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Sommario

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Guest editorial

Financial instruments and access to credit for the development of agricultural and agri-food enterprises # Ecological and digital transition

Lucia Briamonte[a], **Angelo Frascarelli**[b], **Biagio Pecorino**[c]

[a] Research Centre for Agricultural Policies and Bioeconomy (CREA), Italy
[b] University of Perugia, Italy
[c] University of Catania, Italy

The issue of finance and access to credit and other financial instruments has always been an important issue and is increasingly strategic for the management of the agri-food system, which, partly as a result of the pandemic crisis and the war, increasingly see reduced competitive advantages resulting from globalisation, with increasing costs, price volatility, labour shortages and, in an organisational sense, by the inefficiency of the supply chain. This implies the need for rapid repositioning and adaptation, also in the light of the innovations introduced by the ecological and digital transition, through an expert guide, concrete and effective that can play a literacy role for farms in the relationship with the world of credit, aimed at the presentation of viable business projects.

The framework of the instruments made available by the Government and the European Union under the National Recovery and Resilience Plan (PNRR) and the new Common Agricultural Policy (CAP), impose a governance and a strategy aimed at overcoming the specific weaknesses of agricultural and agri-food enterprises, to allow a full and effective use of them (Tirelli Palummeri, 2014); likewise, a "sustainable" accompaniment is necessary banks and the State in the drive towards a regeneration of the farms themselves. The world of universities and research also play an essential role as a reference point for operators and stakeholders in the sector, and it is in this direction that the Italian Society of Agri-Food Economics

(SIEA) in collaboration with the Centre for Policies and Bioeconomy of CREA and ISMEA, organized the XXX Conference of Studies SIEA held in June 2022 in Rome on the theme "Financial instruments and access to credit for the development of agricultural and agri-food enterprises".

The issue of public support and credit is even more important at this stage and it has been important to open a debate on the system of financing farms, involving representatives of the world of research, the banking system, institutions and operators in the sector, to discuss and examine, from different perspectives, the issues relating to access to credit by agricultural and agri-food businesses, the financial support instruments made available by the public authority and the opportunities opening up with the PNRR and the new CAP for the agricultural and agri-food sector.

During these two days, the theme of public support and agrarian credit was put back at the center, a fundamental theme for the development of farms that, in recent years, has not been treated in depth, even in the academic field. With this conference, therefore, it was discussed at a time when it returns to be fundamental programming and definition of investment programs and development of farms and agri-food. The issue of credit seems apparently unrelated to public policy support, but in the agricultural and agri-food sector very often public support has been the engine and lever for development. The data tells us that credit is strong where agriculture is strong and equally for public support: both public support and credit, go where there is efficiency, resources are allocated where they are used more efficiently (Briamonte & Vaccari, 2021).

Many, therefore, the critical issues and challenges to be faced, many opportunities and positive signals emerged in the debate and to be grasped, including the availability of new products, which also adapt to small and micro agricultural enterprises: Basket bond (eg. Amundi Eltif Agritaly PIR, Fondo Cbus, Crowdfunding, etc.) and new financing linked to sustainability-linked and ESG parameters (*Reg (EU) 2019/2088 of the European Parliament and of the Council of 27 November 201 on sustainability reporting in finance services* (SFDR).

The focus has therefore been on the following crucial elements:

1. the credit requirements of agricultural and agri-food enterprises and the consequent need to resolve the difficulties of access to them (Rizzuto, 2020);
2. the need to find "sustainable" solutions to ensure the full use of the numerous and substantial public financial support instruments currently available: VAT co-financing and anticipation, streamlined implementation procedures, adequate timelines;
3. the role of the State, between support granted and potential new options from the EAFRD Fund, not yet tested;

4. the role of research and knowledge to create and support a specific financial culture for agricultural and agri-food businesses.

The scenario of access to credit, therefore, is not a static scenario but is the result of social and cultural transformations, a change of paradigms related to environmental sustainability, the centrality of the agricultural and agri-food business and the rules governing banking (Pascucci, 2022). The perception of an improvement in the quality of credit and the instruments to support the development of agricultural enterprises is also evident from the articles presented in this special issue and listed below in the table, the result of a specific call that aims to highlight the different aspects that characterize a request for external financing by the entrepreneur, in a production cycle of the agricultural enterprise, often characterized by a long-term, technological uncertainty, and which is based on a heavy productive risk due to fluctuations in market prices both of the productive factors and of the products produced, of which the farmer is often a price taker.

Authors	**Title contribution**
Notes	
Giorgio Bertinetti	Changes in SMEs financing: risks and opportunities for agro-food farms
Mattia Iotti	Financial evaluation and credit access of agricultural firms
Assunta Amato, Tatiana Castellotti, Giulia Diglio, Maria Assunta D'Oronzio, Franco Gaudio, Mariacarmela Suanno	The efficiency of agricultural spending in Italy: A territorial analysis
Francesco Rampone, Fabio Lecca, Paolo Giolito, Massimo Romano	Blockchain in the agrifood sector: From storytelling to traceability fact-checking up to new economic models
Articles	
Alberto Bertossi, Stefania Troiano, Francesco Marangon	Financing for sustainable food systems: The role of the vending sector
Manal Hamam, Daniela Spina, Roberta Selvaggi, Gabriella Vindigni, Gioacchino Pappalardo, Mario D'Amico, Gaetano Chinnici	Financial sustainability in agri-food supply chains: A system approach
Giuseppe Timpanaro, Gaetano Chinnici, Roberta Selvaggi, Giulio Cascone, Vera Teresa Foti, Alessandro Scuderi	Farmer's adoption of agricultural insurance for Mediterranean crops as an innovative behavior
Lucia Briamonte, Dario Macaluso, Paolo Piatto, Mariagrazia Rubertucci	Trends and support models in public expenditure on agriculture: an italian perspective

Prof. Giorgio Bertinetti's note gives us a picture of the changes in the financing of SMEs, also following the financial and real crisis that began in 2007-2008 and that has profoundly transformed the way of acting of the financial and capital markets. In this context, Italian SMEs need to be aware of these changes in order not to be expelled from the market itself and to seize the important new opportunities emerging through new products and new intermediaries, which are also well suited to small businesses or even micro-enterprises.

Professor Mattia Iotti's note highlights how access to credit for farms is indispensable for financing their investments in both fixed and working capital in both fixed and working capital. But, as known, they have a number of difficulties, mainly because of their small size, lack of financial culture and difficulties in communicating with credit institutions. To facilitate relations between agricultural enterprises and lenders in Italy, several measures have been enacted, which over time have changed the regulatory framework of agricultural credit. The supply of credit lines is now extensive, even if the granting of credit favours larger and structured farms and credit is concentrated in a few Italian regions. Public intervention, through guarantees and the introduction of the revolving pledge, has favoured in recent years access to credit for agricultural enterprises. Furthermore, the recent increase in loans for ESG investments and the resulting regulatory framework can facilitate the financing of agricultural enterprises, enhancing their social role also in favour of smaller enterprises, cooperatives and enterprises in disadvantaged areas.

Assunta Amato, Tatiana Castellotti, Giulia Diglio, Maria Assunta D'Oronzio, Franco Gaudio and Mariacarmela Suanno's work assesses the efficiency of public agricultural expenditure in each Italian region through the analysis of regional budgets, both as a whole and in relation to specific agricultural policy measures. The degree of integration and complementarity between regional and Community funds of the second pillar of the CAP is also assessed in order to determine whether European resources are used by the regions to replace or in addition to regional interventions.

The contribution of Francesco Rampone, Fabio Lecca, Paolo Giolito and Massimo Romano aims to dispel the many misunderstandings about the blockchain and then illustrate the real opportunities that this technology offers to the "food system" and how it must be correctly implemented to be really useful, for producers, consumers and the various actors in the supply chain.

The agri-food system needs significant funding to start an ecological transition that includes healthy diets and the creation of local circuits and links, as evidenced by the article by Alberto Bertossi, Stefania Troiano and Francesco Marangon, which analyzes in this perspective the vending, whose importance, especially in Italy, is confirmed by its profits.

Historically, both the public and private sectors have invested very little in agriculture. The article of Manal Hamam, Daniela Spina, Roberta Selvaggi, Gabriella Vindigni, Gioacchino Pappalardo, Mario D'Amico and Gaetano Chinnici reviews the literature on financial sustainability and ethical investments in agriculture, the results of which indicate that the academic community has only begun to focus on these concerns in recent years. The aim of the work is to encourage more financial institutions, financial services managers, policy makers and universities to participate in sustainable development projects in the financial services sector.

Farms can experiment with different tools that can contain the impact of adverse events to protect production facilities, investments and income generated by farming. In this context, the study by Giuseppe Timpanaro, Gaetano Chinnici, Roberta Selvaggi and Giulio Cascone, Vera Teresa Foti, Alessandro Scuderi, conducted in Sicily on a sample of farms of different types to explain the decision-making process of farmers in adopting insurance offered in the preferential market.

Finally, the work of Lucia Briamonte, Dario Macaluso, Paolo Piatto and Mariagrazia Rubertucci, allows to identify, qualify and quantify the flows and patterns of expenditure that make up public support to the agricultural sector for the period 2010-2020, with the objective of providing answers to the main preliminary needs in the field of the actions carried out for the benefit of the sector (Briamonte *et al*., 2022).

From what emerges from the debate conducted and from the work collected in this Special Issue, it is necessary, *on the demand side*, to resolve the ancient difficult relationship between farms and credit institutions: the data, in fact, confirm that larger farms have easier access to credit because they are more structured, with a greater ability to present themselves on the financial market, a greater confidence with medium-sized planning toolslong-term and better ability to communicate their business strategies (Fontana, 2012); smaller enterprises, on the other hand, have a poor financial culture, necessary to finance their investments in both fixed and working capital, and difficulties in communicating with credit institutions, hence the need for literacy in the relationship with the world of credit and in the presentation of business projects. The data also confirm the concentration of access in just 4 few Italian regions (north-east): there is a segment of Italian farms that are very fast from a performance point of view, Moreover, the orientation law has produced three different types and speeds that require reading, modelling and benchmarking work.

On the supply side, the banking logic underlying the granting of credit has changed. Investors' awareness of everything that is an investment linked to the circular economy and that highlights environmental and social sustainability has increased. This provides an opportunity for farmers to

invest in their ecosystem services. There is an increase in loans for ESG investments for agricultural enterprises, which also enhances the social role of smaller enterprises, cooperatives and enterprises operating in disadvantaged areas.

There are many products currently made available by the banking system, even if, in Italy, the capital market – especially for venture capital – is still a fairly limited market. Of great interest, is the opening towards bond issues in mini-bonds of small size and quasi-equity instruments, especially for the crisis phases, such as the one we had in recent years and, for the financing of small businesses.

The banking system, on the other hand, moves from a logic based on guarantees of a patrimonial nature, to one based on financial sustainability and therefore it is necessary to overcome the information opacity that characterizes especially very small enterprises, in the absence or lack of balance sheets and lack of a credit history.

This logic makes it necessary:

- correct analysis of sectors and markets;
- the construction of business plans calibrated on the phases of the life cycle of the company and, therefore, the construction of financing instruments for the different phases of the business cycle;
- the construction of systems capable of predicting insolvency, not only on the basis of so-called hard information but also soft information;
- the construction of an "active relationship" bank-enterprise, through which to share and build the business project to be financed;
- the construction, also, of a dialogue with the institutions in the design of the measures, such as to be operative also in terms of adequacy with respect to credit assessments.

In this context, public intervention is fundamental and linked to the availability of credit and, requires actions aimed at sustainability, equity, stabilization of incomes, competitiveness of supply chains: all objectives that go in the direction of improving the creditworthiness of an enterprise.

There are many different types of measures implemented by the State in support of enterprises to facilitate access to credit, including:

- introduction of the rotary token;
- PAC, agricultural "de minimis" (Decree-Law 21/2022 in Article 19 renegotiation and restructuring of agricultural loans);
- Decree Cura Italia (March 2020);
- new Temporary Framework, Decree-Law No. 50 of 2022, the so-called Aid Decree (n.d.r. Decree-Law 21 March 2022, n. 21);
- significant resources managed by ISMEA to encourage the release of guarantees in support of financial loans;
- small and medium-sized enterprises fund;

- debt restructuring, Decree Ukraine;
- PNRR: 1 billion and 200 million supply chain contracts, 1 and a half billion for the Agrisolare park, 800 million for logistics, 880 million for irrigation infrastructure, 500 million for mechanization;
- Bank of the Earth;
- Women in the Field;
- More Enterprise Young and More Enterprise Women.

In this context, a crucial role is played by the Regions, to create the conditions for which local economic policies can help overcome the fragmentation of intervention schemes: it would be desirable to have a national scheme at territorial level, because this leads to economies of scale, new legal instruments and new technologies.

In conclusion, the signs of economic recovery and the availability of resources and financed products are indispensable factors for the growth of any productive activity and, therefore, also for agricultural enterprises. These factors allow agricultural enterprises to invest and develop according to the quality requirements that lead to the evolution of the agri-food system. The agricultural enterprise should avoid the economic-financial risk generated by the aleatory nature of its production cycle and by the contractual weakness towards the input and output market. Innovation in agricultural enterprises, also through appropriate investments, should be realised with alternative forms of self-financing. To this end, it is necessary to develop an ability of the company to adequately combine endogenous and exogenous financial sources, both as a strategy to overcome periods of liquidity shortage, but above all to support suitable investments for its growth. On the other hand, Italian credit institutions must become more aware of the specific characteristics of agricultural enterprises in order to prevent them from being excessively penalised in the granting of credit.

The articles presented at the SIEA Conference and the debate helped to determine an analysis and perspectives of intervention to model the peculiarities of the agri-food system farms and the credit needs that must be met with simple tools, tables of values, standard costs and above all exemplify what may be the economic results – improve the bank-enterprise relationship, but also the management of businesses and their financial education.

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Changes in SMEs financing: Risks and opportunities for agro-food companies

Giorgio Stefano Bertinetti[*,a]

[a] Ca' Foscari University of Venice, Italy

Abstract

The financial and real crisis started in 2007-2008 has deeply transformed the way the Italian financial and capital market act. Italian SMEs need to be aware of the transformation not to be pushed out of the market itself and to take profit of the new relevant opportunities coming out thanks to the emerging new products and new intermediaries.

The paper focuses the disappear of banks relationship lending and provides evidence about how to approach the market in the emerging "competing for capital" prevailing rule.

It also stresses the relevance of ESG topics as emerging risk factor companies must look at when asking for new finance because of the Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability related disclosures in the financial services (SFDR).

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* *Corresponding author*: Giorgio Stefano Bertinetti - Department of Management - Ca' Foscari University of Venice, Italy. E-mail: giorgio.bertinetti@unive.it.

Introduction

The international financial crisis, which arose with the default of sub-prime mortgages, led to the failure of several major international credit institutions, starting with the British Northern Rock in 2007 and then culminating with the US Lehman Brothers in 2008.

The resulting contagion effect produced heavy repercussions worldwide not only in the banking and financial sector, but also in the real world, with the huge decline in world trade and widespread recessionary conditions.

To face the situation, the central banks, on the one hand, combined maneuvers aimed at rescuing banks in difficulty together with a more careful and precautionary regulation of the banking and financial sector[1] and, on the other hand, activated expansionary measures for the economy as a whole.

The result was operational mechanisms for the allocation of credit by the banking system profoundly different from those to which a historically bank-centric system such as the Italian one continued to operate even in partial defiance of the precepts already introduced by the Basel Accords and their periodic revisions. In fact, the approach based on pure relationship lending and on the diversification of risk on a statistical basis, that is on the provision of relatively small loans to a large number of customers, definitively disappeared. Instead, an eminently market approach took place, based on the analysis of customer fundamentals in line with the key dictate of finance given by the risk-return combination in a forward looking approach.

These are rules of the game that in many cases Italian companies were not prepared for and it is essential to get familiar with in order to seize the interesting opportunities that may arise and stop to regret a past that will inevitably never return.

1. Towards the competition for capital

In a full free market context, the financial and capital market selects the investment opportunities where to allocate the mass of available savings and plays this role by maximizing the growth rate of the economy.

Under the hypothesis of perfect and complete financial markets, introduced by the financial economists of the so called modern theory of finance, the

1. Stress test activities were implemented to measure the vulnerability of institutions and greater attention was paid to quantifying the regulatory capital required for the loans activated, with increases due to the Supervisory Review and Evaluation Process (SREP), to the adoption of the IFRS 9 accounting principle and, more recently, with the Calendar Provisioning adoption, which imposes greater prudential provisions for non-performing loans.

market itself provides optimal allocation and investors just have to diversify their portfolio in order to mitigate overall portfolio's risk and achieve optimal risk-return combination (Markowitz, 1956). Within the market portfolio, asset specific risk will be diversified away to the extent possible, so the relevant measure of the risk of a security is the risk it adds to the market portfolio, and not its risk in isolation. In this context, the volatility of the asset, and its correlation with the market portfolio, are historically observed and investors just have to combine the market portfolio of risky assets with the risk-free investment in order to have the top return for the targeted level of risk (Sharpe, 1964). It follows that companies can be considered black boxes and their capital structure is irrelevant (Modigliani and Miller, 1958). Subsequent studies proved that the model works even with not perfect markets, if at least efficient (Fama, 1970), and a market is efficient if prices immediately and fully reacts to upcoming information. The empirical evidence supporting the modern theory of finance mainly focused on listed public companies, highly traded in the stock markets.

Following studies showed that: market imperfections exist due to asymmetric risk sharing between shareholders and bond holders and between minority and majority shareholders too (Jensen and Meckling, 1976); different financing instruments can provide investors better risk diversification (Allen and Gale, 1994); "*most companies do have a large shareholder, who is not well diversified*" (Zingales, 2000, p. 1628). Therefore, capital structure does matter and investors should better pay attention to investment selection rather than just diversify the portfolio.

More recently, the relevance of investment selection has further grown because of the speed of technical innovation and its disruptive impact on competitive advantage of companies. Turnarounds must be frequently played together with the revision of the business models, so a resilient management approach is needed to mitigate company risk profile.

It follows that the selection of financial investments is based on two fundamental drivers: expected return and total risk. Looking at return means quantifying the ability of the invested money to find return over time; looking at risk means estimating the probability that the actual return differs, for better or worse, from the expected one.

Hence some first important considerations for companies (Bertinetti, 2021):

a) there is competition for capital, so it is necessary to be attractive to the market in terms of return-risk combination in order to attract the financial resources available on the market itself before they are directed towards alternative uses (i.e. other companies). This need is all the more stringent the fewer the overall available resources are compared to the opportunities outstanding in the market. The number of alternative opportunities is

enormous as long as there are no geographical constraints since money is free to move very quickly from one part of the globe to the other;

b) the transfer of resources from the market to the company takes place in the face of "promises" of return, contractually regulated or not, given that the use of these resources made by the company inevitably takes time before generating return capacity, i.e. free operating cash flows (FCFOs);

c) the market needs to appreciate both the time it takes for the promised return to actually become available, i.e. adequate FCFOs begin to accrue, and the credibility of these promises;

d) the credibility of the promises depends on the risk profile of the business practiced and the goodness of the corporate strategy adopted, but also on the ability of the company to interface with the market, so as to enable potential investors to appreciate business risk and the company's ability to cope with it (Greenwald & Stiglitz, 1990). In the absence of this capacity it is easy for the market to perceive the presence of an additional risk component, defined in the Doctrine as "information risk" (Campbell & Kracaw, 1970). The attractiveness of the specific investment opportunity for a given promised remuneration would be reduced.

Basically, in this context, the ability of a company to find the financial resources necessary to carry out its business and to implement the chosen strategy depends, first of all, on its ability to identify investment opportunities that generate FCFOs big enough to let the company promise the market an adequate return, i.e. not lower than that of the alternative investment opportunities present on the market itself at the same risk. The company thus becomes an important piece of the virtuous growth circuit that the market aims to feed.

However, there is a second no less important aspect to consider: the risk appetite of existing investors on the market. In fact, not all risks are attractive to all investors, regardless of the return they can promise with adequate credibility. There are "patient" investors, who are willing to wait even medium-long times before receiving the return and there are "impatient" investors, who wish to almost immediately receive a return; the preference is not the result of purely subjective conditions, but mainly depends on treasury constraints and liquidity requirements to be respected. At the same time, there are investors who are very risk averse and others who are willing to take on considerable risks, in search of higher return; also in this case the preference does not depend on purely subjective assessments, but is mainly affected by the level of risk tolerance based on the investor's equity capital consistence and any restrictions imposed on it by the legislation. Adequate knowledge of the company ability to generate FCFOs in the future and also of the risk profile related to them therefore become essential for identifying and intercepting suitable market counterparties.

2. Transforming change into opportunity

By combining the events described in the Introduction with the logic of competing for capital outlined in Paragraph 1, the decrease in overall loans disbursed by the Italian banking system to domestic companies, which fell by 27 billion euros between November 2011 and December 2017, is explained, as well as the concentration of bank lending in larger companies belonging to the best risk classes. The losses suffered by the banking system as a result of the insolvency of debtors pushed by the economic crisis eroded the regulatory capital of the institutions which, consequently, saw a decrease in the total amount of loans disbursable to the private sector because of the constraints introduced by the Basel agreements. Furthermore, the persistence of economic uncertainties, and the correlated fear of a further deterioration in the solvency of the companies that can be financed or are already financed, were further elements of caution which led to the concentration of bank loans to customers with a lower risk profile. Taking the 2002 situation as 100 basis, the average Risk Weighted Assets of Italian banks (RWA)[2] dropped to about 65 in 2021 (see: Bank of Italy, 2022, p. 169).

On the other hand, in the face of the evident credit rationing adopted by the banking sector, new interesting products have appeared on the market and categories of operators that were previously absolutely marginal have largely developed also in Italy. The three most important cases outlined below concern respectively:

a) Private Equity;
b) Minibonds;
c) Crowdfunding.

In the last decade there has been a growing presence also in Italy of private equity players, i.e. institutional investors who typically invest in the equity capital of unlisted companies, usually through the activation of closed-end investment funds. These closed- end investment funds are often focused on specific purposes, or business sectors, or even geographical areas. Many national and international funds focus on food, beverage and agro-business[3].

In the 10 years between 2012 and 2021 the private equity deals concluded in Italy have almost tripled (+ 280%) with total assets in the hands of Italian players which increased in the same period from 3 to 17 billion euros. Also

2. Risk-weighted assets (RWA) are used to determine the minimum amount of capital a bank must hold in relation to the risk profile of its lending activities and other assets. This is done to reduce the risk of insolvency and protect depositors. The capital requirement is based on a risk assessment for each type of bank asset. The more risk a bank has, the more capital it needs on hand.

3. Italian examples of such funds are Taste of Italy 2 and ADeAgro.

the presence in Italy of foreign players has grown with investments which rose from 1.3 billion in 2012 to 11.1 billion in 2021 (Source AIFI).

It is important to note that this segment of the capital market is increasingly global with very important cross-border and even transcontinental investment flows (Table 1), which our country is able to intercept to a less than proportional extent with respect to its economic importance.

Table 1 - Private Equity: Geographical investment flows 2021

	€ bn
Non-EU investments in EU	8.9
EU investments outside EU	11.4
Cross-border investments within EU	45.7
Domestic investments in EU countries	83.2

Source: Our processing of data Invest Europe/EDC.

Developing the ability of Italian companies to enter the private equity circuit is therefore important to open a channel for the collection of "patient" resources willing to bear even significant risks, functional to the implementation of challenging development strategies and plans.

Alajmo S.p.A. and Rigoni di Asiago S.r.l. are examples of successful Private Equity investments in the Italian agro-food industry.

Thanks to Palladio Finanziaria, Alajmo S.r.l., a top quality catering company, revenues increased from 5 to 15 million euros between 2010 and 2017 not only opening new restaurants in Italy, but also expanding outside national borders. The private equity not only provided financial contribution, but also useful skills and networks contacts. At the end of the investment period the Alajmo family bought back all the shares.

Rigoni di Asiago S.r.l., a food company, got the support of Fondo Italiano di Investimento from 2011 to 2018. The private equity invested 14 million euros, of which 10 million euros of equity capital and 4 million euros of convertible bonds. The objective was the consolidation of the competitive position, the expansion and growth in national and international markets, and the expansion of the production capacity, also aimed at launching new products and innovative packaging. Rigoni di Asiago S.r.l. revenues increased from 56 to 113 million euros between 2012 and 2018, while the net profit jumped from 0,7 to 6,2 million euros. In 2018 Fondo Italiano d'Investimento sold its 35.55% participation in the company equity capital to the Swiss fund Khalis Partners, percentage subsequently increased to 42.70% by acquiring

some shares from the Rigoni family that still owns the majority. Total revenues in 2021 was 118 million euros and the net profit 5,3 million euros.

Minibonds were born in 2012 thanks to Legislative Decree 83/2012 'Development' and Legislative Decree 179/2012 'Development-bis', when:

- have been eliminated the maximum quantitative limits to the issue of bonds previously established by art. 2412 of the Civil Code;
- the deductibility of interest expense has been extended to unlisted companies, for securities listed on multilateral trading systems and subscribed by qualified investors who do not hold more than 2% of the share capital;
- the deductibility of issue costs for unlisted companies has been envisaged;
- the exemption from withholding tax on proceeds for securities listed on multilateral trading systems of EU member states or "White List" countries was ordered.

Minibonds can be subscribed only by professional investors, but a deregulation in this regard is imminent, they can have a single final maturity (so-called *bullet*) or provide for periodic repayment (so-called *amortizing*). Their average duration settled at around 5.5 years.

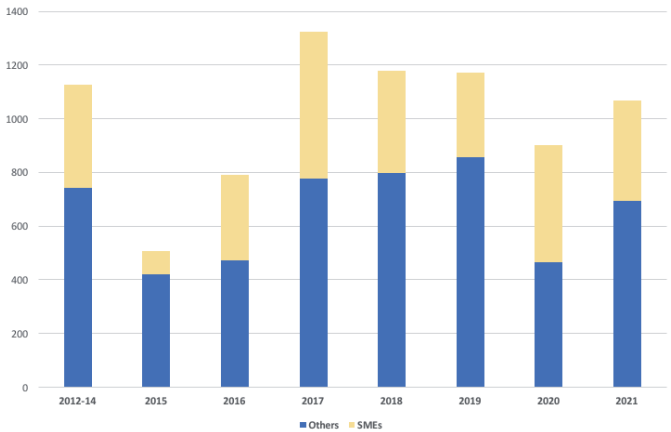
An important capital raising channel was thus opened. In ten years it saw the completion of 1250 issues with a unit amount of less than € 50 million (Table 2), for a total collection of € 8.07 billion, of which € 2.85 billions by issuers belonging to the SMEs as defined by the EU (Figure 1). It is therefore an important opportunity to gather the resources necessary to support growth paths.

Table 2 - Monthly and cumulated issuance of Minibond

Year	Yearly number of issues	Total number of issues
2013	30	30
2014	71	101
2015	86	187
2016	110	297
2017	170	467
2018	166	633
2019	207	840
2020	191	1031
2021	219	1250

Source: Our pocessing of data: Rigoni U., Veller A., *Conference: Minibond – Quali evidenze per le imprese del Nord-Est a cinque anni dalla loro introduzione*, Auditorium M9, 8 maggio 2019 and Osservatorio Entrepreneurship Finance & Innovation, 8° *Report italiano sui Minibond*, Politecnico di Milano, different editions.

Fig. 1 - Capital raised and dimension of the issuers



Source: Our pocessing of data Osservatorio Entrepreneurship Finance & Innovation, 8° Report italiano *sui Minibond*, Politecnico di Milano, marzo 2022.

Many well known agro-food companies issued Minibond from the very beginning of their inception, like: F.lli De Cecco di Filippo S.p.A. (pasta producer); Nosio S.p.A. (winery); Rigoni di Asiago (food producer); Menz& Gasser (food producer); Pasta Zara (pasta producer)[4].

The aggregative forms called Basket Bond deserve particular mention within the Minibond category. These are coordinated issuance by several companies, even small ones, which are merged through a securitization process so as to reach a critical mass able to make them attractive for large institutional investors. Baskets are often focused on specific purposes, or business sectors, or even geographical areas. There is a frequent possibility of enjoying ancillary guarantees provided by third parties, such as SACE or the promoter Region, which contributes not only to the ease of placing the bonds, but also to reduce the interest rate to be promised to the market. Table 3 shows the list and the main characteristics of the Basket Bonds issued up to the end of 2021; the presence of an operation dedicated to the wine sector should be noted.

Thanks to the Garanzia Campania Bond program 10 agro-food SMEs have issued Minibond for a total of 20 million (15% of the total issued by the program). This way an important funding channel has opened up for local smaller companies with promising growth plans, like: La Contadine S.r.l.; Salerno Pesce S.r.l.; Davia S.p.A.; Qualitiagro S.r.l.; Bioitalia S.r.l.; Trade Coffee S.r.l.; Viniexport S.r.l.

4. Some company made more than one issue. For example, Rigoni di Asiago S.r.l. issued 7million euros Minibond in 2015 and 25 million euros Minibond in 2016.

Table 3 - Basket Bond issued in Italy until 2021

Issue	Focus	Main investors	Nuber of issuers	Total amuont (€ mln)
Viveracqua Hydrobond (4 issues)	Integrated water system in the Veneto region	BEI, CDO, Kommunalcredit Austria	13	623.5
Garanzia Campania Bond	SMEs in Campania region	CDP, MCC	65	144.1
Basket Bond Puglia	SMEs in Puglia region	CDP, MCC, Unicredit	21	87.2
Export Basket Bond Programme	Companies belonging to the Elite programme	CDP, MCC	11	623.5
ELITE Basket Bond	Companies belonging to the Elite programme	BEI, CDP	10	122
ELITE - Intesa Sanpaolo Basket Bond	SMEs	Intesa Sanpaolo	18	135
ELITE Basket Bond Lombadia	Companies from Lombardia region belonging to the Elite programme	CDP, Finlombarda	4	37
Industry Basket Bond	Wine industry	CDP, Unicredit	3	21
Industry Basket Bond	Culture industry	CDP, Unicredit	3	21
Basket Bond Sella	Growth company	CDP, MCC, Banca Sella	2	24.5
Basket Bond Euronext Growth	Growth company listed on the Euronext	CDP, MCC, Banca Finnat	3	13

Source: Our translation form Osservatorio Entrepreneurship Finance & Innovation, 8° Report italiano *sui Minibond*, Politecnico di Milano, marzo 2022, p. 27.

Crowdfunding is a form of bottom-up microfinance that aims to mobilize a large number of people, each of whom contributes a modest sum to the realization of a project with either non-profit or for-profit purposes. Originally born to support "*donation*" and "*reward*" initiatives, in more recent years it has seen the growth mainly of "*lending*" and, above all, "*equity financing*" transactions, becoming today one of the most widespread and effective forms of financing new business projects of relatively small amount, as a maximum amount of € 5 million per transaction has been established by law.

The promotion of projects and the collection of financial resources takes place through digital platforms and has allowed to complete in Italy a number of *equity* financing campaigns always higher than 100 in each of the last 5 years, with a peak of 170 in 2021, for an overall capital collected which in 2021 exceeded 90 million euros (Table 4).

Table 4 - Equity crowdfunding: capital raised and number of companies financed

Year	Number of companies	Capital raised (€/000)
2014	4	902
2015	7	1.714
2016	18	4.190
2017	47	10.597
2018	103	26.644
2019	119	45.406
2020	122	47.118
2021	170	90.352

Source: Our processing of data Crowdfundingbuzz.it.

Crowdfunding market is therefore still small in size and works in support of small projects. In most cases, the funded projects concern start-ups, but the share of resources raised by existing SMEs has grown in the last two years, reaching approximately 45% of the total.

The collection of *lending* crowdfunding is substantial, which for the part dedicated to the non-real estate business has led to total loans that have exceeded 270 million in the last year.

It should be noted that the three evolutionary trends outlined above also tend to overlap each other with projects that use several contemporary collection methods. Furthermore, since last year some platforms have also been authorized to sell Minibonds, a sign of a regulatory evolution taking place worldwide destined to bring growing masses of savers closer to investments in unlisted assets. The establishment of the European Long Term Investment Funds (ELTIF), launched by EU Regulation 760 and implemented in Italy with the Legislative Decree 233/2017, goes precisely in this direction.

The last of the three Minibond issued by Davia S.p.A., a tomato processing company located in Gragnano (Naples), was recently offered in the Fundera crowdfunding platform and in a few days the 1 million euros issue has sold out.

3. What challenges for the agro-food sector?

The solutions illustrated in Paragraph 2, which by the way do not exhaust the range of innovations that are affecting corporate finance in Italy, testify to the existence of important alternatives for the procurement of financial resources, such as to be able to make up for bank credit rationing.

It is therefore important that the agro-food sector manages to enter the "new" finance circuit, learning to seize the opportunities that derive from it. This requires, in the first instance, to think about the two fundamental parameters already mentioned: return and risk.

Return is undoubtedly a problematic factor for the industry. The analysis of the economic performance of 61.762 Italian SMEs ranks the agro-food sector as one of only two critical sectors in 2017 in terms of return on capital (Banca IFIS Impresa, 2019). Entering the market finance circuit therefore requires an effort aimed at recovering efficiency if not even strategic innovation.

An important contribution in this direction can come from a deep effort of digital transformation (Finotto and Mauracher, 2020) and orientation towards eco-sustainability (Mauracher, Procidano and Valentini, 2019).

Digitization paves the way for smart agriculture and the internet of farming, which are a prelude to the optimization of production processes and the best possible satisfaction of customer needs, even thanks to more precise paths of traceability and certification of origin.

Environmental sustainability is now the object of consumer attention and the propensity to buy organic products with a low environmental impact is growing and will grow significantly in the near future, especially in the groups of consumers with the highest level of education and income (CSRI, 2022) and, therefore, with greater spending power and less attentive to the price factor. Mass organic, circular economy, hydroponic crops, vertical farming are important ideas for starting the process of strategic innovation and recovering the ability to pay a return on capital. There are many studies and empirical tests that testify, among other things:

- high customer loyalty for companies more sensitive to sustainability issues (De Luca, Lucido, 2022);
- the availability of growing numbers of end users willing to pay higher prices for "sustainable" products (EY, 2121 and EY, 2022).

The issue of sustainability is equally relevant with regard to the risk parameter. If final consumers become more sensitive to the issue, the entire supply chain is called upon to oversee this aspect, since distributors will ask producers to certify the quality of the products and these, in turn, will impose the same attention on their subcontractors, whatever their position along the value chain and also their size. Failure to adapt promptly exposes to the risk of being placed on the edge of the market and, over time, even being expelled. Also in this case there are many studies and empirical tests that testify, among other things:

- the higher market value of ESG compliant companies (Atz *et al.*, 2021);
- the lower volatility of the share prices of companies with the best ESG rating even in contexts of disrupted economy (Giakoumelou *et al.*, 2022).

Further strengthening the opportunity to promptly turn towards eco-sustainable strategies is the fact that both the regulatory-political-regulatory system and the financial and capital market are pushing in the same direction.

With regard to the legislative-political-regulatory system, think of the attention that in Italy is dedicated by the National Recovery and Resilience Plan (NRRP)[5] to the modernization of the agro-food sector, for which 4.9 billion euros have been allocated[6], beyond the many legal provisions already adopted and the shared commitment at international level on environmental protection.

However, the opportunity to find financial resources by launching a strategic innovation project aimed at sustainability is not only linked to the economic moment that led to the aforementioned public aid, but is on the way to become structurally functional for access to the entire capital and financial market. In fact, on 10 March 2021 the Sustainable Finance Disclosure Regulation (SFDR) provided for by EU Regulation 2017/2088 and EU Regulation 2020/852 came into force throughout Europe, through which it is clear the intention to make the capital and financial market a decisive push factor of the entrepreneurial system towards the ecological transition.

Indeed, the SFDR does not simply aim to ensure that all players in the world of finance provide clear, transparent and standardized information to investors in relation to ESG products and policies, but rather looks to the creation of a common European framework for the promotion of sustainable investments. The financial industry, starting with the banking system, is thus required to:

- integrate sustainability risks into decision-making processes for the selection of loans and capital investments;
- consider the ESG factors among the relevant parameters for determining the variable component of personnel remuneration;
- report, in the annual report, on the activity actually carried out in support of sustainable initiatives.

In this direction, the SFDR expressly envisages the development of:

- financial instruments that "promote environmental or social characteristics, or a combination of these characteristics" (art. 8);

5. The National Recovery and Resilience Plan is part of the Next Generation EU (NGEU) program that the European Union negotiated in response to the pandemic crisis. The Italian NRRP envisages investments and a consistent reform package for the total amount of € 222.1 billion. The Plan is developed around three strategic axes shared at a European level: digitalisation and innovation, ecological transition, and social inclusion. The intervention that not only aims at repairing the economic and social damage caused by the pandemic crisis, but also at addressing the structural weaknesses of the Italian economy, andleading the country along a path of ecological and environmental transition.

6. The amount also includes the resources of the Complementary Fund allocated by the Government and those of the React-Eu programme of the European Commission.

- financial products that target sustainable investments (with or without a benchmark) or those that aim to reduce carbon emissions. (art. 9).

Several concrete experiences have already been gained in this regard with the appearance of sustainability-linked bonds and loans, which also allow significant savings in the cost of debt upon achieving the agreed sustainability goals by the financed company. It is easy to foresee that further stimuli in this direction will come in the near future, when the ESG parameters will determine a reduction coefficient of the above mentioned Risk Weighted Assets (RWA).

The specific characteristics of the agro-food sector, highly exposed to ESG risks, mean that the outlined evolutionary trend of the capital and financial market is on the way to open up significant opportunities for easier access to capital and loans. On the contrary, failing to promptly give attention to and report on the sustainability of company activities, processes and projects exposes to the risk of being placed on the sidelines also of the capital and financial market and, over time, even being expelled from the market itself.

Conclusions

A new era has begun in Italy for corporate finance, closely aligned with the evolution of corporate finance models and attitudes and therefore aimed at supporting value creation strategies. That is the way to promise and provide adequate return over time to the risks which inevitably exposes those who contribute, with either debt or equity, the financial resources needed to implement the strategy itself.

Entering the circuit of such a market with satisfaction requires some preliminary cautions which can be summarized as follows:

- develop a clear orientation towards the future, making projects developed in a medium-long term strategic plan;
- quantify the financial resources needed to implement the plan;
- carry out scenario analysis in order to perceive the risk profile of the plan, a risk which, consequently, the players of the capital and financial market are asked to share.

These are the essential starting points to be able to select products and categories of intermediaries consistent with the proposed return-risk profile and, equally important, to prepare an adequate and credible presentation of the profile itself.

In this regard, it is also useful to highlight the way the company plans to act to mitigate the risk profile and make it economically and financially sustainable, which means minimizing the probabilities of insolvency and default consequent to the various scenarios that can be foreseen. In this

context, ESG risks are assuming great importance and cannot be forgotten, both in their material dimension and in that linked to the ecological transition.

Even unforeseeable scenarios, linked to any extraordinary events, should be considered by preparing recovery plans that can be activated if necessary.

A good and complete presentation should testify to full knowledge and mastery of business risks and, with them, provide clear evidence of the managerial skills on which the company can rely. This is the qualitative aspect necessary to avoid the emergence of a perceived "information risk" that often stems from a lack of dialogue and understanding between the company and the capital and financial market.

Overall, by adopting these measures and effectively communicating with the market, companies can navigate the Italian corporate finance landscape and seize opportunities for growth and value creation.

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Giorgio Stefano Bertinetti
Department of Management, Ca' Foscari University of Venice, Italy
Cannaregio 873 - 30121 Venezia, Italy
E-mail: giorgio.bertinetti@unive.it
Full Professor of Corporate Finance since 2006 and former Dean of the Department of Management (2009-2014). Member of the Ca' Foscari Agri-Food Management & Innovation Lab. Current research interests include valuation, enterprise risk management and private finance, both equity and debt.

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Financial evaluation and credit access of agricultural firms

Mattia Iotti[*,a]

[a] University of Parma, Italy

Abstract

Agricultural firms are characterized by significant investments, both in fixed capital and in working capital. To finance investments, in addition to equity capital, access to credit becomes essential. Concerning this topic, various researches have shown that agricultural firms have difficulty accessing credit, due to reduced average size of farms, often poor financial culture and difficulty in communicating with lenders. To facilitate relations between agricultural firms and lenders in Italy, various regulatory provisions, over time, have changed the regulatory framework of agricultural credit. The offer of credit lines is today wide, even if granting of credit favors larger and more structured firms, and credit is concentrated in a few Italian regions. Public intervention through guarantees, and the introduction of a non-possessory revolving pledge, have favored access to credit for agricultural firms in recent years. The business cases analyzed have highlighted how investments of firms in fixed capital for the purchase of plants, and working capital, for aging of productions, amplify financial needs of firms and make it necessary to evaluate financial sustainability of operations. Recent increase in loans for ESG investments, and consequent regulatory framework, can facilitate financing of agricultural firms, enhancing their social role also in favor of smaller firms, cooperatives and firms in disadvantaged areas.

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* *Corresponding author*: Mattia Iotti - Department of Veterinary Sciences - University of Parma, Italy. E-mail: mattia.iotti@unipr.it.

Introduction

Agricultural firms provide for production of food and have significant effects on the environment, on consumer health and on the protection of rural territories (De Luca *et al*., 2015; Lanfranchi *et al*., 2015). Economic and social roles, and significant impact for circular economy given by farms have been considered and protected by a series of legislative interventions at national and international level, including forms of aid (Zarbà *et al*., 2021).

Agricultural firms have specific financing needs (Lehenchuk *et al*., 2012); these firms require investments in agricultural fund and in production cycle which often make them capital-intensive firms and consequently expand their financing needs (European Court of Auditors, 2015; Omobitan *et al*., 2022).

Food protected with collective EU marks PDO (protected designation of origin) and PGI (typical geographical identification) and TSG (traditional specialty guaranteed) play an important role from an economic, social and environmental point of view. In Italy (ISMEA, 2022), production value of PDO, PGI and TSG products is 19.1 billion euros (21% of agri-food production), of which 10.7 billion is for exports, equal to 20% of total Italian agri-food exports; there are 845 PDO, PGI and TSGs (3,069 in Europe), of which 526 are wines; the sector employs 198,842 operators, organized in 291 consortia for the protection of typical products. Italy is, therefore, the first European country for the number of PDO, PGI and TSG products, followed by France (698 productions) and Spain (349 productions). The analysis of the access to credit of companies producing collective brand products assumes a particular interest, in fact; 1) production specification (Disciplinare di Produzione, in Italian) define mandatory production rules that influence the duration of production cycles and the consequent financing needs (Iotti & Bonazzi, 2014); 2) there are many small and medium enterprises (SMEs) operating in the sector which, as various researches have highlighted, have difficulties in accessing credit compared to large enterprises (Agyapong, 2021; García-Sánchez, 2021; Rossi *et al*., 2015); 3) operate in local contexts where the banking system has a lower presence and breadth of supply of financing instruments (Hasan *et al*., 2017; Meslier *et al*., 2020). PDO, PGI and TSG productions also play an important role in creation of tourist circuits linked to food and local territories (Cavicchi & Santini, 2019; Mauracher *et al*., 2016; Selvaggi *et al*., 2023) and in promotion and export of Made in Italy food in the international market (Belletti *et al*., 2009; Scuderi *et al*., 2019). Furthermore, investments in collective mark products may have characteristics of adherence to the guidelines on environmental, social, and governance (ESG) investments which represent one of the major areas of expansion of financial markets and attraction of investments in international markets.

Agricultural firms have production characteristics that influence investments in fixed capital (Kussainov *et al*., 2016; Lososová *et al*., 2020; Sidorenko *et al*., 2021) and investment in working capital (Fernández-López *et al*., 2020; Zabolotnyy & Sipiläinen, 2020); these investments have two consequences: 1) the need to adequately define the sources' adequate financial coverage; 2) the need to verify financial sustainability of these investments through adequate valuation ratios. The starting point of the reflection on financing needs of agricultural firms is the legal framework that defines agricultural entrepreneur contained in Art. 2135 of the Italian Civil Code (Alessi, 2019); this definition provides for a legal bond between the fund, the activities connected to it, and the activity of agricultural entrepreneur (Goldoni, 2019). It is, therefore, necessary (Ruozi, 1999; Capitanio & Adinolfi, 2009; Lucifero, 2009; Ray, 2019) to investigate the relationship between farm and bank in order to: 1) evaluate how to reduce information asymmetry; 2) analyze demand and supply of credit to agricultural firm; 3) analyze characteristics of agricultural credit compared to credit in other sectors.

Given the statutory definition, it emerges that agricultural firms must acquire the necessary capital to carry out the activity, manifesting medium and long-term financing needs for the acquisition of land, buildings and agricultural production equipment (Koloszko-Chomentowska & Sieczko, 2016; Clapp, 2019; Szymańska *et al*., 2021). Furthermore, agricultural activity takes place with processing cycles often lasting one year, with cycles of aging of the products also lasting several years, including various typical PDO and PGI products (Masarova *et al*., 2017). These production specificities of agricultural firms lead to an expansion of working capital cycle, with consequent short and medium-term financing needs that financial intermediaries have progressively satisfied over time with loans intended for the agricultural sector (Dono *et al*., 2021). Loans for agricultural firms are, in some cases, declinations of loans already present in the credit market for commercial firms but, in other cases, they are loans specifically designed to meet the needs of agricultural firms and capture the needs of financing that these firms manifest; these loans are placed in the context of agricultural credit (Trequattrini, 1994).

The aim of this work is to: 1) carry out an analysis of financing needs of agricultural firms; 2) frame the national rules relating to financing of agricultural firms; 3) present some technical forms of financing foreseen by credit system for agricultural sector; 4) explain the methods of assessing creditworthiness of agricultural firms; 5) expose some significant cases of access to credit and economic/financial performance of agricultural firms; 6) propose some concluding considerations and pose some open questions for future research and reflections.

1. Background

Agricultural firms are characterized by a high capital intensity, i.e. the ratio between invested capital and turnover generated by firms is high, and it is very common to find cases in which capital invested in agricultural activity is often higher than the volume of sales generated by a firm in one year (Borsotto *et al*., 2011; Chinnici *et al*., 2013; Commissione delle Comunità Europee, 1976; Morrison, 1997, 1999); capital intensity generates financing needs, as the invested capital must be financed with sources of financing, which include equity capital contributed by the entrepreneur, and debts of an operational nature. Capital intensity is not found in all agricultural firms, but is influenced by type of activity carried out, by strategic choices of the entrepreneur and by the stage of the life cycle in which firm is located (Ebben & Johnson, 2011; Kropp & Katchova, 2011; Ma *et al*., 2020; Peón & Martínez-Filgueira, 2020; Stillitano *et al*., 2018; Wang *et al*., 2020).

Financing needs of agricultural firms

Financing needs of firms is shared in financing needs for financial coverage of investments in fixed assets and in working capital. Distinction between fixed capital and working capital takes into consideration speed of conversion of these investments into cash flows available (cash conversion) cycle for payment of firm debts, repayment of loans taken out and remuneration of equity capital (Renborg, 1970; Jose *et al*., 1996; Ehrhardt & Wachowicz, 2007; Sardaro *et al*., 2017; Wang, 2019; Lin & Lin, 2021). For this reason, traditional corporate accounting tools are not adequate, because they provide classification of the values of corporate activity according to the principle of destination of investments, without indicating speed of conversion into cash flow. It is therefore necessary for agricultural firms to adopt principles of financial reclassification of values (Kaplan & Zingales, 1997; Morales-Díaz *et al*., 2018; Khanal & Omobitan, 2020; Welc, 2022), taking into consideration the moment of financial manifestation of values through cash flows and, consequently, being able to estimate the ability to meet financial commitments.

Investments in fixed capital are able to generate income and financial flows only in medium and long term, due to the contribution they make to production activity (Su *et al*., 2015; Grashuis & Dary, 2017; Kussainov *et al*., 2021; Omobitan & Khanal, 2022). This contribution is deferred over time and the investment activity anticipates the generation of income and financial flows; since these are benefits deferred over time, these flows are subject to business risks. Investments in fixed capital generate financial coverage

needs with sources of capital that are available in medium/long term (St-Pierre *et al*., 2000; Escalante & Barry, 2003; Denis & Sibilko, 2010; Kropp & Katchova, 2011; Langemeier, 2018). It is necessary that loans are repaid in times compatible with the capacity of investments to generate adequate financial flows to support debt service, according to the deadlines which are regulated in loan agreements between firms and lenders; debt contracted must be repaid increased by cost of debt, given by the interest on debt and any ancillary charges such as commissions and expenses for credit relationship management services (Van Binsbergen *et al*., 2010). Financing of investment needs of agricultural firms is also significant with regard to working capital cycle (Bieniasz & Gołaś, 2011; Gołaś, 2013; Wassie, 2021). The extension of the duration of agricultural transformation has effects on financial needs of agricultural firms, whether it is necessary to finance only the duration of annual cultivation cycle, or whether the need for financing also concerns aging phase, in which case the duration of the cycle can also have a multi-year duration. There may be the case in which agricultural firms, in order to reduce financing needs, decide to modify production mix, so as to combine productions characterized by a longer working capital cycle with other productions, that require less capital and, consequently, less funding (Maksim *et al*., 2014; Sánchez *et al*., 2018; Box *et al*., 2018).

Recent research highlights some structural shortcomings that have a negative effect on ability of agricultural firms to access credit in Italy (European Commission, 2020): 1) Average firm size of the sector, characterized by small farms, causes difficulties in value creation chain, diseconomies in production costs and lower valorization in terms of production prices; 2) Presence of a large number of family-run firms with little or no formal accounting, which hinders ability of farmers to access bank credit due to information opacity in accessing credit; 3) Absence of accounting statements increases information asymmetry; this concerns smaller firms which are perceived by banking system as more risky due to a lack of information base; 4) Low level of financial literacy among segments of agricultural community, especially small farms.

National rules relating to financing of agricultural firms

In Article 2135 of the Civil Code, the definition of agricultural entrepreneur refers to the connection of a firm's activity with land and with the processing, conservation and marketing activity that an agricultural entrepreneur carries out on the goods produced in the firm. Agricultural entrepreneurs, unlike commercial entrepreneurs, are not subject to insolvency proceedings of a bankruptcy nature and, therefore, the qualification of a

firm as agricultural has immediate civil law effects. Distinction between agricultural entrepreneur and commercial entrepreneur concerns the nature of activity carried out and does not concern size of firm activity or legal form assumed by the agricultural activity.

Exemption of agricultural entrepreneur from bankruptcy proceedings has historical reasons, already considered in the bankruptcy law of 1942 (R.D. 16 March, 1942, n. 267); the reason for this exemption is to be disclosed (Mozzarelli, 2014): 1) in the importance of agricultural activity within national production structure and in the importance of food production for the purpose of food self-sufficiency; 2) in the particular subjection to additional risks with respect to commercial firms to which an agricultural entrepreneur is by nature subjected. On this subject, there is a need to consider the relevant debate on agricultural credit defined as a set of financial means in favor of economic subjects operating in the primary sector; the origin of agricultural credit is traced back to Law 1760/1928, from which the specialization of credit in agriculture originates.

The discipline of agricultural credit (ISMEA, 2007) has an important discipline with Articles 43 and 44 of Legislative Decree 385/1993, Consolidated Banking Act (Testo Unico Bancario, TUB, in Italian). In particular, Art. 43 of TUB, regulates agricultural credit as a credit whose object is granting of loans for agricultural activities and related activities; fishing credit has as its object granting of loans for fishing and aquaculture activities, as well as those connected or collateral to them; TUB indicates among connected or collateral activities: farmhouse, manipulation, conservation, transformation, marketing and valorization of products. Art. 43 of TUB indicates that agricultural and fishing credit operations can be carried out through the use of an agricultural bill and fishing bill, which are equivalent to all effects of Law as to an ordinary bill. Art. 43 of TUB, therefore, regulates the use of an agricultural bill as a form of financing that can be used in the context of agricultural credit. Agricultural bills are issued by the person requesting a loan, and are executive titles that allow agricultural firm to obtain short-term credit lines granted by credit institutions, precisely through the discount of agricultural bills; agricultural bills are distinguished from ordinary bills because they present a facilitated fiscal discipline, established by Art. 3 of Law 185/1992. ISMEA (Istituto di Servizi per il Mercato Agricolo Alimentare, in Italian) and can provide a subsidiary guarantee for agricultural credit operations pursuant to Article 43 of TUB.

2. Materials and methods

Technical forms of financing envisaged by credit system for agricultural sector

Financing institutions tend to expand the offer of loans to agricultural firms, so as to operate more profitably in the credit market, acquiring new customers by: a) anticipating financing needs of firms; b) building long-term relationships with client firms; c) diversifying offers of credit instruments with respect to competing financial intermediaries; d) more precisely estimate risk associated with loans, so as to be able to offer credit at better pricing conditions than competitors and, consequently, make its offer of credit lines more attractive than competitors due to lower pricing (Lufburrow *et al*., 1984). Pursuing an increase in the circulation of information useful for correct assessment of creditworthiness makes it possible to reduce information asymmetry as much as possible; 1) favoring access to credit for the most efficient firms; 2) reducing cost of credit as a result of reduction in pricing of transactions determined by the increase in competition on the side of credit offer and by better assessment of risk of transactions; 3) reducing delinquencies on credit lines due to improved creditworthiness assessment; 4) reducing demand for collateral.

Financial intermediaries offer agricultural firms diversified instruments to meet their needs; this diversification takes place: 1) according to duration of credit line; 2) according to the method of calculating interest rate; 3) depending on the presence of ancillary guarantees. Distinction based on duration of various credit lines is useful since duration of credit line is aimed at aligning duration of investments in terms of maturity.

Instruments for financing investment needs in fixed capital are satisfied by taking out loans to be repaid in the medium/long term. In particular, they characterize the offer of loans for agricultural firms (Romania, 1986; Masindi, 1998; Fontana, 2012; Tirelli-Palummeri, 2016; Iotti, 2022): 1) Endowment loans, without mortgage guarantee, with legal lien; these loans are aimed at meeting financing needs for the endowment of durable investments, such as the purchase of live-stock and dead-stock. Among investments that have financial coverage with the endowment loans there are also intangible investments, such as so-called milk quota for production of protected cheeses. These loans may have a collateral guarantee provided by credit consortia and/or public entities, such as ISMEA; 2) Long-term loan with mortgage guarantee; these are loans, governed by Art. 1813 of the Civil Code, in the long term to be allocated to investments for the purchase of agricultural land which makes up the fund, for construction or restructuring of agricultural structures. In general, the loan is assisted by a real mortgage guarantee on the real estate that is the object of investment. This form of

financing provides for the payment of repayment installments, consisting of principal and interest, according to an amortization plan which is defined by contract at the time the loan is stipulated. At the beginning of the term of loan contract, a period in which only interest is paid may be envisaged; this period is defined as pre-amortization and has the purpose of allowing the farm to put the assets object of the investment into operation. A particular case, among long-term transactions, is a land loan governed by Art. 38 of TUB. This loan is disbursed by banks and is characterized by a first degree mortgage guarantee on properties; the land loan satisfies financing needs of agricultural firms, as banks often use this form of financing to provide agricultural firms with capital necessary for investments in the agricultural fund, both for the component that concerns land and for the component that concerns the buildings. Art. 44 of the Italian TUB is the regulation envisaged for land credit operations and applies to agricultural credit and fishing credit secured by a mortgage on real estate; this regulation allows land credit regulation to be extended to agricultural credit operations guaranteed by mortgages on buildings. 3) Agricultural leasing; this is the traditional leasing contract, used, however, in the context of agricultural activity and to meet financing needs of agricultural firms. Leasing contract may relate to immovable property, such as land or buildings, or movable property, such as plant, equipment and machinery. In the case of real estate leasing, the durations will generally be longer, and similar to the durations envisaged for mortgage loan contracts; this extension of duration has the purpose of guaranteeing financial sustainability of the leasing transaction. Property leasing will have a shorter duration; this duration is generally aligned with useful life of the assets acquired through leasing. For financing of working capital cycle, financial intermediaries offer firms various instruments for financing these investment needs (Carluccio *et al*., 2020; Iotti, 2022). In particular, the following characterize this type of financing for agricultural firms: 1) Operating financing, without a mortgage guarantee for financing of advance expenses; these are agricultural loans guaranteed by legal privilege. These loans are aimed at meeting financing needs given by the advance of costs of agricultural activity. In agricultural activity, cost advances are typical during land cultivation or livestock breeding phase. These loans allow agricultural firms to have the capital necessary for cultivation of land during the agricultural year, waiting for the receipts deriving from sale of firm productions. Capital is made available to the farm in a single deadline, or within the limits of a pre-established ceiling and calculated on the basis of an estimate of the costs of agricultural year shared between firm and lending bank. These loans have a short-term duration. 2) Operational financing for financing corporate inventory stock cycle; these are loans, without a mortgage guarantee, assisted by a legal privilege. The management loans

allow the rotation of firm warehouse and the replacement of goods in the warehouse ready for sale with others to be sent for aging. Capital is instead disbursed to the farm in a single solution. The traditional conditions for quantifying cost of loan transaction apply to these loans, since the transaction can be regulated at both a fixed interest rate and at a variable interest rate. These loans can be assisted by real guarantees, such as pledge on agricultural productions covered by the loan, even with a non-possessory pledge, governed by Art. 1 the Legislative Decree 59/2016 and subsequent amendments. With Law Decree n. 59/2016, modified and converted into law with Law n. 199/2016, the regulation of non-possessory pledge was introduced; the Law provided for the issuance of the Decree of the Ministry of Economy and Finance of 25 May, 2021, n. 114, which established the computerized register for the registration of non-possessing movable pledges with the Revenue Agency (D'Addezio, 2021). Regulation of pledge goes beyond the traditional norm of pledge provided for by Article 2784 and following of the Civil Code, according to which pledge of movable property is constituted with the delivery to the creditor of the thing or of the document which gives exclusive availability of the thing. The most relevant regulatory precedent of non-possessory pledge is the provision relating to pledge on controlled denomination of origin hams, pursuant to Law no. 4011. Commercial practice of lenders thus began to use a pledge rotation clause for financing of agricultural firms (Balbusso, 2022); this clause provides that the object of pledge can be replaced over time without this involving novation of the guarantee (Catalano, 2022). The rule on the revolving pledge provides that entrepreneurs registered in the register of firms can establish a non-possessory revolving pledge to guarantee credits granted to them or to third parties, present or future, if determined or determinable and with the provision of the maximum guaranteed amount, inherent to the exercise of the firm. The loss of the element of exhaustion and consequent usability of asset covered by the guarantee are expressly foreseen because the Law establishes that the financed firm is authorized to transform or sell or in any case to dispose of the assets encumbered by pledge. Non-possessory pledge differs from pledge envisaged by Article 2784 and following of the Civil Code due to the absence of dispossession and possibility of continuing to dispose of the asset covered by the guarantee. Art. 78, paragraph 2-duodecies of the decree-law of 17 March, 2020, n. 18, coordinated with the conversion law of 24 April, 2020, n. 27 (D.L. Cura Italia, in Italian) and extended the possibility of constituting the revolving pledge, originally limited to Parma PDO Ham (law 24 July, 1985, n. 401) and aged cheeses (decree of the Ministry of Agricultural, Food and Forestry Policies (MiPAAF) of 26 July, 2016, n. 188), to PDO (Protected Designation of Origin) and PGI (Protected Geographical Indication) products. In particular, it is envisaged that the

aforesaid products can be subjected to a revolving pledge by identifying them through documents or annotations in special registers (ABI, 2021).

In addition to loans that have been discussed, which are specific for satisfying financing needs of agricultural firms, short-term loans can be used, also in the primary sector, which can be used by commercial firms to satisfy financing needs of working capital, such as current account credit lines and forms of advances on commercial credits; these technical forms of financing are similar to what applies to firms in sectors other than agriculture and therefore do not require specific treatment here.

Financial assessments and access to credit are also being investigated in commercial firms (Beck & Demirguc-Kunt, 2006; Sufi, 2009; Fawzi *et al*., 2015; Purnima *et al*., 2021), but the objective of the work is to carry out an in-depth analysis of the instruments that are typical of financing of agricultural activity or which, while not typical of financing of agricultural activity, present, when applied to agricultural activity, elements of typicality or interest that can be usefully exposed for understanding the coverage of financing needs of these firms (Yaron, 1992; Beck & Demirguc-Kunt, 2005; Dodson, 2014; Turvey, 2017; Pokharel *et al*., 2019).

Methods of assessing creditworthiness of agricultural firms

Agricultural firms have characteristics linked to the need for investment in agricultural fund and in production cycle, which often make them capital-intensive firms and, consequently, expand their financing needs (Ferrarini, 1998; Viviani, 2008; Paoloni *et al*., 2022). In fact, invested capital, which is represented in the assets section of balance sheet of annual account statements, has financial coverage with the liabilities of balance sheet, i.e. the set of sources of capital financing. these funding sources are divided into: 1) equity capital; 2) debt capital. An increase in invested assets therefore determines an equal need for an increase in sources of financing, divided into equity capital, financial and non-financial debt capital (Titman & Wessels, 1998). Capital contributed by the entrepreneur, i.e. equity capital or risk capital, is remunerated by firm profits according to risk-return relationship which provides for an increase in the remuneration expected by investors as the risk increases (Fama & French, 1993; Vassalou & Xing, 2004; Smith, 2019).

The case of cooperative firms is interesting as they can overcome difficulties of accessing capital market through widespread participation in capital and voting mechanisms that favor managerial turnover and consequently investor confidence (Cook, 1995; Rinaldi & Cavicchi, 2016; Briggeman *et al*., 2016; Royer, 2017; Pokharel *et al*., 2019; Grashuis & Ye, 2019; Grashuis, 2020; Royer & McKee, 2021).

In financial assessment, it is necessary to calculate that return on invested capital is greater than cost of debt financing (Guida & Sabato, 2017; Ozdagli, 2012), also in agricultural and agri-food firms (Fenyves *et al*., 2020; Santosa, 2020; Tripathy & Shaik, 2019). Cost of financial debt occurs through payment of interest to lenders increased by commissions on credit lines granted and costs for services. Cost of financial debt has characteristics that distinguish it from equity capital: 1) remuneration of lenders is independent of firm results, except for forms of mezzanine financing; in some cases, a change in the interest rate is envisaged as firm performance varies, with application of specific covenants (Rajan & Winton, 1995); 2) cost of financial debt is, therefore, explicit, and is part of firm costs, and has a non-residual nature, thus differentiating itself from remuneration of equity capital, which has a residual nature (Sabasi *et al*., 2021). It should be noted that the characteristics of cost of financial debt, which has a contractual obligation of remuneration regardless of obtaining of profits, are determined by postponement of shareholders' loans and by contributions of equity capital with respect to financial debt and other firm debts in case of default of the firm. Furthermore, financial debt can be backed by various forms of collateral which have the characteristic of attributing to lenders a privilege, given by pledge or mortgage governed by the Civil Code, or a signature guarantee such as the surety, always governed by the Civil Code (Gan, 2007; Jiménez *et al*., 2006). Collateral allows lenders to be able to claim other assets, distinct from firm assets, or to acquire specific privileges on portions of firm assets, as in the case of a mortgage. Thanks to collateral, lenders reduce expectations of loss in the event of default of lender (Ono & Uesugi, 2015) and as a result they may envisage reductions in pricing of financing transactions (Beyhaghi, 2022). In the relationship between firm and bank, in general, and between farm and bank in particular, the reciprocal transfer of information becomes essential, in order to reduce information asymmetries (Gabbi *et al*., 2020). The relationship between bank and firm is based on a long-term relationship in which both parties to the relationship allow the other party to know quantitative and qualitative elements of the relationship. The bank must make transaction costs and, in general, contractual terms of loan transactions available to the firm, in terms of duration, risks for financed firm and type of service offered. Firms must make available to the bank, for the purpose of assessing creditworthiness, quantitative and qualitative data that allow the bank to assess riskiness of the loan requested by the firm and, consequently, to define whether this loan can be granted, and under what conditions of price, duration, and with any request for collateral guarantees (Matias Gama & Dias Duarte, 2015).

Verification of financial balance of firms is necessary in assessing creditworthiness (Basel Committee on Banking Supervision, 2021; Kim &

Katchova, 2020); reference is made to: 1) structural balance between funding sources, i.e. the breakdown of structure of funding sources between equity capital and debts and, as regards debts, between financial debts and non-financial debts (Rajan & Zingales, 1995); 2) coverage of cost of debt and remuneration of equity capital; particularly (Iotti & Bonazzi, 2015; Dothan, 2016), ratios are applied which evaluate the coverage of cost of debt, called interest coverage ratios (ICR); 3) alignment between incoming and outgoing cash flows to verify financial sustainability of debt service; in particular, ratios called debt service coverage ratios are applied (DSCR). Difficulties in accessing credit for agricultural firms are given by: 1) presence of financial constraints to which firms are unable to submit, such as adequacy of financial structure, adequacy of ICRs and DSCRs, compliance with loan covenants, adequacy of collateral requested by lenders (Rampini & Viswanathan, 2013); 2) shortcomings of financial system and/or capital market, in relation to both equity capital market, in terms of market breadth and depth, and debt capital market, in terms of the supply of loans to firms, by technical form, adequacy to the needs of various sectors, territorial coverage of loan offer (Paravisini, 2008; Meslier *et al*., 2022).

In financial assessment necessary for assessing creditworthiness, annual account statements are the main document that allows calculation of financial ratios, i.e. ratios between annual account statement values that have the purpose of expressing firm's performance and, in a synthetic way, estimating probability of default (Soliman, 2008; Lian *et al*., 2016). In agricultural firms, annual account statements are an essential source for assessing creditworthiness and can be usefully integrated with sector and market performance data (Dono *et al*., 2022). First studies in this research area are due to Beaver (Beaver, 1966), Altman (Altman, 1968) and Ohlson (Ohlson, 1980) who applied multivariate discriminant analysis (MDA). MDA was then also applied for the insolvency forecast for agricultural firms (Johnson & Haegn, 1973). More recent applications have made it necessary to estimate the probability of default using Logit and Probit models (Miller & LaDue, 1989; Lyubov & Pederson, 2003; Hofner *et al*., 2017) while the most recent developments in the prediction of insolvency are given by applications of neural network analysis (NNA), back propagation neural network (BPNN) and other estimation techniques that do not need to assume a given default probability distribution and are usefully applicable in big data analysis (Bennouna & Tkiouat, 2018; Horak *et al*., 2020; Abid *et al*., 2022).

For the purpose of assessing creditworthiness, a trend analysis of the regularity of relationship between firm and credit system is also necessary, which is kept under observation through the Central Credit Register (Centrale Rischi, in Italian) held at the Bank of Italy; this information database collects information that financial intermediaries send to the Bank of Italy on a

monthly basis, noting the amount of credit facilities, the related uses, any overdrafts and the presence of prejudicial events in relationship between firm and credit system. Attention to the early emergence of crisis symptoms has application in the early warning principle, i.e. an early emergence of the so-called warning signals, with application of the so-called forward looking approach (Mansi *et al*., 2011; Ashraf *et al*., 2019; Klopotan *et al*., 2018). This approach is due to the organic reform of the business crisis, which has found application in national legislation with Legislative Decree no. 14/2019 "Corporate crisis and insolvency code". The early emergence of symptoms of difficulty, in relationship between bank and firm, favors access to credit for firms that can reasonably repay loans received; in this way, it is possible to reduce the insolvencies in banking sector and favor efficient functioning of credit market (Fama, 1970; Fama, 1998; Wurgler, 2000). To achieve this goal in Italy, ISMEA and Moody's KMV have created a specific rating model for Italian agricultural and agri-food firms; the objective of the model is to evaluate creditworthiness of firms in various sectors of Italian agriculture; the rating has the objective of facilitating transmission of information between agricultural firms and lending credit institutions, with the aim of facilitating access to credit for agricultural firms. ISMEA has developed three models: 1) for corporations, with annual account statement; 2) for small and medium-sized farms, with no annual account statement obligation; 3) for agricultural cooperatives.

3. Results

To apply what was developed in the methodological part, two cases concerning financial evaluation and access to credit in the agri-food system are carried out. These cases relate to productions with Protected Designation of Origin (PDO) for products that require aging times envisaged by the relative production regulations (Disciplinare di produzione, in Italian). These cases may be of interest as (Paoloni *et al*., 2020): 1) firms in the sectors concerned, which relate to the major sectors of PDO production in Italy, have financing needs in fixed assets to finance the fixed production structures necessary for the processing of the product and its storage; 2) firms of the sectors have financing needs in working capital cycle to finance aging of product and this financing need is determined by production regulations which define the minimum duration of aging of production; 3) working capital cycle of these productions can be financed by credit institutions through revolving pledge.

Case 1), Firms operating in aging of Parmigiano Reggiano PDO cheese (Parmigiano Reggiano DOP, denominazione di origine protetta, in italian)

The first case presented relates to balance sheet data of a sample of 8 firms operating in Parmigiano Reggiano PDO cheese aging sector. Overall, annual account statements for 5 years were used, for a total of 40 observations. Parmigiano Reggiano PDO cheese is regulated by production regulations in force since 30/03/2018 and by Regulation (EU) n. 794/2011 of the Commission of 8 August 2011 approving the amendments to the specification of Parmigiano Reggiano PDO.

Parmigiano Reggiano PDO cheese, in 2021, was the first PDO product for annual turnover (ISMEA, 2022), with 1.607 billion euros of production value (ISMEA, 2022) and the annual production was 155, 277 tons in 2021. The value at consumption stage is 2,756 billion euros. Parmigiano Reggiano PDO is produced in the provinces of Parma, Reggio Emilia, Modena, Mantova, south of Po river, and Bologna, left of Reno river. Parmigiano Reggiano PDO has great importance in the economy of these provinces; it characterizes the livestock activity which is directed to production of milk for subsequent transformation into cheese. In the production district, a large part of agricultural activity and related activities are aimed at bovine milk production chain; also technical services, production of machinery and equipment, aging and trade of production, and also financial services operate in the Parmigiano Reggiano PDO supply chain to provide services.

Parmigiano Reggiano PDO is a hard, cooked and slow-aging cheese, produced with raw, partially skimmed milk from cows whose diet consists mainly of fodder from the area of origin. Milk cannot be subjected to heat treatments and use of additives is not permitted. Production regulations provide that after the salting phase, aging must last for at least 12 months. This provision of production regulations determines that firms of the sector must equip themselves with necessary storage structures for production in the course of aging or, alternatively, outsource this phase of production to third parties, with the payment of relative price of the service. Furthermore, the need to finance the cheese aging cycle for at least 12 months is determined, resulting in a need for investment, and the consequent need for financial coverage, for a period of at least 12 months. Firms in the sector therefore need significant capital to finance production cycle and it is therefore necessary that: 1) prepare adequate forecasts on the needs of prospective financial flows in order to facilitate dialogue with lenders in requesting credit lines necessary for financing of production; 2) determine financial structure in order to verify capital solidity; 3) calculate adequate ICRs and DSCRs ratios to verify the ability to cover cost of debt and debt service. This information is necessary not only for firm management, in order to

plan financial needs of firms, but also in relations with lenders, to guarantee information symmetry between firm and bank in the request for loans.

Table 1 - Case 1. Firms operating in aging of Parmigiano Reggiano PDO cheese - Balance sheet analysis (40 observations)

Balance sheet	**Mean**	**Mean**	**Median**	**Median**
	(€)	**(% TA)**	**(€)**	**(% TA)**
Fixed asset	3,628,603	17.54%	1,987,762	9.26%
Inventories (product stock)	16,570,645	54.16%	5,739,496	64.34%
Commercial credits	5,189,072	12.52%	1,137,932	11.15%
Non-commercial credits	1,340,025	13.73%	1,272,647	4.68%
Working capital investment	23,099,743	80.42%	8,424,271	88.77%
Liquidity	578,545	1.99%	286,743	1.93%
Accruals and deferrals investment	12,386	0.06%	8,456	0.05%
Total asset (TA)	27,319,277	100.00%	11,556,104	100.00%
Equity capital (E)	5,030,898	15.27%	1,041,815	11.89%
Financial debts within 12 months	11,982,494	32.20%	3,375,831	32.16%
Financial debts over 12 months	3,054,370	14.13%	1,643,388	5.96%
Financial debts total amount (FD)	15,036,865	46.32%	5,468,245	45.69%
Non-financial debts within 12 months	6,954,168	37.29%	4,054,082	29.38%
Non-financial debts over 12 months	–	0.00%	–	0.00%
Working capital source	6,954,168	37.29%	4,054,082	29.38%
Provisions for risks and charges	113,466	0.52%	28,865	0.02%
Severance indemnity fund (TFR)	107,028	0.36%	33,746	0.30%
Accruals and deferrals source	76,852	0.24%	3,500	0.02%
Third-party capital	22,288,379	84.73%	9,589,438	88.11%
Total source (TS)	27,319,277	100.00%	11,556,104	100.00%

Source: Balance sheet processed data.

Firms in dairy processing sector analyzed are characterized by high investments in the cycle of fixed investments and working capital. The absorption of capital in the active cycle determines a high use of financial resources, with an average high recourse to third-party capital. Balance sheet data (Table 1) shows that: 1) Firms in the sample need investments in working capital equal to 88.77% of investments (median figure); only 29.38% of investments are financed with net working capital as a source of financing. Consequently, active net working capital absorbs 59.39% of investments and

this quota of investments needs coverage with equity capital or with financial debts. 2) Equity capital finances 11.89% of investments. 3) Financial debts are the first source of capital, and finance 45.69% of investments.

Table 2 - Case 1. Firms operating in aging of Parmigiano Reggiano PDO cheese – Income statement (40 observations)

Income statement	**Mean**	**Mean**	**Median**	**Median**
	(€)	**(% TA)**	**(€)**	**(% TA)**
Sales	22,761,947	100.00%	8,199,589	100.00%
Production values	25,549,794	112.25%	7,711,741	94.05%
Raw Materials	–20,755,468	–91.18%	–5,977,941	–72.91%
Services	–1,894,604	–8.32%	–1,015,464	–12.38%
Rent	–90,965	–0.40%	–57,223	–0.70%
Cost of labor	–507,319	–2.23%	–183,683	–2.24%
Other Costs	–667,586	–2.93%	–152,127	–1.86%
EBITDA	1,633,852	7.18%	325,304	3.97%
Depreciation	–	0.00%	–	0.00%
Amortizations	–383,019	–1.68%	–225,630	–2.75%
EBIT	1,250,832	5.50%	99,674	1.22%
Interest charge (IC)	–421,796	–1.85%	–143,924	–1.76%
Extraordinary revenues and costs	97,101	0.43%	–611	–0.01%
EBT	926,138	4.07%	–44,861	–0.55%
Corporate tax	–407,594	–1.79%	–42,984	–0.52%
NET PROFIT (NP)	518,544	2.28%	–87,845	–1.07%

Source: Income statements processed data.

Income statement data (Table 2) shows that: 1) Firms in the sample have modest profit margins (EBITDA and EBIT), 3.97% and 1.22% of sales, respectively, 2) cost per interest charge (1.76% of sales) is higher than intermediate profit margins. 3) Net profit for mean is positive, while it is negative for median. Given the high investment, return on capital must be compared with cost of debt; some firms have a cost of debt higher than return on capital. Particular attention must be paid to the issue of payment of cost and service of debt. Traditional approach to assessing financial sustainability, based on an income approach, is not sufficient in firms in the sector and it is necessary to deepen the analytical tool with financial indicators. On the basis

of these data it therefore emerges that: a) firms in the sector need significant investments in equity capital which determine the relative financial coverage; b) equity capital has a modest weight among the sources of financing, while the main source of financing is bank debt capital; c) it is therefore important to assess that return on invested capital covers cost of bank debt, with an analysis of ROA and ROD ratios and calculation of ICRs, and that the sustainability of debt service is verified, with calculation of DSCRs.

Table 3 - Case 1. Firms operating in aging of Parmigiano Reggiano PDO cheese – financial ratios (40 observations)

Financial ratios	**Mean**	**Median**	**> 0**	**0 <**
	(€)	**(%)**	**(N.)**	**(N.)**
ROA (EBIT : TA)	4.58%	0.86%	31	9
ROD (IC : FC)	2.81%	2.63%	40	0
ROE (NP : E)	10.31%	–8.43%	16	24
			> 1	1 <
ICR1 (EBITDA : IC)	387.36%	226.02%	38	2
ICR2 (EBIT : IC)	296.55%	69.25%	17	23
ICR3 (OCF : IC)	290.52%	102.33%	21	19
ICR4 (UFCF : IC)	85.12%	67.23%	16	24
DSCR (UFCF : Debt service (DS))	60.11%	58.30%	12	28

Source: Annual account statement processed data.

Analysis of financial ratios (Table 3) shows that: 1) ROA is modest (4.58% average value and 0.86% median value); this ratio quantifies return on invested capital. ROD, which expresses cost of debt, has an average value of 2.81% and a median value of 2.63%. Median value of ROD is greater than ROA, this expresses that in the sample analyzed cost of debt (ROD) is greater than return on capital (ROA) with the consequent negative effect of financial leverage; an increase in the level of financial debt, with cost of debt and return on capital being equal, determines a reduction in profitability for shareholders (ROE) because capital is invested at a rate of return (ROA) lower than cost of debt (ROD). 2) The ability to pay cost of debt, calculated with ICRs, is verified if calculated with ICR1 and ICR3, while it is not verified if calculated with ICR2 and ICR4; these last two ICRs are more prudent than ICR1 and ICR3 because they consider more restrictive income and financial margins (EBIT and UFCF respectively). In 23 cases out of

40 (ICR2) and in 24 cases out of 40 (ICR4) the payment of debt course is not sustainable, because ICR value is less than 1. 3) The ability to pay debt service, calculated with DSCR, is not verified. In 28 out of 40 cases, the payment of debt service is not sustainable, because DSCR value is less than 1.

Case shows following conclusions: 1) In Parmigiano Reggiano PDO sector, the sample of firms analyzed shows that production specification causes an expansion of working capital cycle, which requires financial coverage. 2) Firms in the sample have financial debts as their main source of financing; for this reason, relationship with credit system and assessment of the sustainability of cost of debt and debt service, conducted using ICRs and DSCRs ratios, calculated on annual account statements and, if possible, using strategic planning tools become essential forecasts, such as the business plan; these tools comply with recent modifications made to Civil code in terms of adequate organizational arrangements and early warning, also envisaged in Crisis Code (Codice della Crisi, in Italian) which recently modified the provisions of Bankruptcy Law. 3) In the sample of firms, profit margins are modest and do not ensure payment of cost of debt, both in relation to financial leverage (ROA/ROD), and in relation to ICRs for median values of ICR2 and ICR4; debt service is also not guaranteed, as shown by calculation of DSCRs (median values).

Analysis of firms in the sample therefore shows that, in Parmigiano Reggiano PDO sector, firms need financing from credit institutions but, also, they must equip themselves with adequate business planning tools that allow them to verify their ability to meet cost of debt. This is particularly necessary in recent scenario which foresees, in addition to significant increases in production costs and changes in consumers' spending power, as regards relations between firms and banks: a) availability of new legislative measures (revolving pledge) which they have been implemented by credit system by making available to firms an expanded range of credit lines to support working capital cycle guaranteed by collateral in form of a revolving pledge; b) increase in interest rates, determined by the increase in reference rates on the market (EURIBOR and IRS) and increase in average spreads applied by the banks.

Case 2), Firms that operate in aging of Parma Ham PDO (Prosciutto di Parma DOP, denominazione di origine protetta, in italian)

The second case presented relates to balance sheet data of a sample of 88 firms operating in the meat processing sector and associated with Parma Ham PDO Consortium over a 5-year series for a total of 440 observations.

It should be noted that firms in the sample, despite being members of the PDO Parma Ham Consortium, produce other delicatessen products, such as hams not marked with the PDO designation and other delicatessen products which, in general, are characterized by less aging and lower production costs; in addition, some firms in the sample also have commercial activities, acquiring and reselling already aged products, or carrying out processing activities on behalf of third parties (Bonazzi *et al*., 2011a, 2011b).

The denomination of origin "Prosciutto di Parma" was initially legally protected at a national level since 1970 through Law of 4 July 1970 n. 506 and was then recognized as a PDO pursuant to EEC Regulation n. 2081/92 with EC Regulation n. 1107, dated 12.06.96. Production is regulated by production specification published in the Official Journal of the European Union n. C429 with "Publication of an application for approval of a non-minor modification of production specification pursuant to article 50, paragraph 2, letter a), of regulation (EU) no. 1151/2012 of the European Parliament and of the Council on the quality schemes of agricultural and food products 2022/C 429/08".

The estimated total consumer turnover of Parma Ham PDO was 2.171 billion euros for 2021 (ISMEA, 2022) at consumer stage level, of which 294 were intended for export; Parma PDO Ham is the third Italian production with PDO, PGI and TSG mark, at firm stage level, with 650 million euro of production value, after Parmigiano Reggiano PDO (1.607 billion euro of production value) and Grana Padano PDO (1.460 billion euro of production value) at consumer stage level. In 2021, there were 8,487,474 pork legs sent for PDO Parma Ham production, of which 7,705,379 were approved for PDO production (CSQA, 2022). In fact, 140 companies operate in the sector (Consorzio del Prosciutto di Parma, 2022), employing around 3,000 people, and process fresh pork legs which come from around 3,600 pig farms and 78 slaughterhouses. Parma PDO Ham is the first meat-based collective mark product in terms of turnover, companies and number of employees. It is a production of wide interest because it concentrates large capital and labor in a relatively small processing area. In addition to PDO Parma ham, companies in the sector can freely produce other processed meat products; therefore, transformation of pork meat characterizes the production area of Parma PDO Ham.

Production specification defines a minimum aging period of Parma Ham PDO of 14 months. This rule of the specification has two consequences: 1) aging determines an absorption of working capital necessary for the purchase of fresh pork leg and subsequent processing; 2) aging also leads to an increase in fixed capital investments, because companies in the sector require physical aging structures which therefore require fixed capital investments of buildings, plant and machinery.

Firms in the sector are characterized by investments in fixed capital (property, plant and machinery) and in working capital, including firm warehouse of the pork leg in the course of aging, which determine the need to raise risk or debt capital to cover to financial needs, also determined by the warehouse cycle, for times ranging from 14 to 24/36 months. It is therefore necessary to quantify return on equity capital and the management cash flows to assess whether these are sufficient to guarantee the payment of debt service contracted for loans. In firms in the sector, this assessment is relevant due to the time lag that exists between economic cycle and financial cycle.

Table 4 - Case 2. Firms operating in aging of Parma Ham PDO - Balance sheet analysis (440 observations)

Balance sheet	**Mean**	**Mean**	**Median**	**Median**
	(€)	**(% TA)**	**(€)**	**(% TA)**
Fixed asset	7,201,023	48.72%	6,001,609	47.99%
Inventories (product stock)	6,025,022	40.76%	4,998,037	39.97%
Commercial credits	890,023	6.02%	1,136,009	9.08%
Non-commercial credits	540,031	3.65%	500,982	4.01%
Working capital investment	7,455,076	50.44%	6,635,028	53.06%
Liquidity	109,036	0.74%	285,009	2.28%
Accruals and deferrals investment	15,009	0.10%	8,660	0.07%
Total asset (TA)	14,780,144	100.00%	12,505,311	100.00%
Equity capital (E)	3,023,830	20.46%	2,503,938	20.02%
Financial debts within 12 months	5,004,609	33.86%	4,401,039	35.19%
Financial debts over 12 months	2,119,082	14.34%	1,702,928	13.62%
Financial debts total amount (FD)	7,123,691	48.20%	6,103,967	48.81%
Non-financial debts within 12 months	4,005,988	27.10%	3,430,871	27.44%
Non-financial debts over 12 months	120,569	0.82%	85,002	0.68%
Working capital source	4,126,557	27.92%	3,515,873	28.12%
Provisions for risks and charges	98,022	0.66%	50,117	0.40%
Severance indemnity fund (TFR)	329,054	2.23%	201,331	1.61%
Accruals and deferrals source	78,990	0.53%	23,891	0.19%
Third-party capital	11,756,314	79.54%	9,895,179	79.13%
Total source (TS)	14,780,144	100.00%	12,505,311	100.00%

Source: Balance sheet processed data.

The analysis of balance sheet data (Table 4) shows that the first investment item of firms is fixed assets, i.e. investments in buildings, plant and machinery, equipment, and any long-term intangible and financial investments. Investments in fixed assets are permanently invested capital and absorb approximately 47.99% of investments. The second most important investment item is the warehouse, i.e. the complex of pork legs in aging, in the various stages of this, from the initial processing to the aged product ready for sale. The duration of ham processing cycle is more than 14 months due to production specification, but often active aging, for commercial reasons, up to 24/36 months, and this leads to an increase in stock. Investment in inventory stock becomes an almost immobilized capital, in any case with conversion into cash over 12 months; the incidence of inventory on total investments is approximately 40%. The incidence of receivables from customers is significant, and equal to approximately 9% of invested assets; firms in the sector show a significant absorption of money also due to the deferred collection granted to customers. these delays occur in relation to large-scale retail trade (GDO).

Equity capital is not the first source of financing among the sources of financing for firms; equity contributed by shareholders of firms, or reinvested, finances about 20% of investments. Financial debts are the first source of financing (48.81% of invested capital), with a prevalence of loans aging within 12 months (35.19% of invested capital) compared to loans aging beyond 12 months (13.62%). This situation is also due to the particularity of the sector which sees the need for investments in working capital; a part of this capital (including the thigh in the initial stages of processing) is transformed into cash in a period of more than 14 months (for example, consider an average aging period of 24 months to which to add a further 3 average months for extension granted to customers). Data of firms in the sample, in face of high investments in fixed assets, indicating that the choice of alignment of loan maturities is not adequate. In fact, the sum of equity capital and financial payables due beyond 12 months is not able to give financial coverage to fixed assets.

Data show that it is therefore necessary to finance part of the inventories with medium-term credit lines, to align the repayment terms of these loans with the potential collections deriving from the transformation, sale and collection cycle. Trust Consortia (Consorzi Fidi, in Italian), by means of an accessory guarantee signed in favor of credit institutions that finance firm, can facilitate access to credit for firms in the sector on medium-term financing lines (between 18 and 60 months); these lines of financing can also be assisted by non-possessory revolving pledge. In the case of firms in the sample, this financial coverage is not sufficient and this determines non-sustainability of financial cycle, as shown by data in Tables 5 and 6.

Table 5 - Case 2. Firms operating in aging of Parma Ham PDO – Income statements (440 observations)

Income statement	Mean (€)	Mean (% TA)	Median (€)	Median (% TA)
Sales	12,002,891	100.00%	7,550,013	100.00%
Production values	11,603,037	96.67%	7,600,318	100.67%
Raw Materials	–6,404,382	–53.36%	–3,980,937	–52.73%
Services	–1,802,362	–15.02%	–1,098,397	–14.55%
Rent	–155,637	–1.30%	–95,933	–1.27%
Cost of labor	–1,115,607	–9.29%	–856,361	–11.34%
Other Costs	–454,659	–3.79%	–315,308	–4.18%
EBITDA	1,670,390	13.92%	1,253,382	16.60%
Depreciation	–125,303	–1.04%	–99,837	–1.32%
Amortizations	–508,933	–4.24%	–377,609	–5.00%
EBIT	1,036,154	8.63%	775,936	10.28%
Interest charge (IC)	–448,005	–3.73%	–495,334	–6.56%
Extraordinary revenues and costs	11,020	0.09%	51,351	0.68%
EBT	599,169	4.99%	331,953	4.40%
Corporate tax	–299,018	–2.49%	–189,560	–2.51%
NET PROFIT (NP)	300,151	2.50%	142,393	1.89%

Source: Income statement processed data.

Data in income statement (Table 5) show that: 1) economic data of firms in the sample show an average production value of 12.0 million euros per firm; this value is higher than median value (7.5 million euros) and expresses that small and medium-sized firms prevail; Some large firms are included in the sample which are also active in other delicatessen sectors and not in production of Prosciutto di Parma PDO. The highest cost incidence is that of raw materials, which absorb about 53% of the value of production. Fresh pork leg to be processed and ancillary processing materials are the main cost items of firms in the sector. Analysis shows that costs for services also have a high incidence, equal to approximately 15% of the value of production; among the services, the industrial ones have an impact in particular, on energy costs for the functioning of the cold rooms, the costs for external processes, such as the boning services carried out by specialized artisan firms, in addition to commercial costs, for mediations on sales and on purchase, in particular in the case of sale of production through agents. On

the other hand, compared to other sectors, the weight of cost of labor is quite low, accounting for about 10% of the value of production; firms in the sector therefore confirm the characterization of being activities with a high capital intensity, and modest recourse to labor. 2) Firms in the sample have profit margins (EBITDA and EBIT) higher than Parmigiano Reggiano PDO cheese sector and respectively 16.60% and 10.28% of sales; cost per interest charge (6.56% of sales) is lower than intermediate profit margins. Data show erosion of profitability due to financial management, which becomes a critical area of management. This erosion is negatively affected by modest profit margins, on the one hand, and high corporate debt, on the other, which also influences cost of average debt. Financial valuation is useful for accessing credit, as shown by financial ratios in Table 6. The results of analysis suggest that it is necessary to apply a financial valuation approach, based on valuation of cash flows. Financial approach makes it possible to provide information that is not highlighted by traditional analysis, based only on income statement.

Table 6 - Case 2. Firms operating in aging of Parma Ham PDO – financial ratios (440 observations)

Financial ratios	**Mean**	**Median**	**> 0**	**0 <**
	(€)	**(%)**	**(N.)**	**(N.)**
ROA (EBIT : TA)	7.01%	6.20%	401	39
ROD (IC : FC)	6.29%	8.11%	440	0
ROE (NP : E)	9.93%	5.69%	389	51
			> 1	1 <
ICR1 (EBITDA : IC)	372.85%	253.04%	395	45
ICR2 (EBIT : IC)	231.28%	156.65%	286	154
ICR3 (OCF : IC)	155.61%	90.11%	201	239
ICR4 (UFCF : IC)	80.72%	60.51%	184	256
DSCR (UFCF : Debt service (DS))	59.29%	55.12%	152	288

Source: Annual account statement processed data.

Analysis of financial ratios (Table 6) shows that: 1) Analysis of financial ratios of firms in the sample shows a return on equity capital expressed by return on equity (ROE) of 9.93% on an annual basis and 5.69% as median value. Operating return on capital, expressed by return on asset (ROA) expresses a yield result equal to 7.01% as an average value and 6.20% as a median value. cost of debt (ROD) is slightly lower than ROA in average terms, but higher in median terms (8.11%). It should be noted that firms in the

sample pay a higher cost of bank debt than the operating return on capital; this determines that the increase in bank debt, with the relative cost, entails, other conditions being equal, a reduction in firm profitability. 2) Ability to pay cost of debt, calculated with ICRs, is verified if calculated with ICR1 and ICR2, while it is not verified if calculated with ICR3 and ICR4; the latter two ICRs consider financial margins (OCF and UFCF respectively) for verifying the payment of cost of debt, contrary to ICR1 and ICR2 which use income margins for this verification. In 239 cases out of 440 (ICR3) and in 256 cases out of 440 (ICR4) the payment of debt course is not sustainable, because the value of ICR is less than 1. 3) Ability to pay debt service, calculated with DSCR, it is not verified. In 288 cases out of 440, the payment of debt service is not sustainable, because DSCR value is less than 1.

The analysis of the sample data allows the following conclusions: 1) Also in Parma Ham PDO sector, the sample of firms analyzed shows that production specification causes an expansion of working capital cycle, which requires financial coverage; production structures in terms of fixed capital represent the first capital investment. This characteristic of the invested assets of firms, characterized by rigidity in disinvestment and medium-long term conversion of invested assets, determines the need for sources of coverage for stable investments, in terms of equity capital or medium-long term debt. In firms in the sample, these medium-long term funding sources are not sufficient to finance fixed capital investments, highlighting an unbalanced financial structure and the consequent non-sustainability of relationship with lenders. 2) Firms in the sample have financial debts as their main source of financing; this source of funding is greater than equity capital. Assessment of financial sustainability conducted through calculation of ICRs and DSCRs highlights non-financial sustainability. In firms in the sample, data of the ratios express that financial sustainability is not verified if the ratios calculated with a financial approach are considered (ICR3, ICR4, DSCR) which allow to correctly express the misalignment between economic cycle and financial cycle which is evidently present in the sample firms. Calculating financial sustainability by applying the traditional ICR1 and ICR2 would determine overestimation of the ability of firms to pay cost of debt.

Conclusions and policy implications

The history of agricultural credit, and the analysis of related market, allows us to state that credit institutions have expanded their loan offer to agricultural and agri-food firms (Licciardo, 2020; Ricolli, 2021). This has also been possible thanks to recent regulatory changes that have affected rules on granting of credit, including non-possessory revolving pledge,

and have favored creation of credit instruments useful for supporting the development of firms in the sector. However, many critical issues remain concerning (Bank of Italy, 2022; ISMEA, 2021): 1) information asymmetry in relationship between firm and bank, in particular the transmission of adequate data for assessment of creditworthiness; this is particularly evident for smaller firms which have greater difficulties in accessing capital market; 2) a non-homogeneous territorial distribution at national level of the offer of agricultural credit, which is concentrated in some regions, in particular in Central and Northern Italy, where firms have larger average sizes; 3) need for credit instruments capable of supporting growth of smaller agricultural firms (micro-firms, first-generation firms and/or new firms mainly composed of young people, firms located in disadvantaged territories).

Credit market trends must consider that various quasi-equity instruments are present today in financial markets, at national and international level, and can be used to support the growth of firms, even smaller ones (European Commission, 2022). In particular, expansion of the capital market will be able to favor dimensional development of agricultural firms, birth of new firms even in disadvantaged areas, and access of larger firms to financial markets. In particular, these are: 1) access to stock market, also for the SME segment; 2) bond/mini-bond issues; 3) creation of investment funds specialized in agriculture and agri-food (De Filippis, 2021); 4) public intervention, also in the form of collateral guarantees. On this last point, ISMEA manages agricultural credit guarantee activities as required by Legislative Decree 29 March, 2004, n. 102, Article 17, and by Law 30 December, 2004, n. 311, Article 1, paragraph 512. ISMEA has incorporated Special Section of Interbank Guarantee Fund referred to in Article 21 of the Law of 9 May, 1975, n. 153 and in article 45, paragraph 4, of legislative decree of 1 September, 1993, n. 385.

Business cases highlight capital intensity of firms and need to support growth with short-term and better long-term credit lines, applying financial assessment to verify sustainability of debt service. Considerations made for the cases in question can be extended with further research to other sectors of the agriculture and agri-food system, in particular for sectors characterized by significant investment needs and, consequently, financing needs to be implemented using credit lines. However, it is necessary for agricultural and agri-food firms to follow a path of financial literacy, to reduce information asymmetry with lenders, for example by envisaging adoption of balance sheet formats or budgeting and reporting systems, in particular for adoption of strategic planning tools for communicating with investors.

The role of public institutions can have a positive impact by promoting: 1) research on economic and financial trends and on granting of credit; 2) application of scoring systems designed for agricultural and agro-

food sector; 3) innovation of financial instruments to meet the needs of firms, including smaller ones; 4) innovation of support and coverage of financial instruments for risk mitigation of firms to lenders; 5) financial literacy of sector operators, also in support of sector operators; 6) support to the Legislator in a regulatory review relating to agricultural credit and related instruments. Finally, market trends have shown that they take into consideration the role of ESG (environmental, social, and corporate governance) impact that characterizes agricultural firms (Li *et al*., 2023) and that distinguishes sustainable investments defined in the Regulation of European Union EU 2019/2088 of 27 November, 2019. ESG investments have been characterized by significant growth and are highly appreciated by investors with an increase in fundraising (Bank of Italy, 2022). Investments of agricultural firms, characterized by compliance with ESG investment regulations, will be able to find funding in capital markets.

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Mattia Iotti
Department of Veterinary Science, University of Parma, Italy
Strada del Taglio, 10 - 43126 Parma, Italy
E-mail: mattia.iotti@unipr.it
Graduated in Economics (1998), attended the advanced course "Managing the food distribution channels" at the IAMZ of Zaragoza (1999), PhD in Economics of Agri-Food Systems of the Mediterranean (2003). Assistant professor (Ricercatore a tempo detetminato "B") since 2022. Research interests concern the analysis of firms' performance, access to credit and agricultural finance, analysis of investment and costs for the agri-food firms.

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The efficiency of agricultural spending in Italy: A territorial analysis

Assunta Amato[a], Tatiana Castellotti[a], Giulia Diglio[a], Maria Assunta D'Oronzio[a], Franco Gaudio[*,a], Mariacarmela Suanno[a]

[a] Council for Agricultural Research and Economics Research Center for Agricultural Policies and Bioeconomy (CREA-PB), Italy

Abstract

This paper assesses the efficiency of public agricultural expenditure in each Italian region through the analysis of regional budgets, both as a whole and in relation to specific agricultural policy measures. The degree of integration/complementarity between regional funds and Community funds of the second pillar of the CAP is also evaluated, in order to determine whether European resources are used by the Regions as a substitute for or in addition to regional measures. In Italy, public agricultural funding comes from three sources: the EU, the State, and the regions. While the literature on the effectiveness and efficiency of public spending in agriculture focuses on EU funds, the present research also takes into consideration the agricultural spending of Regions. This original analysis of agricultural spending at the regional level has been made possible by the databank of the CREA (Council for Agricultural Research and Economics), which has been gathering information on the allocations, payments, and remaining balances of regional accounts since 1990. The expenditure items for the agricultural sector included in the regional budgets were reclassified according to an original methodology created by the INEA (National Institute of Agricultural Economics, today CREA). The results show that the overall efficiency of public expenditure has improved

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* *Corresponding author*: Franco Gaudio - Council for agricultural research and analysis of the agrarian economy (CREA-PB) - Contrada Li Rocchi Vermicelli - 87036 Rende (CS), Italy. E-mail: franco.gaudio@crea.gov.it.

over the last two decades (from less than 40% in 2000 to just over 50% in 2019). This improvement is quite evident in the South and the Islands and less so in the North. Agricultural policy measures that can be defined as "short term measures" (contributions to public and private entities involved in agricultural and forestry activities for running costs, such as salaries, telephone, electricity, etc.) show a good spending capacity, while measures requiring planning, such as business investments, still present difficulties. As regards integration/complementarity between regional funds and EU Fund for Rural Development Programmes (RDPs), the regions have been classified depending or whether or not they differentiate between the RDP financing and Budget financing. In the most recent period of 2014-2020, most regions have tended to target both sources of funding to support the same types of priority activities.

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Introduction

Public funding plays an important role in the Italian agri-food sector. That funding is provided through a governance system made up of three main levels of decision-making and sources of funding: the EU, the State, and the regions (Briamonte, Vaccari, 2021). Funding is therefore subject to European regulations, national laws, and regional laws, and to the agricultural policy objectives and interventions decided at the European, national, and regional level. The EU support to this sector consists mainly of the CAP (pillars I and II). The main objective of the CAP is to respond to the challenges posed to European agriculture, namely: economic sustainability (food security, price stability, productivity growth), environmental sustainability (biodiversity, habitat conservation, climate change), and social sustainability (vitality of rural areas, agricultural diversification, rural development). National support occurs through structural and territorial interventions (support for supply chains, food districts, energy efficiency, National Strategy for Inner Areas, interventions on water networks, waste reduction) and through tax and social security benefits. Regional support for the agricultural sector depends on the needs of the sector at the regional level and can involve investments in farms, infrastructure, and agricultural services.

The CREA, through the Research Centre for Policies and Bioeconomy (CREA PB), has been gathering information on public support for agriculture since the 1990s (Sotte, 1993; Sotte, 2000; Briamonte and D'Oronzio, 2004), fuelling interest in this issue and facilitating debate on public spending, including the systems to steer it (Reviglio, 2007; Comite, 2008) and how

to reduce inefficiencies (Iacovone, 2014). This includes information on expenditure by territory and sources of funding (European, national or regional), which allows an assessment of the efficiency and effectiveness of agricultural expenditure at the regional level. Thanks to the CREA database's reclassification of the expenditure items of regional budgets for the agri-food sector, the regional budget is not a mere accounting obligation to be fulfilled, it has become a tool for improving knowledge of financial flows and the final recipient of funding. The decentralization of agricultural policies at the regional level requires analysis in order to verify the efficiency of public spending at the regional level.

The present article analyses the efficiency of public regional spending in agriculture overall and for individual interventions. The policy interventions taken into consideration concern development services (technical assistance, research, promotion), investments (in farms and in processing companies), infrastructure, and forestry activities. The paper aims to give answers to the following questions: 1) Are regional financial resources used efficiently? 2) Which interventions receive regional funding? In particular, do we want to investigate whether they are used for short-term interventions or for structural interventions? 3) Do interventions financed through RDP funds add to those financed through regional budgets or do they replace them?

The reclassification of regional expenditure by CREA allows us to analyse the efficiency of expenditure (in terms of the Regions' spending capacity) for specific regional agricultural policy interventions. In the literature the focus is on EU policies capacity spending. In this study we not intend to analyse the effectiveness of policies and, then, we not intend to investigate to which extent have the objectives of the regional policies been achieved at minimum costs and to which extent have the objectives of the regional policies been achieved. This paper is intended to be a useful basis for answering these research questions in a later study.

1. Background

Although it has declined over the last twenty years, public support still represents a significant share of the added value of national agricultural (34% in 2019, down from 55% in 2000) (Briamonte, Vaccari, 2021). In 2019, this amounted to about 12 billion euros, of which 64% came from EU resources, 4% from State transfers, and 16% from regional expenditure, with the remaining 16% deriving from tax and social security benefits. The Common Agricultural Policy (CAP) (the first and second pillars) is the predominant source of EU funding and remained fairly constant throughout the period considered (roughly EUR 7.9 billion in 2009 to 7.2 billion in

2019). Public funding has been distributed differently to the Italian regions, thus contributing to a varying degree to their respective performance in terms of agricultural added value. When all sources of funding are considered (CAP, national and regional), the regions of the North receive the most funding (ibid.).

As regards the efficiency and effectiveness of public spending, the best expenditure capacity is often due to the method of resource management. Among the measures of the CAP, which are heavily interdependent and complementary to those financed by regional budgets, the Rural Development Programmes (RDPs) are an extraordinary measure that aims to reduce territorial disparities by concentrating resources on intervention priorities. Some authors (Uthes *et al.*, 2016) suggest that spending priorities are generally in line with regional needs. By contrast, Mantino *et al.* (2022) have questioned the extent to which "development support for investment addresses the territorial differences of rural areas, in particular as regards the differences between rich and intensive areas on the one hand and marginal and peripheral areas (rural areas) on the other hand", finding "the distributive effects of RDP investment support measures appear to be clearly unequal, particularly in the areas of agricultural and agro-industrial competitiveness. They are mainly allocated to areas that are already dynamic and highly competitive", thus negating the structural and territorial character of Community funds that aim to reduce the gaps between rich and poor areas.

In the present research, the focus is on regional support for investments. According to the OECD New Rural Paradigm (OECD, 2022) the effectiveness of rural polices is heavily influenced by the proportion of financial investments in the total policy support. We therefore seek to determine: 1) whether regional resources are used to implement structural changes, and 2) whether the EU resources provided to regions are used to replace the measures decided at the local level or to supplement them (Mantino, 2022; Mantino *et al.*, 2022; Uthes *et al.*, 2016; De Filippis *et al.*, 2013; Henke, De Filippis, 2010; Scoppola, 2005; Terluin, Venema, 2003), and how this affects regional spending capacity.

2. Materials and methods

The CREA classifies the budgets of the administrations that fund the agricultural sector in order to measure the results of sector policies by region. The data and information collected are fed into the regional expenditure database, through which the CREA analyses public intervention in agriculture (Sotte, 1993). The official sources of the data are regional budgets, regional accounts, and information from other institutions, such as ministries

and funder agencies (such as the AGEA) (Finuola, 1995; Briamonte, Vaccari, 2021). The basic unit of data for regional information is the budgetary chapter, to which financial information, allocations, commitments, payments (on an accrual basis and residual accounts) and remaining balances are attached.

The database has information for the last 30 years. The present research refers to the data for the last 20 years (2000-2019) and focuses on support from regional sources, which, as mentioned, represents 16% of total funding for the agricultural sector.

The CREA, in collaboration with the regional administrations, has established the "Monitoring Network", a highly decentralised operational structure throughout the national territory. The Monitoring Network is made up of the regional offices of the Research Centre for Agricultural Policies and Bioeconomy of the CREA, who work in liaison with regional administrations. Each year, the CREA regional offices systematically classify their budgets and balance sheets item by item according to the nine codes of the CREA methodology: economic-functional, support expenditure, final beneficiaries, expenditure management, decision-making function, financial means, productive sectors, environmental protection, and natural disaster.

In the present research, we use the economic-functional code (SPEECFU) to identify and distinguish agricultural policy intervention types. The economic-functional classification framework identifies two types of agricultural policy transfer: economic, i.e. policies that allow the provision of funding, and functional, i.e. in relation to the objectives that the policy itself aims to pursue. The identification of all the possible agricultural policy measures implemented by the regions is very complex. The classification codes allow the categorization of regional policies, regardless of the specific characteristics of each of them and the time period in which they are implemented.

In order to assess each region's capacity for expenditure, the present analysis took into account both the total payments of the budgets (on the balance sheet and on the accrual account) and the total allocations (those of the reference year together with the remaining balances carried over from previous years).

The calculated index is the expenditure capacity (CS) which is given by the ratio between payments (PT) and total allocations (ST):

CS = total payments /total allocations
where
CS = expenditure capacity
PT = total payments (on accrual basis + residual accounts)
ST = total allocations (on accrual basis + remaining balances carried over from previous years)

RDP interventions are compared for two programming periods, 2007-2013 and 2014-2020, for which data and information are available. The measures of the RDPs for each period have been reclassified according to the functional economic codes (SPEECFU) of the CREA methodology, thus rendering them comparable.

Table 1 - Reclassification of Economic-functional and RDP measures

CREA Economic functional Reclassification	**Measures PSR 2007/2013**	**Measures PSR 2014-2020**
Development services	Measures relating to training and information, counselling, management services, cooperation for the development of new products, food quality, promotion, animation and technical assistance (measures 111; 114; 115; 124; 131; 132; 133; 331; 341; 511).	Measures relating to knowledge and information transfer, quality of agricultural and food products, cooperation, Leader (CLLD) and technical assistance (measures 1; 3; 16; 19; 20).
Farm investments	Measures relating to the modernisation of agricultural holdings, improving the economic value of forests, adding value to agricultural and forestry products, diversification, business development, local development and competitiveness in general (measures 121; 121 Health Check; 122; 123; 311; 312; 411).	Investment measures, Farm and business development, Investments in forestry (measures 4; 6; 8).
Direct payments/ Environmental protection	Measures relating to the setting-up of young farmers, restoration of production potential, farm restructuring for the reform of the COM, compensation paid to farmers in mountain areas, Natura 2000 payments and agri-environment and implementation of local	Measures relating to advice, farm management assistance, compensation to farmers in areas with natural handicaps, restoration of agricultural production potential damaged by natural disasters and prevention measures, agri-climate payments environmental, organic farming

CREA Economic functional Reclassification	**Measures PSR 2007/2013**	**Measures PSR 2014-2020**
	development strategies (measures 112; 126; 144; 211; 213; 214; 214; 412).	and animal welfare (measures 2; 212; 5; 10; 11; 14).
Forest activities	Measures to restore forest potential and prevention actions (measure 226).	Measure relating to Silvo-environmental and climate services and forest protection (measure 15).
Infrastructure	Measures relating to infrastructure for development and adaptation, non-productive investment, promotion of tourism, basic services for the economy and the rural population, renewal and development of villages, conservation and improvement of rural heritage implementation of local development strategies (measures 125; 125 Health Check; 216; 216 Health Check; 227; 313; 321; 321 Health Check; 322; 323; 413).	Measure concerning basic services and village renewal in rural areas (measure 7).
Associations	Measures relating to cooperation projects management of local action group and capacity building (measures 421; 431).	Measures relating to the establishment of producer groups and organisations and support for local development Leader (measure 9; 19).

Source: Our elaborations on the CREA-PB database.

The classification of each intervention as either economic or functional revealed the orientations of each region's use of financial resources as well as the changes that occurred between the two RDP programming periods (2007-2013 and 2014-2020)[1].

Subsequently, a synthetic index was calculated based on the ratio between the average percentages of the impact of the RDPs and regional budgets. The index has made it possible to assess the complementarity of regional budgets

1. www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/16412.

with the RDPs, or to determine whether a region used the RDP funding to replace the regional budget for ordinary needs.

In order to compare regional interventions and RDP interventions, the RDP measures have been reclassified on the basis of the economic-functional codes used for regional measures. The analysis of the budget data, classified with the CREA methodology, allows the comparisons between the spending policies of the 19 regions and the two autonomous provinces, and the 21 Rural Development Programmes.

3. Results

3.1. *Efficiency of expenditure in Italian regions*

In this paragraph the focus is on efficiency of expenditure in the Italian regions in the period 2000-2019. The efficiency of expenditure is measured through the expenditure capacity index which is given by the ratio between regional payments and regional total allocations.

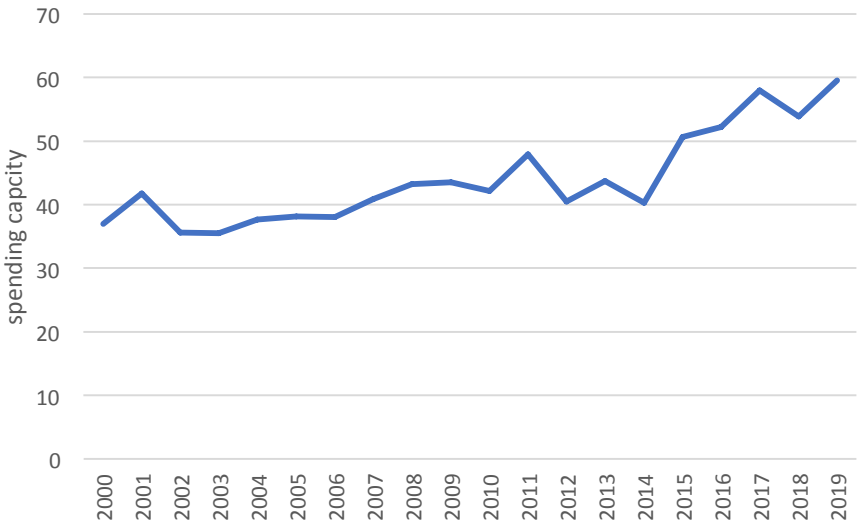
The literature review (Lombardi, 1997; Briamonte, D'Oronzio, 2004; Briamonte *et al.*, 2020; Cesaro, 2006; Gaudio, 1996; Fantini, 2003; Pergamo, 2008; Zaccaria, 2005; Ievoli e Rubertucci, 2014; Nencioni e Vaccari, 2001) shows that the evaluating the efficiency of expenditure was quite difficult because the regional budget structure corresponded more to accounting needs than to the economic purpose of the expenditure. The literature review revealed also that the economic destination of expenditures facilitated the monitoring and verification of results. The CREA methodology makes it possible to calculate the expenditure capacity index for each regional economic-functional intervention.

The efficiency analysis was carried out for spending capacity as a whole and for specific policy interventions implemented in individual regions according to a new aggregation proposal.

Figure 1 shows the development of expenditure capacity in Italy. It is clear that in the second half of the last twenty years there have been more positive results. But does this apply to all regions?

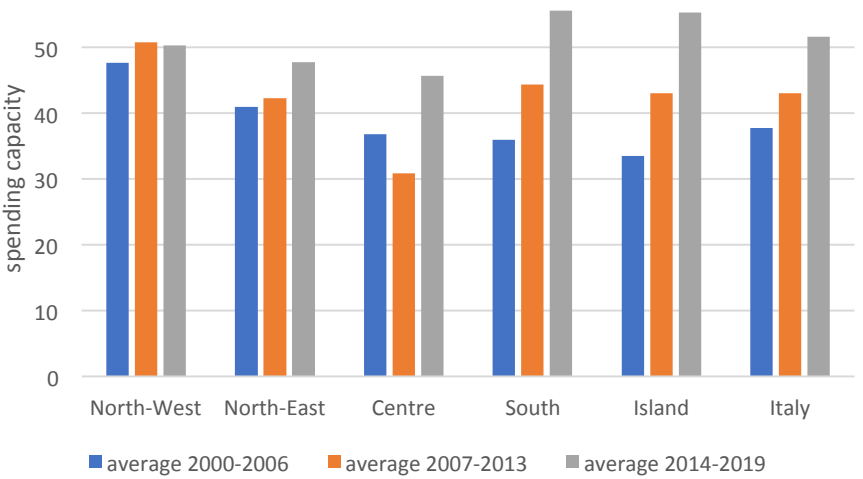
The period 2000-2019 has been divided into three periods: 2000-2006; 2007-2013; 2014-2019. The expenditure capacity of the Italian regions, aggregated by territorial constituency, is represented in Figure 2. The expenditure capacity for the North-West constituency remains constant over the three periods, while in the North-East, in the Centre and, above all, in the South and the Islands it increases in the last period.. Overall spending capacity grew from the first period to the last, with a final spending capacity of just over 50%. The South and the Islands have higher values than the Italian average in the last period. In the North, spending capacity was initially higher than in other circumscriptions (2000-2006).

Figure 1 - Trend in the spending capacity for public funding provided by the Italian regions (2000-2019)



Source: Our elaborations on the CREA - PB database.

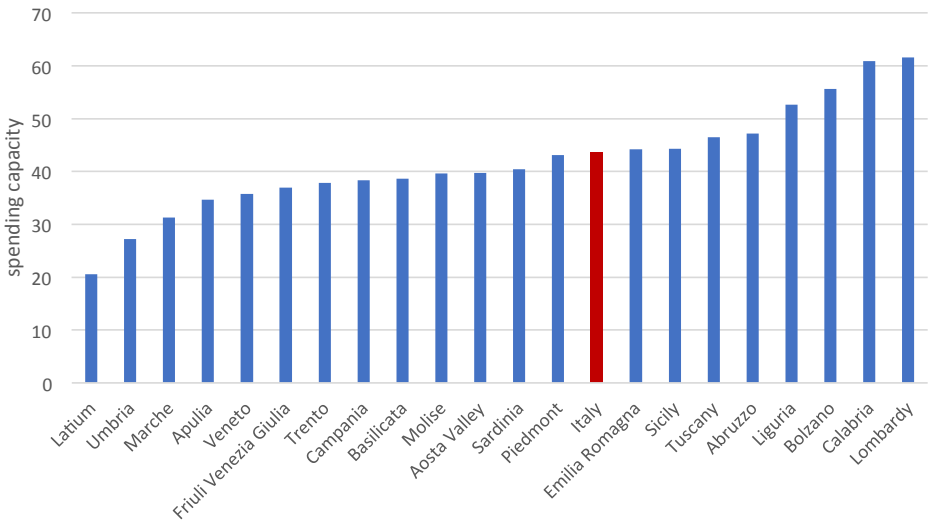
Figure 2 - Trend in spending capacity by district (2000-2019)



Source: Our elaborations on the CREA - PB database.

In the previous period (2007-2013) a larger number of regions had a higher spending capacity than the Italian average (Figure 3): Lombardy, Calabria, Bolzano, Liguria, Tuscany, Abruzzo, Emilia Romagna, and Sicily. Only

Figure 3 - Spending capacity by region (2007-2013)

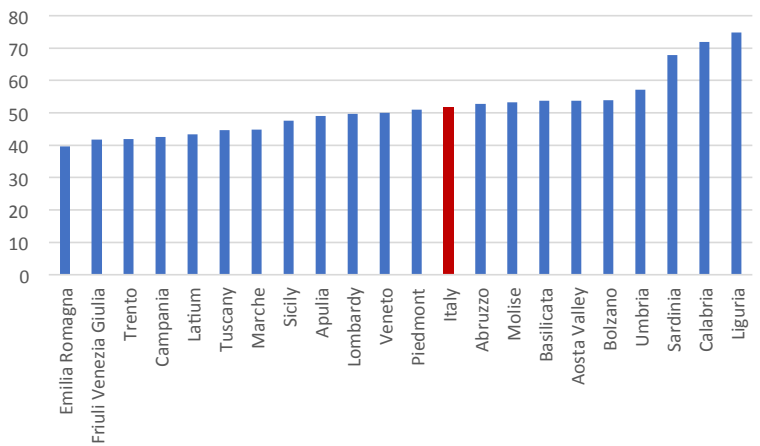


Source: Our elaborations on the CREA - PB database.

Calabria, Bolzano, and Liguria had an expenditure capacity that is higher than the national average in both periods.

Regional spending capacity (Figure 4) in the last period (2014-2019) is higher than the Italian average to a greater extent in Liguria, Calabria and

Figure 4 - Spending capacity by region (2014-2019)



Source: Our elaborations on the CREA - PB database.

Sardinia, while on the opposite side those with a "low" spending capacity below the Italian average are Le Marche, Campania, Friuli Venezia Giulia, Trento, and Emilia Romagna. The remaining regions have an average spending capacity.

Table 2 summarizes the spending capacity of the individual Italian regions for each economic-functional intervention. This capacity is high, medium or low if it is above, equal to or below the Italian average, respectively.

The analysis of the spending capacity in the Italian regions shows that the interventions which allow the regions to be defined as having "high spending capacity" are "income aid" and "investments" in the case of Liguria, "forestry activities" and contributions to "associative bodies" in the case of Calabria and, finally, good performance in various interventions ("income aid", "development services", "investments", "infrastructure") in the case of Sardinia.

Table 2 - Degree of spending capacity of each region based on the new classification of economic-functional interventions

Region	Forestry activities	Direct aid	Hydrogeological defense	Infrastructure	Association bodies	Development services	Investment
Marche	low	low	low	low	low	low	low
Veneto	low	low	low	low	high	low	low
Abruzzo	low	medium	high	low	high	low	low
Basilicata	high	low	low	low	low	low	medium
Bolzano	medium	medium	medium	low	high	medium	low
Calabria	high	low		low	high	medium	low
Campania	medium	low	high	low	low	low	low
Emilia Romagna	low	low		low	high	low	low
Friuli Venezia Giulia	low	medium	low	low	low	low	medium
Latium	low	low	low	low	medium	low	low
Liguria	low	high				low	low
Lombardy	medium	low	medium	low	high	high	medium
Molise	medium	low		low		medium	low
Piedmont	medium	low		low		low	low
Apulia	high	high	low	low	low	low	low
Sardinia		high		medium	low	high	medium
Sicily	medium	low		low	low	low	low
Tuscany	low	medium		low		high	low
Trento	low	low	low	low	high	low	low
Umbria	high	high		low	low	low	medium
Aosta Valley	low	high	low	low	high	medium	medium

Source: Our elaborations on the CREA-PB database.

On the other hand, the interventions that contribute most to defining regions as having "low spending capacity" are "investment", "infrastructure", "development services", "income aid".

In particular, the intervention "Associative Bodies" occurs in the highest number of regions with "high spending capacity": Veneto, Abruzzo, Bolzano, Calabria, Emilia-Romagna, Lombardy, Trento and Aosta Valley. Conversely, the intervention "hydrogeological defence" occurs in the least number of regions with "high spending capacity": Abruzzo and Campania. The regions with high spending capacity in the intervention "forestry activities" are Calabria, Basilicata, Puglia and Umbria, while the interventions "direct aid" occur in Liguria, Puglia, Sardinia, Umbria, and the Aosta Valley and "development services" occur in Lombardy, Tuscany and Sardinia.

3.2. *Expenditure on agricultural policy interventions*

The aggregation of the main interventions shows a different composition of payments according to the programming period.

In particular, while in the first programming period "investments" represent the first item of expenditure, followed by "forestry activities" and "infrastructure", in the second and third periods it is "development services" that becomes the predominant item, representing in the period 2014-2019 32% of payments made to agriculture from regional budgets.

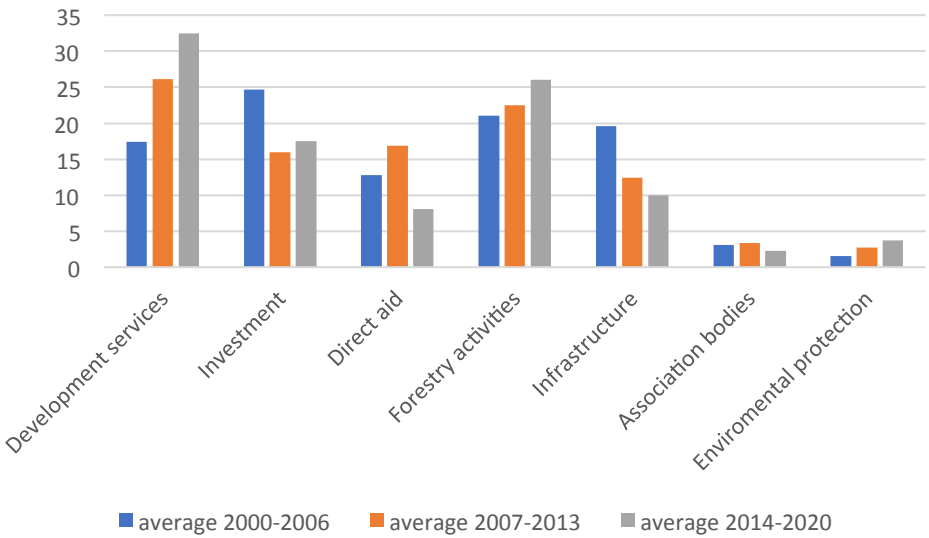
"Forestry activities" remains the second item of expenditure (26% and 22% in the third and second periods respectively), while "investments" become the fourth item in 2007-2013 absorbing 16% of payments and the third item in 2014-2020 with 17.5% of regional payments.

The different composition can be explained by the change in the governance of payments to the agricultural sector from the European Union: starting in the 2007-2013 programming period, it no longer passed through regional budgets, but from the regional Payment Agencies that report to the AGEA.

Even if we look at appropriations, the behaviour in the various programmes remains the same.

In the 2014-2019 period, investments deriving from the implementation of Community programs do not pass through the regional budget, so the regions that have incurred investment expenditure with own funds higher than the national average are those regions that direct programming towards medium-long term structural interventions. This group includes: Bolzano, Emilia-Romagna, Trento, Marche, Friuli, Veneto, Tuscany, Campania, Sicily, Aosta Valley.

Figure 5 - Payments by type of expenditure in the periods 2000-2006, 2007-2013 and 2014-2019



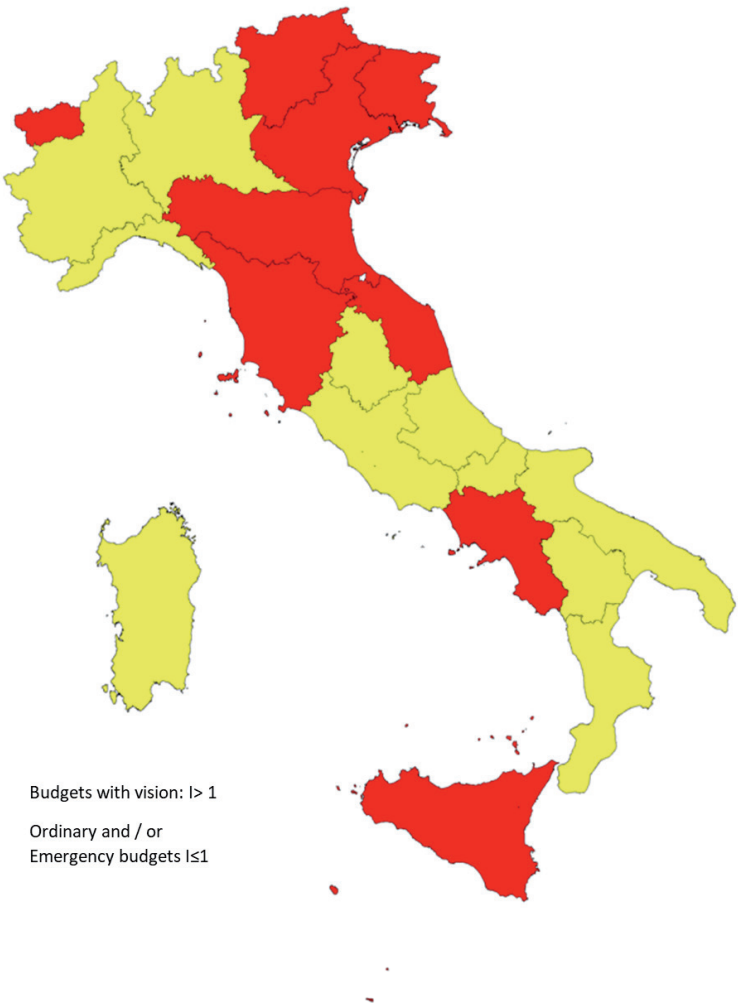
Source: Our elaborations on the CREA-PB database.

The regions belonging to this group can be defined as "with vision" in view of the fact that they make long-term investments. The remaining regions do not use the regional budget for medium-long term expenditure, but for ordinary or emergency management (payment of salaries, natural disasters). This group can be defined as "for ordinary or emergency management" (Figure 6).

Looking at the behaviour of regional budgets in relation to appropriations, Le Marche, Veneto, Abruzzo, Bolzano, Emilia-Romagna, Friuli V.G., Puglia, Sicily, Tuscany, Trento, and Umbria are the regions with an above-average incidence of investment appropriations. This group of regions "with vision" is more numerous than the one built on the basis of payments. This means that with respect to appropriations, the objectives of the budgets then change in implementation: the efficiency of management therefore also affects effectiveness.

How do the two groups behave with regard to expenditure on the other items? (Figures 7 and 8). All the regions that invest with an index much higher than the Italian average (greater than 2) (Emilia-Romagna, Bolzano, Trento, Marche, and Friuli), also allocate an above-average percentage to direct aid.

Figure 6 - Classification of regions by investment expenditure (I) in the agricultural sector (2014-2020)

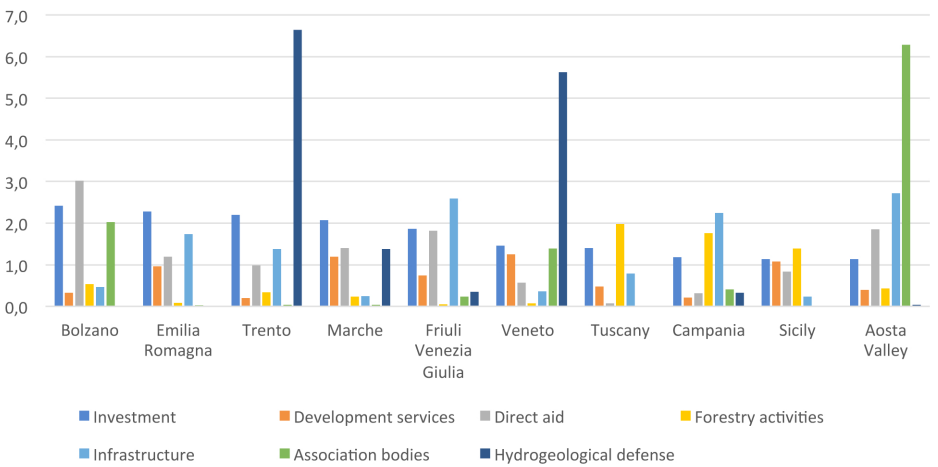


Source: Our elaborations on the CREA-PB database.

It is recalled that expenditure on financing the management of agricultural holdings in the short term is classified as direct aid. In addition, Trento, Friuli and Emilia Romagna allocate a percentage higher than the national average to infrastructure spending while only Trento allocates a percentage considerably higher than the national average to environmental protection.

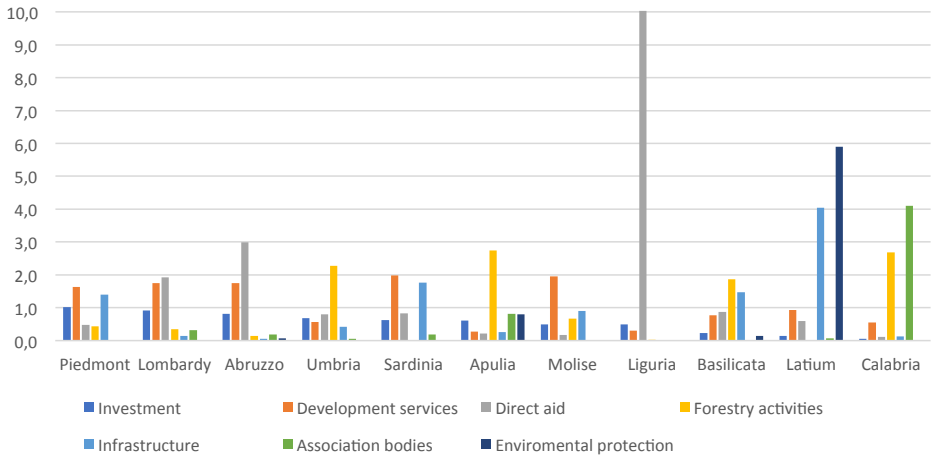
As regards the group of regions with budgets for day-to-day management, some regions allocate a percentage higher than the national average to "forestry activities" (Calabria, Puglia, Umbria, Basilicata, Sicily, and Campania). For the Calabria region, it is the expenses for the payment of forestry workers. Lazio, Campania, Valle d'Aosta and Sardinia finance "infrastructure"; Liguria, Valle d'Aosta, Lombardy and Abruzzo allocate resources to "direct aid"; Calabria and Valle d'Aosta are the only two regions that finance "associative bodies" (for example the Calabria regional agricultural development agency - ARSAC); finally, Piedmont, Abruzzo, Lombardy, Sardinia, and Molise finance "development services".

Figure 7 - Regions with vision (2014-2020)



Source: Our elaborations on the CREA-PB database.

Figure 8 - Regions for ordinary and/or emergency management (2014-2020)



Source: Our elaborations on the CREA - PB database.

3.3. *Comparison between Rural Development Programmes (RDP-PSR) and ordinary funds of the regions*

In addition to the efficiency of agricultural expenditure in the regions and the impact of agricultural policy interventions, this analysis also concerns whether Community funds in the European Agricultural Fund for Rural Development (EAFRD) are effectively extraordinary in the regions or replace the resources to be allocated to ordinary interventions (Mantino, 2022; Mantino *et al*., 2022; Terluin & Venema, 2003) and, finally, whether the implementation of the RDPs has influenced the choices of the Regions in the use of the financial resources of the autonomous regional budgets.

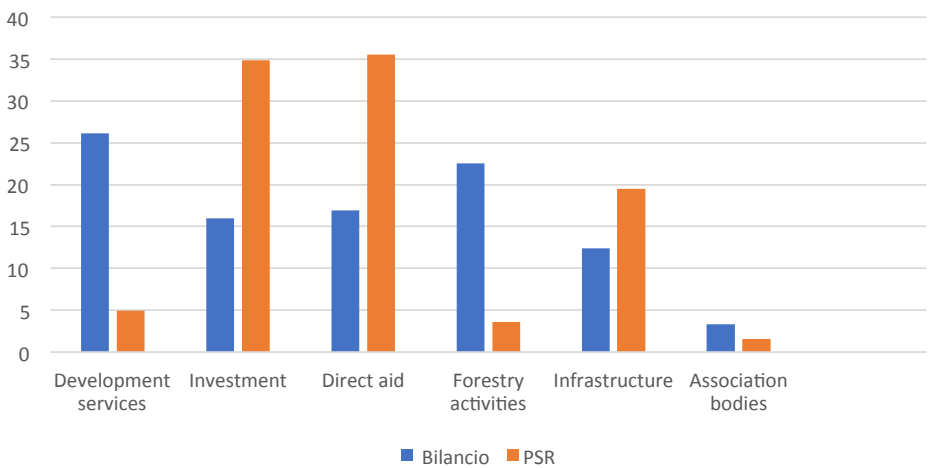
One of the objectives of the European structural funds is to strengthen economic, social and territorial cohesion by reducing the gap between the more advanced regions and those lagging behind. This objective is also pursued through the use of the EAFRD (European Agricultural Fund for Rural Development) which finances the RDPs in implementation of the rural development policy and interventions that are not purely sectoral for agriculture. The same does not happen for regional budgets. Consequently, the different fields and content of the RDPs and Budgets are also taken into account when comparing the two funding sources.

In this regard, the calculations carried out aim to evaluate the use of regional public expenditure through a comparison between payments made with regional budgets and payments with RDPs. The comparison makes it

possible to detect the use of expenditure disbursed through the RDPs and specifically allows us to determine if the latter has performed a function of integration, replacement, or summation to the ordinary regional funds. The reference periods for the analysis coincide with those of the last two programming periods of the European Agricultural Fund for Rural Development (EAFRD): 2007-2013 and 2014-2020.

In general, at the national level in the period 2007-2013, expenditure on development services and forestry activities was mainly supported by regional budgets. Otherwise, RDP payments mainly concerned business investment and direct aid/environmental protection.

Figure 9 - Percentage incidence of support for economic-functional activities (2007-2013)

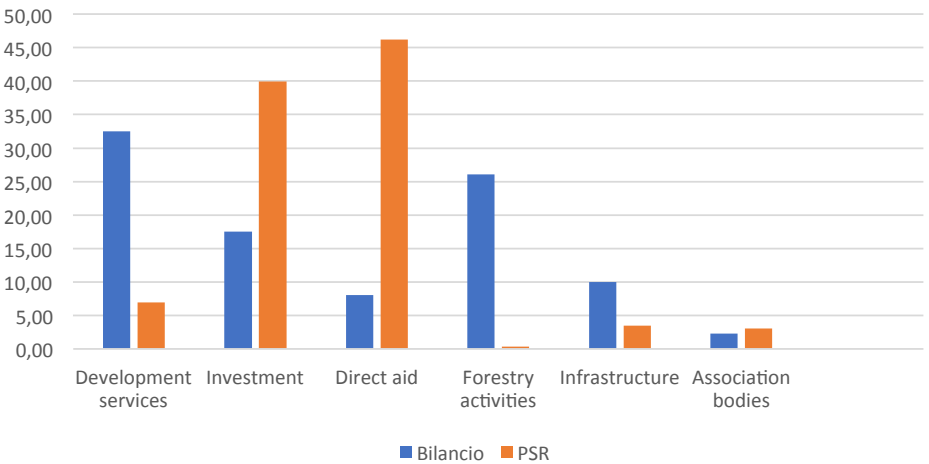


Source: CREA – "Agricultural expenditure of the Regions" database and the tenders archive of the National Rural Network.

In the period 2014-2020, the distribution of public expenditure remains roughly the same as in the previous period, but the differences between the percentage incidences are much more marked: it is very clear that for forestry activities, the expenditure disbursed comes from regional budgets. Only for infrastructure is there a change in the financing disbursed through the RDP.

The two Figures 9 and 10 represent the payments disbursed in Italy for agricultural policy interventions. To better distinguish which interventions were financed by the ordinary regional funds and which by the RDPs, a synthetic index was developed (given by the value deriving from the average of the incidences of the individual interventions). A further objective of the

Figure 10 - Percentage incidence of support for economic-functional activities (2014-2020)



Source: CREA – "Agricultural expenditure of the Regions" database and the tenders archive of the National Rural Network.

synthetic index was to identify the Regions that have opted for interventions other than those of the RDP.

The ratio between the percentage effects of the financial breakdown of RDP public expenditure on the regional budgets shows values which, if close to one, indicate how the destinations of funding in the field RDP follow the same public spending choices made by the Regions with their own budgets. In the case of this result, it can be deduced that the RDP financing ended up being complementary or replaced ordinary expenses incurred by the Regions, losing in part the extraordinary and incentive function of EU co-financed programming for rural development.

Where the value is less than one, the activity is mainly financed from the balance sheet. If the value is much higher than one, the activities are financed almost exclusively through the RDP. The value different to one indicates, therefore, that the Region has decided to intervene with activities, which, although integrated, differ from those supported through the RDP, which is instead used to finance measures to stimulate economic development.

The following table shows that in most regions the values of the indices are not close to one; consequently there is a differentiation in the methods of payment between regional budgets and RDP. In the RDP field, payments for business investment and direct aid are becoming increasingly important in relative weight. Unlike regional resources, the significant relative weight is recorded for development services, forestry, and infrastructure.

Table 3 - Index of expenditure on interventions in agriculture (%) (2007-2013)

Regions	Development services	Investment	Direct aid/Hydrogeological defense	Forestry activities	Infrastructure	Association bodies
Abruzzo	0,13	2,04	2,12	0,09	1,93	13,06
Basilicata	0,18	2,19	2,41	0,49	1,24	-
Bolzano	0,05	0,7	2,74	0,04	3,77	0,39
Calabria	1,37	4,51	11,56	0,06	5,24	0,08
Campania	0,26	4,83	4,44	0,13	1,15	0,66
Emilia-Romagna	0,13	1,23	2,79	0,28	1,15	0,62
Friuli-Venezia Giulia	0,13	2,67	1,92	0,2	0,43	2,87
Latium	0,07	6,28	2,45	1,13	0,71	1,08
Liguria	0,13	4,04	0,33	1,52	46,15	0,56
Lombardy		5,5	0,81	0,22	5,86	0,2
Marche	0,33	0,81	1,2	0,62	17,86	3,26
Molise	0,1	0,81	3,92	0,57	3,75	-
Piedmont	0,3	1,99	18,39	0,02	0,52	-
Apulia	0,26	1,47	1,64	0,21	0,99	1,6
Sardinia	0,04	0,98	5,18	7,37	1,86	0,68
Sicily	0,2	2,86	1,09	0,16	1,56	1,38
Tuscany	0,32	1,83	4,03	0,3	0,99	-
Trento	0,14	0,7	1,58	0,11	2,1	12
Umbria	0,16	3,78	30,85	0,16	0,52	1,16
Aosta Valley	0,25	0,28		3,57	0,43	1,74
Veneto	0,19	3,29	1,11	0,32	1,91	0,5
Italy	0,19	2,18	1,81	0,16	1,58	0,47

Source: CREA – "Agricultural expenditure of the Regions" database and the tenders archive of the National Rural Network.

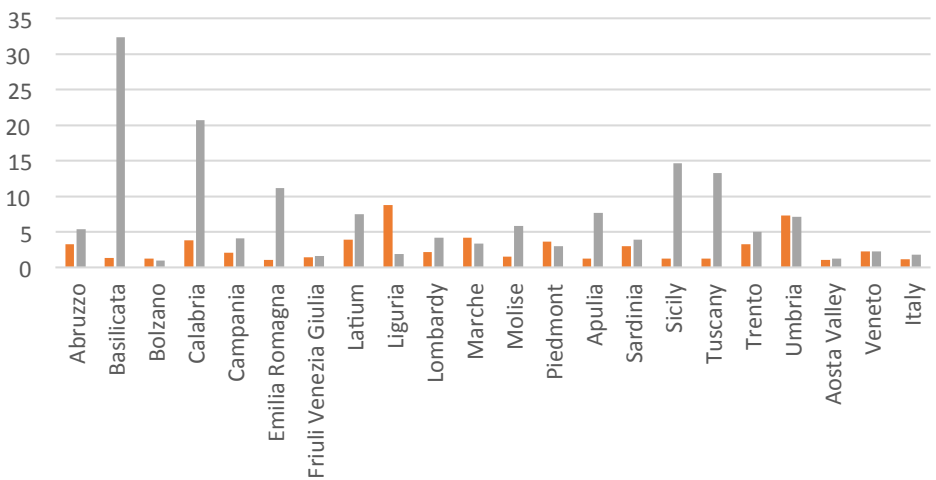
Table 4 - Index of expenditure on interventions in agriculture (%) (2014-2020)

Regions	Development services	Direct aid/Hydrogeological defense	Forestry activities	Infrastructure	Association bodies
Abruzzo	0.16	1.48	-	15.29	6.64
Basilicata	0.29	5.33	-	0.46	144.56
Bolzano	0.18	2.33	-	0.85	0.38
Calabria	0.24	65.08	0.01	0.88	0.17
Campania	0.60	9.95	0.06	0.19	2.46
Emilia-Romagna	0.29	4.40	-	0.23	49.66
Friuli-Venezia Giulia	0.21	1.97	-	0.15	3.77
Latium	0.10	1.88	-	0.13	11.67
Liguria	0.98	0.13	-	-	-
Lombardy	0.12	2.57	-	1.76	14.13
Marche	0.21	2.97	0.01	4.00	7.46
Molise	0.08	21.94	-	0.95	-
Piedmont	0.23	12.34	0.01	0.35	-
Apulia	1.21	11.73	-	0.04	3.57
Sardinia	0.05	9.90	-	0.04	6.92
Sicily	0.08	8.39	-	0.55	62.36
Tuscany	0.53	63.29	0.01	0.41	-
Trento	0.51	1.27	-	0.28	17.69
Umbria	0.66	6.84	0.01	1.22	23.99
Aosta Valley	0.31	3.98	-	0.19	0.10
Veneto	0.27	1.15	0.00	0.99	1.79
Italy	0.21	3.92	0.01	0.35	1.37

Source: CREA – "Agricultural expenditure of the Regions" database and the tenders archive of the National Rural Network.

Figure 11 shows the differences between the two programming periods: the last period is more differentiated than the previous one for almost all the regions. The regions with the lowest values near the horizontal axis (=1) are those that have not differentiated the destination of payments of the RDP budget payments. These regions make the same choices as regional budgets in the allocation of public expenditure financed by the RDP. Between the two periods considered, the first (2007-2013) shows differences in the behaviour of the less marked regions in the choice of spending through the two different funds (regional budgets and RDP) and the general choices in the distribution of expenditure by functional economic type do not change, except for in Liguria and Umbria. In most cases, in the last period 2014-2020 the Regions have chosen to allocate RDP funding to differentiated economic-functional activities. This concerns in particular five regions (in descending order: Basilicata, Calabria, Sicily, Tuscany, and Emilia Romagna). Only Liguria recorded a reverse trend. In general, the tendency is to target the two sources of funding in support of the same types of activities considered to be priorities by the regions.

Figure 11 - Regional budget and RDP payments indices



Source: CREA – "Agricultural expenditure of the Regions" database and the tenders archive of the National Rural Network.

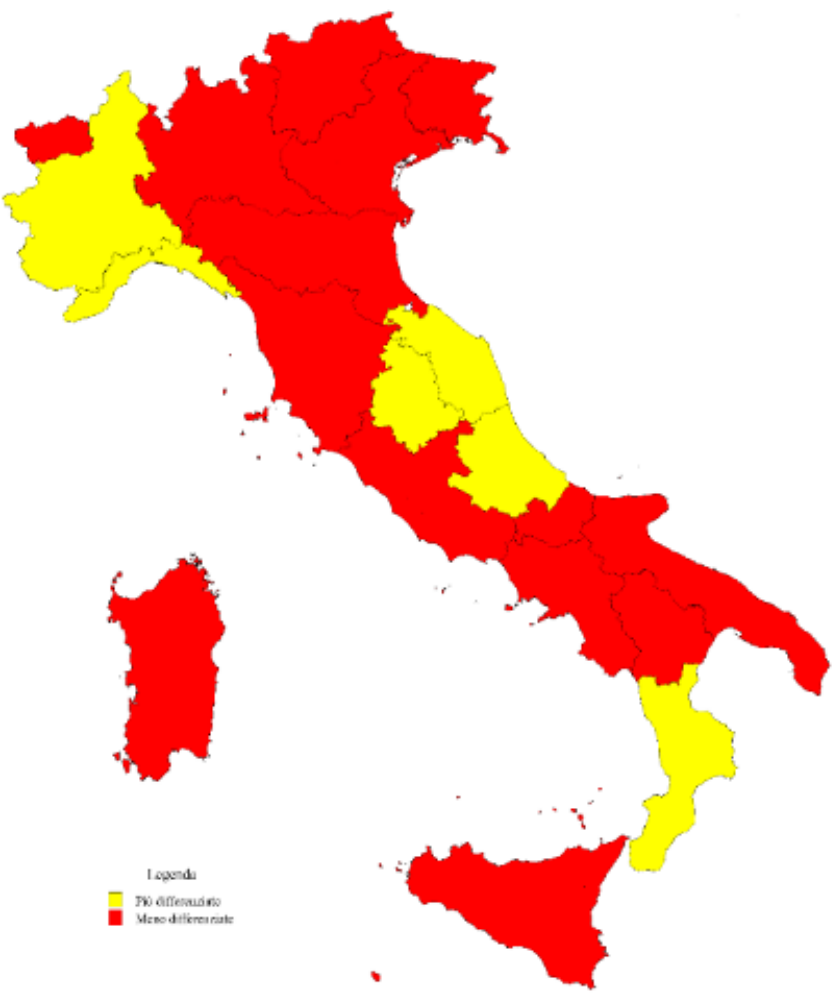
Below, we have developed maps showing the most and least differentiated regions in the different programming periods in the use of expenditure, broken down by functional economic type.

The differentiation between the Regions was calculated by means of an index, given by the ratio between the percentage effects of payments made through the RDP and payments made through regional budgets. Subsequently,

a synthetic index was calculated (sum of the indices differentiated by type of support/6) in order to evaluate the different behaviours of the Regions and to make a comparison between the two programming periods.

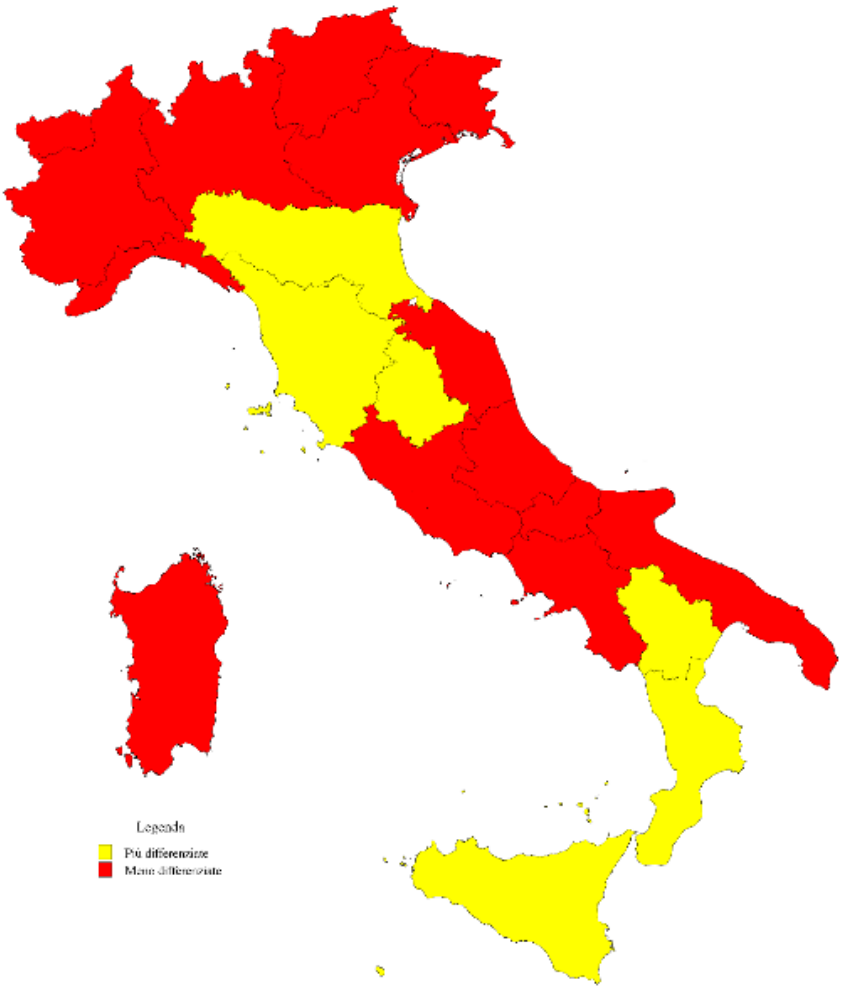
Based on these indices, it was possible to classify Italian regions into two types: the Regions which differentiate between the financing choices of RDP and budget financing, and the regions which do not differentiate. Below are the two maps of Italy, where the two types of situations are represented.

Figure 12 - Regions with differentiation 2007-2013



Source: CREA – "Agricultural expenditure of the Regions" database and the tenders archive of the National Rural Network.

Figure 13 - Regions with differentiation 2014-2020



Source: CREA – "Agricultural expenditure of the Regions" database and the tenders archive of the National Rural Network.

Conclusions

In the last twenty years, the spending capacity of Italian regions has improved. This improvement is most evident in the South and the Islands. In the Northwest, spending capacity has remained constant throughout the period (2000-2019); while in the Northeast and the Centre, the increase in

spending capacity is lesser. Despite spending faster than in the past, there are only three regions with "high spending capacity" and four with "low spending capacity". The 13 remaining regions have an average spending capacity. In the periods considered, the regions with high spending capacity were 4 and 7 always had low spending capacity. Nine regions had a variable trend.

The agricultural policy interventions with the lowest value in terms of spending capacity were "infrastructure", "farm investment", and "development services". By contrast, the agricultural policy interventions with high spending capacity are related to "direct aid" and "forestry activities". Contributions to "associative bodies" more frequently have an average spending capacity. It can be concluded that, while improving in general, the spending capacity of regions still remains anchored in interventions that can be described as "ordinary," which do not require programming.

In the 2007-2013 period, the interventions financed by the regions' budgets or RDPs were quite similar, so that the resources add up and each region finances the policies deemed important for the territory.

In the period 2014-2020, the regions have differentiated interventions by financing them with different Funds: "investments" and "infrastructure" with the RDPs, however the "development services" and other current expenditure interventions with the regional budgets.

In both 2007-2013 and 2014-2020, Italian regions concentrated resources on three types of interventions: "farm investments", "direct aid", and "infrastructure". In Italy, spending on "investments" absorbed 34.90% of payments, while "direct aid" accounted for 35.53% and "infrastructure" interventions for 19.47%. As many as 89.9 percent of payments are concentrated in these types of interventions (these choices are strongly conditioned by the provisions contained in EU regulations, which in particular in the 2007-2013 period bound the regions to allocate a minimum share for interventions with environmental purposes, sustainable development, and to a lesser extent interventions to develop the competitiveness of the agricultural sector.

In the following period, expenditure on "investment" absorbed 56.31% of payments, "direct aid" 30.86%, and "infrastructure" 3.47%. Overall, 90.64% of payments are concentrated in these three types of interventions, but "farm investments", unlike the period 2007-2013, saw the percentage increase. In most regions, "direct aid" is above average.

In the final programming period, the regions changed their way of distributing spending by distinct types of functional economic interventions, showing a shift from a more managerial to a more visionary phase, where support for more structural interventions became a priority. In fact, regions focused spending mainly on "business investments".

In the two periods considered, there were always six regions that showed differentiation in interventions, but only Calabria and Umbria remain "differentiated" in both periods: Emilia Romagna, Tuscany, and Sicily move from undifferentiated to differentiated; while Piedmont, Liguria, Marche and Abruzzo followed the reverse path, from differentiated to undifferentiated.

Compared with what was shown in the context section, where investment support was directed to the richest productive areas (Mantino *et al*., 2022), the present research also confirms that the regions that allocate the most resources to supporting investment are in the north. The regions that most use their own resources from their budgets are the autonomous provinces of Trento and Bolzano, Emilia R., Friuli V.G. and Lombardy. On the opposite side, southern regions have replaced support for business and structural investment with Community resources (which are also insufficient).

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Assunta Amato
Council for agricultural research and analysis of the agrarian economy (CREA-PB)
Contrada Li Rocchi Vermicelli - 87036 Rende (CS), Italy
E-mail: assunta.amato@crea.gov.it
Researcher at CREA PB from 2004 to today. Current research interests include Analysis of the agricultural and rural development policies, with specific topics concerning Support and Assistance to central and regional administrations in terms of evaluation and monitoring of policies for rural development; Technical-scientific support activities for Rural Development Programme and Leader Programme, Analysis of the agricultural expenditures at European, national and local level.

Tatiana Castellotti
Council for agricultural research and analysis of the agrarian economy (CREA-PB)
Contrada Li Rocchi Vermicelli - 87036 Rende (CS), Italy
E-mail: tatiana.castellotti@crea.gov.it
Researcher at CREA PB from 2002 to today. Current research interests include CAP policies, analysis of agricultural sectors, foreign trade in agri-food products and analysis of the food and beverage industry.

Giulia Diglio
Council for agricultural research and analysis of the agrarian economy (CREA PB)
Via Celso Ulpiani, 5 - 70125 Bari
E-mail: giulia.diglio@crea.gov.it
Graduated in Law (Bari, 1993). Researcher at CREA PB from March 1997 to today. Current research interests include Analysis of the agricultural and rural development policies, with specific topics concerning local development of rural areas and state aid, fisheries sector development policies and local development policies for rural areas.

Maria Assunta D'Oronzio
Council for agricultural research and analysis of the agrarian economy (CREA PB)
Via V. Verrastro, 10 - 85100 Potenza (PZ), Italy
Tel. 06 47856858 - E-mail: massunta.doronzio@crea.gov.it
Senior Researcher and Project Manager (national and international) at CREA PB. She has worked in the National Rural Development Network since 2007. Her role includes the provision of methodological support to public authorities in the rural development sector, including the agricultural and fisheries supply chain, innovation, local development issues and research on agricultural expenditure. She has participated in many national and international conferences and workshops and is co-author of national and international scientific papers published in Proceedings of Conferences, books and journals.

Franco Gaudio
Council for agricultural research and analysis of the agrarian economy (CREA-PB), Contrada Li Rocchi Vermicelli 87036 Rende (CS), Italy
E-mail: franco.gaudio@crea.gov.it
Senior Researcher at CREA from June 1990. Current research interests include Rural Development Programme, Leader Programme, Effects of CAP reform at regional level and food chains, evaluation territorial programme in Calabria, analysis of the agricultural expenditures at European, national and local level.

Mariacarmela Suanno
Council for agricultural research and analysis of the agrarian economy (CREA PB)
Via V. Verrastro, 10 - 85100 Potenza (PZ), Italy
Tel. 06 47856858 - E-mail: mariacarmela.suanno@crea.gov.it
Researcher at CREA PB from March 2017 to today. Most important research topics: Research, Technical support, monitoring of the European Fisheries and Aquaculture Fund, Monitoring activities of the public expenditure of the Basilicata Region.

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Blockchain in the agrifood sector: From storytelling to traceability fact-checking up to new economic models

Francesco Rampone[*,a], **Fabio Lecca**[a], **Paolo Giolito**[a], **Massimo Romano**[a]

[a] Associazione Blockchain, Italy

Abstract

This paper aims to demystify a lot of misconceptions still widely circulating today about the alleged properties of blockchain and then illustrate the real opportunities that this technology offers for "food system" and how it must be correctly implemented for it to be truly useful, for producers and consumers, particularly in the agrifood sector. The concepts of blockchain opportunities and incompleteness of agri-food chain projects based on blockchain technology are then explained, setting out the minimum and necessary characteristics required to make the use of this technology useful and effective (Minimum Viable Ecosystem). The process governance levels for the development and maintenance of a blockchain traceability project are then illustrated, focusing on the role and responsibility of each player in the supply chain. Finally, the structure of a blockchain solution is described, focusing on a number of structural and technological solutions by outlining the concepts of consistency checking for the validation of input data with appropriate smart contracts, and of information frameworks for the subsequent scrutiny of data in audit operations and the assignment of levels of reliability. These are essential prerequisites for a collaborative blockchain data management to pursue the objective of actual reliability and transparency of information.

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* *Corresponding author*: Francesco Rampone - Lawyer - Associazione Blockchain Italia. E-mail: francesco.rampone@associazioneblockchain.it.

Introduction

Countless agrifood supply chain projects were announced and developed on blockchain platforms (hereafter, also "BC") of which, after a successful initial promotional launch, no further word has been heard. Maybe they failed to keep their promises, or maybe, when they have, they have not contributed in any appreciable manner to strengthening consumer confidence in the high quality and origin of products.

Blockchain solutions in the agrifood sector have in fact mostly remained anchored to producers' narrative and thus confined at the traditional evocative level of advertising and corporate branding. They therefore did not significantly impact the relationship between businesses and consumers.

As a result, some questions arise about this technology's actual suitability to be usefully applied in non-purely fintech sectors.

The reason for this is mostly to be found in the misconception that blockchain would not be able to solve problems other than those of a mathematical nature. The challenge is, in short, to be able to apply blockchain's original ability to reconcile accounting items without relying on a third-party trustee to food chains. This requires a logical leap and a technology adjustment so that it may solve informative and not merely arithmetical problems[1].

1. Innovations provided by blockchain technologies

1.1. *Blockchain in a nutshell*

Blockchain technology makes it possible to decentralise accounting transactions involving – at least in cryptocurrency protocols – debit-credit relationships between several parties. Prior to 2008, no one had succeeded in designing a computerised system whereby a single set of accounts would be kept in digital format between several operators without one of them necessarily having to take on the role of ledger keeper. In other words, it was not possible to run a shared accounting system without someone taking on

1. The application of distributed ledger technologies to new consortium forms of information management enabled by BC could become one of the most interesting economic levers for the development and valorisation of agrifood products. In a global competitive environment, strongly altered by large investments in marketing, blockchain, when properly applied, makes it possible to provide guidance to consumers by shifting from a market approach dominated by advertising storytelling, where consumers are a passive target of mass communication, in favour of a fact-checking approach, where consumers take an active and conscious role in their purchase choices.

the role of trustee, i.e. ensuring the correct and regular posting of debit and credit entries in the ledger.

Blockchain, therefore, introduced for the first time the possibility, in general terms, of settling relations between traders without necessarily having to rely on an intermediary who would ensure the correct execution of payment orders. It is precisely this ability of blockchain to overcome the traditional approach of information or commercial hierarchies that makes it the ideal tool to make the data uploaded and processed on it reliable without recourse to any third-party authorities.

For this reason, BC is defined as "trustless", in the sense that it does not require for trust to be placed in a particular entity that takes up the role of ledger keeper.

1.2. *What blockchain does not do*

Two myths are most commonly referred to in emphasising the useful nature of blockchain solutions. These are unfounded concepts that lead one to believe that the adoption of a DLT solution consists essentially in uploading data and documents into it in order to certify and authenticate them.

To certify or verify a datum (or information) is to give it the status of true information[2]. Well, no data will be of a higher degree of reliability merely because it is uploaded or managed on a blockchain[3]. Indeed, nothing prohibits participants from uploading incorrect data (the expression garbage-in-garbage-out is used to emphasise this property), so that deployment of a blockchain is unjustified where this technology is merely used as a data repository. Data's higher accuracy, from a statistical appreciability

2. **Certification** refers to a process whereby the "true nature" of data is acknowledged *indirectly*, i.e., through the intervention of an authority which we trust. By contrast, **verification** refers to a process whereby the "true nature" of data is recognised *directly*, i.e., by direct observation or deduction. Unlike certification and verification, data "true nature" in a blockchain is only obtained by **validation**, i.e., by exploiting the ability of the blockchain network to enable distributed consensus decision-making protocols in the IT environment, where no certifier or verifier is therefore needed. These are, however, at least in cryptocurrency protocols, mathematical "truths" consisting in the reconciliation of debit/debit accounting entries, as such not applicable, without appropriate considerations, to data of a logical nature. We will see in the following sections how validation can also be usefully employed in a production process, provided certain properties of the blockchain distributed structure are effectively applied.

3. As will be seen in chapter blockchain makes data both resilient and unchangeable. This is why reference is also often made to the concept of "notarisation". However, notarisation also implies a fiduciary element, the notary public or notarising public official, which by its very nature is completely absent in a blockchain protocol.

perspective, only depends on the system overall design, the controls that are implemented, and the reputation of the parties responsible for data entry, as well as the reliability of the IoT devices and other complementary technologies employed (*contra*, Tripoli & Schmidhuber, 2018, § 3.2.5, p. 15).

Authenticating some data (or documents) means identifying their specific origin or author. Well, blockchain does not confer any certainty as to the origin of data or documents (prior to entering the blockchain)[4]. On the contrary, in the digital environment, authentication is performed widely and very effectively, at least in Italy, by certified electronic mail (PEC) and digital signatures (or other types of qualified or advanced electronic signature or other process meeting the requirements laid down by AgID (Digital Italy Authority) in Article 20 of the Code of Digital Entities (CAD), paragraph 1-*bis*). However, only such systems may constitute evidence against perjury and thus bear a greater probative weight than data uploaded onto blockchain[5].

1.3. *When blockchain is not needed*

Often, when describing the benefits of using a blockchain solution, reference is made to its achievements and alleged prerogatives or characteristics which actually belong to any well-constructed computer system in comparison to which blockchain actually adds nothing. Document digitisation, data immutability, disintermediation, smart contracts, are some, among many, locutions misused when talking about BC.

1.4. *Blockchain Opportunities (BCOs)*

Ownerlessness. This is perhaps the most typical feature of blockchain. The platform performing the relevant protocol and storing transaction data may be a network of peer servers. Each server (node) is potentially owned by a different participant who has no greater privileges than the others (unless

4. Blockchain is used in Self Sovereign Identity (SSI) projects, i.e. in solutions that enable the identification of a party through verification of one or more verifiable credentials. However, these are implementations in which blockchain is neither necessary nor functional for identification per se, but used to enable a decentralised and autonomous management of statements.

5. We have been waiting for years for the Guidelines that AgID should have issued by May 2019 in performance of Article 8-ter of Legislative Decree 35/2018 (the *"Simplification Decree" 2018*) to make written smart contracts effective. These are technical rules that will probably never see the light of day until after this rule is reworded, as at present it creates quite a few interpretative doubts.

otherwise provided for under the shared protocol). In this perspective, in a blockchain solution there is no owner of the hardware/software infrastructure and the database, nor is there a governance pyramid structure, which results in enhancing the participants cooperation and empowerment.

Open execution. Data are processed according to a shared protocol (loaded on each node), which is as transparent and unchangeable as the data, so that observers outside the network can verify that the system's output is obtained by performing the rules stated by participants[6].

Irrevocable open data. The visibility of the data being processed on blockchains can be set in an irrevocable and verifiable manner by regulating the degree to which they can be displayed for the benefit of nodes, participants and third parties, while respecting the protection of personal data or the protection of confidential commercial information.

Resilience. The data cannot be removed or modified (except under some specific protocols)[7] as they are uploaded onto an indefinite number of nodes (servers) and managed by an equally indefinite number of autonomous and independent (and if necessary, also anonymous) players. Any opportunistic manipulation of data by a node will create a mismatch with the data held by other nodes and will therefore be rejected by the network[8].

Validation. The entry of new data into a blockchain may be precluded if they conflict with data already on it or do not comply with certain input parameters or protocols. Data, in fact, may be subject to validation rules (actual smart contracts) that are transparent and cannot be circumvented or abusively modified, so they act as filters ensuring consistency of the data uploaded onto a blockchain. Validation is therefore the emerging property in the BC environment due to the application of smart contracts in open execution.

Unique data "historicising" *(append only*). Data are uploaded onto blockchains in chronological sequence to form a single irreversible time

6. Open execution is therefore the possibility offered by blockchain to make data processing transparent by allowing anyone to verify the reliability of participants' statement. (see Salah, Damiani, Al-Fuqaha *et al*., 2018).

7. There are some blockchain protocols that make it possible for specific nodes to delete data (Florian *et al*., 2019, pp. 367-376). In such cases, however, this function is in any case shared among participants who find it useful to confer specific powers to some of them.

8. The data acceptance criterion on blockchain generally responds to majority principles (as is the case, for instance, in the bitcoin protocol), whereby data only enter the network where they are presented in an identical manner by the majority of nodes in the same time frame. Any "false" data entry therefore implies the existence of a fraudulent agreement between the majority of participants. This is the "51%" attack case. The sheer number of nodes, together with their autonomy and independence, has so far prevented the bitcoin network (by far the most popular and extensive blockchain) from being the target of such an attack.

vector[9]. Their temporal order, therefore, cannot be changed and develops a unique history-line of inputs and outputs as well as their processing protocol, all indelibly stored on blockchains. (Khaqqi *et al.*, 2018; Sharma, 2017).

Tokenisation (*uniqueness*). This is an effect obtained by combining the three previous requirements altogether. On blockchains, "unique" digital documents can be created, i.e. which cannot be duplicated or improperly modified. These characteristics, conferred on computer documents, represent the real novelty element introduced by blockchain and enable the creation of tokens and cryptocurrencies[10], the concept of originality and uniqueness is in fact introduced in the digital environment. Since nodes share the same information, such information may assign a right to someone in a clear manner, so that duplication of that right in favour of someone else is not possible[11].

1.5. *BCO in supply chain*

By virtue of the above-mentioned properties, the information "falling" into a blockchain may give rise to an invariable set of data (which we call tokens) that can only be updated or modified according to a shared protocol on the same blockchain. In a broad sense, we may call this protocol a "smart contract". Where these data are associated with supply chain products, i.e. they refer to actual or potential real-world objects (e.g. an EVO bottle or a load of tomatoes), we can by analogy consider them a "digital representation" of such products, of an informative and descriptive nature, which is reliable as it is shared, non-duplicable and non-falsifiable (i.e. not modifiable following its entry into BC). The degree of reliability, however, depends on the actual implementation of a BCO.

We shall examine in more detail in the next paragraph the blockchain's properties described above for a helpful application thereof in the agrifood supply chain.

As we have seen (§ 1.4), "validation" is an emerging characteristic of a blockchain environment. This refers to the protocol's suitability for execution in an automatic and transparent manner (open execution). In the

9. The "history" uploaded onto a blockchain is unique in the sense that no alternative data sequences may be written in the blockchain. By contrast, this is possible with other technologies with which the availability of data is in the hands of a single party that can opportunistically change the data history or the content of documents.

10. The success of bitcoin and the bitcoin protocol rests precisely on the resolution in a digital environment of the "double-spending problem", i.e. the impossibility, before then, of enabling credit circulation through an online cash system (Nakamoto, 2008).

11. A note receivable, like a banknote, is nothing more than a non-reproducible and non-falsifiable document that grants a receivable to its holder.

Bitcoin network, for example, data are subject to an accounting balance check (the transaction balance, net of change, must be zero). Similarly, in a food chain protocol we can execute a validation of a "material balance". Validation may also take the form of consistency checks, i.e. the comparison of data of different nature and origin, verification of their consistency against shared parameters, the subsequent attribution of a reliability index to the data submitted for verification, and the performance of inspection and audit activities in order to verify compliance with the specifications and fairness of the players' conduct. For example, the production data of a wheat field must be consistent with the upstream invoice data of the plant protection products used or with the weather data from sowing to harvest and, at the same time, with the downstream logistics data of the carrier and the retailer's sales data. If any inconsistency is identified, checks or requests for an explanation could be made by the consortium owning the quality mark that is using the relevant blockchain solution.

2. Transparency and consistency of information

We have seen that blockchain makes it possible to draw up a "story" of the supply chain that is trustworthy, immutable, transparent (on stakeholders' roles and obligations) and accessible to anyone provided that BCOs are properly implemented to the maximum extent.

Let us now see what are the minimum BCOs that must be implemented to justify the adoption of a supply chain BC project.

2.1. *Minimum Viable Ecosystem.*

When it comes to BC, it is crucial to remember that implementation of a BC system is not eminently IT-related: BC is not a new way of doing what was done before, but a technology that enables new conducts previously not possible in a digital environment. In other words, implementing a BC project means first of all deciding to organise information and its management on IT tools in a different way, involving other players, competitors even, thus pooling some resources and repositioning competition at a higher level with beneficial effects on the entire market segment in which the project operates.

In this perspective, the MVE not only concerns the structure of the IT platform on which the BC project rests, but shall also take into account the network of relationships and the value of individual network participants' contributions.

Let us see in the following three paragraphs the MVE elements in a BC project.

2.1.1. Multiple C-type stakeholders

The Bitcoin protocol bases its ledger trustworthiness on its peer-to-peer structure, i.e. a horizontal structure in which stakeholders' equal participation is the keystone that makes it possible to avoid having to rely on "middlemen", i.e. trustees tasked with ensuring the correct posting of accounting information relating to payment arrangements.

Such structure is fundamental in any BC project, and therefore also in a supply chain project. It is the first BCO – "ownerless" – without which there is no reason to deploy a BC solution. That is, it makes no sense to adopt a BC solution without taking decision-making power (transaction validation, data storage and "historicisation") away from a trustee and distributing it "on a democratic basis" to a large number of participants.

We can therefore say that the first element that the MVE in a BC project must certainly possess is of a structural nature: multiple C-type stakeholders.

2.1.2. Multiple W-type stakeholders

However, for BC to be useful in a non-accounting project – such as a supply chain – a data governance shall be implemented that includes a large number of W-type stakeholders. In such projects, implementing a protocol with only one W-type stakeholder would be just as irrational as implementing a BC platform consisting of only one node. A BC's strength specifically lies in its capacity to create equal relationships among participants where no economic, legal and informational hierarchies apply.

The second requirement of a non-purely-accounting BC project's MVE is therefore the large number of W-type stakeholders[12]. This is not a BCO specification, but a necessary precondition for executing validation smart contracts: only if the data subject to validation come from autonomous and independent sources does it make sense to cross-check the data, such that the write type stakeholders provide their contribution, in an uncoordinated but harmonious manner, to creating a chain of validations, in which each entry is consistent with the previous and subsequent entries (Di Cillo 2021).

12. The W-type stakeholder element is typical of non-accounting BC projects. On the contrary, in the Bitcoin protocol, which is a typical BC accounting protocol, there is no need for several W-type stakeholders as validation is only carried out as a result of a mathematical check (performed by smart contracts, or the C-type stakeholders' tools) and not of consistency with other data provided through previous C-type stakeholder inputs or resulting from the output of smart contracts.

2.1.3. Information consistency checks

The third and final MVE requirement – but no less important – that a BC system must possess to be worth using is the implementation of computer protocols (smart contracts) to assess the consistency of incoming information on a BC.

BC was created as a solution to get rid of the fiduciary aspect that all centralised management systems have. More generally, it allows for the regulation of financial, legal or informational relationships between participants without the necessary involvement of third party trustees (*middlemen*) (Pergamo, 2020). Therefore, adopting a BC solution while maintaining this fiduciary component makes no sense[13].

Therefore, limiting the MVE to type C and W-type stakeholders alone is not sufficient. Data entering BC must be subject to transparent and automatic IT protocols (open execution), which work as a "filter", preventing the entry of any incorrect data (because, for example, they do not comply with an accounting balance constraint) or automatically assigning them a reliability label showing their degree of consistency with respect to data already populated on the BC.

A third MVE requirement related to data governance may thus be identified: implementation of consistency checks on incoming data on the BC by means of appropriate smart contracts.

2.2. *Complete and incomplete BC systems*

On the basis of the considerations outlined in the previous paragraphs, a complete BC system may be defined as including an MVE consisting of:

- large number of C-type stakeholders;
- large number of W-type stakeholders (autonomous and independent);
- smart contracts that perform consistency checks on the information uploaded into BC.

Conversely, a system is defined as incomplete when it lacks at least one of the above-mentioned elements.

Of course, a BC system may be more or less complete depending on the number of stakeholders or the reasonable design of smart contracts. In

13. This is the main issue of the BC projects examined by the authors of this contribution. In all cases, while use is made of existing platforms that fulfil the first MVE requirement, data entry is then reduced to the initiative and responsibility of a single operator, which inevitably conflicts with the trustless goal that should drive the development of any BC project.

the following paragraphs we will therefore see some examples of how the complete nature of a non-accounting BC system may be maximised[14].

3. Verifiable information framework

In a BC project, validation is performed by smart contracts in open execution mode.

This makes it possible to any party with sufficient technical expertise to ascertain how a smart contract's algorithm performs validation of incoming data on BC.

However, without an *ex ante* statement of how the relevant smart contact should perform data validation, it is not possible to verify whether it does exactly what the compiler intended, nor whether the algorithm's inputs are timely, are of the expected type and come from the correct input point.

In other words, R-type stakeholders, to be able to verify that data validation has been performed accurately or according to a shared logic, must be able to understand the reasons behind the choice of rules and functions implemented through smart contracts. In fact, as we have seen, in a supply chain project, data validation checks do not pursue the purpose of preventing incorrect data from entering BC, but rather assigning them a specific degree of reliability. In order to ensure transparency and trust in favour of R-type stakeholders, not only do they require to be provided with information on what happens on a BC, but also on what *should* happen; that is, to state, in an immutable manner (on a BC precisely) the choices that have been made at the level of corporate governance and data governance with regard to the network's structure, the rules of the specifications to be complied with, the project objectives, and therefore the useful nature of the criteria and parameters adopted in the smart contracts validation operations in order to achieve these objectives.

14. Bitcoin is a complete system, as it is an open network in which anyone can participate with type write and type commit prerogatives without the need for authorisation from any higher authority and in which no transactions are allowed that do not comply with budgetary constraints (verification of the settlor's funds, sum of transactions net of commissions amounting to zero, change and mining). In contrast, other projects defined as blockchain-based, even though developed on open DLT ("permissionless") platforms, are incomplete systems as they do not involve the participation of multiple W-type stakeholders and the input data are uploaded by or under the authority of a single party (usually the owner of the brand that promoted the BC project), nor are the data subject to automated checks of any kind, thus addressing the market in a manner not different from the usual storytelling through advertising.

Therefore, in order to raise the level of completeness of a BC system, it is best to provide for more than mere transparency of the validation protocols of the relevant smart contacts and metrics (open execution), including by publishing declarative documents onto the BC, drafted in a structured form ("verifiable information framework" or "technical governance framework") so as to make them accessible on multiple applications.

In other words, the system objective is not only to provide consumers with information on "who did what", but also **verifiable information** on whether the "who" and the "what" are accurate, i.e. whether the process (the BC transaction) has been carried out in compliance with the roles, permissions and policies set out in the production specifications and supply chain contracts that ensure the products' quality and origin[15].

4. Digital twining

When describing the BC projects applied to supply and distribution chains, reference is often made to "digital twining" to imply that on a BC it is possible to create "digital twins" of physical assets (the expression "digital representation" is also often used). The underlying idea is that a sort of entanglement may be created between the two entities, the real one and the IT one, whereby the development of the former is reflected in an isomorphic manner on the latter (Notland, Hua, 2017).

In reality, twining and entanglement are two different aspects, and talking about digital twining is definitely misleading[16], often generating a series of erroneous deductions that do not help to accurately frame BCOs and risk pre-emptively making a project fail or be useless.

15. Only a few international working groups are discussing the development of governance frameworks similar to the one presented in this paper. These include the Hyperledger Aries RFC 0430, proposed commentary by Daniel Hardman (Chief Architect of Evernym, recently acquired by Avast, and technical board member of Sovrin) and the IEEE P2145 "Blockchain Governance Standards Working Group". The ISO/TC 309 "Governance of organisations" group as well as the groups related to Self-Sovereign Identity (SSI) technologies dedicated to the development of governance frameworks and data agreements on decentralised systems such as the Trust Over IP Foundation (ToIP) are of a less specific nature, but noteworthy.

16. The expression was invented well before the advent of BC (Gelernter, 1991) when it meant the digital modelling of a product and its components to manage the production stages, verify the assembly stages and test a product's strength and functionality already at the design stage.

4.1.1. Singling-out

In order to associate a product with a token, one must first distinguish it, i.e. make it unique, just as unique is the token with which it is associated, and thus make it different from all other similar products with which it might otherwise be confused.

A product may successfully be singled-out by identifying some intrinsic characteristics (e.g. the veins of a diamond), or affixing of a material tag on the product.

In all cases, the singling-out must lead to a stable outcome, i.e. it must be maintained until consumption or at least until sale to the final consumer, i.e. until the moment when the distinction is no longer necessary for tracking purposes.

A product singling-out obtained by reference to its intrinsic characteristics is by definition stable and is maintained throughout the life of the product until any alteration (due to consumption or damage). In this case, therefore, the unique connection between the product and its token is not problematic from a technical perspective, except for identifying the product unique characteristics, i.e. regarding the tool required to detect these characteristics.

Applying a QR-Code on a product – a solution often used in supply chain BC projects – in no way solves the singling-out problem since a specific QR-Code may be easily cloned and applied on an indefinite number of different products.

4.1.2. Entanglement

As for the reliability of the information associated with a product's digital twin (the second issue mentioned at the beginning of this paragraph), since there is no automatism between facts about a product and the information about those facts uploaded into BC, there is no guarantee that, even if the singling-out problem were solved, the information flow would not be intercepted and modified for fraudulent and opportunistic purposes.

We have already illustrated, however, how to solve (strongly mitigate) this issue in the preceding paragraphs, i.e. by resorting to an information hierarchy that is as horizontal (distributed) as possible, such that it is not necessary to place trust in one or a few players, but in which the various information sources (operators and IoT) contribute autonomously and independently to the writing of a single, coherent story. This means that it is impossible for the story to be made false without a fraudulent agreement between a large number of stakeholders (an agreement, moreover, that would require continuous fraudulent conduct in order to conceal the story inconsistency over time).

4.2. *Reversing the terms of the relationship*

Digital twining should not (only) be understood as a real-to-virtual operation, i.e. as if information from the real world would add to, and characterise the digital twin. This is certainly true and necessary, but does not constitute the essence of "twining".

Entangling a physical asset with a digital asset (token) works in the opposite sense, i.e. in a virtual-to-real sense: only events affecting the token can have an instantaneous effect on the life of the physical asset associated with it.

From this perspective, a digital twin is nothing more than a token whose possession and transfer certifies the holder's ownership (or other right) over the physical asset it represents. Product entanglement, therefore, takes place on a legal level[17].

4.3. *TAG features*

A tag, just like the token it refers to, must be durable, unalterable (not falsifiable) and non-duplicable. That is, it must be permanently associated with one product, and one product only: a tag that is easily reproduced on other products or easily modified or removed is not capable of conferring a unique trait to a product and, therefore, ensuring its unique association with a given token on BC.

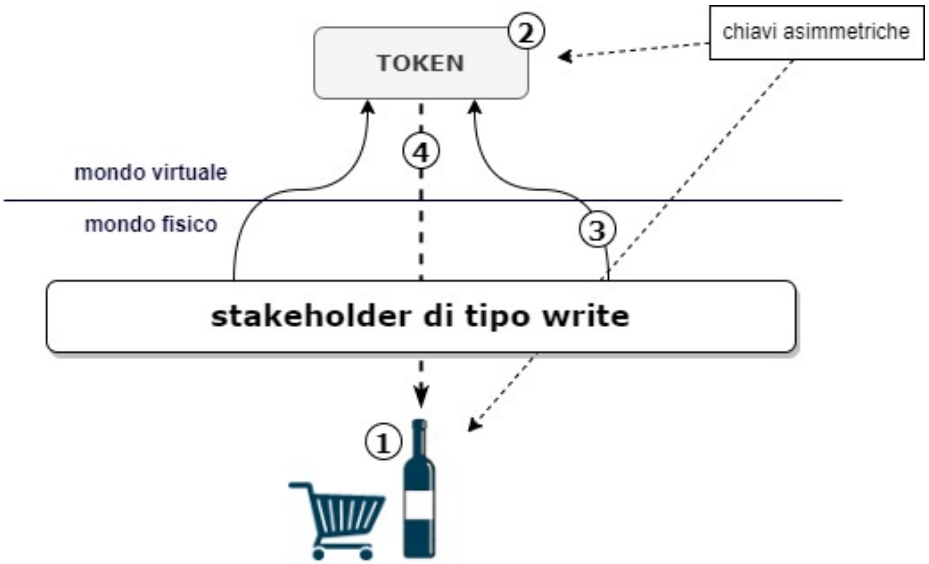
The features of material tags can therefore be summarised as follows:

- **Originality**. Tags must be produced through means that prevent the creation of two identical tags.
- **Uniqueness**. Tags must not be reproducible on other products (except at a cost that would make the reproduction operation unworthy)[18].

17. A token is a unique digital asset, i.e. a digital document, which, thanks to BC technology, is durable, and may not be subject to forgery, "historicisation" and duplicability. The concept has already been mentioned in about BCOs (tokenization item), and thus the possibility of obtaining a digital certificate having all the properties of traditional physical certificates. For digital twining to take place, the same unique characteristics of the token must be implemented in the physical product it is to represent.

18. The tag uniqueness (non-duplicability) can also be achieved "*ex post*", i.e. through endorsement of the tag at the time of purchase when the product is checked out at the counter. In such a case, the cashier acts as the last W-type stakeholder and the endorsement basically consists of updating the information associated with the token by qualifying the product as "sold" (no longer saleable). Any fraudulent duplication of the token would prevent the counterfeited product from being successfully checked out at the counter and, therefore, from being sold (unless it is sold before the original product which would, in any case, reveal the fraud).

- **Immutability**. The tag must not be modifiable (except as provided for by any update protocol).
- **Incorporation**. The tag must not be removable from the product except at the cost of its destruction or identifiable alteration.



Singling-out. The product is identified by its intrinsic properties (e.g. the veins of a diamond) or marked with a **material tag** that makes it unique.

Twining 1. An association is created between a product, or the tag applied to a product, and a token.

Twining 2. W-type stakeholders (directly or through IoT) collect the product information and upload it piece by piece onto BC (information is associated with the token and data are validated through smart contracts);

Entanglement. The token not only contains or refers to a truthful and up-to-date history of a product (campaign journal), but also allows, by simply being circulated (by way of transactions), the establishment, modification or cancellation of specific subjective legal situations concerning the product.

5. Applicability: valorisation of the traditional agri-food chain in a blockchain-based traceability system

Current regulatory references provide for specific provisions concerning the traceability of foodstuffs along the entire production chain as well

as defining mechanisms for food withdrawals and recalls. In particular, Regulation (EC) N. 178/2002[19] provides for the adoption of a traceability system that makes it possible to identify the origin and route of foodstuffs throughout the chain in order to guarantee food safety and consumer health protection. Food business operators are required to take appropriate measures to ensure food safety and to notify the competent authorities of any risk to consumer health. The competent authorities, in turn, are responsible for verifying compliance and managing food-related health emergencies.

6. From storytelling to fact-checking, process and system innovations

According to Cirianni *et al.* in ISTAT Working Paper 4/2021 - "Struttura produttiva e performance economica della filiera agroalimentare italiana" (p. 15): "*Farms within the agri-food chain and compared to the national average have low intermediate cost values on turnover, because they have very low sales volumes and are small in size, many of them are unable to adopt adequate marketing policies and, above all, to penetrate foreign markets*".

The shrewd and reasoned application of blockchain technologies and in particular of the new distributed governance models that can be financed through the funds earmarked for the implementation of market policies and the implementation of the Farm to Fork strategy, can counteract the competition contexts strongly altered by large investments in marketing to focus attention on product quality (excellence of Italian farms). The hoped-for technological and cultural transformation of agricultural enterprises could become the primary socio-economic enabler for transitioning from storytelling approaches to effective and comprehensive fact-checking, provided that it is accompanied by the planning of ministerial campaigns to raise consumer awareness about these aspects.

Following the realisation of this marketing transformation, the foundations will be formed to generate a virtuous circle along which the mere technical possibility of being able to verify and prove the truthfulness of traceability information should generate a demand for access to this information by shifting the consumer's attention to the qualities and values of the product rather than its narrative.

Indeed, we can say that blockchain technologies produce holistic[20] value within the food system, given their fundamental characteristic of being able

19. Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32002R0178.

20. Whereby the overall system has value greater than the sum of its parts.

to organise and re-engineer the relationships among system actors through a technology that supports the disintermediation of the trust.

Through them, consumers, auditors, regulators, and other participants are thus empowered to use or produce information using verifiable, distributed, and independent mechanisms that would otherwise be impossible to achieve. From the improved control of processes and data, relying on *a single source of reliable information shared between the parties* (Single Source of Truth), will come an improvement in business efficiency, thanks to the automation, independence and speeding up of controls.

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Francesco Rampone
Associazione Blockchain Italia; La Scala Law Firm
E-mail: francesco.rampone@associazioneblockchain.it
Lawyer with over 25 years' experience in intellectual property, information technology and data protection. President of the Italian Blockchain Association. Head of the TMT department at La Scala Law Firm.

Fabio Lecca
Chief Technical Officer
Associazione Blockchain Italia; Araneum Group S.r.l.
E-mail: fabio.lecca@associazioneblockchain.it
Computer scientist with over 25 years of experience, he is the Chief Technical Officer of Araneum Group srl working on blockchain and open source projects and counsellor of Associazione Blockchain Italia.

Paolo Giolito
Associazione Blockchain Italia; CA Indosuez Wealth (Europe)
E-mail: paolo.giolito@associazioneblockchain.it
He has over 25 years in Wealth Management (Deutsche Bank, Credit Suisse, CA Indosuez), 10+ years in Italian innovative ecosystem as a Business Angel (IAG, Club degli Investitori, IBAN, A4I) and in partnership with most important players (LeVillage, Doorway, Spartan Capital, Pariter Partners, StartupWiseGuys). Vice President of the Italian Blockchain Association.

Massimo Romano
Associazione Blockchain Italia; Innova4 S.r.l.
E-mail: massimo.romano@associazioneblockchain.it
Bio-bibliographical note: Senior IT Consultant and R&D Manager with over 20 years of experience in designing, redesigning and integrating business information systems using blockchain technologies in recent years. Co-founder of the Italian Blockchain Association and Director of the blockchain-based traceability working group.

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Financing for sustainable food systems: The role of the vending sector

Alberto Bertossi[*,a], **Stefania Troiano**[a], **Francesco Marangon**[a]

[a] University of Udine, Italy

Abstract

The agribusiness sector needs substantial funding to initiate an ecological transition involving healthy diets and the creation of local circuits and linkages. One sector that has yet to be studied from this perspective is vending, whose importance is confirmed by its profits, especially in Italy. At present, the vending sector cannot be considered sustainable as it rarely contributes to the development of healthy diets and local economies with low environmental impact. There are cases of products with suitable characteristics that can push the sector towards more sustainable dynamics, but such products often do not achieve the success they deserve for various socioeconomic reasons. Access to financial investment or alternative modes of financing could help small and medium-sized enterprises in the sector overcome these difficulties.

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* *Corresponding author*: Alberto Bertossi - Department of Economics and Statistics - University of Udine - Via Tomadini 30 - Udine, Italy. E-mail: alberto.bertossi@uniud.it.

Introduction

The Covid-19 pandemic has disrupted food systems worldwide, affecting food security and the nutrition of rural and urban populations and challenging the resilience of the global food system (Clapp & Moseley, 2020; Nemes *et al.*, 2021). The severe blow inflicted on the entire food sector by the pandemic, along with the climate change crisis, exposed the need to develop food systems that are healthier, more sustainable, equitable and resilient (Bakalis *et al.*, 2020; Steiner *et al.*, 2020). Moreover, their effects made it essential to create stronger policies designed to increase economic funding and to make access to such funding easier for food companies (Rockström *et al.*, 2020; Steiner *et al.*, 2020). The goal is to help such enterprises in the transition from 'old way' business models towards more sustainable ones that are capable of reducing the high social and environmental burden associated with supply chains, in line with current international agreements (i.e. Agenda 2030) and European strategies (i.e. From Farm to Fork) (European Commission, 2020). The total amount of investment required each year for the transformation of food systems by 2030 is estimated to be $300-350 bn (Steiner *et al.*, 2020; The Food and Land Use Coalition, 2019), which is divided into 10 key aspects: healthy diets, productive and regenerative agriculture, protecting and restoring nature, healthy and productive oceans, diversifying the protein supply, reducing food loss and waste, local loops and linkages, harnessing the digital revolution, stronger rural livelihoods and gender and demography (The Food and Land Use Coalition, 2019).

The healthy diets dimension plays a key role in the ecological transformation of our society by 2030. Thus far, current food systems (geared towards the production and consumption of high-quantity, affordable foods that are of low nutritional value) have resulted in huge hidden costs, especially with regard to human health. Indeed, they are a major cause of malnutrition and health diseases, in particular obesity (Abdeen *et al.*, 2017; FAO, 2018; Guyomard *et al.*, 2012; Hall, 2018; NCD Risk Factor Collaboration, 2016), cardiovascular diseases, diabetes and cancers (Danaei *et al.*, 2014; Pearson-Stuttard *et al.*, 2018; Wang *et al.*, 2011). A simulation performed in 2011 revealed that if there had not been a prompt change in the growth rate of such healthy diseases, the combined medical costs associated with their treatment would have increased by $48-66 bn/year in the USA and £1.9-2 bn/year in the UK by 2030 (Wang *et al.*, 2011). Incoherent policies and guidelines, current marketing strategies and public investment decisions have been the main drivers of the high consumption of unhealthy foods (The Food and Land Use Coalition, 2019).

Shifting to human and planetary health diets requires annual investments equal to nearly $30 bn, which can, in turn, lead to nearly $2 tn of annual

business opportunities (The Food and Land Use Coalition, 2019). Such investments are fundamental to 1) orient people's diets towards more protective food, limiting the consumption of unhealthy and ultra-processed food high in salt, sugar or saturated fats; 2) support small and medium-sized enterprises in adopting business activities that prioritise the availability, desirability and quality of safe and nutritious food; 3) redirect public finance towards healthy foods, while discouraging at the same time the production and consumption of unhealthy food through taxes and fiscal transfers; 4) stimulate innovation to harness the power of business and orient it towards nutritious and sustainable food product lines thanks to access to investments; and 5) promote behavioural change through new marketing strategies guaranteeing better visibility for healthy and nutritious foods (The Food and Land Use Coalition, 2019).

Another dimension to consider regarding the ecological transformation of our society is building local loops and linkages. According to the Ellen McArthur Foundation (2019), 80% of all food will be consumed in cities by 2050. Nowadays, the production of food intended for cities is highly linear, with huge environmental and social impacts mainly caused by conventional farming practices that prefer quantity over quality (Ellen McArthur Foundation, 2019). Moreover, such production is usually located beyond regional or national boundaries, generating additional environmental impacts in terms of greenhouse gas (GHG) emissions during transportation. Despite the proliferation of initiatives, there are still major barriers to overcome to initiate such a transformation, including the absence of local sourcing strategies by major retailers, the shortage of infrastructure and logistic investments (The Food and Land Use Coalition, 2019), the low level of economic and financial autonomy of farmers (Pereira *et al*., 2018) and a lack of political support (Živković *et al*., 2022).

The annual economic investment required to transition towards strong, efficient and local sustainable food economies amounts to nearly $10 bn, which can, in turn, lead to nearly $215 bn of annual business opportunities by 2030 (The Food and Land Use Coalition, 2019). Expanding local supply will mean shorter distribution networks, resulting in a decrease in the related GHG emissions (Enjolras & Aubert, 2018); the wider and faster availability of nutritious food to help tackle obesity and undernutrition (The Food and Land Use Coalition, 2019); economic gains from the lower transport costs of shorter supply chains, direct sourcing from local farmers and the creation of new jobs through product innovation (Galli & Brunori, 2013); food security by reducing import dependency on raw materials grown at the global level (The Food and Land Use Coalition, 2019); and the promotion of a closer relationship between producers and consumers (Enjolras & Aubert, 2018).

To prepare food systems for a sustainable transition, it is imperative to identify those industrial sectors that have significant negative social and environmental impacts and then redesign them and adapt them to sustainability principles. One such sector that ought to be reconsidered and redesigned for the future is vending. Thus far, research studies that discuss how to transform the vending sector based on sustainability principles are quite scarce. Therefore, the aim of the present study is to fill this research gap by considering 'healthy diets' and 'building local loops and linkages' as future possible development perspectives for the Italian sector, which is the largest market among the European member states. This study is organised as follows: 1) an introduction to the role of vending in our daily lives, its economic importance at the European and Italian levels and the reasons why it cannot be considered a sustainable sector; 2) the presentation of an Italian case study about a local healthy sweet snack as an alternative to traditional vending food and a discussion of the main barriers that the promotion and sale of this sustainable snack currently face; and 3) discussion and conclusions regarding what alternative financial model, along with policy commitments, can be used to guarantee that sustainable snacks developed specifically for the vending sector obtain the success they deserve.

1. The vending sector

The vending sector is nested within the food supply chain, and its role is to provide low-cost food and beverages for immediate consumption. Although other retail services exist (e.g. supermarkets, grocery stores, coffee shops), vending has two unique characteristics: it is widespread in cities within public (e.g. universities, hospitals), private (e.g. companies, offices) and hybrid (e.g. malls, gyms) spaces, and it provides – through vending machines – quick and easy access to different types of food and beverages while meeting consumer needs. Since its global spread during the 1960s and 1970s, the vending sector has owed its success to its ability to exploit certain social dynamics. For example, vending machines are not merely a way to supply food and beverages, but they also serve as meeting places for people to exchange ideas while taking breaks from working or studying. When humans work or study intensely for a long time, their brains require about 12% more energy than usual to do the extra work, and carbohydrates (especially sugar) are their quickest source of energy (Peters, 2019). This is why many feel an irresistible desire for sweets on such occasions, and vending machines often present the nearest solution. Another situation in which people often use vending services is when they are bored. Boredom is powerful enough to encourage people to have a snack when they are not otherwise able to occupy their minds (Braden

et al., 2018; Koball *et al.*, 2012). This is why vending machines are always placed close to spaces such as waiting rooms, airports or hospitals. Last but not least, vending machines are a convenience, as they allow people to find a wide variety of foods and drinks without having to remember to bring them from home.

The European and Italian markets

The ability of the vending sector to reach any geographic region while providing people with what they want when they want it has created considerable economic gains. It is estimated that the total revenue of this sector in Europe reached €17 bn in 2019 (EVA, 2020). Sales of hot beverages represented the driving force, accounting for nearly €11 bn of revenue (62.5% of the total), followed by cold beverages (22%), snacks (12.5%) and food (3%) (EVA, 2021). Overall, in less than 10 years (2011–2019), the European market significantly expanded its offering within a higher number of public and private sites, increasing, in turn, its revenues by 21%. However, the entire sector has been heavily affected by the Covid-19 crisis owing to the closure of sales channels, with significant falls in both the number of vends and profits. In 2020, the total European revenue of the vending sector is estimated to have dropped by 30% (VendingMarketWatch, 2021) compared to the 2019 figures.

Italy is the largest vending market among the European member states, with more than 800,000 vending machines across all its regions. According to a market analysis, the total revenue of the sector in 2019 reached nearly €2 bn, with nearly 5 bn products sold. As in all other European states, the Italian market was also highly affected by the Covid-19 crisis in 2020, with drops in both consumption and revenue of 30.4% and 31.95%, respectively. Nevertheless, recent economic data show a slight, albeit slow, recovery of the sector due to the effects of the Covid-19 crisis, which is, above all, linked to new habits of use of the environments most closely linked to the sector, such as schools, hospitals and offices. Indeed, despite still being substantially lower than the 2019 figures, in 2021, the total revenue (€1.4 bn) and consumption (more than 3.5 bn) increased at rates of +12% and +10%, respectively, compared to the 2020 situation. Similar to in the pre-pandemic situation, hot beverages represented the largest market share in 2021, equal to 68% of the entire revenue (nearly €950 million), with coffee being the most consumed product (more than 2 bn consumptions). Cold beverages (i.e. mineral water, soda, tea, energy drinks, juices) comprised the second most consumed product category, sharing 18% of the market, with a total revenue of almost €250 million. Finally, the third most

consumed product category was sweet and salty snacks, sharing 14% of the market, with a total revenue of nearly €200 million.

A still unsustainable sector

Financing for sustainable food systems: the role of the vending sector

Despite the slow economic recovery, the Covid-19 crisis highlighted how static and fragile the vending industry is in the face of large-scale imbalances. This event has led the industry's major associations to think about how they can transform it and make it agile in view of future challenges. A topic that has recently emerged in Europe (EVA, 2021a, 2021b) and Italy is the greater attention being paid to business aspects related to sustainability, particularly to human health and the environment. The actual vending sector cannot be considered sustainable for two main reasons. The first one is linked to the type of products sold and the second one to its supply chain.

Since the 1960s and 1970s, people have considered vending machines as one of the symbols of modern consumerism as well as one of the possible contributors to unhealthy eating habits and, consequently, the increase in diseases (Segrave, 2002). This accusation was supported in subsequent years by well-established nutritional and clinical evidence of 1) the very low nutritional profile of the foods and beverages sold (i.e. high in energy, saturated fat or trans fats, sodium and/or added sugars and low in fibre and/or vitamins) (Byrd-Bredbenner *et al.*, 2012; Faris *et al.*, 2021; Grech *et al.*, 2017; Rahi *et al.*, 2022) and 2) a possible relationship between the consumption of such products and the risk of developing overweight and obesity (Bertéus Forslund *et al.*, 2005; Fox *et al.*, 2009; Ludwig *et al.*, 2001; Malik *et al.*, 2006; Minaker *et al.*, 2011; Raposo *et al.*, 2018). A recent study also revealed a significant lack of sustainable food products within vending machines (Bertossi *et al.*, 2022), that is, food products that are not only 'nutritionally adequate, safe and healthy' but also 'protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable, while optimizing natural and human resources'.

Despite such evidence, over the years, companies have had to constantly source huge quantities of such junk foods and make them quickly available to meet the exponential increase in demand. The production of massive quantities requires huge amounts of raw materials grown mainly in developing countries, where working conditions are often inadequate to provide people with a decent lifestyle (this is the case, for example, for four main raw materials used in vending products, i.e. cocoa, sugar, coffee and

tea) (ILO, 2017, 2020b, 2020a; Whoriskey & Siegel, 2019) and intensive cultivation techniques are used, causing the degradation of natural systems. Along the food supply chain, agriculture is responsible for GHG emissions, land use, imbalances in the soil carbon cycle and the eutrophication of oceans and freshwaters (Amundson *et al.*, 2015; Crippa *et al.*, 2021; Notarnicola *et al.*, 2017; Ritchie & Roser, 2020). The environmental impacts associated with the remaining supply chain phases (i.e. industrial processing, transportation, packaging, retail, use and end of life), although considerably lower (Notarnicola *et al.*, 2017), are equal to 18% of the total emissions of the entire system (Ritchie & Roser, 2020).

2. Learning from the past to shape the future

Evidence of the high degree of unhealthiness of food products sold in vending machines was (and still is) the main driving force behind several types of interventions that aim to encourage consumers to make nourishing choices, the most common of which concerns the replacement of unhealthy products with healthier solutions (Gorton *et al.*, 2010; Grech & Allman-Farinelli, 2015; Griffiths *et al.*, 2020; Yan *et al.*, 2019), sometimes combined with the use of promotional signs (e.g. labels) (Hua *et al.*, 2017; Rosi *et al.*, 2017; Viana *et al.*, 2018). On the other hand, in terms of the environmental unsustainability of the sector, only one research study aimed to develop a supply chain that was shorter than the existing one (Pereira *et al.*, 2018).

To the best of the authors' knowledge, research papers that discuss the development of food products that are both healthy and environmentally sustainable are still lacking. In the next section, we will briefly present what can be considered an example of a sustainable snack developed specifically for the vending industry as testimony to the existence of sector initiatives to attain a sustainable transition based on the dimensions of 'healthy diets' and 'building local loops and linkages'. Moreover, we will present the main obstacles that the snack has faced since its introduction and that other similar food products could encounter as well.

The Italian 'SCUISÎT' snack

'*Raw materials and pastry know-how on the one hand, quality automatic distribution on the other, interconnect, showing love for the territory, respect for values, genuine and authentic taste and attention to the green economy. From this base comes the precious and delicious content of the SCUISÎT snack, thus expressing the synthesis of Friulian excellence*'. This

is how the Friulian vending company presents its new snack on its webpage[1]. 'SCUISÎT' is a sweet Italian snack launched in 2022 and developed in Friuli-Venezia Giulia, a region located in the northeast of Italy. It is the result of a collaboration between two local actors: a vending company and a chocolate shop. Respect and love for the Earth and the surrounding environment, a sense of belonging, collaboration and the will to serve the local community with seriousness and quality are the commitments shared between them. SCUISÎT is different from other traditional products not only because of the name it bears, which is obligatorily Friulian, but also because of the choice of top-quality local raw materials: in fact, it is made with wheat flour, hazelnuts, gianduja and cocoa cream exclusively produced and processed within the region. The sustainability of the snack also goes beyond its ingredients; by purchasing it, consumers can support a local association that helps patients suffering from eating disorders and their families.

Overall, SCUISÎT represents an attempt to create a regenerative local value chain in line with circular economy principles that will have a positive impact on the environment. In parallel, it endeavours to support the social community with a sweet product made using seasonal raw materials, with 50% fair trade cocoa beans and only natural ingredients.

Despite its features, since its introduction, SCUISÎT has not received the success it deserves. Below we will provide four possible (but not conclusive) reasons by referring to the existing literature.

The first reason is linked to both impulsive needs (e.g. hunger or the desire for something sweet) (Cheval *et al.*, 2017; Hoffmann *et al.*, 2019) and the 'fear of novelties' (also called neophobia) (Rabadán & Bernabéu, 2021). The majority of consumers purchase food from vending machines because of hunger (Ng *et al.*, 2019). Hunger can generally motivate food-seeking behaviour and unhealthy food consumption through its direct effect of wanting for food (Cheval *et al.*, 2017), while hindering consumers from choosing sustainable products due to its influence on taste evaluation and a preference for specific foods (Hoffmann *et al.*, 2019). Moreover, consumers often rely on their past experiences when making food selections (Ogundijo *et al.*, 2021). Therefore, it is possible that when consumers face vending machines in a state of hunger or 'craving- for-sweets', they tend to choose the 'conventional' and 'unhealthy' products they already know will satisfy their cravings over a new product, even if the new product (in this case, SCUISÎT) is perceived as healthier and more sustainable.

The second possible reason, which is linked to the first one, regards marketing and promotion. The influential effect of brand logos, product

1. https://cda.it/projects/arriva-scuisit-la-nuova-mirinde-furlane-al-distributore-automatico.

advertisements and shelf placement on food and beverage consumption is quite well known in the literature (Boyland *et al*., 2016; Chandon & Wansink, 2012; L. Harris *et al*., 2020). In their work, L. Harris *et al*. (2020) found that the products of major companies received significantly more in-store marketing support, including displays and price promotions, than the products of minor companies. The same strategy can be observed within vending machines; that is, famous (and generally unhealthy) food products are present in higher quantities (Byrd-Bredbenner *et al*., 2012; Faris *et al*., 2021; Grech *et al*., 2017; Rahi *et al*., 2022) and are generally more visible compared to healthier and sustainable options. However, SCUISÎT is currently only sold by the vending company responsible for its development and production, and it is very likely that this company has positioned it within its vending machines in a way that makes it highly visible to consumers. Therefore, it is possible that the real reason for its lack of success concerns the high costs associated with its promotion rather than its visibility. The success of famous unhealthy food products generally derives from expensive advertisement campaigns financed by international companies with certain amounts of money (Potvin Kent *et al*., 2022). For example, in Canada alone, it was estimated that nearly $492.9 million of the $628.6 million food and beverage advertising expenditures in 2019 was spent on 'unhealthy' food advertising (Potvin Kent *et al*., 2022). Small food companies usually do not have enough money to finance large advertising campaigns, which leads to the failure to promote their products to consumers.

The third reason is linked to SCUISÎT's price, which is quite high compared to that of an average snack. The cost of foods and beverages is one of the main drivers of food selection (Ogundijo *et al*., 2021). Generally, healthier food products have higher costs compared to unhealthy solutions (Darmon & Drewnowski, 2015), and this trend has been observed for vending products as well (Ng *et al*., 2019; Shi *et al*., 2018). Regarding consumer behaviour, the scientific literature has very divergent ideas on the topic (Dolgopolova & Teuber, 2018); some authors have demonstrated how consumers tend to restrain themselves from purchasing and paying more for healthy and sustainable products, while other scholars obtained contradictory evidence. In terms of the vending sector, price manipulation strategies are common (Bos *et al*., 2018; Grech & Allman-Farinelli, 2015), and most authors agree that consumers express higher willingness to purchase more healthy and sustainable products if their prices are lowered (Grech & Allman-Farinelli, 2015; Ng *et al*., 2019).

The fourth reason concerns the difficulties in managing new local supply chains. A short supply chain can be defined as 'a supply chain involving a limited number of economic operators, committed to co-operation, local economic development, and close geographical and social relations between

producers, processors and consumers' (Regulation (EU) No 1305/2013). Despite being simpler compared to a traditional chain, hidden complexities exist for short supply chains. In their work, Pereira *et al.* (2018) analysed a case study on a local supply chain of fresh milk sold at vending machines. The aim of their research was to evaluate whether the milk supply chain through vending machines had lower environmental impacts compared to traditional supermarket supply chains. Despite the shorter supply chain achieving 45% lower environmental impacts compared to traditional ones, the initiative did not work for many socioeconomic reasons, such as the farmers' lack of processing and marketing capacities, the difficulty of networking and collaborating with other key stakeholders, the necessity of raising consumer awareness of the benefits of pasteurised milk and the limited range of dairy products offered. Other reasons were found by Živković *et al.* (2022), who reported that the main problems small food producers face when trying to implement a short food supply chain are 1) the lack of knowledge and expertise to deal with regulatory issues, 2) insufficient policy support at the EU level and 3) unfavourable subsidy policy.

3. Discussion

SCUISÎT demonstrates how, even in complex and uncertain times, it is possible to contribute to the creation of environmental and social value through local collaboration and the sharing of a common dream. It is likewise an ambitious attempt to contribute to revolutionising the vending sector and orienting it towards more sustainable business models. However, some socioeconomic barriers can hinder vending from completely transitioning towards new patterns by selling healthy and local food products, such as SCUISÎT. Such products generally possess higher prices compared to the average (and consumers usually restrain themselves from purchasing them), they have to compete with more traditional and famous snacks usually preferred by consumers, they are produced by small and medium-sized enterprises without enough money to finance strong advertising campaigns to promote them to potential consumers and they are the result of local partnerships, which could become difficult to manage. All these obstacles could be overcome through both financial investments along the entire supply chain and the development of strong institutional policies.

As discussed previously, nearly $30 bn of annual investments are needed to encourage consumers to choose more protective foods by employing new marketing strategies that guarantee better promotion and by motivating SMEs to invest in new business models and orient them towards nutritious and

sustainable food product lines (The Food and Land Use Coalition, 2019). An additional $10 bn would be needed to expand and strengthen local supply chains, with huge environmental and social benefits (Enjolras & Aubert, 2018; Galli & Brunori, 2013; The Food and Land Use Coalition, 2019). In this context, the Italian PNRR (National Recovery and Resilience Plan) will allocate €1.2 bn for the development of sustainable agri-food supply chains by 2026[2]. In particular, such a plan aims to finance those business activities committed to making food production and processing more sustainable and develop a marketing, promotion and research programme for sustainable products. However, alternative ways should also be defined since access to finance can be a key obstacle for SMEs involved in collaborative short food supply chains (Kneafsey *et al*., 2015). In their work, Behrendt *et al*. (2022) proposed community-based financial models involving citizens and consumers as potential ways to address both sustainable food production and consumption. The authors discussed the role of proximity in fostering community investments in local activities and markets. Proximity refers to 'being close' and comprises both geographical and non-geographical dimensions. Therefore, it seems that consumers and citizens who feel close to a certain local food activity will be more willing to invest in such an activity and pay more for food products owing to the establishment of trust and the presence of shared values. Apart from financial considerations, community financing can also serve as a marketing tool, helping to build or intensify customer relationships. This financial model can be considered an alternative to traditional models, which are too focused on the maximisation of profits (Stephens *et al*., 2019). The positive effects that can derive from such models have been discussed by Stephens *et al*. (2019), who stated that they can help increase prosperity, build adaptive capacity, increase social capital and foster innovation in rural communities where local food activities are common. Such financial models could also help small and medium- sized vending enterprises (which constitute the majority of this type of activity in Italy) to scale their business models and contribute to the sustainable development of their surrounding contexts through sustainable food products. Moreover, they could help sustainable snacks obtain the success they deserve.

A strategy based only on financial interventions, however, risks being ineffective without adequate institutional commitment to give sustainable food greater visibility and access. As for vending, green public procurement (GPP) plays a key role. GPP is an important tool in the context of sustainable food consumption and production through which public authorities are encouraged to integrate various sustainability criteria into their tenders

2. www.italiadomani.gov.it/content/sogei-ng/it/it/Interventi/investimenti/sviluppo-logistica-per-i-settori-agroalimentare-pesca-e-acquacoltura-silvicoltura-floricoltura-e-vivaismo.html.

and select suppliers whose food offerings show greater compliance with these criteria. Despite the criteria having been updated in 2019 (European Commission, 2019), most products found in vending machines today have nutritional and production characteristics that are not in line with European guidelines. Although there may be numerous explanations for this fact, one certainly crucial element is the lack of an institutional policy oriented towards sustainable development. Such a policy is defined by an organisation's mission, vision, objectives and operational strategies. Without a clear policy, any institution (e.g. a university) will have serious difficulties in identifying a sustainable plan, an operational strategy and the necessary interventions to achieve a sustainable development condition (Blanco-Portela *et al.*, 2017), including making proper use of GPP (Cheng *et al.*, 2018). Several studies in the literature have shown how the creation of institutional policies geared towards improving consumers' health has led to a sharp decrease in unhealthy products found inside vending machines in various locations. For example, in their work, Blake *et al.* (2021) discuss the effects of a university policy called the "Deakin Food Charter", which was created with the goal of providing healthy, nutritious and sustainable foods that could meet both the needs of the university community and the commercial needs of the vendor, while at the same time creating as stimulating an environment as possible for the adoption of new lifestyles. In the two years of monitoring, the adoption of such an inclusive and integrated policy has brought several benefits, both nutritional and economic. But the most important point is that such commitment on the part of Deakin University has motivated the service manager not only to adapt to the new university policy but also to improve it and implement the interventions made on campus in other contexts as well. This shows how important it is to create clear, ambitious and inclusive policies, which can also have positive effects in relationships with service providers. However, the commitment to sustainable development should concern not only institutions but also the vending companies themselves. Therefore, for the society of the future, vending companies should reconsider their position as mere passive suppliers of food and beverages, become more proactive and actively collaborate with local institutions in developing policies and interventions that 1) provide an enabling environment for learning healthy preferences; 2) overcome barriers that prevent the expression of healthy preferences; 3) encourage people to re-evaluate their existing unhealthy preferences; and 4) stimulate a positive food systems response (Hawkes *et al.*, 2015).

Conclusions

Financing and policies are key aspects for initiating the necessary ecological transition of the entire agri-food industry. Although all the sectors that are part of the agri-food chain should be included in development plans and programmes, there are still some that do not receive the attention they deserve. The vending sector falls into this group, and little is still known about its dynamics and how it could contribute to sustainable development, despite it being a staple in the daily lives of many of us. Most academic research focuses on how to steer consumers towards buying healthier products, and only one study discusses the development of a local short supply chain market as an alternative to traditional ones. However, virtuous examples exist of companies that are constantly engaged in the sustainable development of the sector. This study discussed SCUISÎT, which represents an attempt to create a regenerative local value chain in line with the principles of the circular economy with a positive impact on regional development. This impact concerns not only environmental aspects (reduction of GHG associated with transport), but also economic (development of partnerships and business collaborations), social (creation of new jobs), and nutritional (development and consumption of healthier products). The SCUISÎT case also shows how even a largely ignored sector, such as vending, can play its part. Circularity, health, and wellness are three of the main topics included within the European Vending and Coffee Service Association's strategy for building a strong, innovative, and sustainable vending sector (EVA, 2021b). What are missing, however, are both a concrete commitment and a set of tools that can help this sector realise its new sustainable potential. SMEs in the sector often struggle to create local and circular supply chains associated with the sale of healthy and sustainable products, as access to the substantial funding required is complex. Nonetheless, Italy is undertaking to create development programs in line with European directives that can help businesses cope with these difficulties.

As previously discussed, this article aims to initiate a discussion on this issue, bringing to light several problems to be addressed and the potential to be cultivated in the future. Unfortunately, its originality is, at the same time, its main limitation, as it prevents a comprehensive and definitive discussion. Future academic research could use this study as a starting point to demonstrate the importance and effectiveness of different types of financing and policies and how the vending industry can use them to transform itself towards more sustainable dimensions. At the policy level, on the other hand, more effort is needed both in not neglecting parts of the food supply chain with great potential and in creating innovative financing programmes, also for those SMEs that are embedded in local contexts and represent a point of reference for the community.

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Alberto Bertossi
Department of Economics and Statistics, University of Udine, Italy
Via Tomadini 30/a - 33100 Udine, Italy
E-mail: alberto.bertossi@uniud.it
Holds a degree in Environmental Sciences (Milan, a.y. 2015/2016) and got a Doctoral Degree Economics and management of innovation (Udine, 2022). Post doc researcher at the University of Udine since 2022. His main research topic regards the sustainability of vending sector.

Stefania Troiano
Department of Economics and Statistics, University of Udine, Italy
Via Tomadini 30/a - 33100 Udine, Italy
Tel: +39 0432 24 92 21 - E-mail: stefania.troiano@uniud.it
Holds a degree in Economics (Udine, a.y. 1993-94) and got a Doctoral Degree Rural Economy in Central Eastern Europe Countries (Venice, 2001). Assistant Professor of Agricultural Economics and Rural Appraisal at the University of Udine since 2006 and Associate Professor since 2016. She conducts research in various agro-environmental fields mainly concerning issues related to the evolution of the agribusiness and rural system and to environmental economics.

Francesco Marangon
Department of Economics and Statistics, University of Udine, Italy
Via Tomadini 30/a - 33100 Udine, Italy
Tel. +39 0432 24 92 17 - E-mail: marangon@uniud.it
Holds a degree in Economics (Trieste, 1985). Researcher of Agricultural Economics and Rural Appraisal at the University of Udine since 1990, Associate Professor since 1992 and Full Professor since 2000. Current research interests include: monetary valuation of environment, farm and agricultural economics, agricultural and agri-environmental policy, multicriteria methods in farm management and spatial planning, sustainable food consumption, rural and nature tourism.

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Financial sustainability in agri-food supply chains: A system approach

Manal Hamam[a], Daniela Spina[*,a], Roberta Selvaggi[a], Gabriella Vindigni[a], Gioacchino Pappalardo[a], Mario D'Amico[a], Gaetano Chinnici[a]

[a] University of Catania, Italy

Abstract

Historically, both governmental and private sectors have significantly underinvested in the agriculture industry. Increasing agricultural and food system investments is necessary to enhance food security and nutrition, reduce poverty, and adapt to climate change. To achieve long-term benefits, it is crucial to ensure not only that more investments are made, but also that these investments are responsible.

The purpose of this paper is to conduct a literature review of financial sustainability and ethical investing in the agriculture industry. The findings indicate that the academic community has begun to focus on these concerns in recent years. Specifically, issues concerning finance in developing nations and the management of irrigation systems are attracting attention.

This paper's goal is to encourage more financial institutions, financial services managers, policymakers, and universities to participate in sustainable development projects in the financial services sector.

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* *Corresponding author*: Daniela Spina - Department of Agriculture, Food and Environment - University of Catania. E-mail: daniela.spina@unict.it.

Introduction

By 2050, the Food and Agriculture Organization (FAO) predicts that the global population will surpass 10 billion people. Against this backdrop, in order to fulfill the rising demand for commodities and assure healthy, safe, and sufficient food, one of the goals of economic policy is to provide financial aid to the agricultural sector (Katan *et al.*, 2018).

The critical role played by the agricultural sector in achieving the United Nations Sustainable Development Goals (SDGs), particularly in terms of poverty reduction, ensuring food security, and improving the ecological situation, underscores the importance of providing financial resources for agricultural production (Katan *et al.*, 2018). In this context, financial sustainability plays a crucial role in a firm's success, and it is becoming increasingly vital to pay attention to environmental, social, and governance (ESG) concerns.

In this regard, voluntary international governance initiatives have begun to emerge that are pushing agribusinesses to reorganize their production processes and make new responsible investments. The aim is to leverage sustainable finance tools as a driver of innovation in the transition to new business models.

The United Nations Environment Program (UNEP) created its Financing Initiative (UNEP FI) in 1992 to provide a broad set of principles regarding sustainable finance (Clapp and Dauvergne, 2011). Furthermore, in 2006, the UNEP FI and the UN Global Compact developed the Principles for Responsible Investment to encourage institutional investors to consider ESG problems in their research and investment choices (Gond and Piani, 2013; Sievanen *et al.*, 2013).

These programs seek to persuade firms and investors to increase socially responsible investments (SRIs) not only because they should behave ethically concerning environmental and social issues, but also because doing so is crucial for their profitability (Carroll and Shabana, 2010; Pimonenko and Lushniak, 2017; Ilchenko-Syuyva and Slyusarchuk, 2019). The Principles for Responsible Investment in Agriculture and Food Systems (CFS-RAI) is defined as the mobilization and deployment of external and internal investment resources and partnerships between governments and businesses to promote the SDGs in rural areas. In May 2018, the European Commission adopted a package of sustainable finance proposals, which included a proposed regulation establishing a framework to encourage sustainable investment (Marx, 2020).

However, there are several challenges associated with financial support for the agricultural sector that mean that it is not accessible to everyone. This has created barriers to accessing funds, including bank loans and governmental financial assistance (Katan *et al.*, 2018).

This literature review aims to understand how financial sustainability might reduce the environmental effects of current agriculture economic systems and motivate businesses to undertake SRIs. The research question addressed is: What contributions does the literature make to our understanding of financial sustainability in agri-food?

To the best of the authors' knowledge, this is the first literature review of financial sustainability in agribusiness specifically focusing on the political and social elements of potential solutions to agriculture's mounting issues. In addition, it aims to provide a complete evaluation of academic papers to identify important research subjects and aid businesses in building more sustainable business plans.

The paper is structured as follows. Section 1 explains the theoretical background and conceptual framework. Section 2 discusses the materials and techniques utilized. Section 3 summarizes the key findings from the literature review, which are discussed in more detail in Section 4. Finally, the study's shortcomings are discussed and final comments are presented in Section 5.

1. Theoretical background

According to several studies (Darnhofer *et al*., 2010; Petrillo *et al*., 2016; Sabău-Popa *et al*., 2020), a growing number of farmers are selecting SRIs that provide a high financial return and perceptible social and environmental benefits.

Investors' increasing social awareness (Petrillo *et al*., 2016) could play a significant role in the revitalization of the European economy (Makarenko *et al*., 2022). This is particularly true in a market such as Italy, where the presence of SRIs is still marginal (Petrillo *et al*., 2016) owing both to the limited availability of financial products and investors' lack of knowledge of these investment instruments (Eurosif, 2012; Makarenko *et al*., 2022).

Advocates of responsible investment emphasize the importance of institutional investors in ensuring that investments in agricultural land, for instance, are managed sustainably over the long term (Scott, 2013). In this context, governments aiming to encourage more responsible investment must first improve the enabling environment via national laws prohibiting human rights violations or environmental harm (Bulman *et al*., 2021). However, the literature has only recently addressed the challenges connected with financial sustainability and SRIs, even though there is growing concern regarding this issue in the agriculture industry. In this context, in addition to a relatively low level of financial sustainability activities on a global scale, Tuyon *et al*. (2022) indicated that the number of scholarly publications on this subject has only recently started to grow. Clapp (2017) studied recent developments in responsible agricultural investment efforts and provided a preliminary evaluation of their likelihood of success in reducing the ecological and

social costs associated with the expansion of private financial investment in the sector. This author cited inconsistent and difficult-to-implement criteria, a lack of transparency, and a lack of enforcement as potential flaws in projects for voluntary responsible agricultural investment. Dono *et al.* (2022) evaluated the capacity of farms engaged in financial sustainability activities to generate cash flows that could offset the depreciation of the farm production system, as well as whether the diversification of farm efforts contributes to enhanced financial sustainability in agricultural sectors.

Prior studies have identified rural banks, the crops cultivated, farm size, and savings as the main predictors of lending (Akudug, 2012; Dzadze *et al.*, 2012). Those actions that have already been taken and the obstacles that policymakers will need to overcome to promote and achieve financial sustainability have also been highlighted (Marx, 2020). Empirical evidence has also been presented that provides a theoretical explanation for investor demand and preferences (Ng and Zheng, 2018). Other studies have analyzed the socio-demographic factors influencing farmers' access to credit (Hananu *et al.*, 2015; Henning and Jordaan, 2016) and examined perceptions of loan repayments, lending procedures, and asset value (Chauke *et al.*, 2013). Recent research has analyzed the financial sustainability of farm samples to determine whether the final cash surplus provided by Free Cash Flow on Equity (FCFE) is sufficient to balance technology depreciation and provisions for risks or other funds (Dono *et al.*, 2021). In this context, Buttinelli *et al.* (2021) conducted an analysis of the cash generated.

Nonetheless, as highlighted by Makarenko *et al.* (2022), the emergence of scientific studies on agricultural transparency and investment logic in sustainability is one of the most significant reasons for investigating the issues pertaining to financial sustainability.

2. Materials and methods

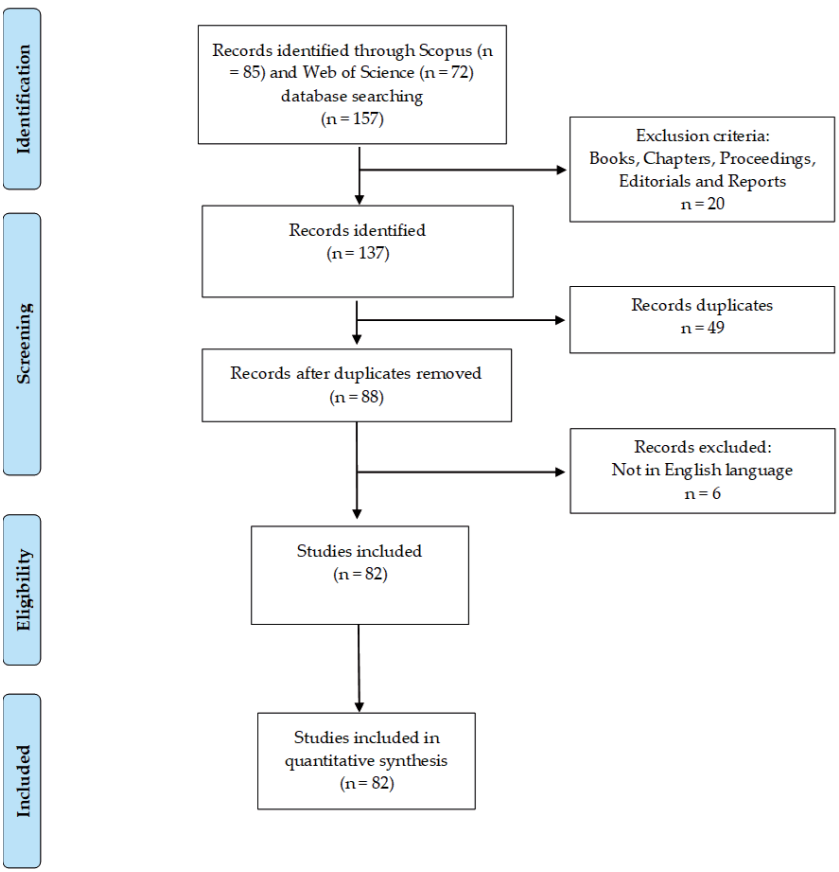
The searches conducted in this article were performed in the Scopus and Web of Science (WoS) online core collection databases on April 14 2022. The authors adopted the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) method, which is a qualitative approach enabling trends in scientific studies to be the captured (Zarbà *et al.*, 2022). The keywords that were utilized were: "financial sustainability" AND "farm*" OR "agri-food enterpris*" OR "agro-food enterpris*" OR "agri-food busines*" OR "agro-food busines*" OR "agri-food firm*" OR "agro-food firm*" OR "agri-food compan*" OR "agro-food compan*".

While gathering articles from the bibliographic sources, the PRISMA process follows a defined protocol (Dardonville *et al.*, 2021) that is reproducible, scientific, and transparent (Spina *et al.*, 2021).

We first adopted a data purification strategy to filter duplicates and include only articles and reviews (written in English) in order to find and evaluate the literature with a high profile in the scientific community (Vindigni *et al.*, 2021). Subsequently, the eligibility step is usually associated with the PRISMA technique (Golbabaei *et al.*, 2020; González-Rubio *et al.*, 2020). However, to avoid potentially reducing the scope of the research, no items were eliminated at this stage since the methodological framework followed for this study incorporated data processing using VOSviewer (Esfahani *et al.*, 2021; Norouzi *et al.*, 2021). A total of 157 papers were extracted, of which 82 were utilized for analysis (Figure 1).

The analysis proceeded using the VOSviewer tool, which is a free Java-based application that produces network-based maps (Van Eck and Waltman,

Figure 1 - Prisma flow diagram



Source: Authors' elaboration.

2018). It was initially created in 2009 by Van Eck and Waltman (2010) of the Centre for Science and Technology Studies (CSTS) at Leiden University in the Netherlands. This application produces network analyses by processing bibliometric maps (Damar *et al.*, 2018) that visually represent diverse network forms of scientific publishing data by integrating many quantitative parameters.

The statistical analysis of the keywords using VOSviewer enabled us to identify the most frequently used phrases and their associations, from which we were able to extract the primary research subjects associated with the area under study. Martinez-Vázquez *et al.* (2021) were previously able to examine existing research trends to anticipate future developments in this way. This was accomplished in the present paper by analyzing the co-occurrence of terms and displaying the associated network map.

The combination of the two methods required importing the data, keywords, article titles, and abstracts (TITLE ABS KEY) obtained following the PRISMA technique into the VOSviewer program (Figure 2). Specifically, VOSviewer generated the so-called co-occurrence network map of the keywords from all the chosen articles from the databases under study, covering all accessible search periods (1998-2021).

The extracted papers were then subjected to descriptive analysis and network analysis using the VOSviewer software, which provides text mining capabilities that enable the construction and visualization of co-occurrence networks among the most frequently used terms in a body of scientific literature.

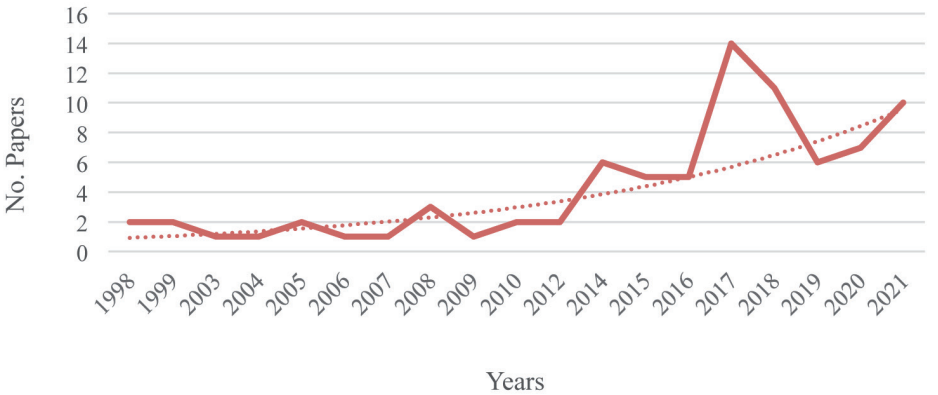
Figure 2 - VOSviewer technique

Source: Authors' elaboration.

3. Results

The growth in scientific output is shown in Figure 3 for the whole period of activity, namely 1998-2021. The findings indicate that the number of articles is extremely low until 2012, with only three articles per year recorded. However, in the subsequent four years, two to six articles were recorded annually. There is a substantial increase in the quantity of articles between 2016 and 2021. Specifically, 2017 is shown to be the most fruitful year thus far.

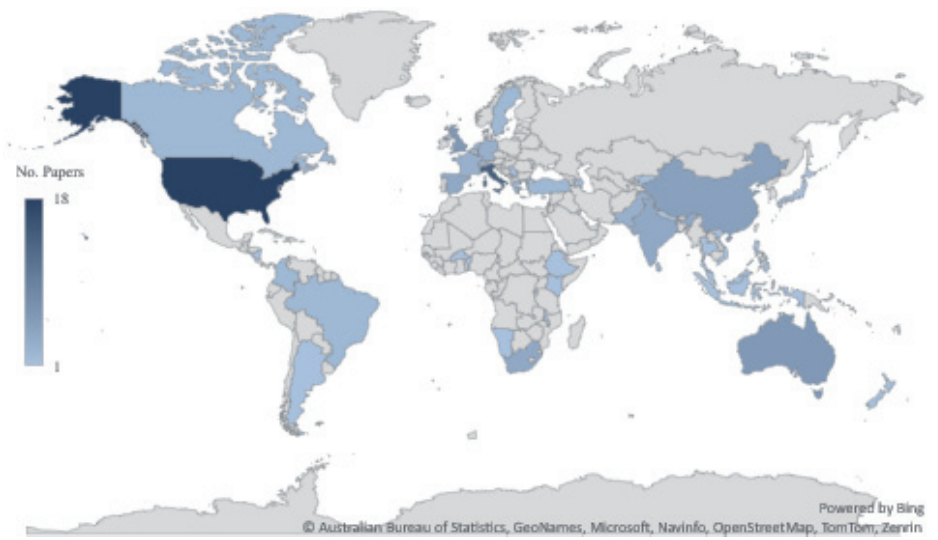
Figure 3 - Number of papers per year



Source: Authors' elaboration.

Figure 4 depicts, on a globe map, the distribution of author connections from various nations for the 82 scientific articles chosen. The colors represent the quantity of research produced in each nation. Specifically, the lighter the color, the smaller the number of studies, while the darker the color, the greater the number of articles. There are no studies in the gray region. The map demonstrates that author affiliations are not spread spatially uniformly. Given

Figure 4 - Countries in which the selected studies were conducted

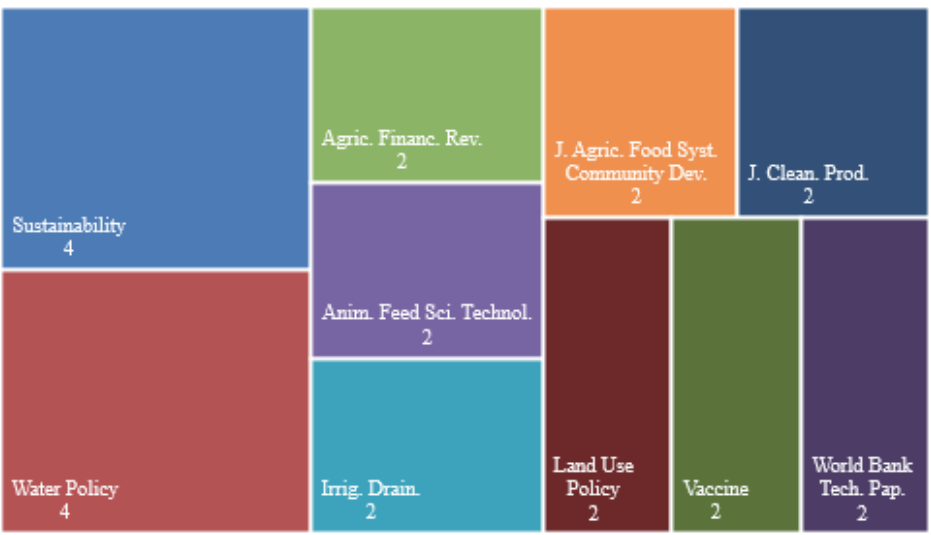


Source: Authors' elaboration.

that the United States, Italy, China, Australia, India, South Africa, and the United Kingdom are the most active nations in scientific production related to financial sustainability in the agricultural sector, it can be concluded that the topic of financial sustainability is of scientific interest to several countries.

Figure 5 shows the journals that published the most articles over the studied period (1998-2021). Sustainability and Water Policy are the journals with the most articles published, with four articles each. The following journals published two articles: Agricultural Finance Review; Animal Feed Science and Technology; Irrigation and Drainage; Journal of Agriculture, Food Systems, and Community Development; Land Use Policy; Vaccine; Journal of Cleaner Production; and World Bank Technical Papers. Overall, the journal papers published on financial sustainability in agriculture cover a variety of subtopics, indicating that the issue is being explored from numerous perspectives.

Figure 5 - Top journals in which the selected studies were published



Source: Authors' elaboration.

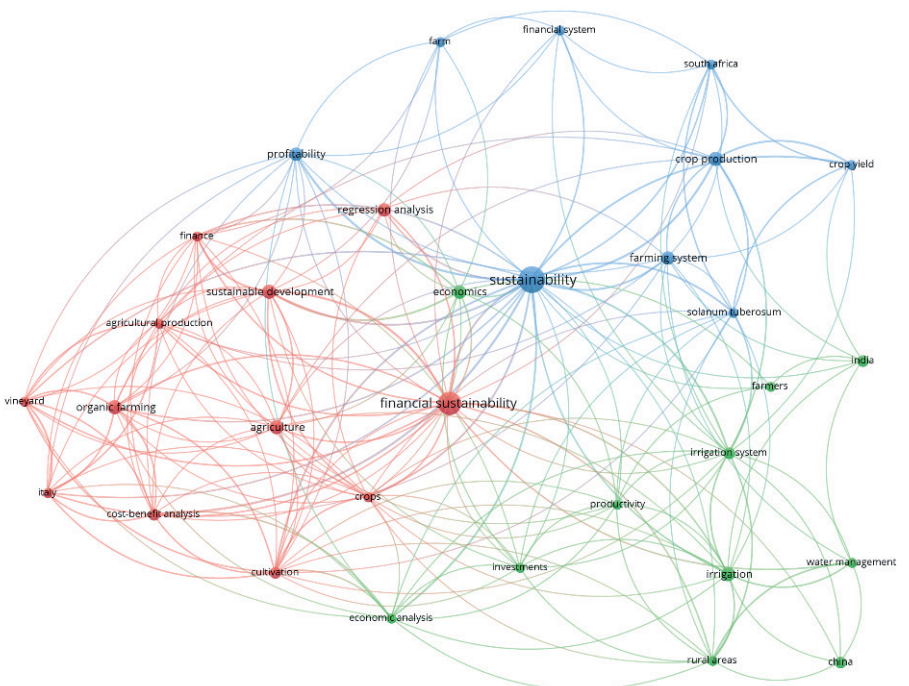
Keyword analysis using VOSviewer revealed the most common phrases and their correlations, highlighting important study subjects and potential future developments in relation to the research topic. This was achieved through co-occurrence analysis of the phrases and the network map display. Figure 6 depicts the search that can be used to find the three clusters generated by the 32 keywords (items).

The first cluster (red) comprises studies conducted on financial viability to assess investments in the agricultural industry in general, as well as specifically for viticulture and organic agriculture in Italy. The items demonstrate the use of economic analysis techniques (cost-benefit analysis and regression) to evaluate profitability.

The second cluster (green) encompasses productivity issues in certain rural regions of the globe, including India and China. This cluster's focus is on the management of irrigation systems, which are used for the economic analysis to assess the productivity of the employed variables.

The third cluster (blue) focuses on the financial viability of various agricultural methods that determine the profitability of agricultural output in general, as well as potato production in particular.

Figure 6 - Keyword co-occurrence map



Source: Authors' elaboration.

According to their co-occurrence connections, the keywords were grouped into three clusters (Figure 7) (Du *et al.*, 2021).

Figure 7 - Cluster analysis

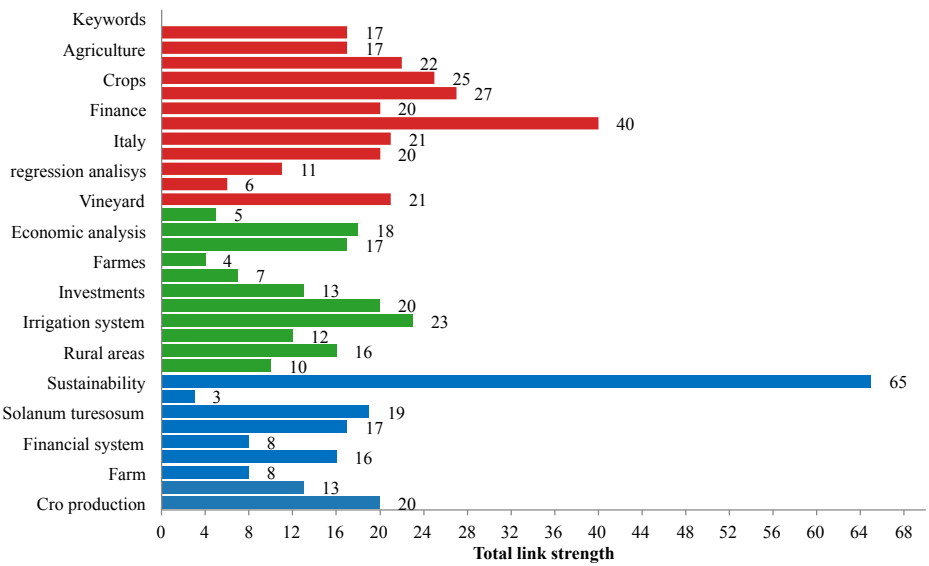
Keywords	Cluster	Color (*)	Occurrences
Financial sustainability	1		12
Irrigation	2		11
Sustainability	3		9

Source: Author's elaboration.

The analysis of the co-occurrence of keywords in the various clusters revealed valuable data (Figure 8), such as the total link strength characteristics, which reflect the overall strength of one item compared to another.

Cluster 1 (red) appears to be the most important, with 12 items, and is based on the following themes: agriculture; crops; finance; Italy; regression analysis; and vineyard. Cluster 2 (green) aggregated 11 keywords, with irrigation system, investment, and economic analysis particularly standing out. Cluster 3 (blue) comprises nine keywords, with sustainability and crop production being the most prominent.

Figure 8 - Total link strength per cluster



Source: Authors' elaboration.

4. Discussion

In recent years, financial risk has emerged as one of the most promising strategies to enhance the environmental and economic sustainability of farms (Pena *et al*., 2022). In this context, international organizations and private investors are promoting programs for the voluntary sustainable financing of responsible agricultural projects (Duong *et al*., 2022). Recent scholarly research has focused on financial sustainability, which is frequently based on short- and long-term financial success variables (Quayes, 2012). For example, Rodriguez Bolvar *et al*. (2016) examined net debt and adjusted income to determine financial sustainability, while Xu *et al*. (2020) highlighted the obstacles that financial constraints present to farm development by adopting a sustainable growth rate.

The analysis of the chosen papers indicates three major clusters identified by the terms "financial sustainability", "irrigation", and "sustainability".

Associated with the first cluster (financial sustainability) are innate concerns relating primarily to the financial sustainability of crops in Western nations, particularly Italy. Specifically, this cluster examines the financial performance disparities between conventional and organic farms (including wine production) in terms of sustainability.

Organic farming is highly valued by many consumers who consider organic products to be of superior quality, particularly due to the absence of chemicals used in the production process or the storage phase. This creates a more sustainable and environmentally friendly supply chain over time (Govindan *et al*., 2014), as well as protecting the entire agricultural agroecosystem and promoting farming practices that make use of natural soil fertility (Mader *et al*., 2002). According to Testa *et al*. (2015), organic farming appears to be more sustainable than conventional farming because of the reduction in process inputs and the resultant drop in total expenses (Acs *et al*., 2007). Considering the higher profitability of organic farming and the use of environmentally friendly inputs that make farms both competitive and ecologically beneficial (Sgroi *et al*., 2015), it is understandable that organic farming has been the subject of research on the challenges of financial sustainability. In addition, as shown in this cluster, the financial and sustainability worlds are intersecting in the wine industry, since both need accurate and verifiable data and transparency to combat climate change and ensure a prosperous future (Sardaro *et al*., 2017). Case studies of wineries (Tenev and Yordanova-Dinova, 2021; Rekova *et al*., 2020) have revealed that the more a winery adopts environmentally friendly practices, the greater its financial success. This cluster also demonstrates that the financial sustainability of wine production is especially important for Italy, which is the third largest nation in Europe by vineyard area and the largest producer

by volume (FAOSTAT, 2014; Sardaro *et al.*, 2017). It also reveals that cost-benefit analysis is the primary assessment technique (Lanfranchi *et al.*, 2014; Carluccia *et al.*, 2015).

In the second category (irrigation), water supply and management issues are particularly prevalent in developing nations such as India and China. This is not surprising as, in densely populated areas that require substantial agricultural productivity and where water resources play a major role in responsible investment, economic analysis of investment and the management of irrigation systems is essential.

China is the world's largest developing nation (China Water Resources Statistical Yearbook, 2019). In 2018, the agriculture sector used 61.4% of the country's water (Ministry of Water Resources of the People's Republic of China [MWRC], 2019). The low coefficient of effective irrigation water usage on agricultural land is due to inefficient water use in agriculture and the pervasive wastewater issue (MWRC, 2019). Because agriculture is China's largest water consumer, there is a substantial opportunity to reduce water usage (Huang *et al.*, 2020; Zhang and Oki, 2021; Zhang *et al.*, 2023). Consequently, sustainable water management could prevent water shortages (Garcia *et al.*, 2019; Suleiman *et al.*, 2020; Musz-Pomorska *et al.*, 2020).

The third category (sustainability) is related to developing sustainable agricultural systems in poorer nations, such as South Africa, as well as specific crops, such as potatoes. Potatoes are the most significant vegetable crop in South Africa and the fourth most important food crop globally (FAOSTAT, 2016). They are cultivated in several distinct geographic regions with varying temperatures, soils, production seasons, management strategies, and market access. All of these variables influence the amount of resources required to cultivate potatoes, the yield and value of the crop, and, consequently, the efficiency of land, water, nutrient, seed, and energy use. This necessarily influences the ecological and economic sustainability of potato production in this region, which generally has less favorable growing conditions than northern Europe and the United States. Using decision support systems, such as irrigation scheduling tools, improved management practices could considerably boost the economic efficiency of potato production and the production efficiency of the region under study (Steyn *et al.*, 2016).

Conclusion

Both the public and private sectors have failed to invest appropriately in the agriculture sector for many years. It is vital to increase investment in agricultural and food systems to enhance food security and nutrition, alleviate poverty, and adapt to climate change. To obtain long-term

advantages, it is vital to guarantee not only that more investments are made, but also that more responsible investments are made. This needs to be accomplished through laws and government regulations.

To the best of the authors' knowledge, this is the first literature review of financial sustainability in agribusiness that specifically focuses on the political and social elements of potential solutions to agriculture's mounting issues.

The findings of the literature review reveal problems associated with water management and irrigation systems in densely populated countries and problems associated with sustainable production in developing countries. Our aim is for these findings to be used to encourage more financial institutions, financial services managers, policymakers, and university professors to participate in sustainable development projects in the financial services sector.

Notably, governments could play a crucial role in promoting sustainable development and achieving the SDGs in agricultural and food systems by providing incentives for targeted investments and adopting inclusive and substantive stakeholder participation at all relevant levels. In addition, soft loans should be used to address this issue and boost the availability of financial resources for agribusinesses. This will enable them to modernize production equipment and technologies, decrease production costs, and increase profitability and competitiveness.

This research, however, has some limitations. We particularly emphasize that conclusions should be drawn with care due to the limited sample size. Finally, given its intricacy and unique nature, this topic requires more research, which provides ample opportunities for new lines of inquiry.

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Manal Hamam
Department of Agriculture, Food and Environment (Di3A), University of Catania, Italy
Via Santa Sofia, 98-100 - 95123 Catania, Italy
E-mail: manal.hamam@phd.unict.it
Research fellow at the Department of Agriculture, Food and Environment. She received her Ph.D. in "Agricultural, Food and Environmental Sciences" from the University of Catania and an Advanced Master's degree in Agricultural Economics and Policy from the University of Naples Federico II. Current research interests include marketing, innovation, sustainability and circular economy in agribusiness and consumer behavior.

Daniela Spina
Department of Agriculture, Food and Environment (Di3A), University of Catania, Italy
Via Santa Sofia, 100 - 95123 Catania, Italy
E-mail: daniela.spina@unict.it
Fixed-term Assistant Professor of Agricultural economics and rural appraisal, she got a Doctoral Degree in Agricultural Economics. Current research interests include the Circular Economy and ecological transition; the economic aspects of innovations within agro-food supply chains; consumer behavior and quality food products.

Roberta Selvaggi
Department of Agriculture, Food and Environment (Di3A), University of Catania, Italy
Via Santa Sofia, 100 - 95123 Catania, Italy
E-mail: roberta.selvaggi@unict.it
Fixed-term Assistant Professor of Agricultural economics and rural appraisal, she holds a master's degree in Agricultural Science and Technology (Catania, 2012) and got a Doctoral Degree in Agricultural Food and Environmental Science (Catania, 2021). Current research interests include the reduction of the economic impact of waste management and the analysis of consumers' preference.

Gabriella Vindigni
Department of Agriculture, Food and Environment, University of Catania, Italy
Via Santa Sofia, 100 - 95123 Catania, Italy
Tel. +39 095 7580314 - E-mail: vindigni@unict.it
Holds a Doctoral Degree in Agricultural Economics and Land Managment (Catania, 1997). Associate Professor at University of Catania since November 2014. Much of her work has focused on Multicriteria decision Aid and Meta-analysis techniques, problem structuring methods, participatory process appraisal with the active involvement and empowerment of stakeholders. Special focus has regarded the evaluation of multifunctional agriculture and its socio-economic impact in local welfare, nature conservation policy and socio-economic benefits evaluation of the marine protected areas.

Gioacchino Pappalardo
Department of Agricultural Food and Environment (Di3A), University of Catania, Italy
Via Santa Sofia 98-100 - 95123 Catania, Italy
E-mail: gioacchino.pappalardo@unict.it
Associate Professor at the Department of Agricultural Food and Environment (Di3A), University of Catania. Holds a degree in Agricultural Sciences (Catania, 1993) and got a Doctoral Degree in Agricultural Economics (Catania, 2000). Current research interests include Rural development policies, Competitiveness and international trade, Consumer behavior and Cost-Benefit Analysis.

Mario D'Amico
Department of Agricultural, Food and Environment, University of Catania, Italy
Via Santa Sofia, 98-100 - 95123 Catania, Italy
Tel: +39 095 7580335 - E-mail: mario.damico@unict.it
He is a Full professor at University of Catania. Holds a degree in Agricultural Sciences (Catania, 1994) and got a Doctoral Degree in Agricultural Economics and Policy (Catania, 1999). Researcher (2002-2006) Associate Professor (2006-2018) at University of Catania. Current research interests include agri-food marketing, economics consumption, circular economy, organic food, firm management and wine business.

Gaetano Chinnici
Department of Agriculture, Food and Environment (Di3A), University of Catania, Italy
Via Santa Sofia, 98-100 - 95123 Catania, Italy
E-mail: chinnici@unict.it
Holds a degree in Agricultural Sciences (Catania, 1997) and got a Doctoral Degree in Agricultural Economics and Policy (Catania, 2001). Associate Professor since December 2021. His recent research interests are related to agri-food marketing, innovation, sustainability and circular economy, with specific topics regarding quality food specialties, organic food, olive oil and wine business.

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Farmer's adoption of agricultural insurance for Mediterranean crops as an innovative behavior

Giuseppe Timpanaro[*,a], **Gaetano Chinnici**[a], **Roberta Selvaggi**[a], **Giulio Cascone**[a], **Vera Teresa Foti**[a], **Alessandro Scuderi**[a]

[a] University of Catania, Italy

Abstract

Agriculture is a risky industry and is present in every management choice the farmer makes. Farms can experiment with different tools that can contain the impact of adverse events to protect production facilities, investments, and income generated by farming. This is the context for the study conducted in Sicily on a sample of farms of different types to explain farmers' decision-making process in adopting insurance offered in the subsidized market. The study adopted three socio-psychological constructs, Attitude (ATT), Subjective Norm (S.N.), and Perceived Behavioural Control (PBC), derived from the Theory of Planned Behaviour (TPB). It proposed the addition of a new construct, Risk Factors (RISK), and farm type. The results indicated that factors including Attitude, S.N., and PBC are positively significant when understanding farmers' intentions to adopt insurance. However, the additional factors included in the regression model (RISK and farm type) were statistically insignificant, rejecting the efficiency of an extended theory of planned behavior framework. Based on these results, it was concluded that combining extension services to improve awareness of the importance of insurance facilitated by the public contribution service could significantly influence farmers' intention to adopt it.

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* *Corresponding author*: Giuseppe Timpanaro - Department of Agriculture, Food, Environment (Di3A) - University of Catania - Via Santa Sofia, 100 - 95123 Catania, Italy. E-mail: giuseppe.timpanaro@unict.it.

Introduction

Economic activity is exposed to risk factors, and the agricultural sector is no exception. Indeed it is probably one of the most vulnerable (Sulewski *et al.*, 2014). Farmers have limited or no control over shocks and events related to external factors, such as adverse weather conditions or market and policy changes, even though such events have a direct impact on agricultural products and outcomes, such as yields, revenues, and incomes (Komarek *et al.*, 2020; Basile *et al.*, 2000). Additionally, farmers are being compelled to adopt tools and strategies to manage various sources of risk in agriculture by growing uncertainty and instability brought on by high price volatility in product markets, the reduction of traditional market regulation instruments in the European Union (E.U.), and the rise of extreme weather events (Iyer *et al.*, 2020).

Moreover, compared to other economic activities, the spectrum of risks affecting the performance of agriculture is quite broad and directly impacts the stability of food production and supply and, consequently, food security (Calicioglu *et al.*, 2019). Risks in agriculture can vary in severity depending on whether the events disrupting the farm outcome are related to production, the market, financial resources, and institutional or personal aspects (Sarwar *et al.*, 2013). The primary source of risk in agriculture is nature-related: unfavorable weather conditions, plant or livestock diseases, pests, and other natural factors can reduce yields. Complexities of the global climate and its evolutionary trends make the effects of weather challenging to generalize. The frequency and timing of hail, heavy rain, windstorms, or frost are unpredictable and strongly impact agricultural activities.

Furthermore, other factors such as drainage, irrigation systems, and the quality of farm management interact with weather conditions and can enhance and amplify their effects (OECD, 2020; Porrini *et al.*, 2019). Therefore, the vulnerability and susceptibility of the agricultural sector lead to systemic risks, which is one of the main limitations of insurability.

Changes in the market and institutional environment are another source of risk in agriculture. Variations in agricultural policies and legal frameworks, i.e., trade liberalization and the introduction of new standards, contribute to rapidly changing in the institutional environment in which farmers operate and require rapid adaptation to avoid facing operational and financial difficulties (El Benni *et al.*, 2012; Koundouri, 2009).

Furthermore, the effects of climate change (Ndamani *et al.*, 2017; Prokopy *et al.*, 2016), increasing global competition, food security (Ferrer *et al.*, 2015), unexpected events such as the recent Covid-19 pandemic (Štreimikienė *et al.*, 2021) and the war economy, linked to the Russia-Ukraine conflict, are added to these type of risk (Figus, 2020).

Different criteria have been used to classify risk in agriculture (Komarek *et al.*, 2020; Marin, 2019). According to nature, agricultural risk can be natural-climatic, agrobiological, or technological. Additionally, all risk factors in agricultural activities are classified based on how frequently they occur, how likely they are to occur, and how severely they affect farmers. Thus, according to the OECD (2020), it is possible to distinguish between: (i) normal risks, i.e., events that occur with high frequency at the local level and usually with minor damage to farms; (ii) tradable risks, which refer to those events that are less frequent, but more challenging to manage due to their greater magnitude for farmers alone; and (iii) catastrophic risks, i.e., events with a very low probability of occurrence, but with very high and systemic impacts. Further classifications consider other factors and characteristics, such as the degree of typicality of the risk phenomenon in a given area, the frequency and intensity of its occurrence, and the degree of predictability and impact on specific stages of crop development.

There is no way to suppress pure risk resulting from the interplay between the organization and the environment in which it operates. However, risk management practices adopted by farmers are not widespread (Cioffi *et al.*, 2011; Ogurtsov *et al.*, 2008) and not only because of a different risk aversion and perception (Iyer *et al.*, 2020; van Winsen *et al.*, 2016; Menapace *et al.*, 2016).

All this happens even though the CAP 2014/2020 has expanded the tools for risk management (Frascarelli, 2007; Bielza *et al.*, 2008; Meuwissen *et al.*, 2013) in a perspective of revisiting the overall support to agriculture, dedicating specific financial resources to "agricultural insurance", "mutual funds" and "income stabilization tools", access to which is facilitated (most recently by E.U. Regulation 2017/2393, Reg. OMNIBUS), and to measures 17 of the National Rural Development Plan (RDPN) with the coverage of the consequent burdens borne by the farm (Trestini *et al.*, 2017 and 2018; Severini *et al.*, 2021).

Agricultural insurance today represents an essential innovation for farmers that, if adopted, would improve risk management for farms and is becoming increasingly important as an agricultural policy tool, both in Europe and the United States (Cordier, 2015). In particular, Italy has paid much attention to insurance instruments. It is one of the European countries making more extraordinary efforts to support the subsidized insurance market, which remains the basis of the risk management system. Despite efforts by the public to encourage participation, only around 15 percent of farmers take part in insurance programs due to factors such as high bureaucratic costs, payment delays, lack of experience with insurance contracts, and inadequate information on insurance options (Santeramo, 2019). The Defense Consortia has been introduced to address this issue and facilitate matches between

insurers and farmers in the subsidized crop insurance market, as well as reduce information asymmetry. However, there is a territorial divide between Northern and Southern Italy, with Defense Consortia being more effective in the North where there is a stronger presence of producer organizations and cooperatives that aggregate demand for crop insurance. This limits farmers' participation in the South. (Santeramo *et al.*, 2016; Rippo and Cerroni, 2023).

The purpose of this paper is to present a conceptual framework using the TPB to study farmers' decisions to purchase insurance. Several works in the literature (Bagheri *et al.*, 2019; Borges *et al.*, 2014; Lalani *et al.*, 2016; Maleksaeidi and Keshavarz, 2019; Bruijnis *et al.*, 2013) indicate that TPB is one of the most common socio-psychological frameworks to explain the factors influencing farmers' intentions towards their behavior.

Specifically, in this study, an additional construct in the TPB model and the type of farming was considered to increase its validity and predictive ability. These variables could be correlated with other TPB variables and provide more reliable results. As Ajzen (1991) states, the TPB is open to further elaboration with important additional constructs that could increase the model's predictive ability. Some crucial studies have used the TPB by including additional constructs to the model to increase its explanatory capacity (Bagheri *et al.*, 2019; Gao *et al.*, 2017; Maleksaeidi and Keshavarz, 2019; Soorani and Ahmadvand, 2019).

1. Materials and methods

1.1. *Agricultural insurance*

Several researchers have investigated the impact of agricultural insurance on farmers' incomes, and opinions are divided into two major camps. According to some research, agricultural insurance positively influences agricultural production and farmers' income, while others take the opposite view. In the 1980s, Yamauchi (1986) used the farmers who had purchased rice insurance in Aomori Prefecture, Japan, as the research object. He found that compulsory agricultural insurance helped stabilize farmers' income, especially in severe disasters. Xavier *et al.* (2008) studied farmers who purchased insurance against storms in southern India and found that agricultural insurance increased local farmers' income. According to Hosseini and Gholizadeh (2008) and Enjolras (2014), agricultural insurance can reduce farmers' income volatility and increase their income. Another study (Barry *et al.*, 2001) concluded from statistics that farmers' income in years exposed to agricultural risks exceeds more than half of their expected production years, illustrating the positive impact of agricultural insurance on farmers' income.

Further research (Robert *et al.*, 2014) found, through statistical data analysis, that the impact of agricultural insurance on farmers' income is not necessarily significant. Even in some years, the two have an inverse relationship. Several scholars have also looked at agricultural insurance and agricultural production. Most believe there is a significant positive correlation between agricultural insurance and agricultural production (Huang and Pu, 2015; Cheng *et al.*, 2016; Jiang and Zhang, 2018). Zhou and Zhao (2016) and Wang (2011) used a dynamic panel model to conduct an empirical analysis and concluded that agricultural insurance broadly promoted agricultural production. However, some researches do not believe there is a strong relationship between these two aspects. According to Zhang *et al.* (2006), the total output of agricultural products will not change significantly as long as the level and percentage of agricultural insurance subsidies are low. Further research (Hu, 2012) analyzed the impact of agricultural insurance on agricultural production capacity using hypothesis tests. The results showed that the impact is almost non-existent, and there is no significant correlation between agricultural insurance and food production.

Other research has also focused on the factors influencing farmers' demand for agricultural insurance. It is believed that the demand for agricultural insurance is not only influenced by farmers' income. Abraham *et al.* (2013) used a three-stage sampling procedure to select 120 rural households in their research. They concluded through a questionnaire survey that age, education level, and agricultural income can influence farmers' willingness to participate in agricultural insurance. According to Moschini and Hennessy (2005), farmers' risk preferences influence their participation in agricultural insurance; farmers with a high-risk tolerance tend to self-insure, whereas risk-averse people may not use agricultural insurance to transfer risks. A recent study (King and Singh, 2020) identified that the demand for insurance is replaced by access to private transfers. However, participation in a farmers' union helps to understand why farmers value index-linked insurance. According to further research (Coble *et al.*, 2008), a single economic factor influences farmers' participation in agricultural insurance, including risk awareness and crop risk status. The study by Sujarwo *et al.* (2017) proposed that experience in purchasing farm insurance and even being willing to attend farmers' group meetings influence farmers' willingness to accept farm insurance. Furthermore, age, female gender, and previous insurance experience seem to favor the adoption of insurance (Ghosh *et al.*, 2022). Giampietri *et al.* (2020) also emphasized the significance of trust in insurance underwriting in Italy. They underscored how trust plays a crucial role in decision-making, particularly when faced with uncertainty, and suggested that trust may act as a substitute for knowledge when it comes to insurance.

Therefore, knowing the characteristics and determinants of the propensity to insure in the primary sector becomes all the more important because such information is fundamental for designing public policies to support and expand demand. Determining agricultural entrepreneurs' behavioral motivations and psychological factors is a rather complex task (Adnan *et al.*, 2017; Borges *et al.*, 2014; Mesa-Vázquez *et al.*, 2021). The choice of a behavioral model turns out to be necessary because the intention on the part of the farm to implement or not to purchase an insurance package clashes with human psychology (Berti and Mulligan, 2016; Hannus and Sauer, 2021; Judge *et al.*, 2019; Brudermann *et al.*, 2013).

The economic literature on farmers' decisions is based on normative theory and the assumption that decisions can only be modeled in terms of individual profit-maximizing actions (Austin *et al.*, 1998; Willock *et al.*, 1999). However, this literature fails to capture the full complexity of farmers' decisions (Austin *et al.*, 1998). Moreover, these models fail to recognize that farmers' behavior is not only driven by profit maximization (Willock *et al.*, 1999). In agricultural economics, farmers' decisions and behavior have been studied using two main approaches: one is based on purely economic models, in which Expected Utility Theory (EUT) plays a central role. The second approach is based on socio-psychological theories, in which psychological constructs explain farmers' behavior. One of the most essential theories used by researchers to understand farmers' behavior was developed by Fishbein and Ajzen (1975), the Theory of Reasoned Action (TRA). The TRA was extended by Ajzen (1991), resulting in the Theory of Planned Behaviour (TPB).

1.2. *Theoretical background*

The TPB, proposed by Ajzen (1991) as a reference model in the field of the theory of reasoned action (TRA), includes a basic framework for clarifying the reasons for individual behavior. The central assumption of TPB is that behavioral intention determines behavior in a more immediate way, which is explained as an individual's willingness to perform a particular behavior (Ajzen, 2002; Fishbein and Ajzen, 1975). Intention, in turn, depends on the individual's beliefs towards a particular behavior, which is based on three factors, including subjective norm (S.N.), perceived behavioral control (PBC), and attitude towards the behavior (Daxini *et al.*, 2018; Sok *et al.*, 2021). However, specific behaviors might be better predicted by only some of these factors (Shapiro *et al.*, 2011). In TPB, it is hypothesized that a higher perceived social pressure is caused by a more positive attitude toward the outcome of the behavior. Considering the numerous promoting

factors, there is a higher intention to carry out the behavior (Wang *et al.*, 2018). Attitude refers to an individual's positive or negative evaluation of a particular behavior based on expected outcomes (Ajzen, 2005; Velde *et al.*, 2015). Therefore, it is the product of a set of relevant beliefs about the consequences of performing the behavior, which is pondered by evaluating the importance of each consequence (Lean *et al.*, 2009; Quine *et al.*, 2001). An intention to perform the behavior exists in a person with a very positive attitude towards a behavior (Zhang *et al.*, 2014; Senger *et al.*, 2017). Consequently, attitudes toward the willingness to purchase insurance refer to the individual's positive or negative evaluation. PBC is the perceived difficulty or facility in performing an expected behavior (Ajzen, 1991, 2002). PBC is a multidimensional construct (Phipps *et al.*, 2015; Trafimow *et al.*, 2002) that has been reconceptualized in recent years, incorporating measures of perceived control (i.e., controllability) and perceived difficulty (i.e., self-efficacy) (Ajzen, 2006; O'Callaghan and Nausbaum, 2006; Saeedi *et al.*, 2022). PBC is a significant predictor of intention in TPB, as individuals will show greater intention to perform a particular behavior if they perceive more significant control over themselves (Webb *et al.*, 2013; Tóth *et al.*, 2020). Therefore, in the case of insurance in agriculture, it is expected that the perceived ease or difficulty in adopting it may influence the likelihood of implementing this behavior. S.N. is initially described as 'the perceived social pressure exerted by the person to perform or not to perform the behavior under investigation' (Ajzen, 2005). According to TPB, the greater an individual's perceived pressure and expectations, the more remarkable that person's intention to perform the behavior (Ajzen, 1991; Matthies *et al.*, 2012; Ru *et al.*, 2018; Shi *et al.*, 2017; Sarkar *et al.*, 2022). Therefore, the objective is to investigate whether others influence farm insurance adoption.

1.3. *Research questions*

The research, using the Theory of Planned Behaviour (Ajzen, 1985) as a model, focused on the survey of a sample of 100 companies in Sicily to investigate the decision-making process that leads to risk management and the intention to purchase an insurance package to counteract the negative impact of accidental events, to provide useful indications to public and private stakeholders because of the definition of the future 2023-2027 programming, to be implemented both at a regional and national level.

According to the theory of planned behavior, attitude is the most effective predictor of entrepreneurial intention, followed by subjective norms and perceived behavioral control (Timpanaro and Cascone, 2022; Zhang *et al.*, 2015). A positive attitude is a belief that individuals are capable

of performing a given task, subjective norms operate as a self-regulatory mechanism that determines whether individuals will take actions, and behavioral control is instrumental in determining what individuals do with the skills and abilities they possess (Gao *et al.*, 2017; Hansson *et al.*, 2012; Soorani and Ahmadvand, 2019).

Specifically, following the literature, this study adopted an integration of the Theory of Planned Behaviour (TPB) by including an additional variable to increase its predictive accuracy (Joao *et al.*, 2015; Rezaei *et al.*, 2018; Sarkar *et al.*, 2022; Tama *et al.*, 2021). This conceptual model considers, in addition to the three classical TPB factors, i.e., attitude (A), subjective norms (S.N.), and perceived behavioral control (PBC), a fourth variable, i.e., Risk Factors (RISK), and hypothesizes that all of these four elements could directly or indirectly influence the intention to purchase an insurance package (Hou and Hou, 2019; J. Müller *et al.*, 2021; Wauters *et al.*, 2010).

To this extension of the theory of planned behavior, the different entrepreneurs type of farming was added to understand whether they increase the model's accuracy and, secondly, to understand which industries are characterized by a higher intention to adopt insurance. To this purpose, a specific question was added to the questionnaire asking each respondent to choose their preeminent type of farming. So, the variable was codified as a dummy variable in the dataset ("1" if chosen by the respondent, "0" otherwise).

The additional variable, Risk Factors (RISK), is the fourth element considered for the conceptual model. We used a 7-point Likert scale system for seven items to evaluate this construct, as described in Table 1.

Based on this knowledge, we have formulated five hypotheses:

H1: Respondents' attitude (ATT) towards purchasing insurance influences their intention;

H2: Respondents' subjective norms (S.N.) towards purchasing insurance influence their intention;

H3: Respondents' perceived behavioral control (PBC) towards purchasing insurance influences their intention;

H4: Risk factors (RISK) have a positive influence on entrepreneurs' intention to take out insurance;

H5: The Extended Theory of Planned Behaviour allows a more accurate explanation of farmers' behavior toward insurance.

1.4. *Data acquisition and processing*

To adequately achieve the objectives of the research, a reference scenario was firstly constructed based on the secondary data available (e.g., ISMEA, 2021), data also used for comparison with various stakeholders active on the subject (Condifesa managers, insurance companies, officials of the Regional Department of Agricultural and Food Resources of Sicily, category representatives, etc.). We then proceeded to the primary data collection phase using a GoogleForm questionnaire circulated through social media within organized groups of agricultural entrepreneurs or on mailing lists granted by the prominent category representatives between June and September 2022.

The questionnaire was divided into sections aimed at capturing general business and entrepreneurial characteristics, general aspects of risk management, the propensity to adopt insurance, the characteristics of the contracts taken out, etc. The latter sections of the questionnaire are those concerning the elements of the TPB concerning the intention to purchase an insurance package and mostly use the 7-point Likert scale, where higher scores indicate greater compliance with the items, as Table 1 shows.

*Table 1 - Constructs and measurement items included in the questionnaire**

Construct	**Measurement items**
Intention	In the coming year, I intend to adopt an insurance
	In the coming year, I plan to adopt an insurance
	In the coming year, I will adopt an insurance
Attitude	For me, the adoption of insurance is a wise choice
	For me, the adoption of insurance is an advantaged choice
	For me, the adoption of insurance is a satisfying choice
	For me, the adoption of insurance is a strategic choice
	For me, the adoption of insurance is a valuable choice for income protection from risks
	For me, the adoption of insurance is a valuable choice for economic sustainability
	For me, the adoption of insurance is an indifferent choice (R)
Subjective norm	My family would approve my choice to adopt insurance
	My employees would approve my choice to adopt insurance
	Farms close to me would approve my choice to adopt insurance
	Defense consortia would approve my choice to adopt insurance

Construct	Measurement items
Perceived behavior control	I have the resources and the knowledge to adopt insurance
	The decision to adopt insurance on the farm is under my control
	Adopting insurance on the farm is easy for me
	I do not have a financial problem purchasing insurance
	Insurance prices are reasonable, considering the coverage offered
	Using insurance is the easiest way to manage the risk
	Insurance is not well known to me (R)
Risk factors	For my farm, adverse weather/climate changes are a source of risk
	For my farm, pests and other phytosanitary problems are a source of risk
	For my farm, the market prices of my products are a source of risk
	For my farm, increasing production costs for factors such as energy, fertilizers, labor, etc., are a source of risk
	For my farm, bank debts and difficulties in repaying loan amounts are a source of risk
	For my farm, substantial changes in the CAP 2023 are a source of risk
	For my farm, contractual conditions with POs, GDOs, etc., are a source of risk

R - Reversed item.
* Our elaboration.

Once the planning phase of the questionnaire was completed, and before starting data collection, we moved on to the control phase. In this phase, the necessary checks were carried out to ensure that there were no programming errors (bugs or malfunctions) and that the questionnaire was computerized appropriately to achieve the research objectives. One hundred fifty responses were collected from as many farms as 100 were selected as suitable for data analysis. The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 27.

First, we cleaned and checked the data to identify missing values or irregularities. Secondly, we calculated descriptive statistics (e.g., averages and standard deviations). The collected data were then subjected to Cronbach's alpha test to check the data's robustness/reliability. Through exploratory factor analysis (EFA), we attempted to associate the variables with the various latent factors. Subsequently, Pearson correlation coefficients were calculated to assess the correlation between the factors (Adnan *et al.*, 2018). We then determined the most important factors influencing farmers' intentions using hierarchical regression analyses. In this study, we

examined psychological factors by hypothesizing that these could explain more significant variation in the dependent variable (intention) than farmers' socioeconomic characteristics. The TPB variables (ATT, S.N., and PBC) were considered independent, while the intention was used as the dependent variable in the first stage. Keeping the same dependent variable, the variable Risk Factors (RISK) was added in the second stage. Then, in the third stage, the farmers' type of farming was included and assessed whether the inclusion of the various types of farming also improved the validity of the model and which of the various farm types showed the most striking propensity for insurance. We then examined whether the additional variable (RISK) explained the variations in intention to a greater extent than the farmers' TPB variables.

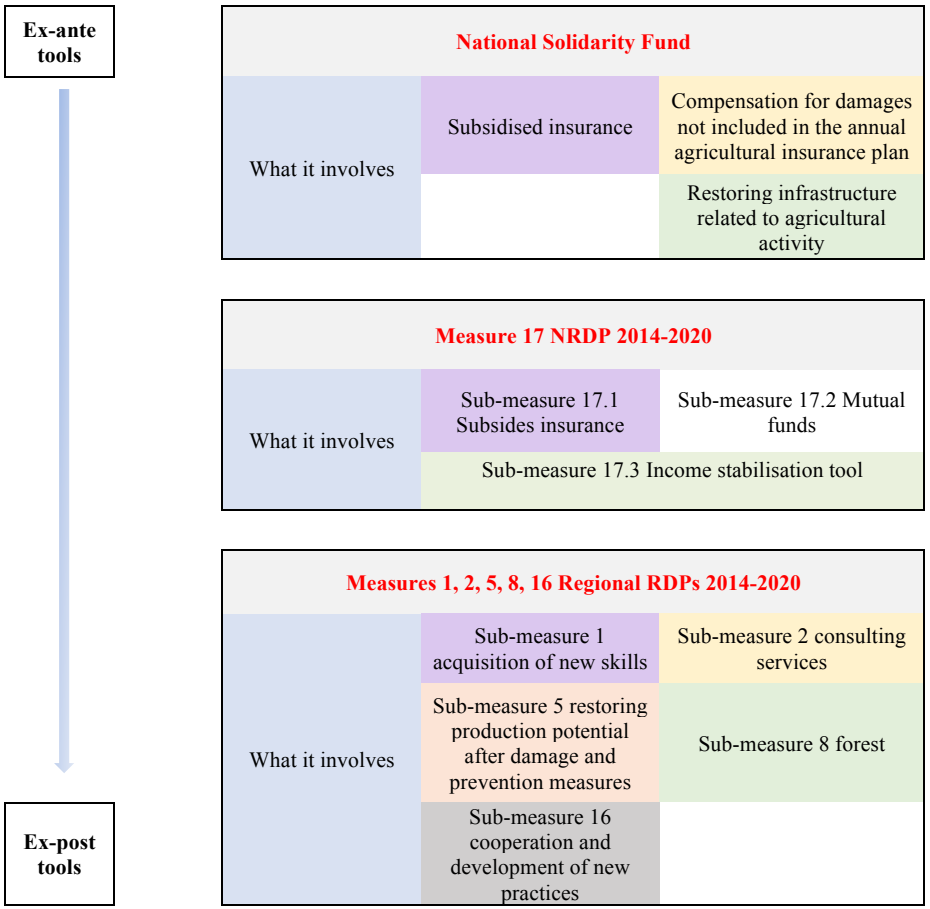
2. Main results

2.1. *Risk management in Sicily in the context of national interventions*

Farm risk management in Italy is linked to individual regional RDPs 2014-2020 through the measures included in the so-called 'Focus area 3B' (Supporting the prevention and management of farm risks). Furthermore, it is necessary to add the public contribution system connected to the 2014-2020 National Rural Development Programme (RDPN), which provides for the so-called Measure 16 and the National Solidarity Fund-FSN (D.lgs. n. 102/2004 e following). Therefore, the range of risk management tools (Figure 1) includes the facilitated insurance under sub-measure 17.1 of the 2014-2020 RDPN, alongside the mutual funds against adverse weather events and phytosanitary risks (sub-measure 17.2 of the 2014-2020 RDPN) and the sector income stabilization tool (sub-measure 17.3 of the 2014-2020 RDPN). The National Solidarity Fund continues to serve as a funding source for the implementation of ex-post compensation interventions, as do the ex-ante interventions (farm structure policies, loss of income for milk and honey production, and carcass disposal), as well as the experimental policies (index-based and revenue policies). (ISMEA, 2022). The Ministry of Agricultural Policy (MASAF) annually publishes the Agricultural Risk Management Plan, specifying the rules for participation in the various initiatives and the types of insurable events on which the insurance supply and demand system of farmers is built.

Despite the complexity and variety of initiatives planned in Italy, the risk management system complains of noticeable delays in adhering to Measure 17 of the RDPN, with consequent problems linked to high costs for

*Figure 1 - Risk management tools available in Italy for farmers**



* Our elaboration.

multi-risk insurance; to bureaucratic complexity due to the involvement of multiple actors (insurance companies, defense consortia, CAA, AGEA, etc.) (Raccosta, 2019); to the limited interest of insurance companies (Sherrick *et al.*, 2004; De Pasquale *et al.*, 2006); to delays in the distribution of aid by AGEA; to limited knowledge; to the absence of dissemination and to the limited ability to make system (Timpanaro *et al.*, 2013; Foti *et al.*, 2017).

At a regional level, the programming of risk management interventions financed under the RDPs is divided into Measures 1 ('Knowledge

transfer'), 2 ('Farm advisory and replacement services'), 5 ('Interventions for the prevention and restoration of damaged production potential'), 8 ('Investments in the development of forest areas and the improvement of forest profitability') and 16 ('Cooperation'). Considering, in particular, Sicily in Table 2, it appears that the regional government has activated a low number of measures (1, 2, and 5), even though the largest allocation has been for damage restoration interventions.

Table 2 - Planned public expenditure (€) by measure in the 2014-2020 RDPs in Sicily and Italy

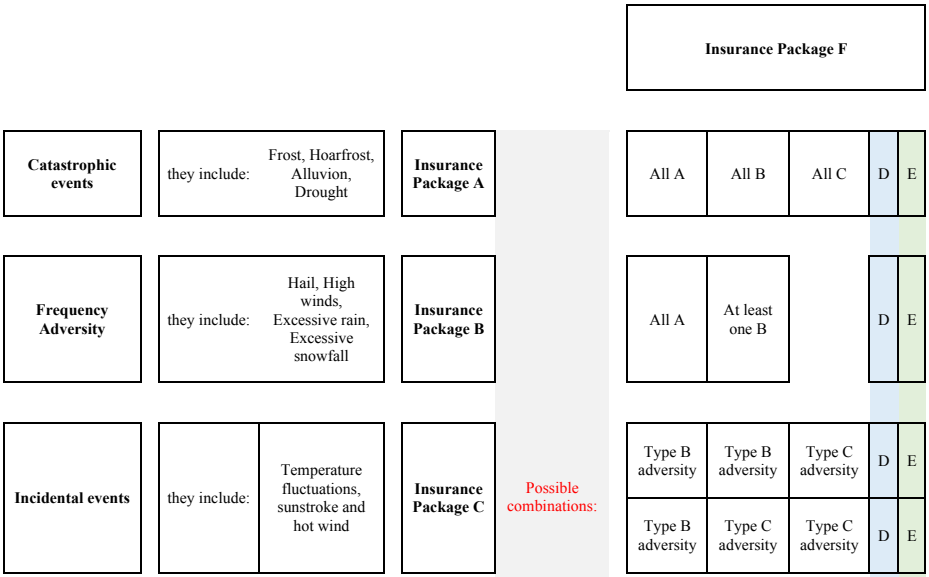
Area	Measure 1	Measure 2	Measure 5	Measure 8	Measure 16	Overall
Sicily	41,931	80,000	18,167,571	/	/	18,289,502
Italy	3,156,733	1,357,500	238,440,169	30,460,631	6,309,549	279,724,582
% Sicily / Italy	1.3	5.9	7.6	0	0	6.5

Source: ISMEA.

In the mid-term modulations, Measure 5 remained preferred with an increased allocation of resources due to the effects of climate change and the intensification of damage from adverse weather phenomena.

Concerning the insurance proposals created within the institutional support framework, farmers face several opportunities when preparing their insurance plans to access the support system (Figure 2). This system, on the one hand provides an incentive to offer insurance solutions but on the other hand does not always correspond to a possible increase in demand for insurance. Firstly, because different insurance needs emerge at the local level, which do not always correspond to national ones, and secondly, because without adequate territorial promotion activities, widespread information asymmetries cannot be overcome. Moreover, the availability of insurance solutions alone is not enough to overcome the delay in risk culture or the cost of policies. Agricultural insurance, even when subsidised, remains very expensive compared to other lines of risk. Therefore, a vicious circle is created, whereby only farms with a high probability of crop damage are insured and rates rise even higher. For this reason, there is increasing talk of parametric policies, to correlate the adverse event with the crop damage.

*Figure 2 - Subsidized insurance packages in agriculture in Italy**



* Our elaboration.

Concerning insurance policies, in Table 3, it is evident that there is regional interest in the so-called "Package F" proposals, whose average rate is considerably lower than the average cost of the other packages, signaling some fundamental market trends:

- need to contain insurance costs, and;
- reduction in the number of insured adverse events.

Table 3 - Types of policies taken out in Sicily and Italy (2019)

Area	Package A	Package B	Package C	Package D	Package F
	%	%	%	%	%
Sicily	1.8	3.5	12.6	0	82
Italy	14.6	20.6	54.9	1	8.8
Index Sicily / Italy	12	17	23	0	932

Source: ISMEA.

Turning to the production sectors, citrus and fruit-growing prevail in terms of regional spread and the growing concern of farms for the prevention of weather and climate risks of a catastrophic nature; also, in the wake of particularly negative experiences in the most recent insurance campaigns, as shown in Table 4.

Table 4 - Policies subscribed in Sicily by type of farming (2020)

Address	**Number of companies**	**Insured value (€)**
Oranges	519	33,228
Peaches	265	11,108
Wine grapes	206	8,221
Nectarines	162	5,866
Apricots	174	4,827
Table grapes	70	4,306
Prickly pears	54	3,745
Pears	72	3,537
Lemons	39	2,681
Peppers	17	1,395

Source: ISMEA.

2.2. *Socioeconomic profile of participants*

Table 5 shows the descriptive statistics of the study, which indicate that most of the Sicilian entrepreneurs interviewed (97%) were male and aged between 31 and 50 years (68%), while only 6% of the respondents were younger than 30 years. Most respondents (59%) had completed their education with a minimum of a three-year degree. In comparison, only 5% had completed primary education, and 28% had finished their studies with a diploma.

Concerning production, it can be seen that the conventional method prevails with 74% of respondents, while only 26% operate organically. Interestingly, the data on the interviewees' experience in the agricultural sector is interesting, with 63% answering that they have been operating in the sector for less than 15 years and only 4% for more than 30 years; this figure is in line with the answers regarding the age group.

Finally, the last figure described in Table 5 was whether or not the respondent had inherited the management of the farm from parents or

other relatives. For this data, we have a very balanced result, 51% of the respondents stated that they had inherited the farm from relatives, and the remainder (48%) answered in the negative.

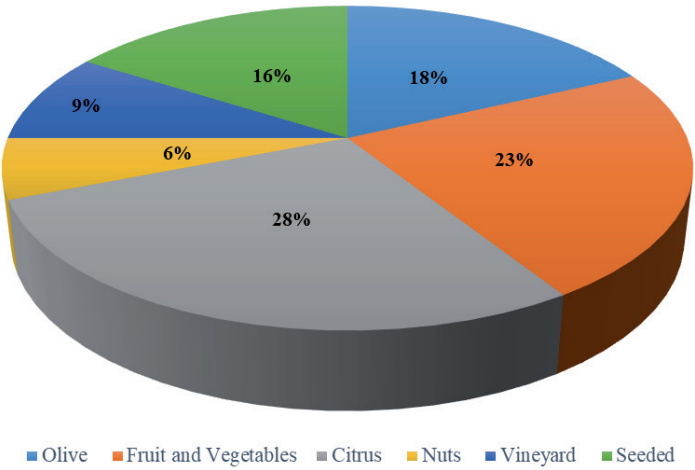
*Table 5 - Socioeconomic characteristics of enterpreneurs**

Variables	Description	Frequency
Gender	Male	97
	Female	3
Age	< 30	6
	31-50	68
	> 51	26
Educational level	Primary school license	5
	Secondary school certificate	5
	High school diploma	28
	Degree	59
	Post Degree	3
Production specifications	Conventional	74
	Organic	26
Experience (years) in agriculture of the entrepreneur	< 15	63
	16-30	33
	> 30	4
Have you taken over the running of the business from a parent?	Yes	51
	No	49

* Our elaboration.

Figure 3 shows the type of farming for the 100 companies surveyed. The results, in this case, are an expression of the territorial reality investigated, with citrus farming prevailing with a percentage of 28%, followed by horticulture (23%) and olive growing (18%), and then gradually by the others.

*Figure 3 - Type of farming for the surveyed companies**



* Our elaboration.

2.3. *Latent variables and extended model measurements*

To extract latent variables from the questionnaire items, exploratory factor analysis (EFA) was used. The validity of the TPB extension, which includes five latent factors indicating intention, attitude, subjective norm, PBC, and risk factors, was assessed through KMO and Bartlett's test. The results show a good fit of the model (Kaiser-Meyer-Olkin measure of sampling adequacy = 0.82, Bartlett's test of sphericity with Sign < 0.001).

Table 6 shows the number of items considered for extracting each latent factor and their standardized factor loadings. Each item is a response to a questionnaire question that was evaluated by entering a single scale from 1 to 7, with each question being differentiated by a distinct scale. Items with item factor loadings less than 0.50 were excluded from the analysis. The study calculated Cronbach's alpha coefficients for each factor to evaluate the scale's internal consistency and reliability (Selvaggi *et al.*, 2021), and considering that Cronbach's alpha to assess internal consistency can be classified as excellent ($\alpha \geq 0.9$), good ($0.7 \leq \alpha < 0.9$), acceptable ($0.6 \leq \alpha < 0.7$), poor ($0.5 \leq \alpha < 0.6$), and unacceptable ($\alpha < 0.5$) (George, 2016). The results show an adequate internal consistency of the scale items, as Cronbach's alpha coefficients range from 0.73 to 0.97.

Descriptive item analyses were conducted, and the table shows the mean and standard deviation, with the highest mean value for risk factors (RISK) and the lowest for perceived behavioral control (PBC).

*Table 6 - Reliability, factor loading, mean, and S.D.**

Variables	Observed items	α	Factor Loading	Mean	Standard deviation
Intention	3	0.977	0.967	3.14	1.110
			0.949	3.20	1.172
			0.987	3.15	1.077
Attitude	7	0.739	0.870	3.22	1.177
			0.919	3.14	1.181
			0.721	4.78	1.079
			0.701	4.42	1.165
			0.953	4.45	1.123
			0.856	2.98	1.263
			0.901	2.93	1.249
Subjective norm	4	0.938	0.887	3.13	0.991
			0.878	3.05	1.067
			0.926	2.96	0.974
			0.867	2.87	1.012
Perceived behavior control	7	0.912	0.556	3.14	1.073
			0.826	3.22	1.133
			0.881	3.11	1.154
			0.798	2.84	1.042
			0.920	1.81	1.161
			0.755	2.07	1.047
			0.960	1.81	1.152
Risk factors	7	0.850	0.936	4.91	1.074
			0.650	4.58	1.007
			0.843	4.66	0.890
			0.771	4.56	1.065
			0.885	4.22	0.894
			0.813	4.23	0.908
			0.876	4.18	0.845

* Our elaboration.

2.4. *Correlations between variables*

The results of the Pearson correlation coefficient test between the variables are shown in Table 7, which reveals significantly positive correlations between intention and all the other variables in the model except for risk factors. In particular, attitude and subjective norms appear to be the variables most correlated with intention. There is also a good correlation between the

variables, with attitude being the most correlated. Risk factors (RISK) appear to be the most problematic factor as it has no significant correlations with any variable except attitude.

*Table 7 - Correlation matrix**

	INT	**ATT**	**SN**	**PBC**	**RISK**
INT	–				
ATT	,848**	–			
S.N.	,827**	,820**	–		
PBC	,236*	,408**	,366**	–	
RISK	,109	,114*	,145	-0,005	–

* Our elaboration.
** Correlation is significant at the 0.01 level (two-tailed).
* Correlation is significant at the 0.05 level (two-tailed).

Notes: Int: Intention, Att.: Attitude, S.N.: Subjective norm, PBC: Perceived behavior control, RISK: Risk factors.

2.5. *Entrepreneurial behavior in risk management*

Three different linear regressions were conducted to test the general relationships between the variables and thus answer the assumptions made. With intention as the dependent variable, a hierarchical regression analysis was performed using the TPB constructs as independent variables in the first stage. Secondly, the hierarchical regression analysis included an additional construct with TPB variables. Finally, the interviewed farms' farming type was included with the ETPB constructs. The three regressions were performed to understand which TPB variables most affect the intention to ensure and to assess whether adding additional factors would increase the model's predictive accuracy.

Concerning the first regression, the ANOVA table shows a significance level p of < 0.001. The regression model, therefore, fitted well. Table 8 shows that the R^2 has a value of 0.78, indicating that 78% of the variance of intention can be explained by attitude (ATT), subjective norm (S.N.), and perceived behavioral control (PBC). These results show that intention is strongly determined by attitude (ATT) and subjective norm (S.N.), which are found to be the most important variables influencing behavior (B: 0.568, significance level p < 0.001; B: 0.416, significance level p < 0.001). Perceived behavioral control (PBC) shows a good influence on

intention but less than the first two constructs (B: 0.148, significance level p = 0.005).

In the second stage, characterized by the addition of a new construct (RISK), attitude (ATT) retained the most significant influence, followed by subjective norm (S.N.), PBC, and finally, risk factors (RISK), which did not show any particular correlation with intention (B: 0.017, significance level p = 0.714). Therefore, the additional factor was shown to be statistically non-significant.

Similarly, step 3, characterized by the addition of the type of farming, showed that this additional variable did not influence farmers' intention to adopt insurance, as neither type of farming proved to be statistically significant.

*Table 8 - Regression coefficients**

	Non-standardized coefficients		Standardized coefficients	t	Sign.
	B	Standard error	Beta		
Stage 1:					
ATT	0.578	0.085	0.568	6.820	<0.001
SN	0.425	0.083	0.416	5.094	<0.001
PBC	0.146	0.050	0.148	–2.891	0.005
Stage 2:					
ATT	0.579	0.085	0.568	6.791	<0.001
SN	0.428	0.084	0.419	5.083	<0.001
PBC	0.147	0.051	0.149	–2.895	0.005
RISK	0.018	0.050	0.017	–0.368	0.714
Stage 3:					
ATT	0.580	0.092	0.569	6.320	<0.001
SN	0.418	0.090	0.410	4.668	<0.001
PBC	–0.148	0.059	0.150	–2.525	0.001
RISK	–0.024	0.053	0.023	–0.457	0.649
Olives	–0.020	0.140	0.008	–0.141	0.801
Fruit and Vegetables	0.050	0.133	0.022	0.373	0.590
Citrus	0.053	0.131	0.026	0.403	0.557
Nuts	–0.105	0.499	–0.011	–0.211	0.770
Seeded	–0.043	0.143	0.017	–0.300	0.660
Vineyard	0.120	0.203	0.035	0.589	0.638

* Our elaboration.

3. Discussion

Agricultural risk management policy seems to have reached its decisive stage, considering both the evolution of CAP measures and what seems to be impending climate change, which is expected to have significant effects in terms of frequency and intensity of adverse events. In this scenario, insurance is a necessary innovation to be adopted in the farm to ensure adequate risk coverage.

This research contributes to exploring farmers' behavioral intentions toward purchasing insurance. The study aims to verify the predictive validity of an extended TPB framework, which considers not only the classical three variables but also risk factors concerning the adoption of insurance in agriculture and adds the farm type of farming.

The result of the hierarchical regression indicates that the additional factors included in the model (RISK and type of farming) are not statistically significant in explaining farmers' intention to adopt insurance. Attitude, subjective norms, and perceived behavioral control were found to influence intention significantly, thus supporting Hypotheses 1, 2, and 3. At the same time, risk factors (RISK) do not directly influence the intention to adopt insurance. Therefore, Hypothesis 4 is not significant and is rejected. Furthermore, the type of farming was also found not statistically significant in explaining farmers' intention to purchase insurance, thus rejecting Hypothesis 5.

The direct positive and significant impact of attitude on intention shows that farmers' evaluation of insurance adoption influenced their behavioral intentions. The more positively farmers evaluated the adoption of insurance, the greater their intention to apply it. Lalani *et al.* (2016) discovered that Attitude has the highest positive and significant effects on intention compared to other constructs. Other previous studies also found a significant positive relationship between direct attitude and behavioral intention (Bagheri *et al.*, 2019; Borges *et al.*, 2014; Maleksaeidi and Keshavarz, 2019). The significant direct effects of the subjective norm (S.N.) on intention indicate that perceived social pressure influences farmers' intentions. A higher perceived social pressure corresponds to a stronger intention to adopt insurance. Therefore, family members, neighbors, and the community can actively improve farmers' intentions (Bagheri *et al.*, 2019; Lalani *et al.*, 2016; Maleksaeidi and Keshavarz, 2019). Perceived behavioral control significantly impacts intention, confirming that farmers' perceived ability also influences behavioral intention (Bagheri *et al.*, 2019; Borges *et al.*, 2014; Bruijnis *et al.*, 2013). However, in their work, Maleksaeidi and Keshavarz (2019) found that PBC has a non-significant impact on the intention to conserve on-farm biodiversity because farmers do not perceive sufficient control to engage in

biodiversity conservation practices. It should be noted that the attention given by advisory services (operators of insurance, trade associations, agronomists, etc.) and media reports on the frequency of extreme weather events have significantly impacted the perception and behavior of individuals.

The two additional variables (RISK and type of farming) were found to be non-significant in explaining farmers' behavior. This indicates that the identification of risk factors and the type of farming do not impact farmers' decision to adopt insurance based on the model applied. However, data that emerged by area of interest show a correlation between the net income obtainable from crops and the intention to insure. One of the most critical obstacles to risk management today is the cost; insurance premiums, in absolute terms, peaked last year at 610.8 million euros. The sectors that show a greater propensity to insure are Fruit and Vegetables, Citrus, and Vineyards, characterized by the possibility of obtaining a margin that can at least cover the insurance cost. Crops such as seeds and nuts generally have little added value in Sicily and are among the sectors with a low predisposition to insurance.

The results indicate critical implications for policy: focus on cooperation and increasing knowledge about insurance. Subjective norms (S.N.) are essential, as they were found to have a positive and significant effect on farmers' intentions. Therefore, government policies and programs should focus on promoting cooperation (as demonstrated by the experience of Northern Italy) through the creation of consortia, producer associations, and similar, which effectively share experience, knowledge, and information on the functioning of the insurance system. Attitude has been found to have the highest direct effect on farmers'intentions. Policy interventions, including specialized education and awareness programs, could prove helpful and positively influence farmers' attitudes towards intentions. The insurance market in Southern Italy is not yet responding effectively. Therefore further communication efforts are needed to transfer to farms not only the specifics of insurance contracts but also a broader knowledge of the advantages to be gained from a developed economic-financial system.

Analysis of the initial results shows that the research has limitations due to the inclusion of other (unconsidered) factors that may influence the actual behavior between the time the intention is formed and its translation into practice. This study assessed the intention to adopt insurance instead of the actual behavior of the farmer. Therefore, future studies could seek to discover whether the farmers' intentions can be translated into practice. The results of this study can serve as a reference for these observations and analyses. However, as mentioned above, the additional factors included in the model (RISK and type of farming) were found not to be statistically significant, so the addition of other factors, such as Knowledge (Bagheri *et al.*, 2019;

Maleksaeidi and Keshavarz, 2019) and Experience (Soorani and Ahmadvand, 2019) could increase the validity of the model and better explain farmers' intentions. Furthermore, the approach proposed in this study did not consider farmers' emotions (e.g., fear/threat, positive or negative feelings).

Despite the limitations, the study is believed to contribute to the development of a line of research based on intentions for insurance adoption in agriculture assessed through psychological factors of farmers since a good part of the literature has investigated insurance adoption by considering socioeconomic factors (Ghosh *et al.*, 2022; Abraham *et al.*, 2013), risk preferences (Moschini and Hennessy, 2005; King and Singh, 2020), and previous experience in insurance purchase (Sujarwo *et al.*, 2017; Ghosh *et al.*, 2022). The study can help formulate future research work that combines psychological and socioeconomic factors in understanding the dynamics of insurance adoption by farmers.

Conclusions

The Italian agricultural insurance market is evolving and becoming increasingly important, and it is expected that this relevance will rise as the agri-food sector's exposition to various risks increases. The possibility of receiving subsidies for subscribed insurance offers an opportunity for entrepreneurs in the sector. Despite this, the diffusion of the insurance instrument is still limited, especially in the southern regions of Italy. Therefore, it is fundamental to understand which factors may influence the adoption of insurance by farmers.

This study contributes to the existing scientific literature by analyzing factors influencing farmers' intentions toward insurance adoption based on an extended TPB framework. The results demonstrate that the constructs of the TPB can explain farmers' behavioral intentions toward insurance. However, adding another construct (RISK) and farm type does not increase the theory's predictive force, as these factors are statistically insignificant.

The analysis confirmed that the positive attitude of entrepreneurs towards insurance directly increases the intention to apply it, being a significant predictor of intention. This result contrasts with reality, which today reveals a limited insurance adoption. Therefore, policymakers should emphasize that this practice favors farmers to increase their insurance choices. Furthermore, subjective norms influence farmers' intentions since they do not operate independently of cultural and societal influences but refer their behavior to essential referents. Therefore, society can actively increase farmers' intention to adopt insurance by prompting them to use this innovation.

A simplification of risk management procedures will condition the future of insurance in terms of policy costs and procedures. This starting step should be accompanied by support from institutions to facilitate the introduction of innovation into farm management. Therefore, insurance may assume a strategic function for managing farms concerning their multi-functionality. Insurance could assume a guarantor function for activities such as tourism, maintenance of the landscape, and social communities concerning the multiple risks to which the farm of the future is subject.

Future research will focus on defense consortia for the mediating role that they play on the demand side, in promoting the aggregation and qualification of insurance demand, and on the supply side, in proposing insurance packages in line with the indications of the national insurance plan and the needs of the territory in which they operate.

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Giuseppe Timpanaro
Department of Agriculture, Food, Environment (Di3A), University of Catania
Via Santa Sofia, 100 - 95123 Catania, Italy
E-mail: giuseppe.timpanaro@unict.it
Giuseppe Timpanaro has a PhD in agricultural economics and policy and is an associate professor in agricultural policy and Agrifood Marketing.
He was a president of the master's degree course in agricultural science and technology at the University of Catania. He has carried out numerous studies on EU agri-food policies, rural and local development, bio-economy, and food security and sustainability. He has collaborated with several international institutions and is involved in several international study and research programs.

Gaetano Chinnici
Department of Agriculture, Food, Environment (Di3A), University of Catania
Via Santa Sofia, 100 - 95123 Catania, Italy
E-mail: chinnici@unict.it
Holds a degree in Agricultural Sciences (Catania, 1997) and got a Doctoral Degree in Agricultural Economics and Policy (Catania, 2001). Associate Professor since December 2021. His recent research interests are related agri-food marketing, innovation, sustainability and circular economy, with specific topics regarding quality food specialties, organic food, olive oil and wine business.

Roberta Selvaggi
Department of Agriculture, Food, Environment (Di3A), University of Catania
Via Santa Sofia, 100 - 95123 Catania, Italy
E-mail: roberta.selvaggi@unict.it
Fixed-term Assistant Professor of Agricultural economics and rural appraisal, she holds a master's degree in Agricultural Science and Technology (Catania, 2012) and got a Doctoral Degree in Agricultural Food and Environmental Science (Catania, 2021). Her research interests include the reduction of the economic impact of waste management and the analysis of consumers' preference.

Giulio Cascone
Department of Agriculture, Food, Environment (Di3A), University of Catania
Via Santa Sofia, 100 - 95123 Catania, Italy
E-mail: giulio_cascone97@libero.it
Giulio Cascone is a PhD student in Agricultural Food and Environmental Science. He is the author of some printed publications in indexed journals.

Vera Teresa Foti
Department of Agriculture, Food, Environment (Di3A), University of Catania
Via Santa Sofia, 100 - 95123 Catania, Italy
E-mail: v.foti@unict.it
Vera Teresa Foti has a PhD in agricultural economics and policy and is a associate professor of 'economics of quality products' at the University of Catania. Her

research activity has focused on local development, food quality, and safety and sustainability, with a particular interest in production and consumption. She has been a speaker at national and international conferences.

Alessandro Scuderi
Department of Agriculture, Food, Environment (Di3A), University of Catania
Via Santa Sofia, 100 - 95123 Catania, Italy
E-mail: alessandro.scuderi@unict.it
Alessandro Scuderi has a Ph.D. in Agricultural Economics and Policy, has been a Research Fellow and a Fixed-term Researcher, and is now an Associate Professor. Throughout his scientific career he has dealt with issues related to agricultural economics and policy and specifically specialized in sustainability, production systems and process and product innovations. He has published numerous scientific papers in national and international journals as well as participating internationally in major conferences related to agrifood production.

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Trends and support models in public expenditure on agriculture: An italian perspective

Lucia Briamonte[*,a], **Paolo Piatto**[a], **Dario Macaluso**[a], **Mariagrazia Rubertucci**[a]

[a] Council for Agricultural Research and Economics (CREA), Italy

Abstract

This paper identifies, quantifies, and qualifies the streams and models of public expenditure in the agricultural sector for the 2010-2020 period, and attempts to respond to the main preliminary needs of interventions that benefit the agricultural sector.

The specific methodology of the CREA has been used to classify public expenditure on agriculture at the national and regional levels, thus allowing for a homogeneous classification of all direct and indirect support for the sector, which has been obtained from the accounting records of the disbursing agencies.

This is accompanied by the use of cluster analysis to identify the support models for the sector that have been adopted by the Italian regions.

Through the analysis of FAO data on the Agriculture Orientation Index (AOI), national trends in spending are identified and compared with the European and global contexts, which also allows tracking of the evolution of the national agricultural policy independently of support from the Community Agricultural Policy (CAP).

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* *Corresponding author*: Lucia Briamonte - Senior researcher - Center for Politics and Bioeconomy of Crea - Research Center for Agricultural Policies and Bioeconomy - Via Barberini, 36 - 00187 Roma - Tel. 0647856254 - E-mail: lucia.briamonte@crea.gov.it.

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Introduction

Agriculture is undoubtedly the key sector of any world economy (Svatoš & *et al.*, 2009), as well as being a strategic sector, since it satisfies one of the population's most important needs: food (Horská, 2011).

Its performance and development are influenced both by market dynamics (supply and demand for products and services) and support policies, which make the agricultural market one of the least liberalised worldwide (Bartolini & Viaggi, 2013; De Castro *et al.*, 2012; Horská & Hambálková, 2008; Svatoš, 2008).

Public support is an important source of funding for the development of the sector (Pokrivcak *et al.*, 2003) and, in the EU, Common Agricultural Policy (CAP) subsidies represent a significant income supplement for individual agricultural entrepreneurs (Bašek & Kraus, 2011; Střeleček *et al.*, 2009).

It is well known and widely recognised by both scholars and decision-makers that, in the absence of public intervention, most EU agricultural enterprises would not be able to remain in the market (Bielik *et al.*, 2008; Ciliberti & Frascarelli, 2018). Indeed, the literature is in agreement in identifying financial barriers as the main constraint to which agricultural enterprises are subjected (David *et al.*, 2000b). Therefore, most interventions are based on direct financial support measures, in the form of aid, or indirect measures (tax and social security incentives).

The EU CAP, from its inception, was one of the main agricultural support policies for supporting farmers' incomes. Subsequently, it also targeted improvement of socio-economic conditions in rural areas. It has evolved over time to respond to the economic, environmental, and local challenges that the European Union has encountered, both in the field of agriculture and within a broader context (Ciliberti & Frascarelli, 2018; European Commission. Directorate General for Agriculture and Rural Development *et al.*, 2021; Lillemets *et al.*, 2022).

These structural changes were also necessary due to the strict budgetary constraints deriving from international agreements within the framework of the WTO trade negotiations and the various phases of enlargement of the

European Union that have occurred since the early 2000s (Galluzzo, 2022). Added to this are the new challenges of supporting resilience and sustainable development of agriculture, taken on by recent support policy guidelines, and implemented through the CAP 2023-2027, the NRRP, and national policy interventions (Buitenhuis *et al*., 2022; Pilvere *et al*., 2022).

In Italy, public support for agriculture as a topic of study developed significantly in the 1980s and 90s (Anania, 1996; Antonelli *et al*., 1989, 1989; Antonelli & Mellano, 1980; Colombo, 1990; Orlando, 1984). In the following decades, interest in the topic within the scientific community waned. Nevertheless, the CREA Research Centre for Agricultural Policies and Bioeconomy has, since the 1990s, analysed and quantified public intervention in agriculture through the analysis of spending on the sector, in an effort to contribute to the awareness and dissemination of knowledge on the matter (Briamonte & Vaccari, 2021; Iacovone, 2014; Reviglio, 2007).

The CREA methodology, which was also designed to respond to preliminary scientific needs, has produced analyses that have been used primarily for the benefit of the "key stakeholders", represented by public decision makers and sector operators involved in the various phases of implementing public interventions in agriculture (Briamonte & D'Oronzio, 2004; Cesaro, 2006; Ievoli & Rubertucci, 2014; Marino, 2005; Pergamo, 2008).

Given the context described above and the available data, the present paper addresses the following questions:

- Is it possible to define models of public support for Italian agriculture?
- How does the analysis fit into an international context?

Compared to the traditional use of data on public expenditure on agriculture and given the research questions above, this paper identifies the main regional patterns of public support in agriculture, based on the incidence of different expenditure components in relation to total transfers (Section 3.1). The efficiency of said expenditures is then evaluated over time and at the regional level (Section 3.2).

Finally, the analysis is framed in an international context using the Agriculture Orientation Index (AOI), from the FAO (Section 3.3).

1. Theoretical framework and research objectives

Large budgetary deficits and the increased national debt in many countries, arising from the international financial crisis in recent years, have highlighted the importance of reliable and timely statistics on administrations and public sectors. Public finance statistics play a fundamental role in the development

and monitoring of fiscal programmes and in the surveillance of economic policies (International Monetary Fund, 2014).

Adopting an approach that allows for international comparability of data is crucial for impact assessment, immediate identification of critical issues in implemented interventions, and timely adoption of corrective measures (Mogues & Anson, 2018).

A review of the literature on this issue finds heterogeneous methodological approaches and the use of different statistical sources (Allen & Qaim, 2012; Bašek & Kraus, 2011; Bielik *et al*., 2008; Coleman & Grant, 1998; Govereh *et al*., 2011; Martini & Sisti, 2009; Olomola *et al*., 2014). For instance, a line of study concerns the composition of public expenditure and the level of support which are often related to economic growth (Agénor & Neanidis, 2011; Alegre, 2010; Devarajan *et al*., 1996; Ormaechea & Morozumi, 2013; Sanz & Velázquez, 2001; Weber & Singh, 1997; Yu *et al*., 2015).

Instead, a relatively recent approach in the study of support policies for different sectors, such as education, social protection, and welfare, concerns the identification of patterns characterising the structure of public expenditure in different countries (Abu Sharkh & Gough, 2010; Angelov, 2019; Besana, 2018; David *et al*., 2000; Halásková, 2015; Provazníková & Chlebounová, 2018).

More specifically, with reference to the agricultural sector, several studies analyse government spending in order to assess its economic impact (Pietriková & Radomíra Hornyák, 2022; Shucksmith *et al*., 2005; Wielechowski, 2019; Wielechowski & Grzęda, 2019; World Bank Group, 2015; Zeszyty, n.d.). Many of these relate to developing countries and the effect of support on growth and poverty reduction (Ahuja & Pandit, 2020; Maïga *et al*., 2021; Olawumi & OYEWOLE, 2018; Olomola *et al*., 2014; Pernechele *et al*., 2021; Singh *et al*., 2021), other studies use AOI for cross-country comparative analysis (Chiaka *et al*., 2022; Dastagiri & Vajrala, 2018; FAO, 2017, 2022; Kaya, 2021; Wielechowski, 2019).

The literature review highlights that a shared system for classifying interventions is rarely provided and that the results of analyses are not always sufficient to assess the efficiency of public resources in producing net effects, i.e. effects that would not have occurred in the absence of public support. Indeed, sharing methodologies and findings would allow for analyses that overcome geographic and temporal barriers and would prepare the ground for a convergence of ideas and experiences to improve standards for measuring public expenditure (Govereh *et al*., 2011).

To address the need for a comprehensive source of homogeneous and comparable information for the Italian agricultural sector, the CREA methodology (Briamonte & D'Oronzio, 2004; Sotte, 2000) provides a

framework to interpret the empirical results of the application of agricultural policy interventions in Italy, both at the national and the regional level (Briamonte & D'Oronzio, 2004; Cesaro, 2006; Ievoli & Rubertucci, 2014; Marino, 2005; Pergamo, 2008).

In light of the above, this paper provides indications regarding the extent of total support and its related incidence on the growth of the agricultural sector.

In particular, the CREA has gathered data on combined total agricultural expenditure, the main institutional players, the methods of disbursement, and the extent of financial resources. This data can be used to geographically and temporally describe the characteristics and evolution of agricultural expenditure by classifying the financial flows in the financial statements of the administrations that directly or indirectly supply resources to the sector (Briamonte & Vaccari, 2021).

The primary objective of the present research is to identify regional models of public support for agriculture, defined according to different components of expenditure (objective 1, analysed in paragraph 3.1), through the use of the CREA methodology to analyse expenditure combined with cluster analysis.

Close examination of the data set shows that the predominant form of public support comes from EU policies and, for the most part, it is constant for the entire period considered. Therefore, the impact of regional support from EU sources and from the other aforementioned types of support (Pillars I and II) on total transfers was examined, and subsequently the efficiency of EU transfers was evaluated, based on the ratio of public resources used and results achieved in terms of added value (objective 2, analysed in paragraph 3.2).

Finally, FAO's Agriculture Orientation Index (AOI) index has made it possible to frame the analysis within an international context (objective 3, analysed in paragraph 3.3).

2. Materials and methods

The quantification of public resources for agriculture and their qualitative analysis makes it possible to create an overview of the Italian agricultural policy implemented through direct and indirect interventions that, on the basis of the decisions of the public authorities, aim to achieve the planned sectoral targets.

In this paper, "total public support" (TPS) for agriculture is defined as all the aid provided by the different decision-making levels (European Union, National government, Regions and Autonomous Provinces) intended to boost

the economic growth of the sector. Such support can take place directly, through the provision of actual payments referred to as "transfers" (T), or indirectly, in the form of tax and social security contributions "reliefs" (R), which are advantageous for farmers who, notwithstanding the rules for determining and applying taxes, pay smaller sums to the Treasury than those due in relation to ordinary tax rates (Briamonte *et al.*, 2012; Briamonte & Vaccari, 2021; Fiore *et al.*, 2012).

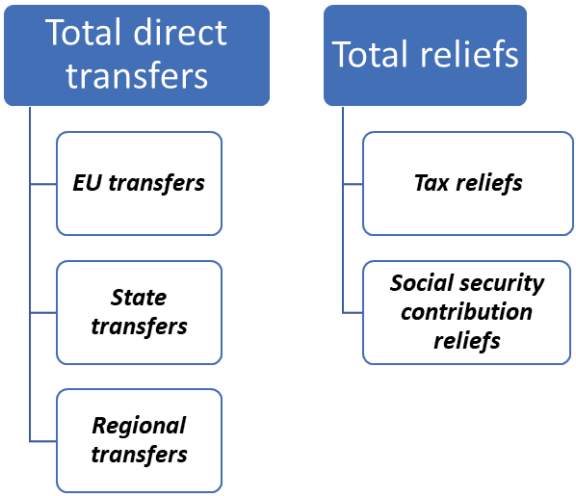
The amount of total support is equal to the sum of the two components indicated, attributable to the total number of transfers disbursed to farmers by EU, national, and regional public authorities and to the estimation of tax and social security contribution reliefs determined at the national government level. The resulting aggregate quantifies the total monetary value of public aid to the primary sector and corresponds to the advantage received by operators (Finuola, 2006, 2010). The amount of support is therefore expressed by the following formula:

[1] TPS = T+R

where:
TPS = Total public support
T = Total direct transfers to the sector expressed as tEU + tN + tR, where
tEU = EU transfers
tN = National government transfers
tR = regional transfers
R = Total reliefs, expressed as tr + sscr, where
tr = tax reliefs
sscr = social security contribution reliefs

Depending on the disbursing agency, the transfers come from the following sources: the EU, disbursed through AGEA (Italian agricultural payments agency), OOPPRR (regional paying agencies), SAISA (autonomous service for interventions in the agricultural sector) and ENR (national rice authority); the national government, disbursed by ministries and national bodies, such as Sviluppo Italia, Invitalia and ISMEA (Institute of services for the agricultural food market); or regional origins (Regions and public administrations). Reliefs are determined at a national level by the competent ministries (Figure 1).

Figure 1 - Composition of combined total transfers and reliefs for agriculture



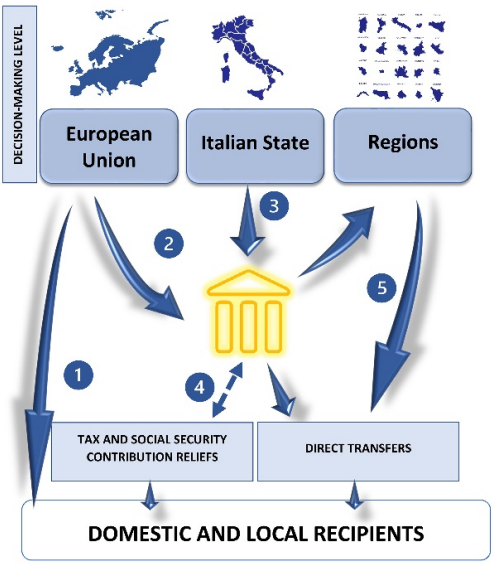
Source: CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

Figure 2 shows a diagram of the support for the agricultural sector and its components, where decision makers and disbursing agencies act as a link to the multilevel system of Italian public intervention in agriculture.

Some of the transfers that come from the European Union (1) – in particular, those disbursed by Pillar I and EU programmes – are characterised by the rather limited role played by the Italian State and Regions in the decision-making process, compared to what, by contrast, takes place with reference to other streams of EU support. This is the case, for example, with Pillar II, where the role of the Italian State and Regions is considerable, during both the planning and management phases (2).

Alongside European support, interventions implemented on a national level should be considered. Some of these, similar to those previously mentioned, are characterised as expenditure streams (3), others – tax and social security contribution reliefs – equate to a reduction in national government levies (4). Lastly, the expenditure streams determined independently by the Regions (5) on the basis of their budgetary resources, complete the overview of support for agriculture.

Figure 2 - Diagram of public support for the agricultural sector



Decision-making level	Component of expenditure	Type of expenditure
European Union	CAP, Pillar I	Direct payments (DP) and agricultural market measures
	CAP, Pillar II	Rural development measures
	EU Programmes	Directly managed EU programmes that financially support projects aimed at achieving EU objectives
Italian State	State transfers	Direct aid from state sources (Ministries and other bodies)
	Tax reliefs	Reductions in the tax base or in the estimated taxes for particular individuals or sectors
	Social security contribution reliefs	Reductions in the contribution rate for particular tax subjects or sectors
Regions	Regional transfers	Direct aid from regional sources

Source: CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

The original analysis methodology (Briamonte & D'Oronzio, 2004; Sotte, 2000), produced by the CREA, is applied to examine the expenditure flows related to public support policies for the agricultural sector in a standardized accounting information framework and to identify economic aims and the extent of financial resources, supply methods, disbursing agencies and beneficiaries.

This methodology is used for the collection, processing, analysis, and dissemination of data, which is managed by a special working group. This is, therefore, a tool that provides a homogeneous framework of rules for reclassification and re-aggregation of public spending on agriculture, applied to financial data derived from official accounting sources. It allows for assessments of the dynamics of expenditure over time, the economic effects of financial interventions and their effectiveness in relation to the stated objectives of agricultural policy.

The resulting database is a unique instrument that maps the last thirty years of public expenditure on agriculture and is intended to be used as a reference for operators and analysts in the sector. It also allows calculation of the total support for the sector and total expenditure by source (the EU, the National government or regional origin), as well as how the national government and the individual regions spend, and how much is allocated

to direct income support and to tax and social security contribution reliefs. More specifically, this database allows national and regional administrations to identify the changes that have affected policies in the sector and, consequently, to improve the management and monitoring of agricultural policy interventions (Aa.Vv., 2021b, 2021a; Vieri *et al.*, 2006).

The data analysed were collected via a direct survey and processed through the application of the CREA methodology for classifying the budgetary chapters (the base unit of measurement) of the bodies providing support to the sector, thus providing a homogeneous picture of expenditure, from a territorial (regional detail) and temporal perspective[1].

With regard to regional expenditure alone, the classification is aimed both at analysing the results of regional policies in terms of efficiency and effectiveness and at evaluating the quality of the policies adopted. More specifically, it is divided into ten thematic frameworks, each of which is aimed at understanding a particular aspect of the policy implemented (Figure 3), and deals with the main financial aggregates present in the estimated budgets and final financial statements (Figure 4).

In order to respond to research objective 1 of analysing regional support models, the statistical technique of cluster analysis was used (Cattell, 1943; Zubin, 1938), through the application of the k-means algorithm (Hartigan & Wong, 1979; Lloyd, 1982; Macqueen, 1967; Steinley & Brusco, 2007) to identify the potential existence of groups of regions that may be distinguished by a certain homogeneity in the mode of support employed.

The choice of variables to be adopted for the analysis was made on an empirical basis in view of the fact that the different support models are determined solely by the incidence of the various components of expenditure in relation to the amount of total support at a regional level (the region, therefore, corresponds to the unit of observation). In order to normalise the measurements (mathematical normalisation), i.e. to take into account the aspects related to scale and thus to "neutralise" the dimensional effect, the percentage of each support method (Pillar I, Pillar II, National government, Region and Reliefs), with respect to total regional support was compared to the corresponding percentage at the national level. Therefore, for each region,

1. ISTAT's National Statistical Plan, which classifies statistical work, defines the Survey of Public Expenditure on Agriculture conducted by CREA as a statistic derived from administrative sources and new data sources, i.e. statistical information produced through a transformation of non-statistical sources. Information is drawn from administrative sources, or sources responding to other purposes owned by public or private entities, as well as new data sources such as Big data. The information transformation process entails the stages of acquisition, processing (checking and correction, possible integration with other data sources), analysis, and dissemination.

Figure 3 - CREA methodology: classification of agricultural expenditure

Thematic frameworks	*Purpose of expenditure*
Economic - functional	Type of agricultural policy intervention
Support expenditure	Type of support disbursed to the agricultural sector
Final beneficiaries	Recipients of agricultural policy intervention
Expenditure management	How funds are distributed to the final beneficiary
Decision-making function	Level of delegation in relation to Region
Financial means	Origin of the resources disbursed that are used to finance expenditure
Production sectors	Production sector that the intervention is exclusively or predominantly aimed towards
Environmental protection	Environmental protection interventions
Natural disasters	Mutually beneficial nature of the intervention
Essential performance levels for agriculture (LEPA*)	A guarantee of essential levels of agricultural performance and development objectives

* The concept of essential levels of performance for agriculture was developed by Briamonte and Ievoli in "*Spesa agricola regionale e federalismo fiscale: Problemi di determinazione dei fabbisogni finanziari*", 2010, INEA.

Source: CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

five different parameters were calculated, indicated as location quotients (LQ), one for each component of expenditure (Pillar I LQ, Pillar II LQ, National government LQ, Region LQ, Reliefs LQ), according to the following formulas:

$$[2]\ LQ - Pillar\ I = \frac{\frac{{}^{1}P_R}{T_R}}{\frac{{}^{1}P_N}{T_N}}$$

$$[3]\ LQ - Pillar\ II = \frac{\frac{{}^{2}P_R}{T_R}}{\frac{{}^{2}P_N}{T_N}}$$

$$[4]\ LQ - National\ govt = \frac{\frac{S_R}{T_R}}{\frac{S_N}{T_N}}$$

$$[5]\ LQ - Region = \frac{\frac{R_R}{T_R}}{\frac{R_N}{T_N}}$$

$$[6]\ LQ - Reliefs = \frac{\frac{Rel_R}{T_R}}{\frac{Rel_N}{T_N}}$$

where *1P* indicates Pillar I expenditure, *2P* indicates Pillar II expenditure, *S* is national expenditure, *R* is regional expenditure, *Rel* is reliefs and *T* indicates total public expenditure. The subscript *R* and *N* denote geographical area, specifically regional and national, under whose jurisdiction each of the above-mentioned components fall.

Figure 4 - CREA methodology: classification of financial data

Financial Code	***Code Description***
	Final Financial Statements
C1	Final accrual-based appropriations
C2	Commitments
C3	Accrual payments
C4	Residuals from previous years
C5	Residual payments
C6	Confirmed residuals (C4-C5) + (C2-C3)
C7	Final cash appropriations
	Provisional Budget
P1	Estimated residuals on 31/12 of each year
P2	Estimated accrual-based appropriations
P3	Estimated cash appropriations

Source: CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

Values of LQ that are greater than 1, which correspond to an incidence of the specific mode considered (e.g. Pillar I) being higher than the Italian average, indicate a region with a prevalence of this mode of support. Conversely, an LQ value less than 1 indicates a lower weight of support than what is found on a nationwide level.

The five parameters calculated in this way were used to identify the clusters.

In order to frame the analysis carried out with the data collected by the survey on public expenditure on agriculture in an international context, data from FAO's Agriculture Orientation Index (AOI) were analysed (FAO, 2017, 2022; Wielechowski, 2019).

The AOI is an indicator determined through the following formula:

$$[7]\ \text{AOI} = \frac{\text{ASGE}}{\text{AVASG}}$$

$$[8]\ \text{ASGE} = \frac{\text{CGEA}}{\text{TCGE}}$$

$$[9]\ \text{AVASG} = \frac{\text{AVA}}{\text{GDP}}$$

where:
ASGE = Agriculture Share of Government Expenditure;
AVASG = Agriculture Value Added Share of GDP;
CGEA = Central Government Expenditure on Agriculture;
TCGE = Total Central Government Expenditure;
AVA = Agriculture Value Added;
GDP = Gross Domestic Product.

The AOI is a currency-free index since it is calculated as the ratio of two shares. It indicates the level of orientation of national economies towards agriculture: index values greater than 1 denote high shares of national government expenditure allocated to agriculture compared to the contribution in terms of value added contributed by the sector to GDP; by contrast, values lower than one indicate that greater importance as regards support is given to non-agricultural sectors.

3. Results

This paper analyses the trend in the value and structure of public expenditure on agriculture in Italy for the 2010-2020 time period.

During this period, the agricultural sector changed its position in the national economy and, towards the end of the decade considered, its performance was affected by the Covid-19 health crisis (Cesaro *et al.*, 2020).

The Italian agricultural system, although affected by the measures that were put in place to control the spread of the epidemic, nevertheless ensured food supply and food safety for the entire population, thanks to the efforts of operators and the intervention of institutions[2]. In fact, the heath crisis

2. In order to contain the spread of Covid-19, the Italian government planned a series of interventions. In particular, 90 million euros were disbursed by the MIPAAF (Ministry

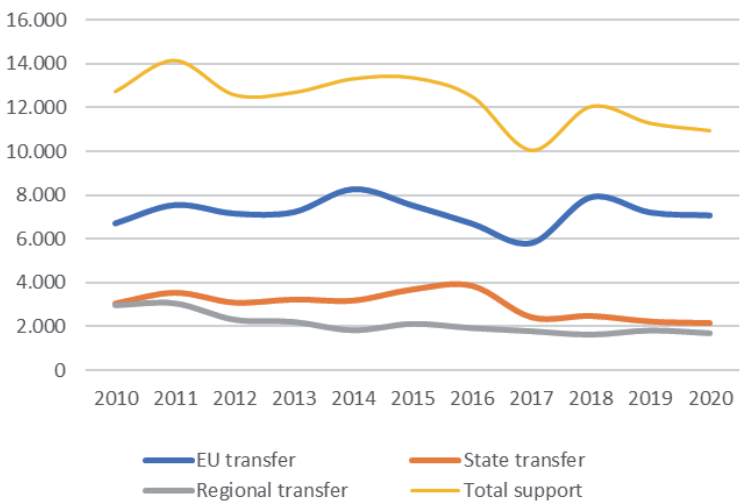
enhanced the essential and strategic function of the agricultural sector, highlighting the tenacious resilience of the system and refocusing the debate on this topic with some comprehensive observations on how to mitigate its vulnerabilities and weaknesses (Aa.Vv., 2021a, 2021b; Carè & Varia, 2020).

The data currently available do not allow us to quantify the impact of the pandemic on the sector and on public support. That will be the focus of a subsequent study based on updated data.

3.1. *Regional models of public support for agriculture*

An informative overview of the combined support for the agricultural sector is shown in Figure 5 for the 2010-2020 period, in terms of total volume and contributions offered by the individual decision-making components of expenditure.

Figure 5 - Public support for Italian agriculture by source of origin (in millions of euro, 2010-2020)



Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

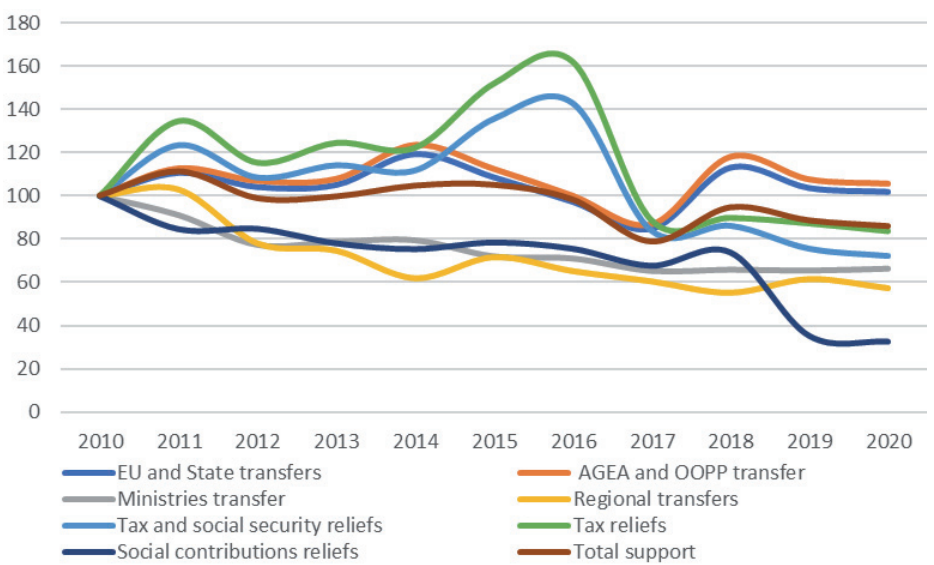
of Agricultural, Food and Forestry Policies) emergency fund (budgetary chapter 2303). In addition, the regional rural development programmes (RDPs) planned a specific measure (M21 "Extraordinary temporary support due to the Covid-19 crisis") through which approximately 107 million euros were disbursed.

In 2020, public support for the sector amounted to 10.9 billion euros (adjusted for inflation at the date of writing). About two-thirds (64.6%) is attributable to European agricultural policy measures; 19.9% originates from national government policies in the form of transfers and reliefs, and 15.5% derives from regional policies.

The figures for the last available year differ from the average figures for the decade 2010-2020: total support was higher at roughly 12.3 billion euros, and the distribution by spending origin also varied, with 58.5% from the EU, 24.3% from national and 17.2% from regional sources.

During the period under examination, the series of fixed-base index numbers with 2010 as the reference year shows a reduction in the combined resources dedicated to the sector, estimated to be 14.0% at the end of the period, corresponding to a reduction in expenditure of about 1.8 billion euros (adjusted for inflation at the time of writing) (Figure 6). In particular, it can be observed that between 2010 and 2020, the decline in support is mainly attributable to the progressive reduction both in the support provided by the Regions through their budgets (–42.4%) and the national government in terms of transfers (–33.6%) and reliefs (–27.6%). The latter type of national support

Figure 6 - Fixed base index numbers for public support by source of origin (2010=100)

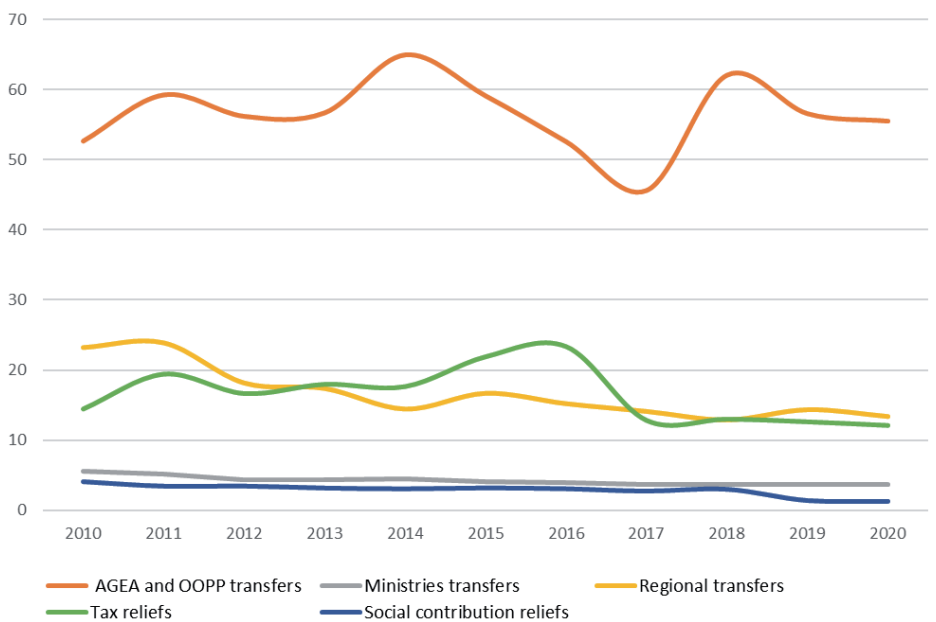


Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

saw a significant reduction in social security contribution reliefs (–67.5%), while the decrease in tax reliefs is less significant (–16.3%), which had a significant upward trend until the year 2016 and then experienced a sharp decline in 2017. For EU transfers, a stable trend emerges over time, with a deviation of +5.4% between the beginning and the end of the period.

The incidence of the various combined components on total expenditure (Figure 7) demonstrates an upward trend for transfers made by AGEA and other Paying Agencies which, starting from a 53% share in 2010 and after reaching a peak of 66% in 2018, amounted to 56% of the total support in 2020. Therefore, for the entire period considered, this component is the most significant, accounting for more than half of the support given to the sector. By contrast, regional transfers experience a steady decline throughout the period examined, from 23% in 2010 to 13% in 2020. Starting in the 2007-2013 planning period, and unlike what had occurred previously, the national government and EU co-financing shares have been managed directly by AGEA and the other Paying Agencies and, as a result, they no longer pass through regional budgets. Hence, the decrease in regional transfers has, at

Figure 7 - Trend in the incidence of each component on overall total support (%, 2010-2020)



Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

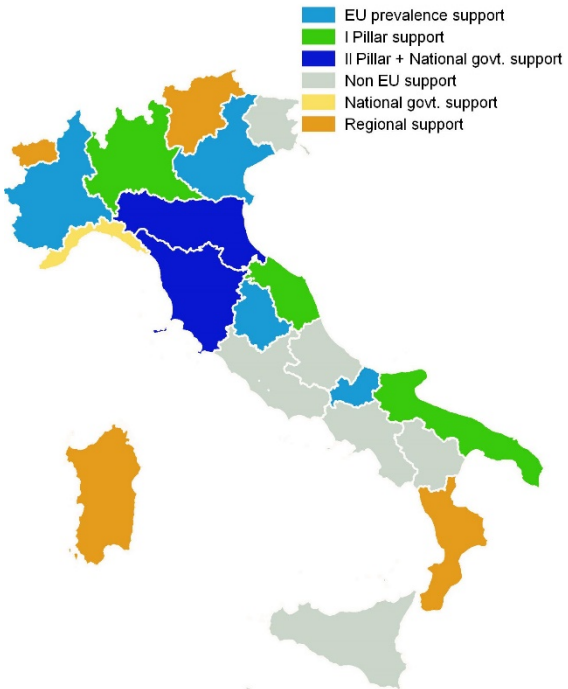
least in part, resulted in the aforementioned increase in transfers by AGEA and other Paying Agencies. Moreover, added to this is the effect of the curbing of public expenditure at the national government level and the resulting repercussions on regional budgets. Tax reliefs remained steady at an average level of 17% but showed considerable growth in the central years of the period, especially in 2016, when the national stability act provided for the abolition of the IMU (municipal property tax) on agricultural land, the IRAP (regional income tax) exemption for individuals who engage in agricultural work and the exemption for IRPEF (personal income tax) purposes for rental income and agricultural income relating to farmland declared by farmers and professional agricultural entrepreneurs who are registered with the agricultural social security scheme. Although these measures were also extended to the years following 2016, the incidence of tax reliefs gradually returned to previous levels, which was also due to the introduction of the regulation that provides for the revaluation of rental and agricultural income from farmland ownership. The weight of transfers made by ministries and by social security contribution reliefs, which in 2020 account for 4% and 1% of total support, respectively, is much lower, and has decreased in the last decade.

The composition of support on a regional scale has been examined using cluster analysis, applying LQ values referring to the entire period examined (2010-2020 average). The cluster analysis results revealed differing support models across the Italian regions, depending on their production and political-administrative specificities. Six clusters have been identified, as illustrated in Figure 8, according to their level of similarity in terms of the composition of expenditure.

Among the regions that base their support model on EU sources, a first group can be defined by the prevalence of EU interventions under CAP Pillars I and II, named "EU Prevalence" (light blue), which includes Piedmont, Veneto, Umbria and Molise. Alongside this, a second group emerges, consisting of Lombardy, Marche and Apulia (green), which mainly relies on Pillar I support.

Many regions, by contrast, have adopted a model that focuses on non-EU sources. Among these, a group has been identified in which the greatest weight of national and regional reliefs and transfers ("non-EU support") is found, which includes the majority of regions (grey), specifically Friuli-Venezia Giulia, Lazio, Abruzzo, Campania, Basilicata and Sicily. Other regions, on the other hand, show the prevalence of a single non-EU source: this is the case with Valle d'Aosta, Trentino-Alto Adige, Sardinia and Calabria (dark orange), which are characterised by a greater incidence of regional support, and Liguria (light orange), which is a group in its own right due to the predominance of national government spending. Lastly, Emilia-

Figure 8 - Regional clusters according to support models (LQ on 2010-20 average, k-means method)



Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

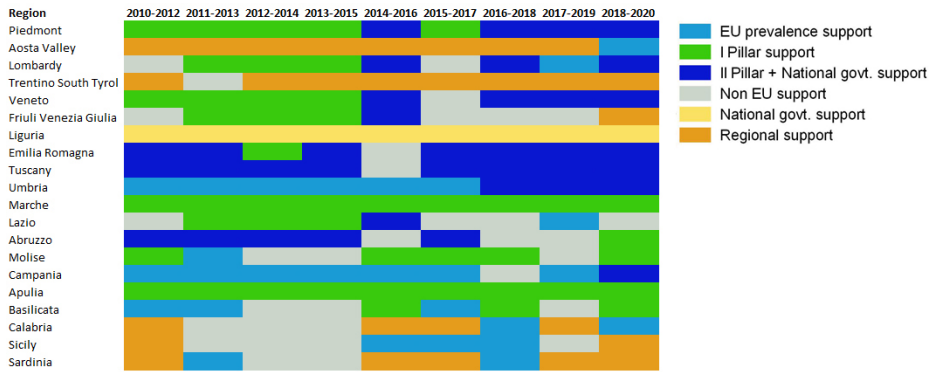
Romagna and Tuscany (dark blue) are characterised by a mix of support streams related to Pillar II and national government interventions (including reliefs).

In order to analyse the dynamics of the different regional support models during the period considered (Figure 9), LQ values calculated using a simple three-year moving average were used. Considering that the planning and subsequent implementation of public support interventions take place on a multi-year basis, an analysis of annual data would produce "noisy results". Conversely, the adoption of three-year moving averages makes it possible to minimize the fluctuations caused by the discontinuity of the procedural steps.

During the period under review, it was observed that only Liguria, Marche and Apulia kept their support model unchanged, while Valle d'Aosta, Trentino-Alto Adige, Emilia-Romagna, Tuscany and Campania only occasionally moved away from the model that distinguished each region for the entire period. By contrast, many of the regions used between two and

four different support models. However, even in these regions, there are several cases in which it is possible to identify a certain continuity in the use of a particular model, for periods of varying length (Piedmont, Veneto, Friuli-Venezia Giulia, Umbria, Abruzzo, Lazio, Molise, Sicily). On the other hand, Basilicata, Calabria and Sardinia are characterised by the fact that they have changed more frequently between three support models.

Figure 9 - Trend in regional clusters according to support models (LQ on simple three-year moving averages, k-means method)



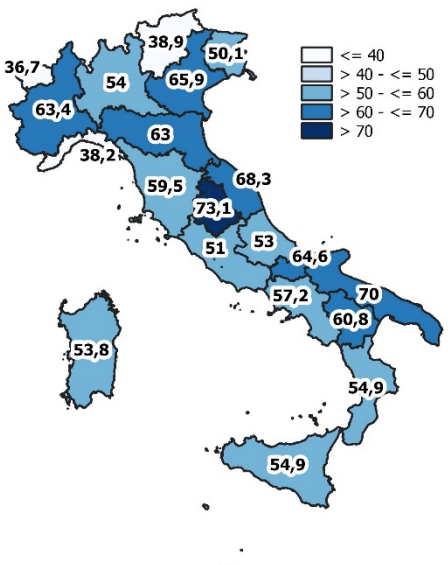
Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

3.2. *Incidence and efficiency of support items on overall transfers*

Delving further into the analysis of the main source of support for the agricultural sector, it should be noted that transfers related to the CAP considered as a whole (Pillar I and Pillar II) on a national level account for an average of more than half (58.5%) of the total resources transferred to the regions in the 2010-2020 period (Figure 10). The analysis on a regional level, however, demonstrates highly diverse situations: only three regions, Valle d'Aosta, Liguria and Trentino-Alto Adige, show significantly lower percentages than the national average (36.7%, 38.2% and 38.9%, respectively). On the contrary, for a rather large group of regions, in particular, Abruzzo, Calabria, Campania, Friuli-Venezia Giulia, Lazio, Lombardy, Sardinia, Sicily and Tuscany, the weight of these transfers is close to the national average, with an incidence ranging from 50.1% for Friuli-Venezia Giulia to 59.5% for Tuscany. The fact that regions from the north, centre and south of Italy all belong to this group highlights that there is no correlation between the

incidence of CAP transfers and the geographic district to which the region belongs. This is also confirmed by considering the regions in which the incidence of CAP transfers on total resources is greater than 60% (Basilicata, Emilia-Romagna, Marche, Molise, Piedmont, Apulia, Umbria, Veneto). Within this group, only for the Umbria region are CAP transfers particularly significant, exceeding 70% of the total.

Figure 10 - Weight of CAP transfers on total transfers for 2010-2020 period (values in %)



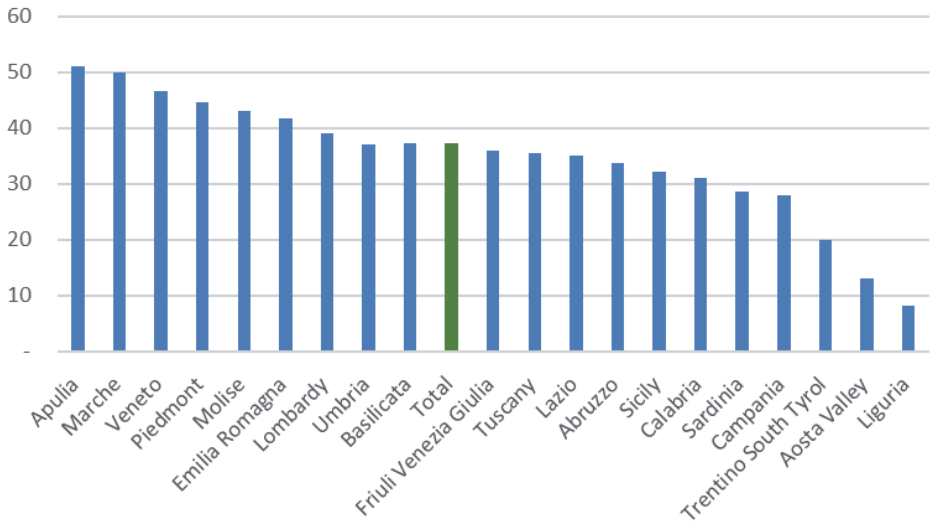
Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

With reference to the analysis of the individual components of expenditure, the national average of the incidence of Pillar I in total regional transfers is 37.2%, while Pillar II is 21.3%. With reference to Pillar I, if we focus on the macro-areas, the regions in central Italy have a higher average incidence (39.3%), followed by the southern regions (35.7%) and, lastly, the northern regions (31.1%).

As can be seen in figure 11, the incidence of transfers related to Pillar I compared to overall support is higher than the Italian average in Emilia-Romagna, Marche, Molise, Piedmont, Apulia and Veneto. The regions of Abruzzo, Basilicata, Friuli-Venezia Giulia, Lazio, Lombardy, Tuscany and

Umbria are in line with the national average, while in the remaining regions, the incidence is lower than the national average.

Figure 11 - Pillar I share of total transfers (%)



Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

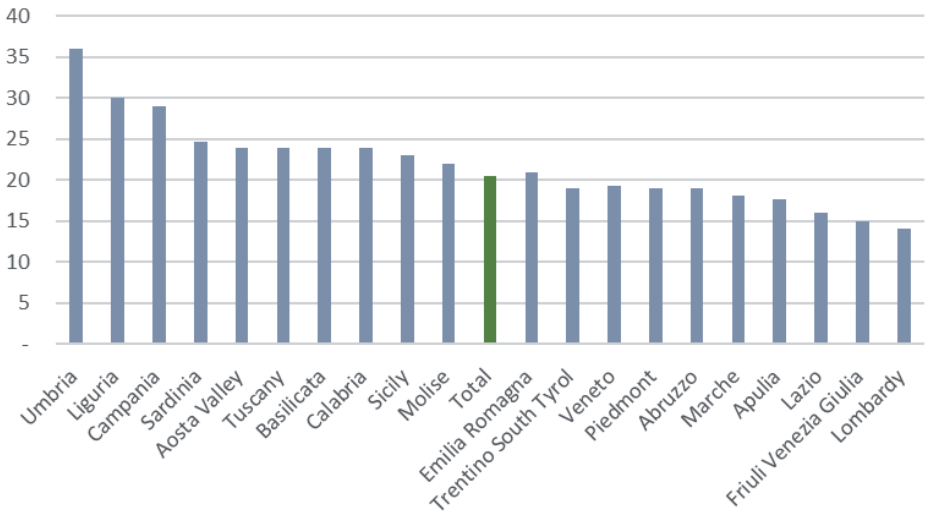
With regard to Pillar I, the districts of central and southern Italy show similar values compared to the national average, 23.7% and 22.9%, respectively. Once again, for this component of EU policy, values in the north of Italy are slightly lower than the national average (20%).

On a regional level, the incidence of transfers related to Pillar II in overall support is higher than the Italian average in Campania, Sardinia and Umbria. The values recorded for Basilicata, Calabria, Emilia-Romagna, Molise, Sicily, Sardinia, Tuscany, Trentino Alto-Adige, Valle d'Aosta and Veneto are mostly in line with the national average while in the remaining regions, the incidence is lower than the national average (Figure 12).

The indicator obtained from the ratio between CAP transfers and value added in the agricultural sector is one way of measuring the impact of EU agricultural expenditure on the sector.

On average, during the 2010-2020 period, the incidence of CAP (Pillar I and II) with respect to value added was 23.9%. At the level of geographic macro-areas, we can observe that the centre of Italy has a higher average

Figure 12 - Pillar II share of total transfers (values in %)



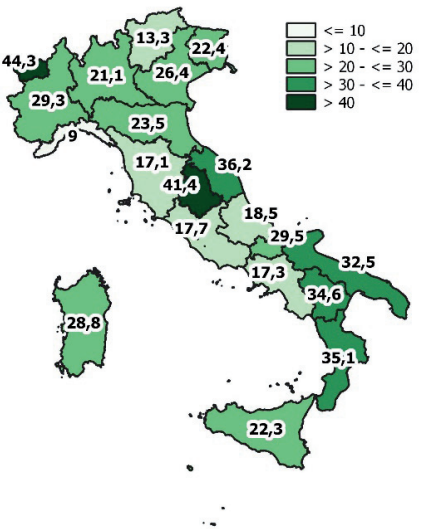
Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

incidence than the national average (28.1%), followed by the south (27.3%) and finally, the north (23.7%).

Leading the group in the central regions are Umbria and Marche – with an average incidence of 41.4% and 36.2%, respectively – followed by Lazio (17.7%) and Tuscany (17.1%). As far as the southern regions are concerned, Calabria (35.1%), Basilicata (34.6%), Apulia (32.5%), Molise (29.5%) and Sardinia (28.8%) have a higher average incidence than the national average, while values in Sicily and Campania are below the national average (22.3% and 17.3%, respectively). Among the northern regions, only Valle d'Aosta (44.3%), Piedmont (29.3%) and Veneto (26.4%) have values higher than the national average (Figure 13).

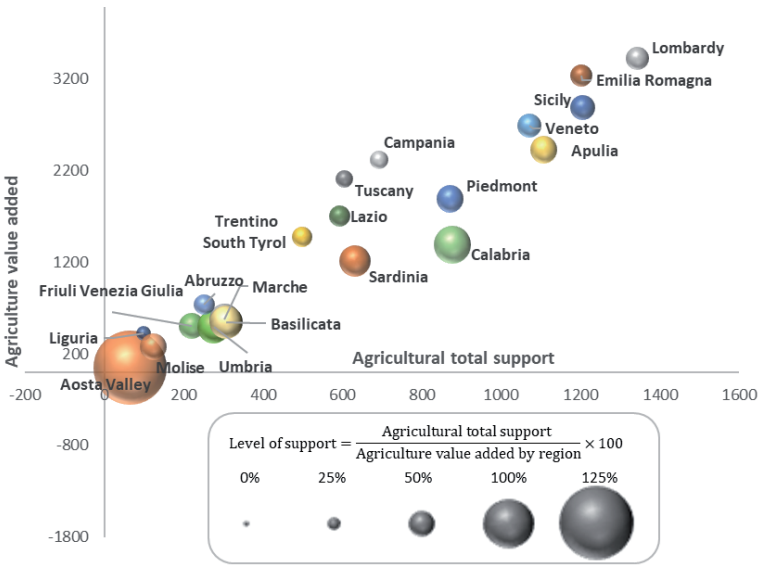
A more complete picture of agricultural expenditure at the regional level is obtained through the analysis of total support in relation to the value added of agriculture shown in Figure 14. The bubble chart presents three dimensions of data: total agricultural support (horizontal axis) and agricultural value added (vertical axis) are the coordinates of the bubbles that represent the twenty Italian regions; the relationship between the two previous dimensions defines the size of the bubbles and represents the level of support for the sector with respect to its importance in the regional economy. Large bubbles indicate a high value of this ratio: in the case of Valle d'Aosta, for example, total support is quite high compared to the low value added of

Figure 13 - Weight of CAP transfers on Value added (%, mean 2010-2020)



Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

Figure 14 - Total agricultural support and Agricultural value added by region – Italy (euro, 2010-2020 average)



Source: Authors' processing of data from the "Agricultural expenditure of Italian Regions" database, CREA-Research Centre for Agricultural Policies and Bioeconomy (CREA-PB).

agriculture. At the opposite extreme, Lombardy and Emilia-Romagna are represented by two small bubbles since the total support is lower than the value added of agriculture, which reaches its highest amount here.

3.3. *Agriculture Orientation Index: data analysis in an international context*

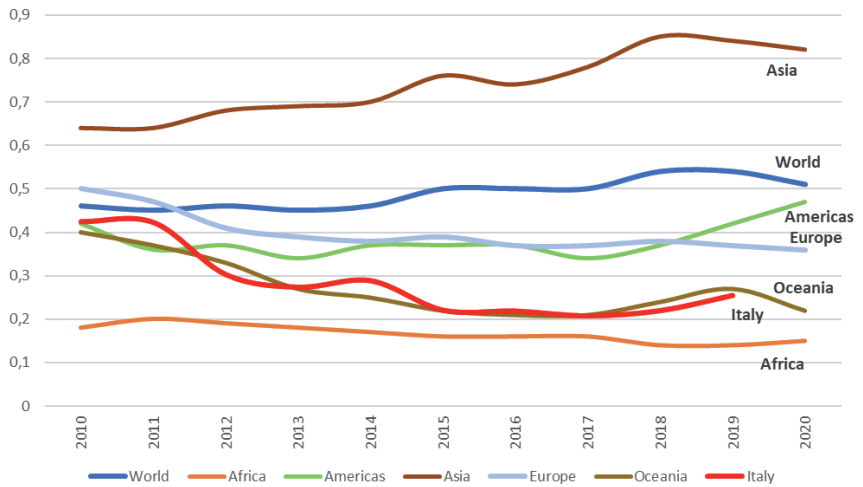
The AOI data refer only to the expenditure of the central governments of the countries included and, therefore, for EU member states, they do not consider CAP support for agriculture. This index provides useful information to help us understand the extent to which the principle of additionality is actually applied in the EU countries, according to which contributions disbursed through EU funds should not replace the public expenditure of a member state and, therefore, should not lead to a reduction in national investments but should be additional.

In general, on a global scale, index values are below 1 and, therefore, show support for the sector that is not commensurate with its economic importance (Figure 15). The highest index values, even if below 1, are found in Asia, which grew during the period considered. Conversely, the lowest values are found in Africa.

Analysis of the index on a European scale shows a level of support that is lower than the world average. Specifically, Italy is at a lower level than most European countries and shows a downward trend until 2017 and a slight recovery starting in 2018 (Figure 16). Among the main European countries, Germany stands out with a higher average index and with a rising trend over the period considered but with a reduction in the last two years. The most striking case, however, concerns Switzerland and Luxembourg (not represented in figure 16), which have an index greater than 3, which is equivalent to a level of investment in agriculture that is three times greater than the sector's contribution to GDP. While in the case of Luxembourg, which is considered the richest country in the world, this can be traced back to the high availability of national resources that are added to EU resources, for Switzerland, a non-EU country, the figure should be interpreted without taking CAP aid into consideration when examining national support for agriculture. Even for other countries in the European area, albeit with a lower intensity than what was observed for Switzerland, there are similar situations (the average value of the AOI index for European countries that are not part of the EU is 0.8, double that of the European average). The cross-reading of the data illustrated above, therefore, suggests a common tendency by EU members states to delegate the more general trends for planning investments in agriculture to EU policy guidelines, while keeping certain interventions of a more specific nature within the framework of

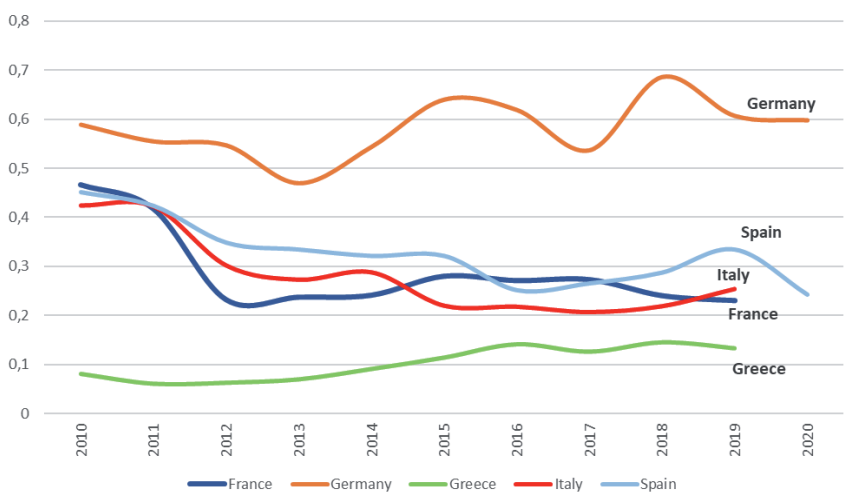
national political decisions, such as is the case in Italy, for example, with tax and social security reliefs for the sector.

Figure 15 - Agriculture Orientation Index by geographic region - World



Source: *Authors' processing of data based on* data from the Food and Agriculture Organization of the United Nations (FAO) (2022).

Figure 16 - Agriculture Orientation Index by Country – Europe



Source: *Authors' processing of data based on* data from the Food and Agriculture Organization of the United Nations (FAO) (2022).

Conclusions

In view of the present research objectives and the need for data comparability, this paper highlights the usefulness of having a comprehensive source of homogeneous and comparable information, the use of which allows for some considerations with reference to public support for the agricultural sector.

The analysis carried out demonstrates that in Italy, for the 2010-2020 period, public expenditure on agriculture has decreased, due both to lower support from the national and regional levels and to a reduction in tax and social security contribution reliefs. The resources disbursed by the EU increased slightly, but there is no correlation between their impact on overall support and the geographical location of the regions. Through in-depth analysis of the available data and the use of an empirical approach, we can hypothesize the existence of a relationship between the growth of the agricultural sector and public support for the sector. Moreover, we can highlight how various factors, such as the heterogeneity of agricultural systems, different policy objectives and the expenditure management capacity of regional administrations, affect the use of public resources, thus determining different allocations and uses. These differences affect the ability of each region to attract resources, which is reflected in the predominance of certain support streams, and have made it possible to distinguish six different models of support for the sector (Regional clusters according to support models). Among the possible objectives for future analytical study, thanks to the updating of the information contained in the CREA database, priority should be given to an analysis of the implications of the Covid-19 epidemic and to the new guidelines related to the 2023-2027 CAP planning, especially given the importance of EU sources of support within the support mechanisms for the Italian agricultural sector.

In addition, further study may be beneficial to deepen our understanding both as regards the quantification of the sector in terms of growth ascribable to the amount of support, and the identification and quantification of the economic variables that affect the choice of the support model on a local geographical level.

One question that remains is whether public support has generated additionality, that is, if public expenditure is complementary and, therefore, "additional" to private expenditure or if it replaces and tends to "displace" private expenditure (David *et al*., 2000a).

There are mixed answers to this question. For example, Jaffe (Jaffe, 2002) claims that assessing the beneficial effects of public interventions (especially if oriented towards supporting the choices of policy makers) should always be based on the responses that come from the application of various approaches.

The issue of additivity reflects the fundamental problem of evaluating whether the final objective of a programme has long-term effects; something which, in real terms, is inherently very difficult to measure and attribute to specific programmes and interventions. For the agricultural sector, this problem is likely to be mitigated by joint planning by different levels of government of programmes for the sector and this may be the subject of further study.

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Lucia Briamonte
Council for Agricultural Research and Economics, Research Centre for Agricultural Policies and Bioeconomy (CREA-PB), Italy
Via Barberini, 36 - 00187 Roma, Italy
E-mail: lucia.briamonte@crea.gov.it
Lucia Briamonte is senior researcher of the Center for Politics and Bioeconomy of Crea. Her activity is research, technical assistance and support to public institutions on international, national and regional agricultural policies and economic evolution of the agri-food system. Her main research interests di lei is: Public spending and taxation in agriculture, National and regional agricultural policy, Funding for agricultural entrepreneurs, CSR in the agri-food system, Human rights, analysis on the state of Italian agriculture and fruit and vegetable sector. She participates in many institutional and universities activities. She is manager and coordinator of many projects and working groups, she conceived and coordinated many editorial series and magazines, and she is the author of many publications and speaker in many conferences in line with the topic of proposal. She was a lecturer in the subject in several universities where she taught. Since 2010 she has been a member of the SIEA, Italian Society of Agri-food Economists, and member of Presidential Council of SIEA since 2016.

Paolo Piatto
Council for Agricultural Research and Economics, Research Centre for Agricultural Policies and Bioeconomy (CREA-PB), Italy
Centro Direzionale, Isola E/5 - 80143 Napoli, Italy
E-mail: paolo.piatto@crea.gov.it
Responsible for the project “The Public Spending in Agriculture”. Analysis and research on agricultural policies of the Campania Region.

Dario Macaluso
Council for Agricultural Research and Economics, Research Centre for Agricultural Policies and Bioeconomy (CREA-PB), Italy
Via Libertà, 203 - 90143 Palermo, Italy
E-mail: dario.macaluso@crea.gov.it
Dario Macaluso is Technologist at Research Centre for Agricultural Policies and Bioeconomy. Holds a degree in Agricultural Sciences (University of Palermo) and a Doctoral Degree Agricultural Eco-nomics (University of Palermo). Currently he is involved in different projects and working groups with specific reference to FADN survey management at regional level (Sicily). His research interests focus on structural and economic analysis of agriculture, public spending in agriculture, employment of immigrants in agriculture, economic sustainability of organic farming.

Mariagrazia Rubertucci
Council for Agricultural Research and Economics, Research Centre for Agricultural Policies and Bioeconomy (CREA-PB), Italy
Via Gianbattista Vico, 4 - 86100 Campobasso, Italy
E-mail: mariagrazia.rubertucci@crea.gov.it
Her activity is of analysis and research on agricultural policies. She is responsible for the Molise region of the projects "Public expenditure in agriculture", "Business accounting data network", "Foreign workers in agriculture". She is author of various publications.

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