions by 50% compared to 2018 and is consequently creating an action plan to reduce Scope 3 emissions.

However, the three case studies analyzed have several points in common, such as seen in this chapter. In particular, all three companies are committed to reducing environmental impact, the use of renewable energy, Certifications and transparency, social sustainability and welfare, reduction of food waste. Below you can find the common points of the cases studied.

1. Reduction of environmental impact:
    a. Parmacotto and Rovagnati are active in improving the sustainability of their production chains, adopting practices to reduce the use of natural resources (water, energy) and improving the efficiency of their operations. In particular, they focus on reducing CO2 emissions and adopting greener technologies.

   b. Esselunga, despite being a supermarket chain, has developed responsible purchasing policies, favoring suppliers who adopt eco-friendly and sustainable practices. Reducing the environmental impact in its stores and logistics is also a priority.
2. Use of renewable energy:
   a. Parmacotto and Rovagnati are committed to adopting renewable energy in their production activities to reduce dependence on fossil fuels and minimize their ecological impact.
   b. Esselunga has also launched several initiatives for the use of renewable energy, both in its distribution centers and in its stores.
3. Certifications and transparency:
   a. The three companies focus on transparency in their practices through certifications such as ISO 14001 (environmental management) and others related to sustainability. The certification of responsible supply chains is a common aspect to ensure that products are traceable and come from sources that respect environmental standards.
4. Social sustainability and welfare:
   a. In addition to the environmental part, there is also a commitment on the social front. Parmacotto, Rovagnati and Esselunga are involved in welfare projects for employees, with attention to health, safety and well-being, as well as in initiatives to support the community.
5. Reduction of food waste:
   a. The three companies have oriented themselves towards initiatives to reduce food waste, such as the promotion of solutions for the management of surpluses and the use of sustainable packaging, in line with circular economy policies.

In summary, these companies, although operating in different contexts (food production and large-scale distribution), have in common a strong commitment to the transition towards a more sustainable economy, with a focus on the environment, innovation, and social responsibility. Regarding the last element in common, waste reduction, the three companies have joined the Regusto platform to contribute to the

reduction of food waste, supporting the distribution of products to people in food poverty.

The adoption of Regusto by Parmacotto, Esselunga and Rovagnati highlights their commitment to sustainability and the fight against food waste, contributing to a positive impact on both a social and environmental level.

In the following table we see the comparison between the Regusto indicators of the three companies.

Table 3.1 Comparison of Regusto indicators (Source: Report sustainability Regusto 2023)

	Product Risk Wasted	Total Meals Distributed	KG CO^2 Saved	M^3 Water saved	M^2 Land saved	Sales € /000	% Product Risk Wasted /Sales	% CO^2 Saved/Sales	% Water Saved/Sales
PARMACOTTO	56.092	112.184	417.038	792.372	1.209.410	129.000	0,043%	0,323%	0,614%
ROVAGNATI	15.696	31.391	133.702	254.033	387.735	312.000	0,005%	0,043%	0,081%
ESSELUNGA	200.000	400.000	720.000	480.000	1.400.000	8.000.000	0,003%	0,009%	0,006%

To evaluate the commitment of the three companies on the issue of fighting food waste, we compared the Regusto indicators with the turnover of the three corporate groups; from a very initial analysis it emerges that in proportion the company that invests most in Goal 2 of the SDGs is Parmacotto which manages to give "new life" to 0.04% of its overall turnover in terms of non-wasted products; the Emilian company is in first place in percentage of sales also in terms of Co2 and water saved (0.3% and 0.6%).

From reading the table it also emerges that the number of meals distributed is equal to a quarter of those distributed by Esselunga but with a Parmacotto turnover equal to 1% compared to the well-known Milanese supermarket chain.

The three companies together in 2023 provided over 550,000 meals to disadvantaged people, redistributing over 300,000 kilograms of products at risk of waste.

It is therefore believed that the collaboration of large food companies with the Regusto platform is a social activity of great impact that all companies should consider. The new launch phase of the Regusto platform and its projection abroad could become strategic in contributing to the redistribution of food to the less fortunate and to the achievement of some of the most important SDGs.

Conclusions

The main objective of this study was to understand how AI could improve sustainability performance in the agri-food supply chain through the analysis of three case studies. Artificial intelligence, applied within this platform, promotes sustainability through several mechanisms.

First, intelligent systems allow for the optimization of food waste management, thanks to their ability to monitor and predict the quantities of food at risk of becoming unusable, in fact these help to make the donation process more timely and effective. By analyzing historical data on the quantities of unsold food, AI suggests when and how to redistribute the surplus, reducing the risk of waste, therefore, algorithms allow for more accurate forecasts on the trends of expiring foods, allowing companies to better adapt to donation needs. Machine learning systems also helps improve the logistics of donations, facilitating the matching between the supply of excess food and the demand from charities. This automatic matching system, supported by algorithms, reduces the time and effort required to complete donation operations, making the entire process more efficient. Likewise, AI helps optimize delivery routes, reducing fuel consumption and, consequently, greenhouse gas emissions, which is particularly relevant in an industry like the food sector, where a significant part of the ecological footprint is linked to logistics.

An additional benefit of AI in the platform is the improvement of the operational efficiency of companies participating in the donation process, in fact, the algorithms are able to suggest ways to optimize orders and inventory, reducing waste resulting from unsold surpluses and thus improving the efficiency of resource management.

This approach promotes greater transparency and awareness regarding the importance of sustainability, providing participating companies and charities with concrete information on the benefits resulting from their actions.

Finally, Regusto also contributes to raising awareness among companies and consumers on sustainability issues, therefore by analyzing users' past behavior, AI is able to propose personalized educational content, suggesting specific actions to improve

supply chain management. In summary, AI Regusto platform offers fundamental support to reduce food waste, improve efficiency in food distribution, reduce environmental impact and promote a sustainable model in the food sector.

Empirical evidence has shown an effective reduced environmental impact on many fronts such as specifically the recovery of meals and their redistribution, water saved, land not overused and carbon dioxide not emitted.

Another important aspect found by the study of the companies that joined the platform was the huge investments in research and development of new packaging for more eco-friendly products, which has become a focal point in the fight against climate change.

Subsequently, the effort of companies was directed towards the careful selection of energy sources to be used in their production processes. In this case, it was seen that the primary sources are mainly renewable or generate low environmental impact. In all three companies, there is a significant focus on trying to find energy independence, a determining factor in the coming decades to ensure a reduction in production costs but above all to reduce pollution and resources wasted in the transport of these elements.

In essence, this study demonstrates that AI is a fundamental partner to accelerate the transition process towards a more sustainable economy, integrating into existing processes and breaking down complex problems into simple steps that could be easily managed by companies. It is also highlighted that to achieve the objectives of the 2030 agenda, it would be sufficient for a good part of companies in the agri-food supply chain to start using these platforms, speeding up the ecological transition process.

Appendix

Sector/Industry	Authors	Title	Year	Ranking ABS	Methodology used	SDGs mentioned	Cluster
FOOD	Astuty E.; Sudirman I.D.; Aryanto R.	Sustainable resilience strategy: unleash the micro-businesses's potential in the digitalization and sustainability era.	2024	1	quantitative	general	blue
FOOD	Ghosh S.; Raut R.D.; Cheikhrouhou N.; Sinha S.; Ray A.	Attaining Sustainable Development Goals through embedding circular economy principles: Evidence from food processing small- and medium-sized enterprises in India.	2024	3	quantitative	general	blue
FOOD	Yu M.; Principato L.; Formentini M.; Mattia G.; Cicatiello C.; Capoccia L.; Secondi L.	Unlocking the potential of surplus food: A blockchain approach to enhance equitable distribution and address food insecurity in Italy	2024	2	quantitative	general	blue
FOOD	Bag S.; Rahman M.S.; Sharma J.; Chiarini A.; Srivastava S.K.; Gupta S.	Building digital technology and innovative lean management capabilities for enhancing operational performance: an empirical study	2024	3	quantitative	2	yellow
FOOD	Le T.T.	The association of corporate social responsibility and sustainable consumption and production patterns: The mediating role of green supply chain management	2023	2	quantitative	general	violet

FOOD	Liszbinski B.B.; Brizolla M.M.B.; Patias T.Z.	Driving factors for the involvement of agroindustries in the sustainable development goals	2023	2	quantitative	general	violet
FOOD	Vallet-Bellmunt T.; Fuertes-Fuertes I.; Flor M.L.	Reporting Sustainable Development Goal 12 in the Spanish food retail industry. An analysis based on Global Reporting Initiative performance indicators	2023	1	quantitative	12	green
FOOD	Ndung'u H.N.; Mwirigi P.M.; Gatimbu K.K.	Strategic sourcing and performance of milk processors in Kenya	2023	1	quantitative	9,12	orange
FOOD	Iazzi A.; Ligorio L.; Vrontis D.; Trio O.	Sustainable Development Goals and healthy foods: perspective from the food system	2022	1	quantitative	2;12	green
FOOD	Stauffer J.M.; Vanajakumari M.; Kumar S.; Mangapora T.	Achieving equitable food security: How can food bank mobile pantries fill this humanitarian need	2022	4	quantitative	2	blue
FOOD	Rashidi Chegini K.; Pakravan-Charvadeh M.R.; Rahimian M.; Gholamrezaie S.	Is there a linkage between household welfare and income inequality, and food security to achieve sustainable development goals?	2021	2	quantitative	2;10	turquise
FOOD	Secundo G.; Schena R.; Russo A.; Schiavone F.; Shams R.	The impact of digital technologies on the achievement of the Sustainable Development Goals: evidence from the agri-food sector	2022	2	quantitative	ALL	yellow

FOOD	Herrmann B.; Rundshagen V.	Paradigm shift to implement SDG 2 (end hunger): A humanistic management lens on the education of future leaders	2020	1	quantitative	12,16	yellow
FOOD	Gössling S.	Technology, ICT and tourism: from big data to the big picture	2020	3	quantitative	12,17	yellow
FOOD	Adefare T.; Adeola O.; Mogaji E.; Nguyen N.P.; Mogaji S.A.	Empowering women agriculture entrepreneurs: banks' role in achieving sustainable development goals	2024	1	qualitative	general	violet
FOOD	Morris J.; Guenther E.	Can the Sustainable Development Goals support nexus thinking in companies? The case of water	2024	3	qualitative	general	turquise
FOOD	Hao X.; Demir E.	Artificial intelligence in supply chain management: enablers and constraints in pre-development, deployment, and post-development stages	2024	3	qualitative	general	blue
FOOD	Venturelli A.; Caputo A.; Pizzi S.; Valenza G.	A dynamic framework for sustainable open innovation in the food industry	2022	1	qualitative	2;12	orange
FOOD	Chaurasia S.; Pati R.K.; Padhi S.S.; Jensen J.M.K.; Gavirneni N.	Achieving the United Nations Sustainable Development Goals-2030 through the nutraceutical industry: A review of managerial research and the role of operations management	2022	3	qualitative	2	yellow

FOOD	Rajic S.; Đorđević V.; Tomasevic I.; Djekic I.	The role of food systems in achieving the sustainable development goals: Environmental perspective	2022	3	qualitative	12	green
FOOD	Svensson G.; Padin C.	The role of spinoffs and tradeoffs of business-driven sustainable development in the marketplace	2021	2	qualitative	12;13	blue
FOOD	Thapa Karki S.; Bennett A.C.T.; Mishra J.L.	Reducing food waste and food insecurity in the UK: The architecture of surplus food distribution supply chain in addressing the sustainable development goals (Goal 2 and Goal 12.3) at a city level	2021	3	qualitative	12, 2	blue
FOOD	Cane M.; Parra C.	Digital platforms: mapping the territory of new technologies to fight food waste	2020	1	qualitative	12	orange
FOOD	Pohlmann C.R.; Scavarda A.J.; Alves M.B.; Korzenowski A.L.	The role of the focal company in sustainable development goals: A Brazilian food poultry supply chain case study	2020	2	qualitative	12,9	blue
FOOD	Kumar M.; Raut R.D.; Jagtap S.; Choubey V.K.	Circular economy adoption challenges in the food supply chain for sustainable development	2023	3	mixed	general	blue
TOPIC COVERED	**Authors**	**Title**	**Year**	**Ranking ABS**	**methodology used**	**SDGs mentioned**	**cluster**
A.I.	Fosso Wamba S.; Queiroz M.M.; Trinchera L.	The role of artificial intelligence-enabled dynamic capability on environmental performance: The	2024	3	quantitative	11 , 9	turquise

		mediation effect of a data-driven culture in France and the USA					
A.I.	Braganza A.; Chen W.; Canhoto A.; Sap S.	Productive employment and decent work: The impact of AI adoption on psychological contracts, job engagement and employee trust	2021	3	quantitative	3	yellow
A.I.	Kota H.B.; Singh G.; Mir M.; Smark C.; Kumar B.	Sustainable development goals and businesses	2021	1	quantitative	8	turquise
A.I.	Agarwal A.; Ojha R.	Prioritizing implications of Industry-4.0 on the sustainable development goals: A perspective from the analytic hierarchy process in manufacturing operations	2024	2	qualitative	general	orange
A.I.	Ajwani-Ramchandani R.; Figueira S.; Torres de Oliveira R.; Jha S.; Ramchandani A.; Schuricht L.	Towards a circular economy for packaging waste by using new technologies: The case of large multinationals in emerging economies	2021	2	qualitative	8, 12	orange
A.I.	Goralski M.A.; Tan T.K.	Artificial intelligence and sustainable development	2020	1	qualitative	9,12	yellow
A.I.	Tomasella B.; Wylie A.; Gill D.	The role of higher education institutions (HEIs) in educating future leaders with social impact contributing to the sustainable development goals	2023	1	mixed	0	orange

A.I.	Goel R.K.; Yadav C.S.; Vishnoi S.	Self-sustainable smart cities: Socio-spatial society using participative bottom-up and cognitive top-down approach	2021	2	mixed	ALL	violet
A.I.	Mahajan R.; Kumar S.; Lim W.M.; Sareen M.	The role of business and management in driving the sustainable development goals (SDGs): Current insights and future directions from a systematic review	2024	3	literature review	general	violet
A.I.	Reyes-Menendez A.; Clemente-Mediavilla J.; Villagra N.	Understanding STI and SDG with artificial intelligence: A review and research agenda for entrepreneurial action	2023	3	literature review	general	orenge
A.I.	Bednarski L.; Roscoe S.; Blome C.; Schleper M.C.	Geopolitical disruptions in global supply chains: a state-of-the-art literature review	2023	3	literature review	9	blue
A.I.	Satornino C.B.; Du S.; Grewal D.	Using artificial intelligence to advance sustainable development in industrial markets: A complex adaptive systems perspective	2024	3	conceptual	general	violet

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