International Food and Agribusiness Management Review
Volume 25, Issue 5, 2022; DOI: 10.22434/IFAMR2021.0149

Received: 23 November 2021 / Accepted: 9 May 2022

Special issue: Opportunities and challenges of EU farm-to-fork strategy

Collective smart innovations and corporate governance models in Italian wine cooperatives: the opportunities of the farm-to-fork strategy

CASE STUDY

Concetta Nazzaro[a], Marcello Stanco[b], Anna Uliano[c], Marco Lerro[d] and Giuseppe Marotta[e]

[a]Associate professor, [b]Research fellow, [c]PhD student, [d]Researcher, [e]Full professor,
Department of Law, Economics, Management and Quantitative Methods,
University of Sannio, via Delle Puglie 82, Benevento 82100, Italy

Abstract

European policies, especially the 'farm-to-fork strategy', address the challenge posed by the ecological transition in agriculture setting up a new technological paradigm. In this context, collective smart innovations may play a crucial role, enabling to meet current citizen-consumers' needs as well as producing positive environmental and social externalities. Lately, wineries, in the attempt to improve the sustainability of production process and the creation of competitive advantages, reoriented their investments in research and development embracing smart innovations. The latter, when supported by appropriate models of corporate governance, can facilitate business decisions and create shared value. Despite its relevance, literature on the topic is still scarce. This study aims to investigate the role played by collective smart innovations and corporate governance in the sustainable and ecological transition of wineries and, specifically, wine cooperatives. The case study methodology was adopted investigating the collective innovation 'I mille per l'Aglianico' implemented by the Italian wine cooperative 'La Guardiense'. Results show that the collective smart innovation experienced by 'La Guardiense' had impacts in terms of internal economies, such as increase in sales and costs reduction; and in terms of external social economies, such as local development and environmental protection.

Keywords: innovation, sustainability, cooperatives, governance, value creation
JEL code: Q13, Q16, Q18

Corresponding author: cnazzaro@unisannio.it

1. Introduction

Agri-food sector adversely impacts the environment for two main reasons: firstly, it leads to over exploitation of natural resources (e.g. water, soil, etc.), it is also responsible of more than 10% of greenhouse gas emissions (GHG) in the atmosphere (Climate Watch, 2017). The effects reflect on people's health, climate change and biodiversity loss, resulting in social, environmental and economic costs. Accordingly, it is increasing significantly citizen-consumers' awareness towards environmental issues, lifestyles and consumption habits (Demirtas, 2018; Marotta and Nazzaro, 2012; Rezai *et al.*, 2012; Rhein and Schmid, 2020).

Recently, food system is playing a central role in the European debate to become the first climate-neutral continent by 2050. More specifically, the 'farm-to-fork strategy', which represents the core of the European 'Green Deal', addresses the sustainability of food system. It aims to create a fair, healthy and environmentally-friendly food system, emphasizing the link between healthy people, societies and planet. The new 'Biodiversity strategy' also goes in this direction, preserving nature and contrasting the ecosystems' degradation. Consequently, the European Commission is looking at new green business models to renew the social pact with the agri-food sector (European Commission, 2020).

The common agricultural policy (CAP) addresses these issues as well. It promotes ecological and digital transition in agriculture setting three key objectives: (1) promoting a smart and resilient agricultural sector; (2) supporting care for the environment and climate action; (3) stimulating growth and employment in rural areas. The European Union (EU) aims for a more sustainable agriculture pursued through innovation and technology (European Commission, 2017).

Companies become socially responsible by embracing social and environmental issues in their economic activities also engaging sustainable innovations (Borsellino *et al.*, 2020; Gaito, 2008; Marotta *et al.*, 2017; Medaets *et al.*, 2020; Pulina and Timpanaro, 2012; Topp-Becker and Ellis, 2017). To this extend, environmental protection may represent a competitive lever that – through the introduction of collective sustainable innovations (Stanco *et al.*, 2020) – enables to meet the current citizen-consumers' needs while producing positive environmental and social externalities (Grolleau *et al.*, 2007; Iakovou *et al.*, 2014; Marotta and Nazzaro, 2012, 2020).

The wine sector, which represents a leading sector in the Italian and European economy, both in terms of sales and product quality (Rizzo and Bonuzzi, 2008; Stanco and Lerro, 2020; Vecchio *et al.*, 2018), it is currently experiencing innovative production processes, that are smarter and greener, along with renewed organizational and managerial models (Dries *et al.*, 2013; Fiore *et al.*, 2017; Nazzaro *et al.*, 2016).

In particular, wine cooperatives are orienting their investment in research and development, improving the sustainability of production processes through the adoption of smart innovations (e.g. precision agriculture) (Doloreux and Lord-Tarte, 2013; Figueiredo and Franco, 2018; Lerro *et al.*, 2019; Raimondo *et al.*, 2020). The latter, are able to support business decisions, create shared value and increase competitiveness (Alves *et al*, 2007). These effects are enhanced when cooperatives members are actively involved in business decisions through contractual relations and governance model that guide collective innovations.

In the current European policy scenario, cooperatives can – better than other institutions – address citizen-consumers' social and environmental instances. In addition, developing collaboration networks, both horizontally and vertically, cooperative model can secure rural environments and promote traditional food products, generating positive externalities for the community, in line with the 'farm-to-fork strategy'. More deeply, the cooperative model leads to positive effects, producing public goods and social wealth, encouraging environmental conservation and local development as well as countering the depopulation of rural areas (Vitale, 2019). Lastly, cooperatives, by involving the whole supply chain, can facilitate the transition to green economy models that require, to be effective, a collective participation.

The role of cooperation and innovation in the ecological transition to green economy models is still unknown in literature. Literature on innovation in the agri-food sector is mainly oriented to the farm rather than on the whole supply chain, focusing, especially, on the identification of the determinants that encourage its dissemination (Avermate *et al.*, 2004; Capitanio *et al.*, 2010; Grunert *et al.*, 1996, 1997; Triguero *et al.*, 2018). This study investigates the innovation process along the whole supply chain, according to a collective model and in relation to governance mechanisms. When innovation is driven by governance models, it enables to spread, along the supply chain, the value created (Karantininis *et al.*, 2010). Further, governance becomes a determining factor in the process of innovation and value creation (Gosh and John, 2005; Menard, 2004). It also represents the strategic factor for the success of collective smart innovations, allowing the sharing of value created and the establishing of trust between the actors of supply chain (Martino, 2007, 2010).

This study focuses on the Italian wine cooperatives, in terms of collective smart innovations and supply chain governance, in order to investigate how they support the sustainability and ecological transition of agri-food sector. More specifically, the study poses the two following research questions:

- RQ1: How do collective smart innovation create value for wine cooperatives and territories?
- RQ2: How do governance models contribute to a fair distribution of the value created between the cooperative and its members?

2. Theoretical background

2.1 Literature review

European food products are well recognized, globally, as safe, nutritious and of high quality. Currently, they are also becoming a global standard for sustainability. Indeed, pursuing the 'farm-to-fork strategy', European Union aims to accomplish six main objectives: (1) ensuring the sustainability of food production; (2) providing food supply chain security; (3) stimulating sustainable practices in the whole food sector (i.e. from wholesale to retail); (4) promoting sustainable food consumption, facilitating the transition to healthy and sustainable food; (5) reducing food losses and waste; (6) contrasting food fraud in the food chain (European Commission, 2020).

The European 'Green Deal' represents an opportunity for the agri-food sector to encourage the choice of healthy and sustainable food regimes, by the adoption of smart innovations.

Smart innovations are considered as part of Agriculture 4.0, which derives from the concept of Industry 4.0. It embraces the adoption of digital technologies to create a value chain integrating customers and other stakeholders (Hrustek, 2020; Sott *et al.*, 2020).

It is possible to distinguish between precision agriculture and smart agriculture. Precision agriculture is a 'discipline characterized by the collection, storage, processing, and sharing of digital data from various sources with clearly defined objectives' (Hrustek, 2020: 4). It represents the area in which technology can be used in order to manage agriculture by understanding the temporal and spatial changes in soil, crop, production, and management through the use of innovative techniques (Salam and Shah, 2019). This term was used, for the first time, in 1990 (Oliver *et al.*, 2013) and later was related to the concept of smart agriculture. The latter, starting from precision agriculture, includes the implementation of software systems with integrated digital components, supporting the conversion of raw data into useful information for the agricultural production process (Bucci *et al.*, 2019; Hrustek, 2020).

Innovation represents the cornerstone of precision and smart farming. There are innovations concerning crop, input, and resource management, but also organization, marketing, and distribution. New technologies, such as sensors, decision support systems (DSS), automation and robotics, collected data, traceability, and blockchain are available to farmers for supporting agricultural activity along with improving their sustainability (Adamashvili *et al.*, 2020, 2021; Galati *et al.*, 2021; Lombardo *et al.*, 2018; Sarri *et al.*, 2020).

There are several benefits related to the adoption of smart agriculture. Smart technologies, in fact, are able to increase yields and reduce inputs of production (Rose *et al.*, 2021). Furthermore, they may improve the environment increasing the production on the cultivated land, eco-efficiency (Schieffer and Dillon, 2015) and sparing further land use (Balmford *et al.*, 2019; Phalan *et al.*, 2011).

Smart agriculture also helps to fight climate change and take long-term decisions (Nguyen *et al.*, 2017). It can help to face all the threats related to crop, fish or animal production by avoiding diseases, risks of pest attack and other soil and environmental factors. It also preserves natural resources and the environment, representing one of the key tools for achieving sustainability. In recent years, internet of things (IoTs) accomplished relevance in daily lives, extending our perceptions and ability to modify the environment around us. In particular, the agri-food sector applies IoTs in both diagnostics and control (Muangprathub *et al.*, 2019; Rehman *et al.*, 2022). Further, it provides information to consumers about the origin and properties of products consumed (Talavera *et al.*, 2017).

Another concept widespread in literature is represented by climate-smart agriculture (CSA). The Food and Agriculture Organization of the United Nations (2010) defines CSA as 'agriculture that sustainably increases productivity, enhances resilience, reduces GHGs, and supports the achievement of national food security and development goals'. It aims to achieve food security and other development goals in a context of climate changing and increasing food demand (Lipper *et al.*, 2014; Ngcobo and Chitakira, 2021; Nyagumbo *et al.*, 2022; Totin *et al.*, 2018).

The application of smart agriculture in viticulture is relatively recent (Arnó Satorra *et al.*, 2009). Viticulture is largely responsible of GHG emissions due to the production and application of chemicals, irrigation, pruning, tillage, soil emissions, and crop residue management (Recchia *et al.*, 2018; Sarri *et al.*, 2020). Specifically, mechanization in viticulture represents more than 60% of the total warming of wine production (Aguilera *et al.*, 2015). Accordingly, it is important to apply smart agriculture in viticulture to improve economic, environmental, and social sustainability (Sarri *et al.*, 2020). More deeply, it may reduce GHG emission enacting on: (a) the enhancement of the soil's ability to operate as carbon stock reserve (Angers and Eriksen-Hamel, 2008; Khan *et al.*, 2007); (b) the reduction of fuel consumption due to less in-field operations (Sarri *et al.*, 2020); (c) the decreasing of inputs for the agricultural field operations (Sarri *et al.*, 2020). These practices optimizing the agricultural inputs, produce higher or equal yields with a lower cost, reducing also the carbon footprint of the process by one-quarter (Belafoutis *et al.*, 2017). A further benefit is given by the added value recognized by citizen-consumers for the protection of natural and social environment (Bekmezci, 2015; Marotta and Nazzaro, 2012; Van Evert *et al.*, 2017). Therefore, the application of smart agriculture in viticulture allows to enhance the environmental, economic, and social sustainability of the production process (Sarri *et al.*, 2020).

2.2 Conceptual framework

The 'farm-to-fork strategy' enables the ecological transition in agriculture that requires a new technological paradigm (i.e. low environmental impact with zero emissions), embracing an efficiency-oriented technology (e.g. cost reduction and profit maximization), and a technology geared to citizen-consumers' needs (e.g. health, environment and ethics). In agriculture, this technological paradigm is addressed through smart agriculture. The latter, to be effective, requires a collective approach to innovation, involving public and private actors in the food value chain and rethinking the governance models (Schebesta *et al.*, 2020; Stanco *et al.*, 2020). Indeed, since it relies on the behavior adopted by the actors in the food supply chain, the main risk lies behind their opportunistic behaviors. In the cooperative sector the implementation of innovations may be critical due to potential divergence in the innovation objectives set by the cooperative and its members. For instance, members may strive to increase the production whilst the cooperative to improve the quality in order to better compete on the markets. As a result, members' involvement represents a condition for an effective innovation process in a cooperative. The latter requires a collective approach based on integration strategies (i.e. vertical and horizontal) and on coherent and synergistic behaviors of all economic actors involved (Stanco *et al.*, 2020: 3,4).

The effectiveness of smart collective innovations in the agri-food value chain depends on: (1) the structural characteristics and internal skills of the supply chain; (2) the degree of integration among the various stages of the supply chain and the cooperation between its actors with Universities, research institutions and other stakeholders in the territory; (3) the governance of the supply chain; (4) policies (Stanco *et al.*, 2020; Triguero *et al.*, 2018: 51). The Italian agri-food sector results highly fragmented, with the prevalence of small and medium enterprise (SME) with limited R&D capability and in which integration is a resource to establish smart collective innovations. In this context, cooperation with companies in other sectors and with the research institutions (e.g. Universities) may unlock knowledge and technologies of smart innovations to the agri-food chains.

The implementation of smart innovation requires a collective strategy led by a leading company (e.g. a cooperative and/or agri-food company). The positive effects of this approach are twofold. Since the leading company is the economic player closer to the market, it is able to catch citizen-consumers' needs. Moreover, it ensures the coordination of the supply chain to reduce transaction costs and share equally the value created by innovation.

This study identifies as leading company of the proposed conceptual framework, the cooperative that is able to intercept the current citizen-consumers' needs by implementing the smart innovations in the whole production process (i.e. in field and winery) (Figure 1).

The leading cooperative defines a competitive collective strategy involving several members (i.e. wineries) (Farm M_n) in the collective smart innovations. To encourage farms in the implementation of smart innovations, the competitive collective strategy has to apply fair governance models. The latter involve contracts that encourage members' commitment paying a price premium and, they establish the sharing of the value created by the sale of the 'smart' products among the different actors in the wine supply chain (Farm M_1, Farm M_n).

To sum up, governance becomes a strategic driver in the implementation and management of collective smart innovations, regulating the relationship in the supply chain, reducing transaction costs (Williamson, 1985), ensuring the success of the innovation and, determining the sharing of the value created.

3. Materials and methods

The case study methodology was applied in the study as this methodology enables to analyze an emblematic case (Harling and Misser, 1998; Siggelkow, 2007; Yin, 2009), highlighting its distinctiveness and uniqueness, within a specific socio-economic context (Stake, 2005).

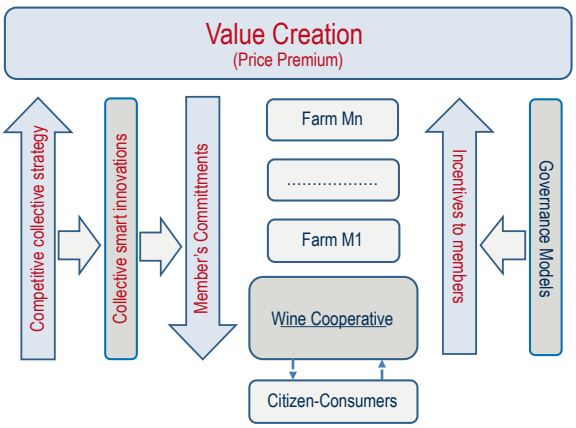

Figure 1. Collective smart innovations and governance models.

The case study investigates as collective innovation process 'I mille per l'Aglianico' implemented by the Italian wine cooperative 'La Guardiense'. The latter was chosen as it represents an emblematic case of a cooperative engaged in the implementation of many sustainable and smart innovation projects – both in the vineyard and in the cellar – aiming at improving the environmental sustainability of the whole supply chain and producing high quality wines.

The study relies both on primary and secondary data. The primary data were collected with face-to-face interviews, administering a semi-structured questionnaire to the cooperative management and few members. The questionnaire addressed three main objectives: (1) the smart innovations applied in vineyard and in cellar; (2) the degree of involvement of the cooperative's members; (3) the internal and the external effects of the implemented collective smart innovations. As for the smart innovations, the questionnaire detected the initiatives put into place by the cooperative to improve product quality and pursue the sustainability goals (i.e. environmental, social and economic). Another section of the questionnaire revealed the commitment required to the cooperative members to implement the smart innovations in vineyards, as well as the incentive received. Lastly, the interview unveiled the resulting impacts of smart innovations adopted in terms of internal economies, such as increase in sales and costs reduction; and in terms of external social economies, such as local development and environmental protection.

The secondary data were collected analyzing the cooperative website, published reports and, the cooperative financial data.

4. The case study

4.1 The cooperative

'La Guardiense' founded in 1960 in Guardia Sanframondi, in Sannio area, is one of the greatest wine cooperatives in Southern Italy. It counts more than 1000 members producing approximately 200,000 quintals of grapes per year and 150,000 hectoliters of wine, with a turnover of about 15.5 million euros in 2020. The wine cooperative holds 1,500 hectares of vineyards over the 10,000 total hectares of the province of Benevento, with an average of 2 hectares per winery. Cooperative members cultivate three native vines, namely Aglianico, Falanghina and Piedirosso (both protected designation of origin (PDO) and protected geographical indication). 'La Guardiense' produces approximately 4 million bottles per year, divided into four production's lines (i.e. Janare, Fremondo, Aicon, and Classica), and the sparkling wine produced with both the Charmat/Martinotti method and the classic one.

All the wines are certified SQNPI Sustainable Quality, a certification conceived by the Italian Ministry of Agricultural, Food and Forestry Policies, in which the wine is obtained from grapes treated with integrated cultivation practices (e.g. limited use of chemicals on grapes).

Since it was founded, 'La Guardiense' has always looked for improving the quality of wines through process and product innovations. As a consequence, the cooperative was able to face increasingly competitive markets, becoming a real symbol of technological progress for its territory. All the innovations implemented are aimed at preserving environmental sustainability. Indeed, the cooperative promotes the adoption of sustainable agronomic practices, as well as the experimentation of smart agriculture to improve the efficiency of natural resources, reduce the use of chemicals and preserve soil fertility. In the cellar, instead, the contribution to the environmental sustainability explicit in: (1) self-producing most of the electricity needed in the production process; (2) using technologies to reuse and purify waste water; (3) experimenting new fermentation processes that limit the use of chemistry.

4.2 'I mille per l'Aglianico': a project of collective smart innovation

'La Guardiense', over the last few years, implemented several products and process innovations, to achieve the aims set by the 'farm-to-fork strategy', and realize the transition process toward sustainable and smart agri-food sector. These innovations contributed to its growth and to the creation of shared value. Previous studies (Drucker, 1985; Jacobides *et al.*, 2006) pointed out that innovation is central for value creation for consumers, producers and for individuals not directly involved in the production process. The concept of value extends beyond the economic one, focusing more and more on the immaterial aspects related to the realization and diffusion of innovation. In this context, it becomes essential to act in the perspective of smart agriculture, through sustainable and responsible collective innovation, in order to generate positive consequences in the context in which the company operates.

The collective smart innovation project called 'I mille per l'Aglianico' was launch in 2009 to respond to a market crisis that hit Aglianico, one of the most important indigenous grape varieties of Sannio. It takes its name from the number of cooperative members (i.e. 1000) involved.

The main objective of the project was to relaunch the Aglianico wine on the market: (1) improving the quality of the grapes produced, by reducing the production of grapes per vine; (2) encouraging the adoption of more sustainable agronomic practices and smart innovations; (3) implementing more efficient and environmentally friendly transformation processes, excluding chemistry in cellar.

About 110 producers were involved in the experimental phase of the project accounting for over 70 hectares, located between 200 and 400 meters above sea level and facing south-southwest of the Sannio wine area. Such a large experiment, with the involvement of a large number of members, took place for the first time in Italy. The experimentation also represented a great challenge for the cooperative as Aglianico is a complex vine that requires specific care, especially with regard to quantitative management.

The success of the experimental phase of 'I mille per Aglianico' project led 'La Guardiense' to extend the collective smart innovation process to the whole production area of the Aglianico PDO grapes cultivated by the cooperative members.

The project carried on the market a new type of wine with 'smart' attributes. As a consequence, a new label was adopted to distinguish it from the classic Aglianico wine sold by the cooperative.

■ *The innovations in vineyard*

First of all, the project concerned the experimentation of a cultivation protocol based on the application of sustainable agronomic practices aimed at the natural reduction per hectare of the grapes produced, from 120 qls[1]/ha (enabled by Aglianico PDO's disciplinary) to a maximum of 70 qls/ha. The protocol was designed by a committee of agronomists of the cooperative coordinated by the well-known oenologist Riccardo Cotarella. More specifically, in order to reduce the yield, the cultivation protocol provides different operations:

- targeted pruning. A maximum of 20 buds are left on the plant and the quantity of shoots is reduced;
- green pruning (gem selection). Only the largest buds are left on the plant;
- no fertilization in vineyard. In order to avoid the increase in production and preserve sustainability;
- grassed vineyard. Weeding and the passage with tractors are abandoned, letting the spontaneous grass grow;
- green manure. It is a sustainable agronomic practice which consists in the sowing of an herbaceous crop with pure or known essences – to be totally buried or chopped – as a fertilizer;

[1] qls = quintals.

- thinning of the bunches. The purpose of this practice is to remove any damaged bunches from the plant both in the veraison phase (i.e. the phase in which the bunch begins to ripen), and just before the harvest, to avoid that these can compromise the quality of the wine produced;
- targeted phytosanitary treatments. Phytosanitary treatments are carried out only if strictly necessary and based on plant health. The vines of each farm are, in fact, kept constantly under control through vegetative maps.

The cultivation protocol also plans to recover up to 50 q.ls of grapes[2] per hectare of thinned grapes. The latter, due to their acidity (as they are removed from the plant before they reach maturity), become an excellent basis for the production of sparkling wine.

The winegrowers involved in the project were also able to count on the constant technical assistance provided by the committee of agronomists who, in addition to carrying out inspections in vineyard, also took care of organizing periodic events to spread best practices.

To mechanize phytosanitary treatments, 'I mille per l'Aglianico' project experimented collective smart innovations, introducing mechatronics in vineyard. Experimentally, the cooperative adopted multi-parametric control units set on quads that periodically cross the rows of the vineyards to detect plant health. Data collected by the multi-parametric control units were sent in real time to a database updating a vegetative map. The latter were then used by smart tractors which, retracing the same rows, recognized the plant releasing a sufficient amount of nutrients based on the plant health. Lately, to further preserve environmental sustainability, and reduce the use of natural resources and soil erosion, the quads were replaced by drones, while the smart tractors by a smart fertilization and irrigation system, still under test today.

■ *The innovations in cellar*

Once the grapes reached the cellar, to preserve the quality of the final product, they are processed with soft holds. It maintains the integrity of the skins, reducing the presence of harmful particles in the fermentation mass, and containing the development of harmful organisms in the bottle. Moreover, during fermentation, the operation of refrigerators allows to limit the use of chemicals in wine, reducing both the environmental impacts of wine production, and the costs of chemicals. The maintenance of low and constant temperatures during the fermentation also enables to drastically reduce the quantity of sulphites adopted into wine production.

Finally, to preserve the environment and save energy, 'La Guardiense' installed a photovoltaic plant that occupies an area of 950 square meters, with a power of 130 Kw picco and an annual production of 176,000 Kwh. Noteworthy, there is also an industrial water treatment plant, that facilitate the internalization of water resources and, along with the use of photovoltaic, reduce the impact of production on the environment.

4.3 The governance model introduced by 'I mille per l'Aglianico' project

The success of the collective smart innovation provided by 'I mille per l'Aglianico' project was the governance model adopted by the cooperative. The latter created a climate of widespread trust among the cooperative members, which enabled to achieve shared and participatory results (Martino, 2007, 2010).

'La Guardiense' to encourage members to follow the rules set out in the cultivation protocol and adopt the smart innovations, it set up contracts that pay up to a maximum of 120 qls/ha (maximum production enabled by Aglianico PDO's disciplinary), even if the maximum amount of grapes vinified, is 70 qls/ha. As for the 70 qls/ha vinified, the cooperative recognizes the market price for Aglianico PDO grapes increased by 50%.

[2] They represent the difference between the 120 q.ls/ha enabled by Aglianico PDO's disciplinary and the maximum 70 q.ls/ha provided by the cultivation protocol of 'I mille per Aglianico'.

As regards the approximately 50 q.ls/ha of grapes obtained from thinning and used as a sparkling wine base, the cooperative recognizes the expected market price for Aglianico PDO grapes (Figure 2).

Therefore, the members benefit of a price premium per quintal of grapes produced of about 30% more than the market price. The contract, which in the experimental phase were stipulated only with a limited number of members, is currently extended to all members involved in the cultivation of Aglianico PDO grapes.

5. Results and discussion

To answer to the first research question, the study analyses the impacts generated by the adoption of the collective smart innovations by 'La Guardiense'. Specifically, the study findings show that the collective smart innovations establish both internal (i.e. internal economies) and external (i.e. external social economies) impacts. The formers reflect in sales increase and in the improvement of the production process due to the reduction of costs management in vineyard and the use of chemical products. The new wine produced by the cooperative granted, from 2015 to the present, a significant increase in sales and turnover going from about 12.8 million euros in 2015 to about 15.5 million euros in 2020, with an increase of over 21%. Literature widely acknowledges the economic impact resulting from the implementation of innovation in the agri-food sector. More deeply, scholars agree on the role played by innovation in improving competitiveness and market position (Capitanio *et al.*, 2010; Nazzaro *et al.*, 2019; Roucan-Kane *et al.*, 2011). As for the external social economies, the collective smart innovations enhanced the sustainability of the production process as well as the development of the territory. More deeply, it, firstly, limited the negative externalities of production on the environment; secondly, it enabled the characterization of the wine in terms of typicality and promotion of the Sannio wine area. In other words, the collective smart innovations increased the economic value created as well as preserved the environment and local development, contributing to the growth of both the Cooperative and the territory. The Cooperative also promoted the innovative aspects, the high quality and the environmental sustainability of the new wine through three publications in the magazine 'La Civiltà del Bere'. Further, in 2013, the wine 'I mille per l'Aglianico' won a prestigious international award recognized every year for the best wine produced among those participating in the competition, namely the 'Oscar del vino'. In addition, this award contributed to the development of the territory as well as its distinctive identification at national and international level. These findings are in accordance with previous studies highlighting the relevance of collective smart innovations for the revamping of inner areas in economic and social terms (Pancino *et al.*, 2019; Stanco *et al.*, 2020).

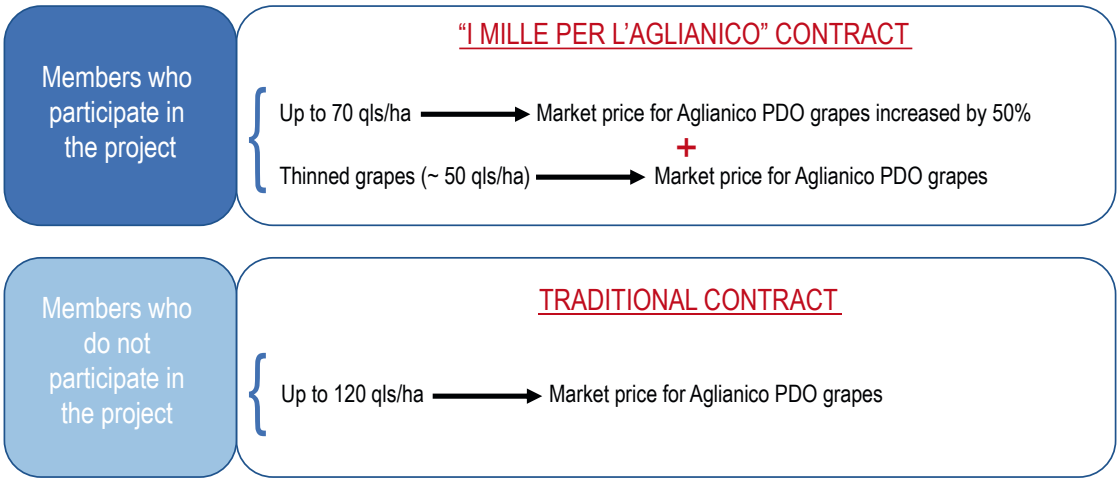

Figure 2. Governance model of 'I mille per l'Aglianico'.

As for the second research question addressed in the study, the case study reveals the value created by the smart collective innovations and the role of the governance models in its distribution between the cooperative and its members. The collective smart innovation 'I mille per l'Aglianico' led to the launch on the market of a new wine with 'smart' attributes. The new wine was first released in December 2013 with a price tag of around €15.00 for a 0.75 liter bottle. Subsequently, the 'I mille per l'Aglianico' wine was withdrawn from the market to be launched definitively in January 2015. The wine Aglianico PDO 'I mille per Aglianico' was sold on the market with a price tag of €25.00 for a 0.75 liter bottle. Compared to a bottle of medium quality Aglianico PDO produced by the same cooperative, that is sold at a price of €8.00 for a 0.75 liter bottle, there is a price difference of about €17.00 per bottle. It represents the value created by the collective smart innovation 'I mille per l'Aglianico' which is shared with all the cooperative members due to the governance model implemented. Indeed, cooperatives' members benefited of a price premium per quintal of grapes produced of about 30% more than the market price of Aglianico PDO; whilst the cooperative, since the launch of the new wine on the market, showed an increasing in its turnover year by year. The benefit for the members is due to the twofold mechanism of incentives put into place by the wine cooperative (Figure 2). The cooperative, instead, was able to increase the turnover and reposition its products on the market, producing a wine in line with the current citizen-consumers' instances.

Literature well recognizes the importance of governance models for the distribution of the value created by the innovation as well as for the creation of stable relationship among the different actors of the supply chain (Martino, 2010). Moreover, it is central for avoiding opportunistic behavior by the actors involved in the innovations (Karantininis *et al.*, 2010; Zilberman *et al.*, 2019).

Currently, 'La Guardiense' extended the collective smart innovations to the whole production area of the Aglianico PDO grapes cultivated by the cooperative members. Lastly, given the success achieved by the previous project and the restored confidence of members towards innovation, due to the adoption of the governance model, the cooperative proposed a similar project for its white wine (i.e. Falanghina) namely 'I mille per la Falanghina'.

6. Study implications and limitations

The study findings provide useful implications for both decision makers and practitioners, as they contribute to the debate on the sustainability and ecological transition in the agri-food sector. In particular, the study highlights the central role of collective smart innovation and its resulting effects in terms of internal and external social economies.

The first implication of the study is related to the policy for the agri-food sector that should support mainly strategic development plan able to foster innovation in the supply chain. Indeed, as the case study highlighted, the benefits of collective smart innovations affect the actors involved in the food supply chain along with the territory. European Union is already set to meet the arising instances of the agri-food sector in terms of innovation. More specifically, the 'farm-to-fork strategy', which represents the core of the European 'Green Deal', addresses the sustainability of food system by the innovation point of view. Moreover, the forthcoming Common Agricultural Policy 2023-2027 will put into place a bundle of funds aimed at encouraging innovation in the agri-food supply chain. A further implication of the study regards governance models. Specifically, the study uncovered that the effectiveness of the collective smart innovation relies on the adoption of new governance models able to share the value among the actor involved. Therefore, practitioners should pay more attention to the governance models to implement in the agri-food supply chain.

The study limitations are mainly related to the use of the case study methodology that limits the generalization of the results observed. However, such methodology well fits the aim of the study that focuses on the role of collective smart innovations and the governance models adopted.

Future studies should investigate deeply new governance models able to facilitate innovation and the distribution of shared value. Further, they may explore different supply chains and territories, in order to corroborate the role of collective smart innovations in the sustainability and ecological transition pursued by European policies.

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