11 *The Resilience of a Farming System at Crossroads between Intensification and Environmental Sustainability*

The Hazelnut Case in Viterbo (Italy)

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11.1 Introduction

Italy is the second-largest producer of European hazelnut in the world after Turkey. The farming system (FS) is in the province of Viterbo (Latium region), the largest production area in central Italy. According to the National Statistics Institute (ISTAT), 46,200 tons of in-shell hazelnuts were produced in 2018 within the FS.

Hazelnut cultivation is historically and culturally rooted in the area, covering around 23,000 ha and embracing more than 6,000 farms nowadays. Most hazelnut farms are family farms managed on a part-time basis, with around two-thirds having a size between 2 and 10 ha. The volcanic area of Cimini Mountains, surrounding the Vico lake, is regarded as the most traditional territory, characterised by highly fertile soil and a unique microclimate. The primary cultivar locally grown is the round-shaped nut 'Tonda Gentile Romana', registered under the Protected Denomination of Origin (PDO) scheme (Silvestri et al., 2021). The average nut and kernel quality is relatively high and suitable for further processing by the downstream processing industry (Figure 11.1).

The revenues generated by hazelnut cultivation represent a major economic resource in the province since any other type of farming does not offer similar profitability. Hence, this perennial crop provides satisfactory levels of income to farmers. Traditionally, hazelnuts coexisted with other woody species (e.g., olive or chestnut trees) in the southeast territory, particularly around the Vico Lake. However, the

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Figure 11.1 Typical landscape in the Viterbo farming system.
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last decade featured a soaring market demand for hazelnuts, while other crops' profitability levels plunged, leading to a significant spreading of the perennial cultivation in the surrounding areas, historically excluded (Nera et al., 2020). Furthermore, substantial modernisation led to growing specialisation and mechanisation levels in the hazelnut sector, with the confectionery industry asking for higher quality standards, fomenting irrigation systems, and chemical treatments. Simultaneously, irrigation ensures larger kernels, and agro-chemicals allow for higher quality levels and lower defects caused by insects (both on taste and appearance). The importance of chemical products for ensuring profitable campaigns hampers the development of organic farming, which represents less than 10 per cent of the whole production.

The irrigation system is pivotal for new plantations especially for those more affected by droughts and heatwaves in the less suitable areas. However, the paucity of groundwater sources is a severe concern. In contrast, farmers settled in traditional areas do not require to irrigate as the impact of heatwaves and droughts is limited.

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Environmental organisations started raising their voice, concerned by the massive expansion and intensification of hazelnut farming and its effects on the landscape, biodiversity, soil pollution, and water resources. This fuelled a fierce local debate between farmers and their organisations, environmental groups, and public administrations, which reached the national level and affected the downstream confectionery industry, whose role is questioned (Liberti, 2019).

The supply chain is quite articulated since the very first steps: raw unshelled hazelnuts are channelled through a complex network of intermediaries, with six producer organisations (POs) handling most of the harvest; their role is relevant in terms of supply concentration and storage, albeit very few engage in further processing besides collecting and storing the harvest. Therefore, unshelling, processing to obtain semi-finished products (e.g., hazelnut flour and past), and marketing to retailers are usually performed by large companies such as Ferrero and Loacker. These were not located within the area until now, and even though they have recently acquired local factories in Viterbo province, they continue to operate on the international market of raw hazelnuts, where Turkey is the largest and most important player. Indeed, Turkey's production levels and policy decisions are relevant in determining the world market's hazelnut price. Other countries, such as Chile, Georgia, and Azerbaijan, are witnessing an essential rise in hazelnut cultivations, heavily stimulated by confectionery firms to enlarge their production basin and reduce dependency on one or two regions of origin.

The FS comprises farms and agricultural households engaged in the hazelnut production and local POs and further local downstream operators and wholesalers. The enabling environment consists of local public authorities – including those managing the Common Agricultural Policy (CAP) at the regional level – machinery providers, small confectionery industries, research institutions, professional associations, and input providers. As mentioned before, environmental activism and related organisations are increasingly influencing the FS, exerting political pressure to restrain the expansion and intensification of hazelnuts. The CAP also plays a role in developing the FS, particularly through the Common Market Organisation (CMO) and Pillar 2, i.e., the Rural Development Program (RDP). POs are entitled to channel the CMO's support, playing a crucial role for farm investments, technical advice, supply concentration, and environment-friendly

practices. At least 10 per cent of the PO's expenditure under operational programmes shall cover environmental actions or, alternatively, two or more environmental actions with specific constraints in terms of surface and duration. On the other hand, RDP supports farms engaging in environment-friendly practices and supports Leader programs operated by Local Action Groups. However, RDP policies suffer from heavy bureaucracy, limiting their uptake and potential impact. Finally, direct payments provided via Pillar 1 of the CAP represent a negligible share of hazelnut farms' total revenue.

This chapter offers an overview of the results obtained for this FS via applying different approaches outlined in Chapter 1.

11.2 Exploring the Current State of the Resilience of the FS

FoPIA SURE-Farm workshops provide useful and relevant insights into the current state of resilience. Investigating how the FS can be described according to resilience capacities revealed a robust system, nevertheless characterised by weak adaptability and transformability capacities. Due to the perennial character of the hazelnut cultivation, robustness, adaptability, and transformability are defined according to the extent of changes and the time frame within which such changes occur. Robustness relates to short-term changes, whereas adaptability refers to changes occurring on a medium time horizon, and transformation requires relevant changes to occur over more extended periods (Anderies et al., 2013; Severini et al., 2019). The system's robustness is strongly and positively affected by the current significant mechanisation of farming practices reducing labor costs by ameliorating labor productivity. Likewise, adaptability is somewhat enhanced by this strategy (Severini et al., 2019). Concerning the functions the FS is able to ensure, private functions embrace (i) offering healthy and affordable food products; (ii) securing the economic viability of farms, contributing to territorial development; and (iii) improving the local economy, hence life quality, by providing employment and offering decent work conditions. On the public side, the FS contributes to (i) maintaining local natural resources in good condition, (ii) protecting the biodiversity of habitats and different species, and (iii) ameliorating landscape quality. During recent years, the FS performed well in profitability, generating a gross margin between 5,000 and 8,000 €/ha, with a farm-gate price of average-quality shelled hazelnuts of approximately 7.20 €/kg (2019).

The price level is strongly influenced by technical characteristics such as kernel size and shape, pellicle removal after kernel blanching or roasting, the mould incidence in the kernel, or other defects caused by insects (mainly different bug species). This probably incentivises the application of irrigation systems (Cristofori et al., 2014) and chemical products; instruments apt for increasing the product's quality. The crop's relatively good economic performance (i.e., gross margin) contributes to ensuring farming as a viable activity, supporting the local economy, which is mainly based on the agricultural sector. This has a positive effect on resilience attributes supporting rural life and on the social self-organisation of the system (concepts explained earlier in this book) that, in turn, support the whole farming system.

The capacity of being resilient in the future depends on the evolution of current FS challenges. Indeed, stakeholders are expecting significant changes to the FS, particularly due to the following: (i) on the environmental side: the increasing climate change; (ii) regarding the organisation of the hazelnut supply chain: the increasing bargaining power exerted by the confectionery industry; and (iii) regarding social and political changes: the possible introduction of more binding eco-friendly requirements, lately pushed by the rise in environment-related concerns.

Climate change – especially the random variation in temperatures and rainfall poorly distributed throughout the year – leads to more frequent and severe droughts and heatwaves, with negative impacts on production levels and, although to a lower extent, the whole FS viability. In certain years extended droughts and frosts are lowering both hazelnut quality and yields (Zinnanti et al., 2019), with the former further increasing the pressure on water resources as larger volumes and longer periods of irrigation are necessary. Besides, phytopathology and other biotic factors represent a critical challenge for growers, damaging the harvested product, affecting farms' profitability. Remarkably, there is growing concern about the infestations of *Halyomorpha halys*, a new bug species that may spread in the area as already happened in northern Italy, where hazelnut trees are also farmed (Bosco et al., 2018). This would result in heavier use of chemicals to preserve high quality standards and yield levels.

The concentration of the downstream confectionery industry and its purchase strategy became a challenge for the FS. Processing companies commonly influence protocols affecting production practices and costs.

In particular, prices are maintained low whenever hazelnut quality level is not consistent with the industrial production strategy. Thus, the FS seems strongly affected by the confectionery industry's decisions, hindering its adaptability and transformation strategies: high-quality standards required by the industrial processors contrast with the social request to maintain high environmental standards. This also constrains the growth of organic farming.

Reducing hazelnuts' ecological footprint and taking into account the impact of agricultural practices on public health and natural resources would undoubtedly produce public goods, but at the detriment of private interests – especially for the farmer, who will receive a lower price for a lower-quality product and a lower income from a lower volume of production. Some municipalities already introduced more stringent regulations on farming practices to limit the environmental impacts and curb the expansion of hazelnut cultivations. The trend is expected to endure and even to reinforce.

11.3 Exploring the Future State of Resilience

In recent years, stakeholders do not trust the FS's ability to adapt to challenging conditions envisaged in the next ten years. At the same time, they cannot imagine the FS without hazelnuts, dismissing any opportunity for a relevant change in production patterns (e.g., crop substitution), mainly because of its perennial nature and its historical and traditional character. Two FoPIA-SURE farm workshops involving FS stakeholders allowed for thresholds' identification regarding resilience indicators (e.g., gross margin), attributes (e.g., support rural life) and challenges (e.g., droughts) (for more details, see Accatino et al., 2020). For each indicator, attribute, and challenge, thresholds define a band of inaction within which the FS maintains the current state. Whenever thresholds (maximum or minimum) are exceeded, the FS performs differently, a situation depicted via the Causal Loop Diagram[1] in Figure 11.2, illustrating the cascading scale effects.[2]

[1] Described earlier in this book.

[2] Cascading effects refer to the impacts of an initiating event where: (i) System dependencies lead to impacts propagating to other systems; (ii) the combined impacts of the propagated event are of greater consequences than the root impacts; and (iii) multiple stakeholders and/or responders are involved.

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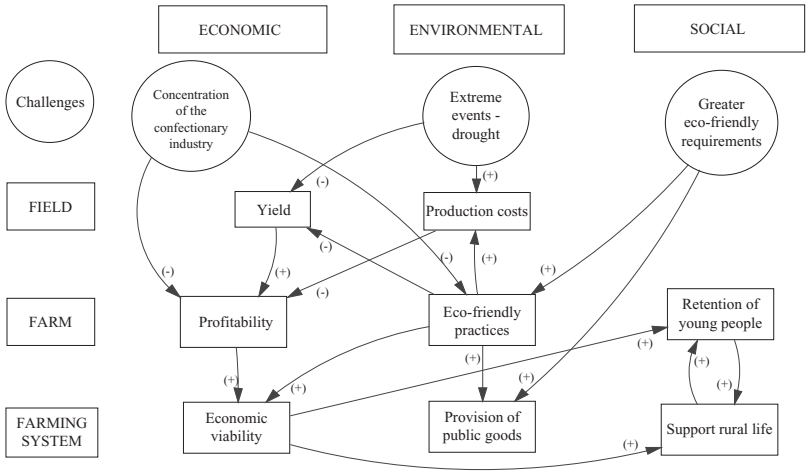

Figure 11.2 Impacts of challenges on key aspects of the hazelnut farming system in Viterbo.

Arrows between boxes indicate the existing positive (+) or negative (−) correlations among resilience indicators, attributes (squared boxes), and challenges (circle boxes). Interestingly, it shows several interactions across domains (economic, environmental, and social) and levels (field, farm, farming system) written in capital letters in horizontal and vertical axes, respectively (Accatino et al., 2020).

Concerning the unbalanced bargaining power, favouring industrial processors, some stakeholders perceive that the growing quality standards are pushing down prices, affecting farm profitability and the system's economic viability. Furthermore, the latter is utterly hampered by the lack of local product valorisation: all the transformation processing occurs outside the FS, excluding potential value-adding activities. This seems a significant missed opportunity, besides being a strategy to weaken the bargaining power of big industrial players. Finally, higher quality standards prevent environment-friendly practices, including organic production, threatening the provision of environment-related public goods.

Climate change is perceived as severe, particularly for non-traditional areas of production. This entails a decline in farm profitability, driving the general decline of FS's economic viability because of the lack of similarly profitable crop alternatives to the hazelnut cultivation. In this sense, a resilience attribute such as crop diversification is

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likely to reduce the FS's average profitability, eventually pushing out young people from farming.

Introducing more binding environmental constraints could limit yields and increase production costs (Coppola et al., 2020), lowering the FS's economic viability. However, shifting to an eco-friendly production process and promoting precision agriculture applications could be beneficial only if the system will be able to exploit the potential willingness of consumers to pay a premium price for organic products. Under these circumstances, this could permit to increase both the economic viability of the system and the provision of public goods. However, the confectionery industry is not pursuing any strategy in this direction, and most hazelnuts are not processed locally but sold to retailers by companies operating outside the FS. Hence, this valorisation strategy could be implemented only with the confectionery industry's active participation or with the FS's ability to develop a successful marketing strategy and create the ideal conditions for a small-scale local processing industry.

The previously mentioned challenges are putting the system under pressure, moving towards an alternative configuration of the FS when the thresholds of indicators, resilience attributes and challenges are exceeded. The following alternative configurations of the system have been identified during the second FoPIA workshop. Furthermore, some boundary conditions (i.e., conditions that need to be fulfilled before the alternative system can flourish) were identified.

i. A system oriented to satisfy the growing demand of raw hazelnut exerted by the big confectionery industries: increasing demand would generate, ceteris paribus, positive repercussions on the farms' profitability (Table 11.1). The promotion of hazelnut-based products in markets where demand is growing, such as China, could stimulate such a system. In turn, this may generate positive effects on the system's organisation, the infrastructure for innovation, and ultimately the private viability of the FS. Removal of trade barriers is among the boundary conditions which could make the alternative system happen.
ii. Local valorisation: a complex process involving a plurality of actors who have specific interests and potentially pursuing different – and sometimes conflicting – objectives and strategies. Product

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Table 11.1. *Perceived performance expectations of the main functions and the presence of resilience attributes in future configurations of the FS*

			Future systems			
Indicator	**Current level**	**Status quo**	**Sustained demand (high and stable prices)**	**Product valorisation**	**Technological innovation**	**Eco-friendly agriculture**
Gross saleable production	High	↗	↗	↗	↗	↘|↗
Gross margin	High	→	↗	↗	↗	↘|↗
Organic farming (Ha)	Low	↗	↘	→	↗	↑
Retention of young people	Moderate	↗	↗	↗	↗	↗
Socially self-organised	Moderate	→	↗	↗	↗	↑
Coupled with local and natural capital	Low	↗	↑	↗	↑	↑
Supports rural life	Moderate	↗	↗	↗	↗	↗
Infrastructure for innovation	Moderate	↗	↗	↗	↑	↗
Diverse policies	Low	→	→	↗	↗	↑

Table 11.1. (*cont.*)

Boundary conditions	Dimension						
Growing demand	Economic	V	V				
Prices linked to the real cost	Economic					V	V
Concentration of the confectionery industry	Economic	V	V				
New markets	Economic		V	V			
Short supply chain	Economic			V			V
Brands with high local value	Environmental			V			V
Extreme weather events (droughts)	Environmental	V					V
Greater eco-friendly requirements	Environmental	V					V
Cultural changes	Social	V		V			V
Research	Social					V	V
More young people in the system	Social	V				V	
Information flow	Social					V	
CAP support	Institutional	V				V	V
Duty-free markets	Institutional		V				

→ implies no change, ↗ implies moderate positive change, ↑ implies strong positive change, ↘ implies moderate negative change, ↓ implies strong negative change, V implies that a boundary condition is relevant for a future system.

valorisation could be pursued by developing locally processed and differentiated products exploiting the opportunities offered by the current and alternative geographical indications. This is expected to bypass large downstream processing firms or at least weaken their bargaining power. In this alternative system, there is a general improvement of the economic indicators, ameliorating the FS's competitiveness (Table 11.1). In this regard, boundary conditions are represented by developing local high-value brands allowing the valorisation of both the intrinsic and extrinsic quality of local production. CAP support for investments of local processors can play a crucial role in pursuing this strategy.

iii. Technological innovation is considered a driving strategy for the future of the FS because of its potential to reduce production costs and increase production value. Stakeholders mentioned, among others, precision agriculture and the digitalisation of the farm processes. CAP support does not play a relevant role in this process: policies, such as RDP, do not promptly adapt to the system needs because of their slow and complicated bureaucratic procedures. This future configuration of the FS requires increasing research activities at the field level, the presence of more young people in the FS, ensuring information flow among stakeholders along the value chain, increasing CAP support for technological investments, and reducing the red tape.

iv. Shifting to more eco-friendly agriculture: this would foster the conservation of natural resources. The performance of economic indicators may decline at the beginning due to lower yields and product quality. It should be considered that farmers in the area have limited knowledge of eco-friendly farming practices. Providing widespread training activities in this direction may facilitate such transition. Moreover, if consumers are willing to pay higher prices for the final product, this could offset lower production levels and higher production costs.

11.4 Strategies towards the Future

The alternative configurations of the system are not independent: technological innovations could facilitate the shift towards more eco-friendly practices, and, simultaneously, a system based on eco-friendly

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activities which could add value to the product if this is properly communicated to final consumers.

While some strategies are vital to maintaining the status quo, others are essential to trigger future alternative systems. Therefore, while mechanisation, consortia for technical advisory and more substantial cooperation among stakeholders are useful to maintain the status quo, more binding agro-environmental policies and requirements are essential for transitioning towards more environment-preserving agriculture. In contrast, the opening of international markets is needed, especially for a demand-oriented system.

On the other hand, to envisage alternative configurations, consortia for technical advice mixed with increasing CAP support may encourage environment-friendly agriculture and technological innovation; in addition, promotional activities could be useful for the alternative system based on local product valorisation to communicate with consumers. Participants at the workshops argued that the interaction among stakeholders in the supply chain and training activities are expected to generate positive effects on each alternative configuration system mentioned earlier. Nowadays, the FS requires trained stakeholders, able to collaborate vertically within the value chain. Indeed, cooperation among FS actors seems to be a fundamental resilience attribute for guaranteeing the system's efficient organisation. Finally, the EU public support could enhance the system's resilience when facing external changes/shocks: current RDPs and CMO instruments foster the robustness and adaptability of the local FS. However, the effectiveness of these measures depends on adjusting them according to the FS configuration to be pursued and to external shocks.

11.5 Conclusions

The relevant growth of hazelnut production in the last decades, both in terms of quantity and quality, brought the FS near to a crucial point: whether to embrace a path of intensification following the increasing demand of the confectionery industry or to move towards a system based on the local valorisation of the product adopting technological innovations and environment-friendly approaches.

Results suggest the current situation of the hazelnut FS relies mostly on robustness capacities to cope with challenges, although, to a lower

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extent, adaptability capacities are also detected. On the contrary, the ability to pursue radical transformations is minimal. Due to positive economic performances, the FS performs well in terms of food production and economic viability, but its performances concerning the quality of life, natural resources, biodiversity and habitat, and area attractiveness are questionable. Thus, the system looks resilient for specific short-term disturbances, tackled by a good organisation, redundancy, and significant financial resources availability. However, the hazelnut's perennial nature, the lack of alternative (profitable) crops, and the strong dominance of the downstream industrial process hinder its transformability capacities.

Nevertheless, the analysis has revealed that alternative configurations in response to climate change, increasing societal concerns over environmental quality and public health, and the increasing concentration of the confectionery industry would need relatively greater changes to occur. In this regard, four alternative systems have been identified.

The first alternative system aims at meeting the needs of the confectionery industry: the growing international demand for manufactured products would increase both robustness and adaptability capacities, mainly reinforcing the private functions provided. However, it would also exacerbate some critical environmental issues, negatively affecting the system's resilience through reducing its connection with natural and local capital. Furthermore, the increasing dependence on global markets may drive the system to be even less resilient.

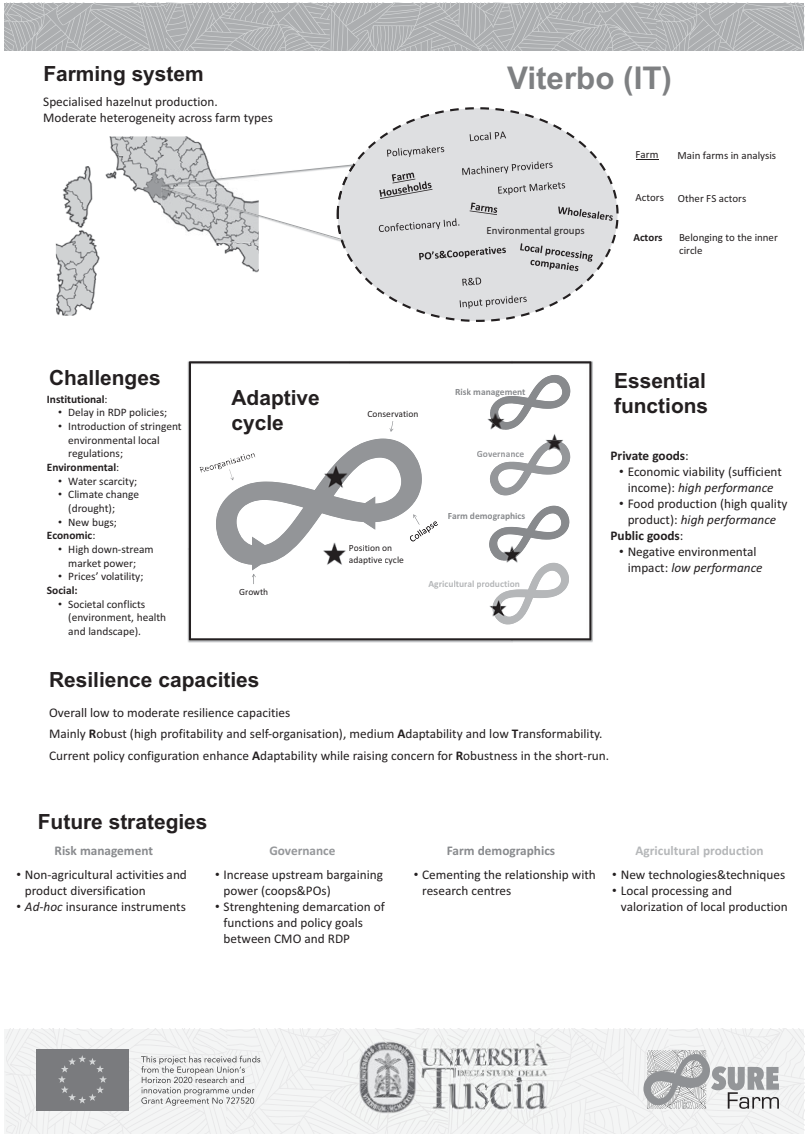
On the contrary, local product valorisation may enhance resilience, reducing exposure to international markets, and strengthening ties with local resources. This would also generate attractive job opportunities for young people in the (new) local downstream enterprises, opening up new market channels, and improving the reputation and the attractiveness of the area, beneficial to non-agricultural activities too, such as local tourism. However, this strategy rests on enhancing vertical coordination led by the local production system: producers, when properly organised and supported by targeted policy measures, should manage the supply chain. Clearly, this requires identifying the market shares available to absorb valorised products and involves producer organisations.

A reconfiguration of the system based on technological innovation could positively affect farmers' income with a potentially positive impact on system resilience. However, while this is not necessarily the solution for the problems previously described, technological innovation offers opportunities for reconciliation, at least to some extent, between hazelnut production and the environment due to better use of chemical inputs and irrigation.

Finally, the system could shift to eco-friendly farming practices ensuring a higher level of environmental sustainability. This will require relevant changes along with all components of the FS, especially the marketing strategies of the dominant industrial processors: final industrial products based on organic hazelnut production would increase the likelihood of this alternative configuration to happen.

In conclusion, discussions with stakeholders have shown that there is room for improvement for the FS's resilience, primarily through an adequate mix of strategies to increase the connection with the local and natural capital. In this regard, a higher level of eco-compatibility and technological innovation may generate synergies if the Agricultural Knowledge and Innovation Systems (AKIS) orient research and technological innovation in this direction.

EU policies could have a crucial role in fostering the adoption of a local valorisation strategy. The current CAP, focused on providing financial support to operational programs (planned and implemented by POs), is factually oriented to promote a strategy based on local valorisation, innovation and environmental sustainability. The current European Commission orientation is to increase the share dedicated to environmental actions within the CMO policies up to 20 per cent. Indeed, the recent Green Deal and the Farm to Fork strategy are expected to strengthen such an orientation. However, its implementation in the investigated FS is constrained by the dominant position of confectionery companies not located in the area. Indeed, a strategy based on local valorisation, innovation and environmental sustainability requires strong cohesion between producers to be effective. This calls for a collective action involving different actors of the FS, the reduction of the fragmentation of the POs and the reinforcement of the local value chain. Nevertheless, as already mentioned, these conditions are still far from being satisfied.



Annex 11.1 Factsheet synthesising resilience of the current farming system in Viterbo (Italy).

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References

Accatino, F., Paas, W., Herrera, H., et al. 2020. 'D5.5 Impacts of future scenarios on the resilience of farming systems across the EU assessed with quantitative and qualitative methods'. Sustainable and resilient EU farming systems (SURE-Farm) project report, EU Horizon 2020 Grant Agreement No. 727520.

Anderies, J. M., Folke, C., Walker, B., Ostrom, E. 2013. 'Aligning key concepts for global change policy: Robustness, resilience, and sustainability', *Ecology and Society* 18(2): 8.

Bosco, L., Moraglio, S. T., Tavella, L. 2018. '*Halyomorpha halys*, a serious threat for hazelnut in newly invaded areas', *Journal of Pest Science* 91(2): 661–670.

Coppola, G., Costantini, M., Orsi, L., et al. 2020. 'A comparative cost-benefit analysis of conventional and organic hazelnuts production systems in center Italy', *Agriculture* 10: 409.

Cristofori, V., Muleo, R., Bignami, C., Rugini, E. 2014. 'Long term evaluation of hazelnut response to drip irrigation', *Acta Horticulturae* 1052: 179–185.

Liberti, S. 2019. 'Il gusto amaro delle nocciole', *Internazionale* 1312: 38. Available at www.internazionale.it/reportage/stefanoliberti/2019/06/21/nutella-gusto-amaro-nocciole-ferrero (accessed on 15 September 2019).

Nera, E., Paas, W., Reidsma, P., Paolini, G., Antonioli, F., Severini, S. 2020. 'Assessing the resilience and sustainability of a hazelnut farming system in central Italy with a participatory approach', *Sustainability* 12(1): 343.

Reidsma, P., Paas, W., Accatino, F., et al. 2020. 'D5.6 Impacts of improved strategies and policy options on the resilience of farming systems across the EU'. Sustainable and resilient EU farming systems (SURE-Farm) project report, EU Horizon 2020 Grant Agreement No. 727520.

Severini, S., Paolini, G., Nera, E., Antonioli, F., Senni, S. 2019. 'FoPIA-Surefarm case-study report Italy'. In: Paas, W., Accatino, F., Antonioli, F., et al., 'D5.2 Participatory impact assessment of sustainability and resilience of EU farming systems'. Sustainable and resilient EU farming systems. (SURE-Farm) project report. EU Horizon 2020 Grant Agreement No. 727520.

Silvestri, C., Bacchetta, L., Bellincontro, A., Cristofori, V. 2021. 'Advances in cultivar choice, hazelnut orchard management and nuts storage for enhancing product quality and safety: An overview', *Journal of the Science of Food and Agriculture* 101(1): 27–43.

Zinnanti, C., Schimmenti, E., Borsellino, V., Paolini, G., Severini, S. 2019. 'Economic performance and risk of farming systems specialised in perennial crops: An analysis of Italian hazelnut production', *Agricultural Systems* 176: 102645.