Project acronym: SURE-Farm
Project no.: 727520

Start date of project: June 2017
Duration: 4 years

FoPIA-Surefarm Case-study Report Italy

Work Performed by UNITUS (P10),

Università degli Studi della Tuscia, Viterbo (Italy)

Severini S., Paolini G., Nera E., Antonioli F., Senni S.

(Contact person: Severini S.)

Due date	31 May 2019
Version/Date	31 May 2019
Work Package	WP5
Task	T5.2
Task lead	WU
Dissemination level	Public

INDEX

This Project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 727520

Please, cite this FoPIA-Surefarm case-study report as:

Severini, S., Paolini, G., Nera, E., Antonioli, F., Senni, S., 2019, 'FoPIA-Surefarm Case-study Report Italy'. **In:** Paas, W., Accatino, F., Antonioli, F., Appel, F., Bardaji, I., Coopmans, I., Courtney, P., Gavrilescu, C., Heinrich, F., Krupin, V., Manevska-Tasevska, G., Neumeister, D., Peneva, M., Rommel, J., Severini, S., Soriano, B., Tudor, M., Urquhart, J., Wauters, E., Zawalinska, K., Meuwissen, M., Reidsma, P. D5.2 Participatory impact assessment of sustainability and resilience of EU farming systems. Sustainable and resilient EU farming systems (SURE-Farm) project report.

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Abstract

This case-study report focuses on assessing the resilience and sustainability of a hazelnut farming system in central Italy. The economy of the area is strongly specialised in hazelnut farming, but the local hazelnut market is unstable and strongly dependent on the Turkish production. In order to assess the resilience and sustainability of the farming system, a participatory approach was used in this report, based on a stakeholder workshop.

The results of the stakeholder workshop depicted a system with a good economic and productive performance. However, the maintenance of natural resources was perceived to be moderate. In terms of resilience, the system is highly robust, but it has lower adaptability and transformability. In the past decades, the system has undergone exploitation and conservation of production through increased mechanisation, which has led to an expansion of hazelnut farming to less suitable areas in the province. Currently, the system is close to reorganisation of the hazelnut supply chain, e.g. by starting to process hazelnuts within the region by cooperatives. Based on the inputs of participants in the workshop, it seems that the system has the resources to successfully re-organize, i.e. there seems to be enough financial and social capital to invest. However, pressure on the environment is likely to stay a point of concern for future sustainability and resilience.

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1 Introduction

1.1 Case study

The province of Viterbo, located in Lazio (central Italy), is the first Italian province in terms of hazelnut production (*Corylus avellana*), with a harvest of 48,400 tons in 2017 according to the Italian National Statistics Institute (ISTAT website, 2017). The case study includes most of the Viterbo province, excluding the coastal zones. The main cultivar in the area is the "Tonda Gentile Romana", which is registered under the PDO (Protected Denomination of Origin) scheme. The cultivar "Tonda di Giffoni" is also used in smaller percentages (Rugini & Cristofori, 2010). Hazelnut production is a major economic resource in the province, and it is a traditional activity: the area does not offer favorable conditions for farming, therefore hazelnut cultivation has allowed agriculture to survive, providing an income to farmers. Traditionally, hazelnuts used to be cultivated together with other species (e.g. olive trees, chestnuts, vineyards), in the south-east area of the province and particularly around the Vico lake. In the last few years, the increased market demand and competition (especially with Turkey) has led to an expansion of the cultivated area and to a modernisation of the production, with growing levels of specialisation. Therefore, most cultivations are now hazelnut monocultures, with high planting density of trees, and hazelnut farming has expanded to new areas of the region (Biasi & Botti, 2010).

Six different farm types have been identified in the province of Viterbo, based on statistical data and interviews with experts performed by UNITUS. These are reported below, from the SURE-Farm Deliverable 3.1 (Bijttebier et al., 2018). The structural characteristics considered in distinguishing these typologies are farm size, managerial ownership, horizontal specialisation, intensity.

- Family Farms + Field crop farms (Arable and limited permanent crops)
- Family Farms + Extensive Livestock (Sheep, Goats, and Mixed Livestock)
- * Small Family Farms (<10 ha) + Specialized Hazelnut
- * Medium-Large Family Farms (≥10ha) + Specialized Hazelnut
- Family Farms + Other Permanent Crops (Vineyards and Olive groves)
- Family Farms + Intensive Livestock (Specialized Bovine, Pig, and Poultry)

In the project, the focus is on farms specialised in hazelnut production (with an asterisk in the list). As a general trend, the Used Agricultural Area (UAA) of large farms is increasing, although small family farms based on family work remain the most common holding type in the province (Bijttebier et al., 2018).

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In the preparation phase of the workshop, some challenges to the farming system were identified by the SURE-Farm team, considering both shocks and long-term pressures, as well as economic, environmental, social, and institutional challenges. They are presented in Table 1.

Table 1: Identified challenges.

Challenges	Economic	Environmental	Social	Institutional
Shocks (permanent and non-permanent)	Hazelnut price volatility	Spring frost		Payments delays from RDPs (Rural Development Programmes)
	Volume of Turkish production	Drought		Processors' strategic decisions (for vertical integration)
	Turkish economic conditions (e.g. policies, exchange rate)	Hail		Binding local environmental regulations
		Phytopathology (insects)		
		Heat-related issues (e.g. sterility, fruit development)		
Long-term pressures	Expansion of hazelnut cultivated area, in Italy and worldwide	Climate change	Increasing societal awareness on environmental issues (e.g. pollution from agrochemicals)	
	Market power of the confectionary industry	Depletion of groundwater resources		

1.2 Workshop

The workshop was held on the 21st of January in the Rectorate of Università degli Studi della Tuscia (UNITUS) in Viterbo (Italy). A total of 39 stakeholders were invited, of which 21 participated in the workshop and 16 stayed until the end. The participants were divided in four categories: *Farmers*, *Government*, *Industry*, and *Others*. This last category included members of NGOs and other types of stakeholders which were difficult to include in one of the existing groups (e.g. agronomists, members of local organisations).

It was not considered necessary to further divide the participants in subgroups during the workshop; the results were generally presented as an average of all participants and/or per group. As not all participants stayed until the end of the workshop, in the final phase (resilience attributes) the *Government* group was represented by only one participant; therefore, in this report the *Government* group was aggregated to *Others* in the section related to resilience attributes (Appendix D). The proportion '*Farmers* : *Government* : *Industry* : *Others*' at the start of

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the workshop was approximately 40:15:15:30. A workshop memo with details on the participants can be found in Appendix A.

2 Farming system

Figure 1 shows the visualisation of the Farming System developed by the SURE-Farm team, which was presented at the beginning of the workshop. The actors within the farming system (FS) were mainly chosen based on the results of previous research activities carried out by UNITUS in the SURE-Farm project, particularly the demographic interviews (Task 3.1.2), as well as on interviews to experts. Apart from farms and farm households, the FS also includes wholesales, producers' organizations (POs) and cooperatives, and local hazelnut processing companies. All these actors influence farms and are influenced by them. The FS is characterized by a high presence of processing industries (for the first processing activities, i.e. shelling and, in a few cases, production of semi-finished products) and wholesales interacting with the confectionary industries outside of the system; therefore, these actors mainly have mutual economic influences with farms. Cooperatives (often organized in POs) are important in terms of both economic and social influences on/from farms: they represent the main form of social organisation inside the FS, but they are also essential in connecting producers to confectionary industries and downstream market.

The first comment from the participants on the proposed visualisation was that the public support to agriculture, both from local administration and Rural Development Programme (RDP), is considered as external to the system in the proposed visualisation. According to the participants, as public support has a strong influence on farms, it should be considered as internal to the system. A second comment was that the growth of the FS in the last decades has been allowed by the development of machinery, through a reduction of the production costs. Moreover, the machinery sector has become extremely specialised, following the development of the system. For these two reasons, machinery providers should be considered when analysing the FS.

It was decided by the team not to modify the visualisation of the system, since neither public support nor machinery providers are directly influenced by the system, despite their strong influence on it. Machinery providers sell machinery in a broader market (i.e., international market) hence what happens in the considered FS affects their business but not strongly.

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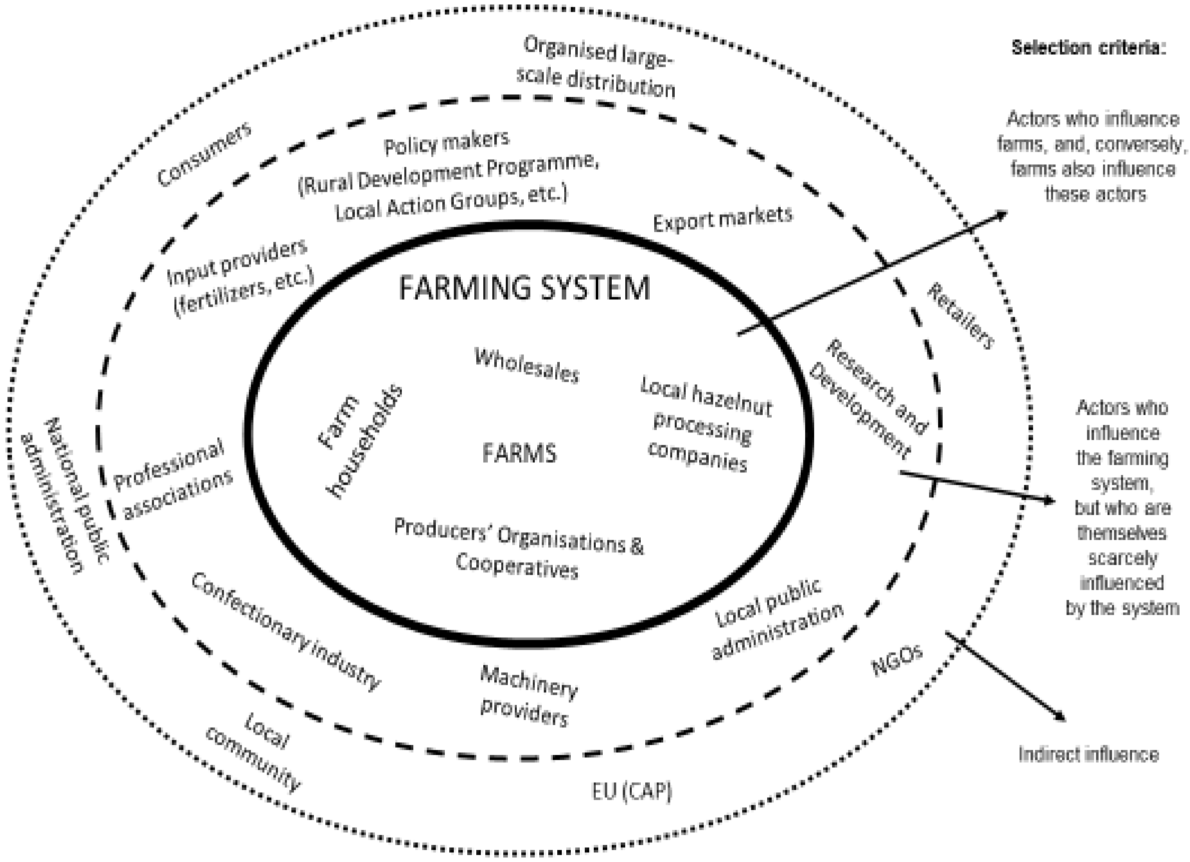

Figure 1: Farming system as proposed by the SURE-Farm team.

3 Functions

In this case study, the function "Ensure animal health and welfare" was not applicable. Therefore, participants were asked to distribute 100 points among seven functions, based on their current importance in the FS. Based on the results of the scoring (Figure 2), the most important function delivered by the system was "Economic viability" (with 33 points), followed by "Food production" (25). The third function, with a much lower importance (13 points), was "Quality of life". The lowest scores were given to the functions related to public goods, particularly to "Natural resources", "Attractiveness of the area", and "Biodiversity & habitat" (8, 7, and 6 points respectively). A detailed table with all values of means and standard deviations (SD) for this exercise can be found in Appendix B.

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There was generally more agreement on the functions that received the lowest scores, while the highly rated ones showed higher SD. The highest value of SD was recorded for "Economic viability", followed by "Food production". Overall, the different stakeholder groups were relatively homogeneous in their scoring of functions. Members of *Industry* tended to prefer "Food production" and then "Economic viability", whereas all other stakeholders put this second function first (particularly the *Others* group, which gave the function a higher score compared to all other groups). Moreover, the *Industry* also had a higher perception of the importance of "Natural resources" compared to the average. Another significant result is that "Attractiveness of the area" was generally perceived as low by *Farmers*, *Industry*, and *Others*, whereas the score given by the *Government* category was much higher.

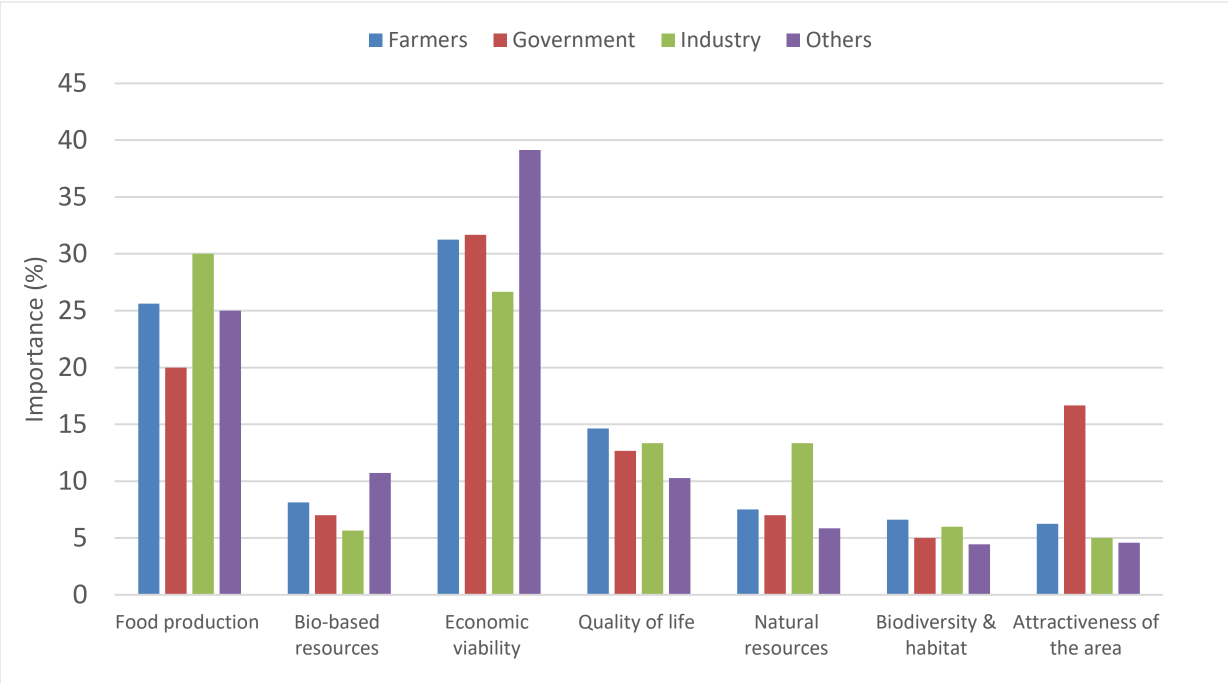

Figure 2: Bar graph with average scoring per function, per stakeholder group. 100 points needed to be distributed among seven functions.

The overall result was expected by the participants, as reflected by the general agreement among the stakeholders. The difference in the perception of "Attractiveness of the area" was the only point generating a discussion: according to some participants, the farming system ensures attractiveness from a gastronomic point of view, but not in terms of landscape. However, the landscape topic was highly debated. Other participants argued that hazelnut cultivations resemble forests. Hence, they give the area a more natural appearance compared to areas of the Lazio region based on other crops, which are associated to a more urbanized landscape. There was a general agreement on the fact that it is the policy makers' responsibility to increase the attractiveness of the area, and there is high potential for improvement.

4 Indicators of functions

4.1 Discussion on the indicators

After all indicators were presented (Table 2), the participants were asked for comments on the proposed indicators. This section includes an overview of the plenary discussion that followed. For practical reasons, it was not possible to insert the added indicators in the following exercises of the workshop.

Table 2: Proposed indicators per function, with related stakeholder groups. Below each function (in italics), the abbreviated name commonly used in this report.

Functions	Indicators	Stakeholder
Private goods		
Deliver healthy and affordable food products (*Food production)*	Hazelnut production	Farmers
	Hazelnut quality	Farmers/Industry
	-	
Deliver other bio-based resources for the processing sector (*Bio-based resources*)	Shell production for heating	Farmers/Industry
	Production of pruning waste for energy generation	Farmers/Industry
	-	
Ensure economic viability (viable farms help to strengthen the economy and contribute to a balanced development) (*Economic viability*)	Gross Margin per hectare	Farmers
	Public support to agriculture (CAP and RDP)	Farmers/Government
	Margin from *in situ* processing activities	Industry
	-	
Improve quality of life in farming areas by providing employment and offering decent working conditions (*Quality of life*)	Number of people in the area employed in the farming system	All stakeholders
	Percentage of women among the people employed in the system	All stakeholders
	Health of agricultural workers	All stakeholders
	-	
Public goods		
Maintain natural resources in good condition (water, soil, air) (*Natural resources*)	Groundwater availability	All stakeholders
	Water quality in the area	All stakeholders
	-	
Protect biodiversity of habitats, genes, and species (*Biodiversity & habitat*)	Diversification in land use	Government/Others
	Number of organic farms	Farmers/Government/Others
	-	

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Ensure that rural areas are attractive places for residence and tourism (countryside, social structures) (*Attractiveness of the area*)	Touristic flow	All stakeholders
	Retention of young people in the area	Farmers/Government/Others
	-	

Generally, the participants found that the separation between some of the functions was not always clear (e.g. between "Natural resources" and "Biodiversity & habitat"), and that the division in private and public goods was debatable. For "Food production" it was suggested to insert an indicator on the continuity of production over time, to identify stress. Other suggestions were production diversification, and certification (such as PDO) as an indicator of quality. For the second function ("Bio-based resources"), it was suggested that the pruning waste should be considered not only for energy production, but also as mulch. It was argued that the efficiency of this type of waste for energy production is low, whereas integrating the waste in the soil could increase the organic matter, which is generally lacking in the area. For the function "Quality of life", it was argued that the indicator for employment should also account for the percentage of families involved in agriculture, not only for single employees. It was also suggested to consider the proportion of young people working in the system. Other mentioned indicators were the birth rate and the increase in residents in the area. Finally, for the functions related to the provision of public goods, soil organic matter and micro fauna were suggested as additional indicators, as they changed over time with the growing level of specialisation of the system.

4.2 Indicator importance

For each function, the participants were asked to distribute 100 points among the indicators, based on each indicator's capacity to represent the function. Figure 3 shows the results of the scoring, corrected accounting for the scoring of the function and for the number of indicators per function (Corrected value = function scoring * indicator scoring / 100 * number of indicators under that function). Details can be found in Appendix B.

The "Gross Margin per hectare" showed the highest score (53 points), followed by "Hazelnut production" and "Margin from *in situ* processing activities" (equally rated with 26), and by "Hazelnut quality" (24). These high scores reflect the scoring of the functions, where "Economic viability" and "Food production" were the most important ones. The indicators "Gross Margin" per hectare and "Margin from *in situ* processing activities" have the highest SD; this was due to differences between stakeholder groups (they gave different importance to the function "Economic viability"), but also within groups, since the values of SD were relatively high inside each group. The lowest average scores were given to the functions related to public goods, with the exception of "Number of people in the area employed in the farming system" (17 points) and

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"Health of agricultural workers" (15). The indicator "Production of pruning waste for energy generation" also had a low score of 5, despite representing a function related to private goods. Overall, the indicators with the lowest scores also showed low SD, demonstrating a general agreement among the participants.

For each function, the stakeholders differed in their choice of the most representative indicator. Generally, the *Government* group tended to differ from all other stakeholder, and in some cases *Government* and *Industry* shared the same choice. This was unexpected: based on how stakeholder groups were connected to indicators (see table 2), the groups which were expected to occasionally differ from the other stakeholders were *Farmers* and *Industry*. However, the number of participants was low (and especially *Government* and *Industry* were represented by only three participants each), thus this might have influenced the results. The following list reports a summary of the stakeholders' choices per function:

- For "Food production", the most representative indicator waes "Hazelnut production". *Farmers* and *Others* tended to prefer this indicator, whereas according to *Industry* and *Government* "Hazelnut quality" was the most representative indicator.
- For "Bio-based resources", all stakeholders gave higher importance to "Shell production for heating": the production of pruning waste for energy is a relatively new activity, therefore it is currently less representative of the function.
- For "Economic viability", "Gross Margin per hectare" received the highest score. *Farmers*, *Industry*, and *Others* largely preferred this indicator, whereas the *Government* group put the "Margin from *in situ* processing activities" first and "Gross Margin per hectare" second.
- For "Quality of life", the most representative indicator was "Number of people in the area employed in the farming system" for the groups *Farmers* and *Others*, and "Health of agricultural workers" for *Government* and *Industry*. Overall, the most important indicator for this function was "Number of people in the area employed in the farming system".
- For "Natural resources", all stakeholders put "Groundwater availability" first, and only *Government* showed a clear preference for "Water quality in the area". As a result, "Groundwater availability" was the most representative indicator.
- For "Biodiversity & habitat", "Number of organic farms" was the indicator which received the highest score. It was chosen by all stakeholders apart from the *Government* group, which gave higher importance to "Diversification in land use".
- For "Attractiveness of the area", the indicator "Retention of young people in the area" was unanimously chosen as the most representative one.

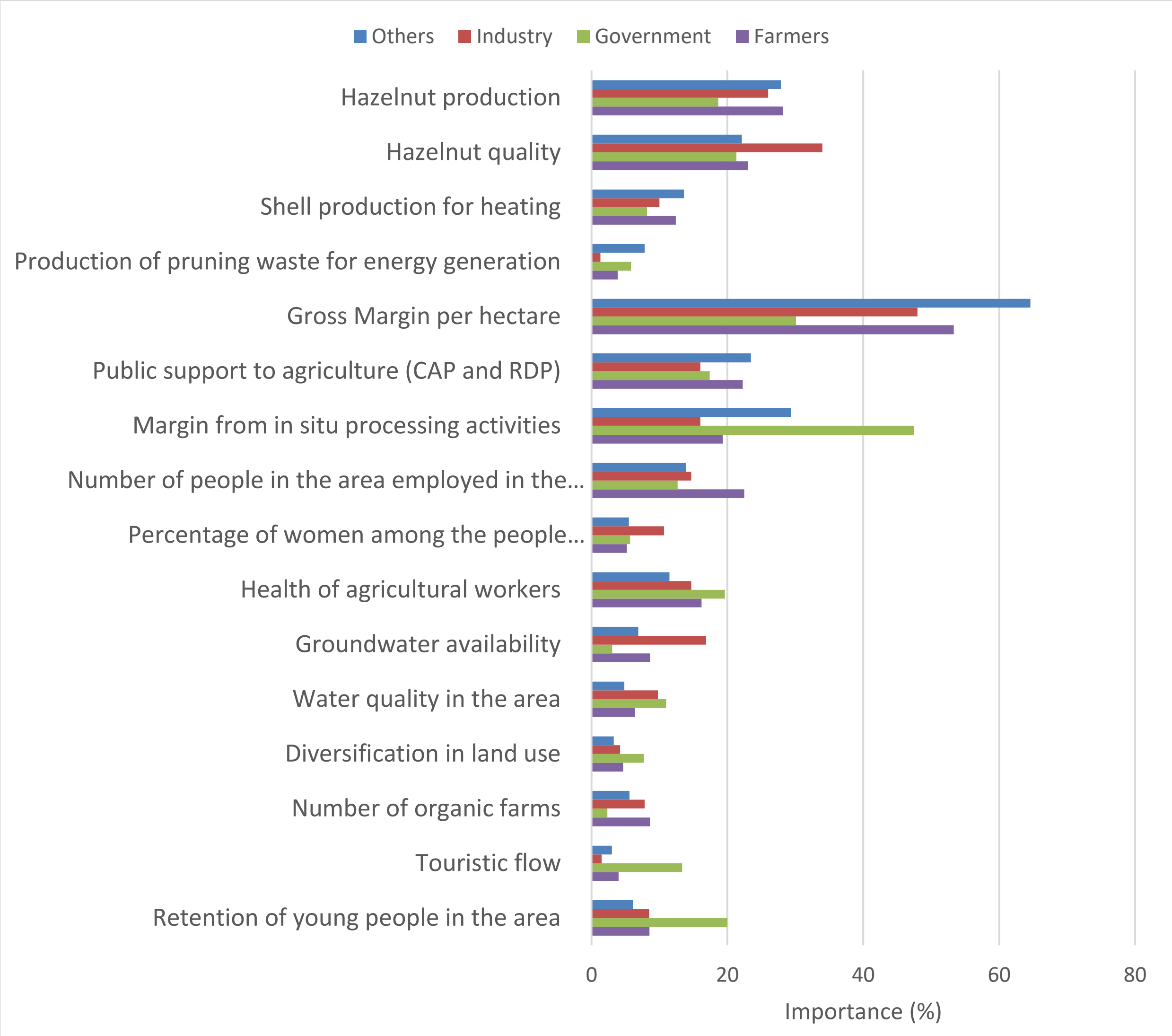

Figure 3: Capacity of indicators to represent the functions (average scoring per stakeholder group). 100 points needed to be divided among the indicators of a certain function. Corrected values, accounting for the importance of the functions and the number of indicators per function.

4.3 Indicator performance

Participants were asked to evaluate the current performance of the indicators, on a scale from 1 to 5: 1) very poorly performing, 2) poorly performing, 3) not good not bad, 4) well performing, 5) perfectly performing. The bar graph in Figure 4 shows the results of this exercise (details in Appendix B).

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Overall, the indicator performance followed the general trend of the scoring of importance of functions, with better performance for the indicators of functions related to private goods and worse for those related to public goods. The highest scores were given to "Hazelnut production" (4.2), followed by "Hazelnut quality" and "Gross Margin per hectare"(4.0 in both cases; the lowest scores were those of "Diversification in land use" (1.8) and "Touristic flow"(1.9). Two exceptions to this general pattern were "Production of pruning waste for energy generation" (private goods but scored only 2.3), and "Retention of young people in the area" (public goods, medium score of 3). However, many indicators showed high values of SD, particularly "Margin from *in situ* processing activities" due to variability among stakeholder groups, "Production of pruning waste for energy generation" and "Percentage of women among the people employed in the system" due to differences between and withing groups. There was generally more agreement on the indicators with higher performance.

Looking at differences between stakeholders, the results were again homogeneous for the indicators with high performance. For "Margin from *in situ* processing activities", both *Industry* and *Others* gave significantly higher scores than the other two groups. The results also clearly differed for "Percentage of women among the people employed in the system", where *Others* was the only group rating the performance as higher than medium. For "Production of pruning waste for energy generation", the rating from the *Government* group was relatively high, in contrast with the low rating coming from *Farmers* and *Industry*, while *Others* gave a medium rating. "Diversification in land use", which had a low overall score, was unanimously rated as "very poorly performing" by all *Government* stakeholders.

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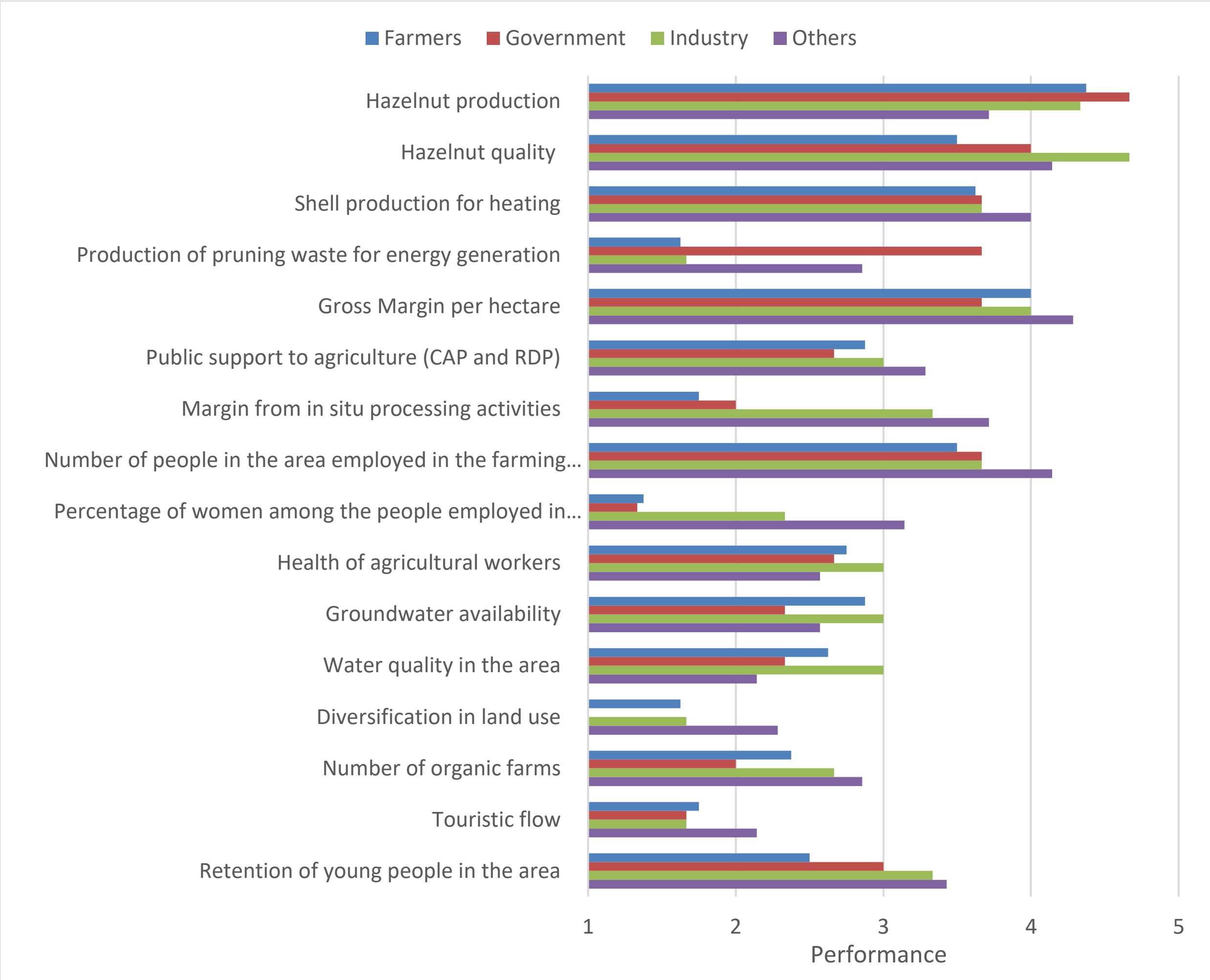

Figure 4: Performance of indicators (average scoring per stakeholder group). Score from 1 to 5: 1) very poorly performing, 2) poorly performing, 3) moderately performing, 4) well performing, 5) perfectly performing.

4.4 Indicator selection

The bubble graph of the indicators, which combined the information from the last two bar graphs, was shown to the participants (Figure 5). The results generated a discussion. One of the main points that emerged was that many indicators were complex and sometimes strongly connected among them, and this made it complicated to interpret and evaluate them. Similar bubble graphs for the functions (for all participants and per stakeholder group) can be found in Appendix B.

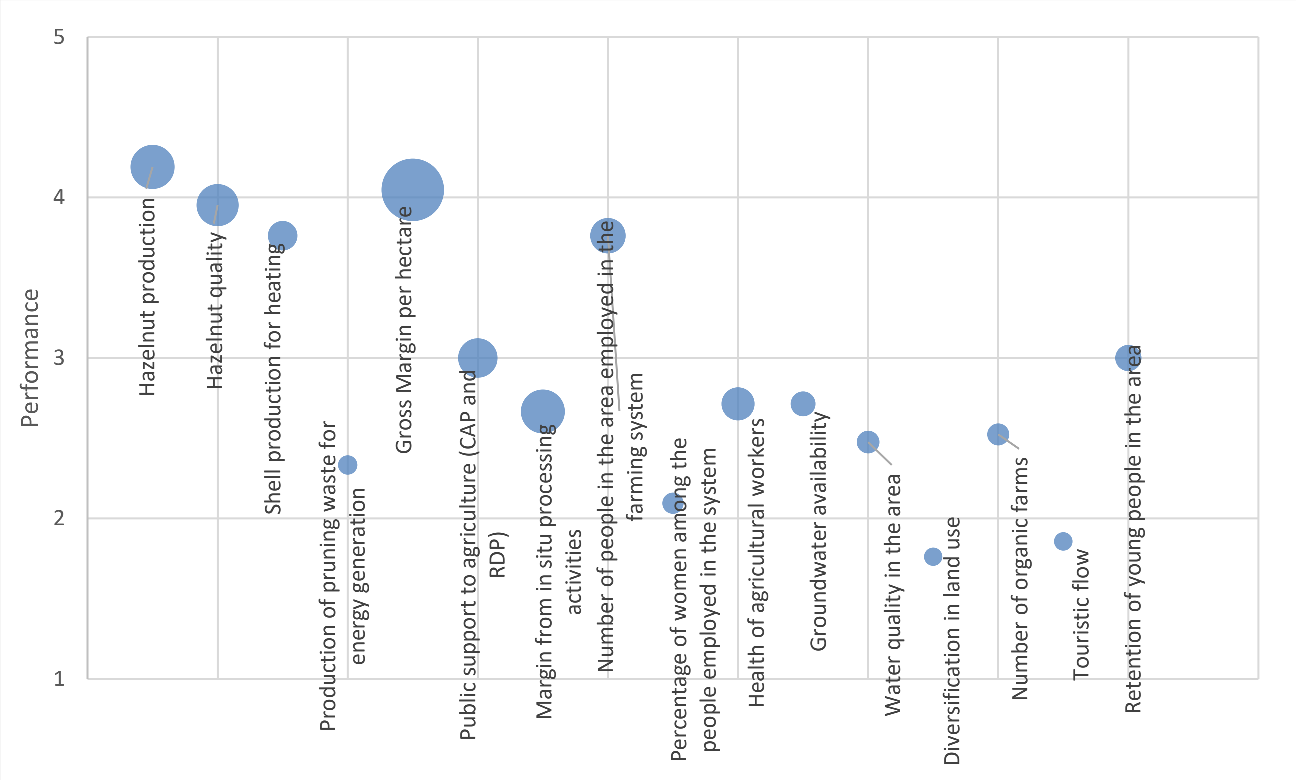

Figure 5: Performance of the indicators (on the vertical axis, from 1 to 5) and their importance (size of the bubbles) relative to each other.

"Retention of young people in the area" was a very debated indicator: it was positively influenced by the expansion of the system in the last decades, which pushed young people to go back to farming instead of abandoning the area for their studies. One participant from the *Others* group connected the presence of young people to the touristic flow in the area, rather than directly to the agricultural activities. Therefore, it was argued that an enhancement and promotion of the landscape could have a positive impact on the employment of young people. This was in contrast with the view of other participants, according to whom the attractiveness for the youth is in conflict with the landscape attractiveness of the area, as young people can be retained mainly through a development of the hazelnut processing activities.

The discussion also concerned the indicator "Percentage of women among the people employed in the system". According to the participants, the development of the system in the last decades determined a regression in the role of women, as especially the increased mechanisation pushed them out of the system. In the past, women were involved in the harvesting activities, which were carried out by hand. Even though women are still present in the system, their main roles are now in processing and commercial activities, as well as in farms with diversified activities such as

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holiday farms. The participants agreed that this division of roles between men and women is due to a cultural factor, as the physical work and the use of machinery do not justify by themselves the change in the women's function in the system. According to some participants, their reduced role could also be due to the need of families to increase their income, which would encourage women to look for other jobs.

After the discussion, it was decided to select some indicators for further analysis by choosing some with high performance and some with medium or low performance, including both functions related to private and to public goods. In one case it was decided to assign two indicators to one group ("Hazelnut production" and "Hazelnut quality"), as the participants argued that these two indicators were too strictly related to consider them separately. This group also wanted to consider hazelnut price evolution, therefore the group sketched the dynamics of "Gross Saleable Production" (gross revenue), a combined indicator depending on quantity, quality, and prices. The four selected indicators were:

1. Gross Saleable Production.
2. Gross Margin per hectare.
3. Number of organic farms.
4. Retention of young people in the area.

5 Resilience of indicators

Each group was asked to draw the dynamics of their assigned indicator from the year 2000 until the present. Upon request of the participants, it was decided to leave groups the possibility to expand the time span, also considering that hazelnut is a perennial crop and therefore longer-term dynamics of some indicators could provide a more complete overview. This chapter includes digitalised versions of the drawings; the original ones can be found in Appendix C.

5.1 Gross Saleable Production

The first group sketched the dynamics of the combined indicator "Gross Saleable Production". The group expanded the time span to the previous 20 years, thus considering the period between 1981 and 2018 (Figure 6). In the first few years, there was a fast increase in the indicator. It then slowed down and became more stable between the early 1980s and the year 1990, when there was a significant drop. After 1993, the indicator started rising again, quickly at first and then more

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steadily from the middle 1990s. This constant increase continued until 2014, when there was a peak. Afterwards, the indicator dynamic went back to the previous growing trend.

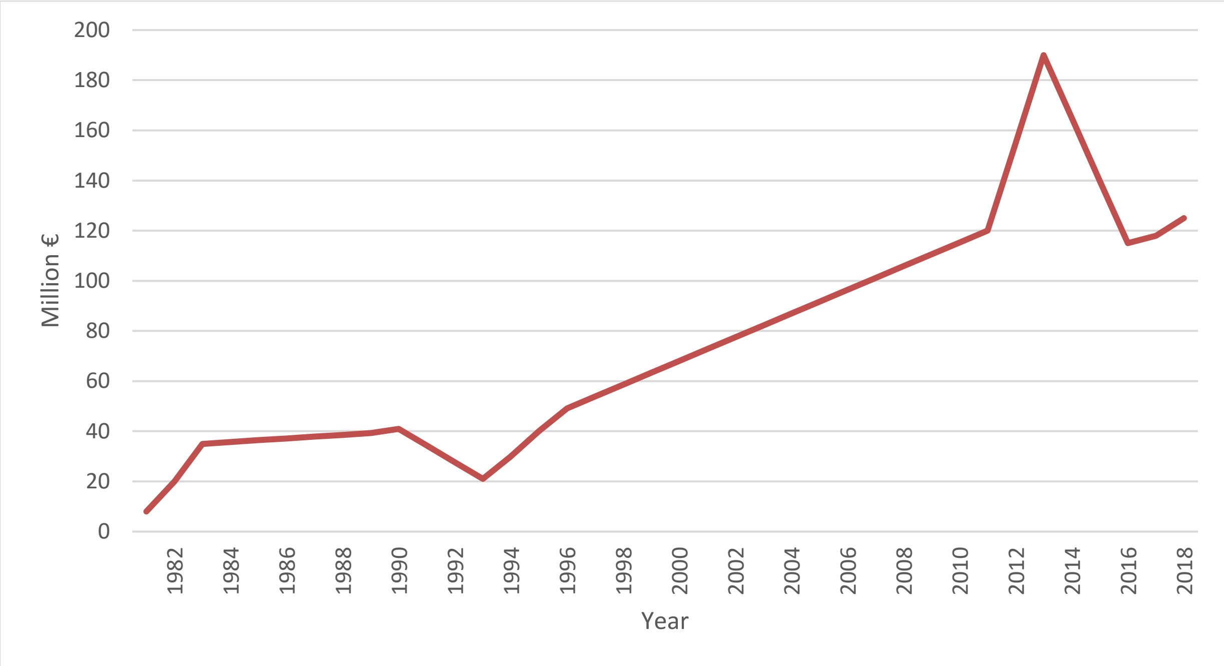

Figure 6: Dynamics of "Gross Saleable Production" (combining "Hazelnut production", "Hazelnut quality", price evolution) from the year 1981. Values were indicated by the participants for the years 2000 (68 million €) and 2018 (125 million €).

The initial growth was determined by machinery development, whereas the first interventions for quality standardisation stabilised the indicator in the following years. The drop around 1990 was due to the opening of the Turkish market, which was therefore identified as one of the main challenges for the indicator. A further development of mechanisation in 1993 (particularly self-propelled machinery) determined a fast increase, hence mechanisation emerged as one of the main strategies to address labour costs. The growing trend which followed was maintained by several factors which represented opportunities to the system: a crisis of the industrial district, leading to an increase in investments in hazelnut farming; the launching RDP tenders; the incoming of big confectionary industries, associated with the introduction of strict qualitative parameters. The peak in 2014 was determined by a frost in Turkey: as the Italian production remained stable, the drop in the Turkish production generated a price peak in Italy, and an

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increasing interest for the hazelnut sector. With the recovery of the Turkish market and an increase in production costs, the Gross Saleable Production went back to the previous trend.

Even though mechanisation and cooperatives were selected as strategies to evaluate in the following phase (see chapter 6), when Group 1 presented the drawing the members argued that basically no strategy was implemented to face the challenges, as in the last few decades the system has been passively dependant on the Turkish production and economy. The only identified strategy was to focus on quality, which was possible thanks to machinery development and to the incoming of the industry and its restrictive parameters. According to the group, in the future the Turkish production will still be higher than in Italy, but the quality of Italian hazelnuts will be higher. However, the group argued that this strategy only partially succeeded in protecting the system from the Turkish dependence: it set the basis for a distinction of Italian hazelnuts on the market, but it also pushed out of the market all hazelnuts which did not respect the qualitative standards. Moreover, until now the main benefits of the increased quality have been for the industry, as industries were able to create high-quality production lines, whereas the benefits for producers were indirect and mainly expected in a future perspective.

In order to compare the results with data, revenues were calculated based on the price of hazelnut (€/ton) and on the production (ton), using data from ISTAT and ISMEA (the Institution of Services for the Agri-food Market) for the period 2007-2017 (ISMEA website, 2019; ISTAT website, 2017). Even though comparisons for this short period were difficult to make, the data confirmed the peak around 2014, with a maximum value in 2015 (around 200 million €). The data also showed significant oscillations in the previous years (e.g. around 50 million € in 2010, 100 million in 2011 €), which were not reported by the participants. The calculated value for 2017 (around 128.8 million €) was higher than the one indicated on the drawing, but not too far from it (125 million €), thus the participants' reliability on this indicator was relatively high. Moreover, the first self-propelled machines for hazelnut cultivation in the province of Viterbo were in fact designed and produced in 1993, as confirmed on the website of the FACMA company, a major machinery provider in the area (FACMA website, n.d.)

5.2 Gross Margin per hectare

Group 2, sketching the dynamics of "Gross Margin per hectare", also decided to extend the period, in this case including the ten years 1990-2000 (Figure 7). The indicator had the lowest point in 1993, then it grew fast until the early 2000s and afterwards it kept growing at a slower

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pace. Around 2014, the Gross Margin had a peak, then it decreased again and became more stable. The only values indicated on the drawing were 100 and 200, but since no unit was reported they were probably intended as indicative values. For this reason, in the digitalised graph the units are not specified on the vertical axis.

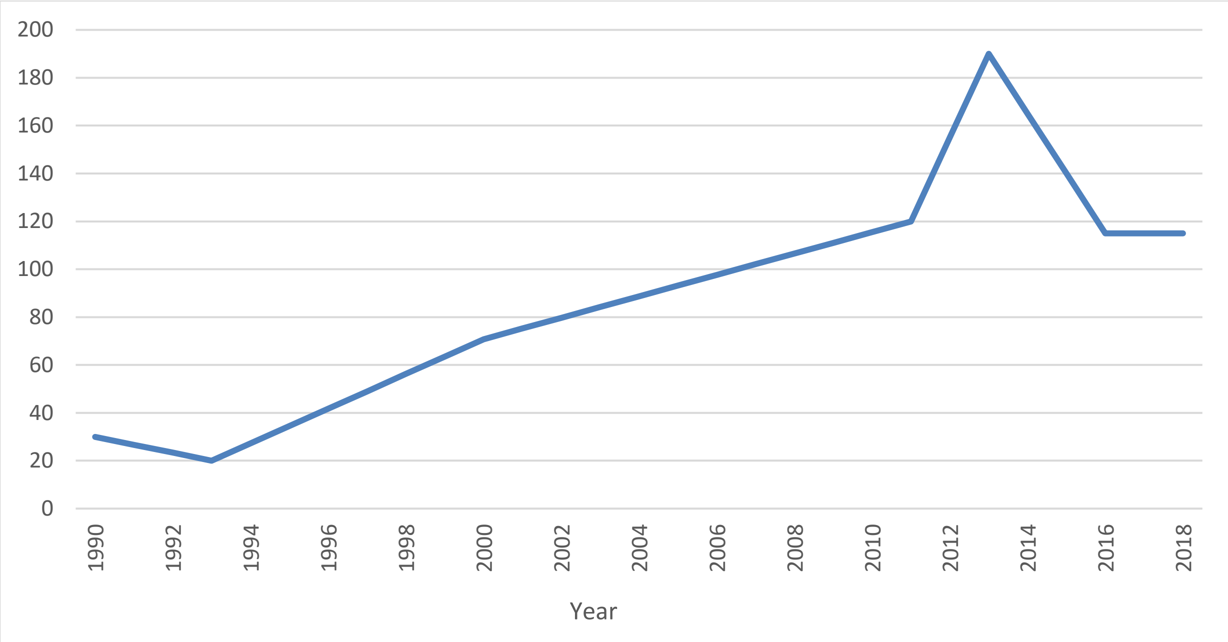

Figure 7: Dynamics of "Gross Margin per hectare" from the year 1990. Only the values of 100 and 200 were indicated by the participants, but since they were indicative values the units were are not specified on the vertical axis.

The first challenge causing this dynamic was the incoming of the Turkish production on the market, responsible for the initial decreasing trend. Starting from 1993, a fast machinery development determined an increase in the Gross Margin. The increase became faster with the Common Agricultural Policy (CAP) incentives in 2004, which were delivered also thanks to POs. The peak around 2014 was determined by a frost in Turkey, and afterwards the price was stabilised by the incoming of a big multinational industry on the territory. The main identified strategies were agricultural policies favouring development, and the aggregation in POs, which increased the bargaining power of producers. According to the group, an increase in profitability would currently be possible if there was a development of local processing, with farms (including the small ones) taking part to all processing activities until the product sales. As observed by the participants during the workshop, the dynamics of this indicator were similar to those reported for the Gross Saleable Production (see Figure 6), as they are both related to similar factors: price fluctuations depending on the Turkish market, increased mechanisation (leading to lower production costs and thus land expansion), RDP and CAP incentives, relationships with the industry.

Data on the average Gross Margin per hectare per year coming from the Farm Accountancy Data Network (FADN) were only available for the period 2008-2016. However, also in this case the data confirmed the peak around 2014, with the average highest Gross Margin in 2015 (6151 €/ha). The FADN data also showed a fast increase between 2008 and 2011, which was not reported by the participants (FADN website, n.d.). Comparing the challenges mentioned by the first two groups to those previously identified by the SURE-Farm team (see section 1), the challenges emerged from this exercise were mainly the economic ones: volume of Turkish production and Turkish economic conditions in terms of shocks, global expansion of hazelnut cultivated area and market power of the confectionary industry as long-term pressures. The local expansion favoured by machinery development was a strategy to face the world-wide expansion of hazelnut production, and the incoming on the market of new countries. Among the environmental challenges, spring frost emerged as a challenge for the Turkish production, which in turn favoured the Italian one.

5.3 Number of organic farms

Group 3 was assigned the indicator “Number of organic farms”, but the group members decided to change it into “Organic cultivated area”: as a general trend in the farming system, the cultivated area has increased while the number of farms has decreased, due to the expansion of some farms which incorporated the smaller ones. The group took 1000 ha as an initial reference number, and then showed the dynamics of the indicator in relation to it without indicating other values. Moreover, as the indicator represented the function “Biodiversity and habitats”, the group decided to also show the biodiversity dynamic, as it differed from the indicator itself.

Between 2000 and 2007, the organic area showed a slightly growing trend, relatively stable (Figure 8). Between 2007 and 2012, the indicator was generally lower but oscillating. These oscillations were not shown on the original drawings, but they were mentioned by the team members and therefore they were included in the digitalised graph for clarity. Around 2012, a clear increasing trend started, which continued until the present. Biodiversity showed a general decreasing trend, more pronounced after 2012.

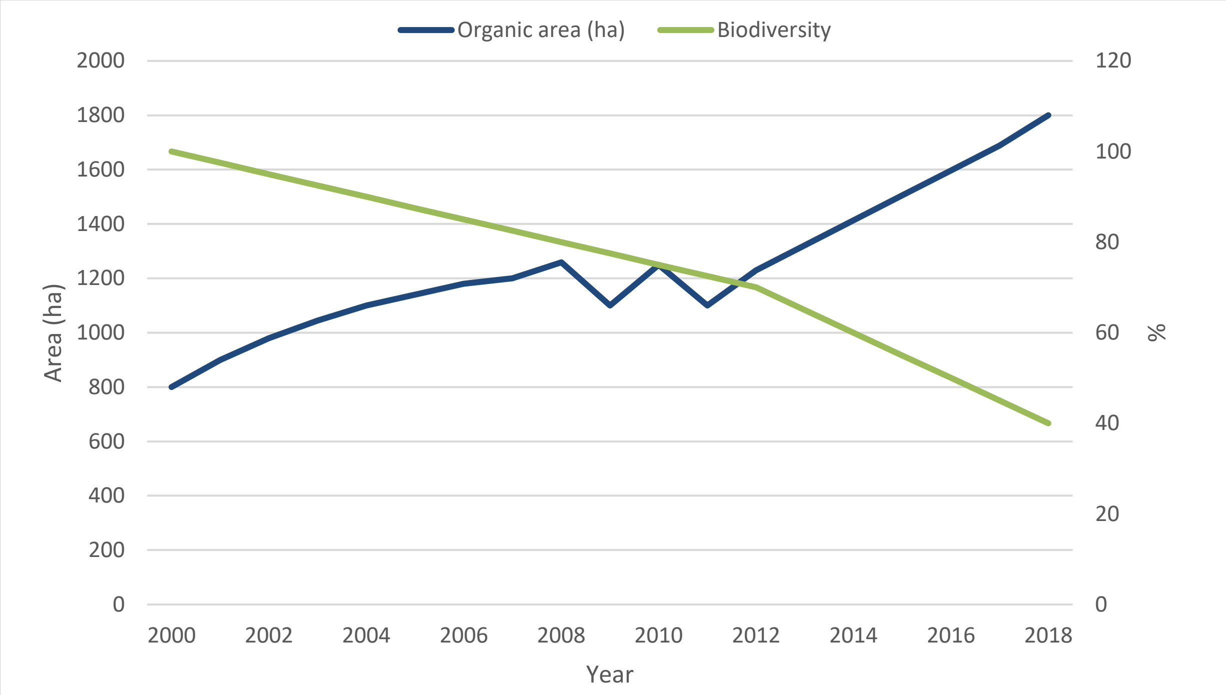

Figure 8: Dynamics of the organic cultivated area and of biodiversity since the year 2000. The only value indicated by the participants was 1000 ha as a reference for the period until 2012. For biodiversity no value was indicated, therefore the graph is based on a relative scale, with the level in the year 2000 considered as 100%.

The initial slow growing trend of organic area was mainly connected to the launching of tenders for organic production. The decrease and oscillations in the indicator starting in 2007 were caused by the fact that the RDP started operating, therefore the organic area depended on funding availability: according to the participants, organic areas in Italy tend to expand at the end of the tenders, when financial resources become available for organic production and farmers can apply. Until 2012, the expansion of organic production was slow, and limited to existing hazelnut cultivations. Around 2012, the rise in the indicator was determined by a frost in Turkey, which led to an increase in the investments in hazelnuts in Viterbo and to the establishment of new plantations. At the same time, a big multinational entered the system, due to the positive price peak. In order to expand the areas, many farmers used the funding from the RDP for organic production, thus determining an increase in the organic area.

The expansion was mainly related to the international competition and to the opportunity created by hazelnut profitability. Hence, the only identified strategy was the use of RDP subsidies, particularly during the Turkish crisis. The funds were provided to farmers with the condition of a five-year commitment to organic, but in fact many farmers switched to conventional farming after the first five years, during which hazelnut trees are not productive and do not require high inputs.

Therefore, according to the group, the RDP funds were often used only as a way to compensate for the planting costs.

Biodiversity showed a general decreasing trend, which became stronger with the hazelnut expansion starting in 2012. The organic expansion was associated with a general expansion of monoculture, as areas that were previously used for grazing and vineyard cultivation were converted to hazelnuts. This also had a negative impact on the groundwater availability, as hazelnut cultivation is more water-intensive. Furthermore, there is no biodiversity in terms of cultivars: the main cultivar is the "Tonda Gentile Romana", and the introduction of the "Tonda di Giffoni" did not really influence the biodiversity, as the two cultivars are very similar from an ecological perspective. This homogeneity is mainly due to industry requirements, but also to the use of machinery and the automatisation of some interventions, such as weeding and harvesting. Since the dynamics of the indicator and of the respective function were opposite, the indicator cannot be considered as representative of the function. The same applies to the initial indicator "Number of organic farms", as it is mainly connected to structural changes in farm size rather than to the dynamics of biodiversity.

As for the reliability of the information provided by the group, little data is available on organic hazelnut production in the area. However, Pancino & Franco (2009) reported 952 ha of organic hazelnut in 1999, close to the value of 1000 indicated by the group, and an increase in the following years (note that other numbers were not indicated by the participants). Looking at the challenges presented in section 1, Group 3 also mainly referred to the economic ones (e.g. international competition). Among the environmental challenges, insects were mentioned by the group as one of the factors which make organic production difficult in the area, as particularly the presence pathogens in the municipalities with highest hazelnut densities does not allow for organic cultivation.

5.4 Retention of young people in the area

According to the fourth group, the retention of young people was stable over time (Figure 9), as most young people remained in the area. From 2000 onwards, the hazelnut value chain generated many jobs, allowing to include more skilled labour in the system. Together with mechanisation, which helped to make hazelnut farming more attractive to the youth, this strategy prevented the outmigration of young people. Moreover, the group argued that until the present there has been a good generational renewal in the area, with young farmers taking the lead of their family farms. However, the point of view of some young workshop participants was different: the outmigration was observed in the last twenty years, particularly from some municipalities, and there is indeed a problem with generational renewal among farmers.

Group 4 also drew a hypothetical dynamic of the indicator, under the scenario of the complete disappearance of hazelnut farming. As shown in Figure 9, in this case the retention of young people would have decreased over time. This is because the system has become so specialised, that other activities which used to be important in some municipalities have disappeared. The current economy of the area has a very low diversification; therefore, it would be difficult to find new strategies.

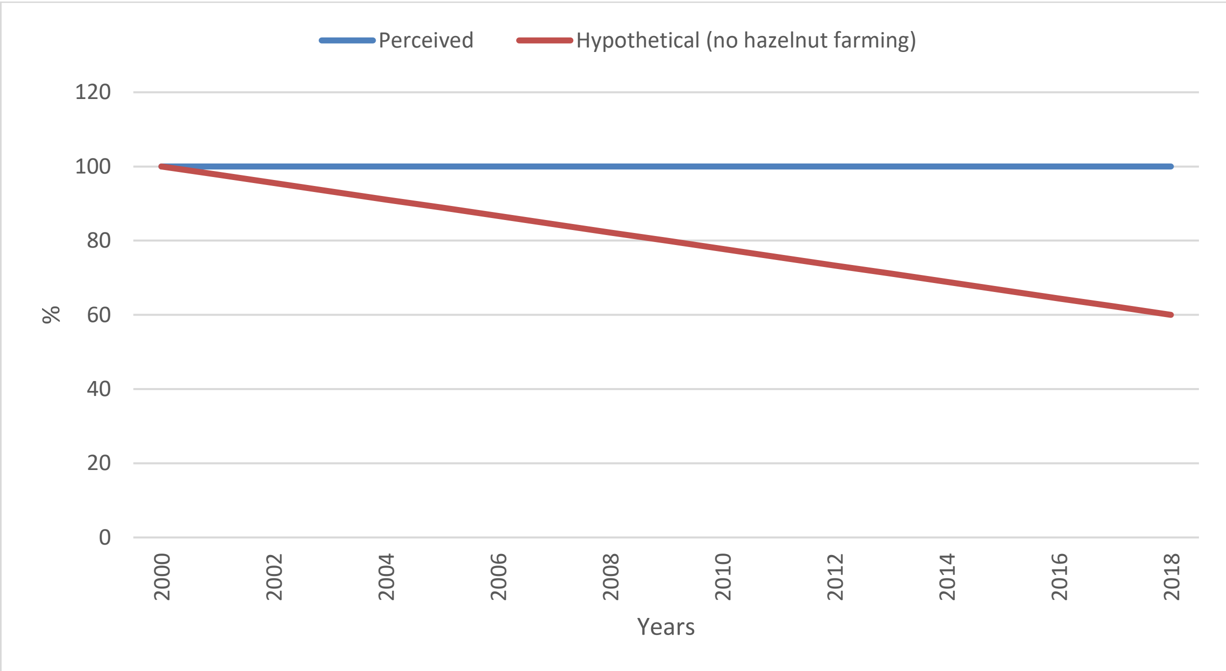

Figure 9: Dynamics of "Retention of young people in the area" from the year 2000, perceived and hypothetical (under the scenario of no hazelnut farming). Relative scale, the level in the year 2000 is considered as 100%.

6 Resilience attributes

6.1 Case-study specific strategies

Before this phase, the participants discussed in groups to agree on the main challenges and the relative strategies for their assigned indicator. Table 3 shows an overview of the challenges and strategies identified by each group, presented per indicator.

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Table 3: Challenges and strategies per indicator.

Group	Indicator	Challenge	Strategy
1	Gross Saleable Production	Labour availability and costs	Mechanisation
		Market instability	Cooperatives
2	Gross Margin / ha	Production costs	Mechanisation
		Production fragmentation	POs
3	Organic area	International competition	RDP funds
		Opportunity - Profitability	
4	Retention of young people	Abandonment of farming	Mechanisation
		Profitability reduction	Value chain activities

The participants were asked to evaluate the level of implementation of the strategies identified in their own group, on a scale from 1 to 5: 1) not, or very badly implemented, 2) badly, 3) medium, 4) well, 5) very well implemented. Figure 11 shows the results of this scoring.

Overall, all strategies appeared to be well implemented. Mechanisation was applied to challenges related to different indicators, and in all cases it was considered as very well implemented (average score of 4.8 in relation to the three challenges). POs was also a very well implemented strategy (4.8), whereas cooperatives showed a lower level (3.8). Therefore, mechanisation was stronger than social organisation, thus indicating that shared strategies at farming system level are still less strongly implemented in the system than those implemented at farm level. A good implementation level was also assigned to the value chain activities (3.8), and a lower one to the use of RDP funds (3.4).

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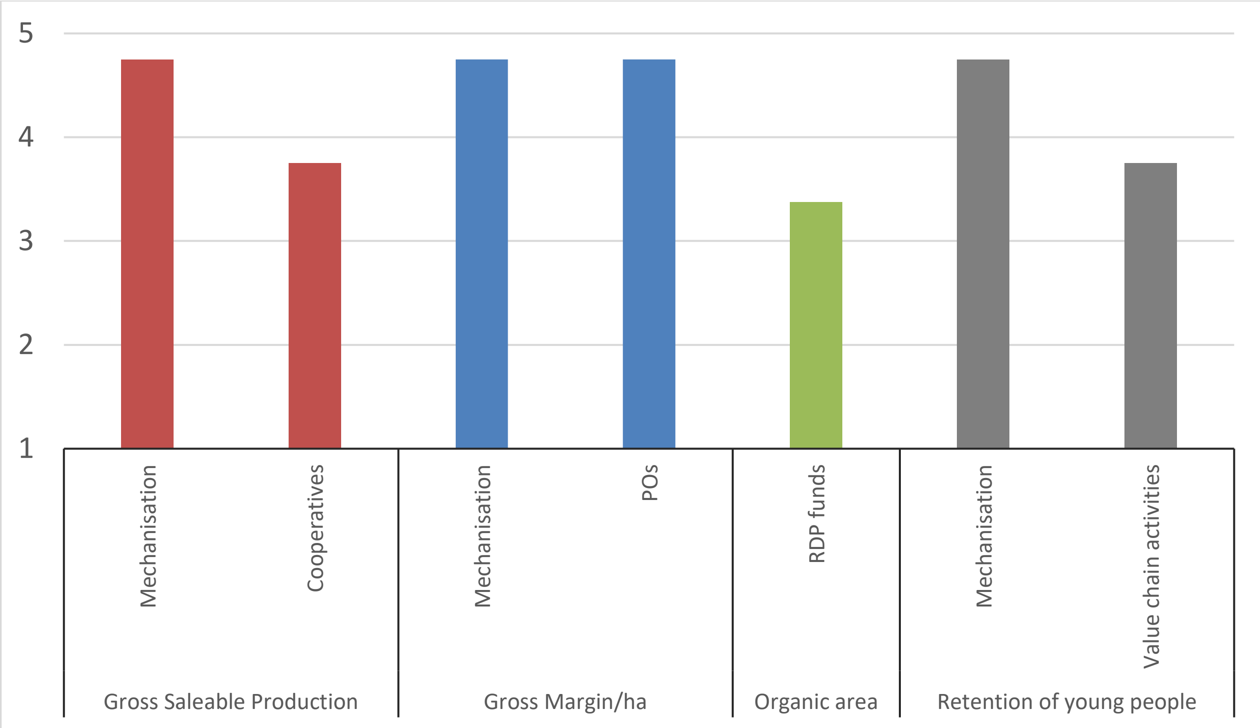

Figure 10: Average level of implementation of strategies per indicator. Score from 1 to 5: 1) not, or very badly implemented, 2) badly, 3) medium, 4) well, 5) very well implemented.

Afterwards, participants were asked to evaluate the relationship of the strategies with the three resilience capacities (robustness, adaptability, transformability). The scoring scale was from -3 to +3, indicating a negative (-) or positive (+), weak, medium, or strong (1, 2, or 3) relationship. 0 indicated no relationship. The results are displayed in Figure 12 (details in Appendix D).

Considering "Gross Saleable Production", mechanisation had a strong positive impact on robustness, medium/weak on adaptability and transformability. Cooperatives also had an enhancing effect on all three capacities, between medium and strong. In relation to "Gross Margin per hectare", mechanisation had a very weak effect on the capacities: slightly positive for robustness and adaptability, negative for transformability. This is probably because innovating in mechanization comes at a cost for farmers. The other strategy for this indicator (POs) had a weak positive effect on robustness, which increased for adaptability and for transformability. These latter results suggest a potential important role of the POs for adapting and transform the system. The only strategy relating to the indicator "Organic area" (use of RDP funds) had a weak negative impact on robustness and adaptability, and a weak enhancing effect on transformability. From the perspective of the indicator "Retention of young people in the area", the impact of

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mechanisation slightly decreased from robustness to transformability, but it was between medium and strong for all three capacities. For the second strategy (value chain activities), all capacities were strongly improved, with a maximum for adaptability and equally for the other two.

The two strategies identified for the first indicator were synergistic between them, and for each strategy there was a synergy among resilience capacities. The implementation of mechanisation rather than cooperatives would have a stronger effect on robustness and a weaker effect on adaptability and transformability. However, the two strategies are very different, mechanisation being an on-farm strategy and cooperatives a shared strategy. Therefore, it was not possible to clearly evaluate trade-offs between the two, as they are applied in different ways and there is no real choice between them. Mechanisation had a weak effect in relation to "Gross Margin per hectare". This was probably becase mechanization can improve the condition in the short-run but does not provide an effective way to cope with unexpected changes. The role of POs was more significant. The main trade-off between the two strategies (Mechanisation and POs) was in terms of transformability. Even though the same consideration applies as before (the strategies are of two different types), in this case there is a synergy between them: POs can provide fundings to farmers for financing mechanisation trough their Operational Programmes (funded within the Common Market Organisation of the CAP). However, mechanisation can also be funded by using RDP measures, if available. Considering the use of RDP funds to support organic farming, there was again a weak trade-off between transformability (which in this case was positive) and the two other capacities. This strategy had a low impact on the resilience capacities, and its role was limited and uncertain: it was mainly used as a way to cover the costs for establishing new plantations (hence the positive effect on transformability), but not to actually expand and retain in the long-run the organic area, thus its impact was unclear. This suggests an ambiguous role of the current policy, that seems to provide only a short-term incentive for organic conversion.

Finally, the two strategies related to "Retention of young people in the area" were synergistic between them, and there was a synergy between all resilience capacities. Also in this case, comparing the effect of choosing one strategy instead of the other was difficult, because they are two different types of strategies and it is not possible to choose which one to implement. While mechanisation can be pursued on farm, the strategy based on POs requires a strong collective effort. However, both strategies seem synergistic: mechanisation allows young farmers to perform more attractive activities requiring technological skills. On the other hand, young and educated farmers can be involved in the activities developed by POs by becoming members of

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the board or being involved in post-farm activities carried out within the POs. Both options require social interactions and relatively skilled people, which can be found more easily among young farmers than among older farmers.

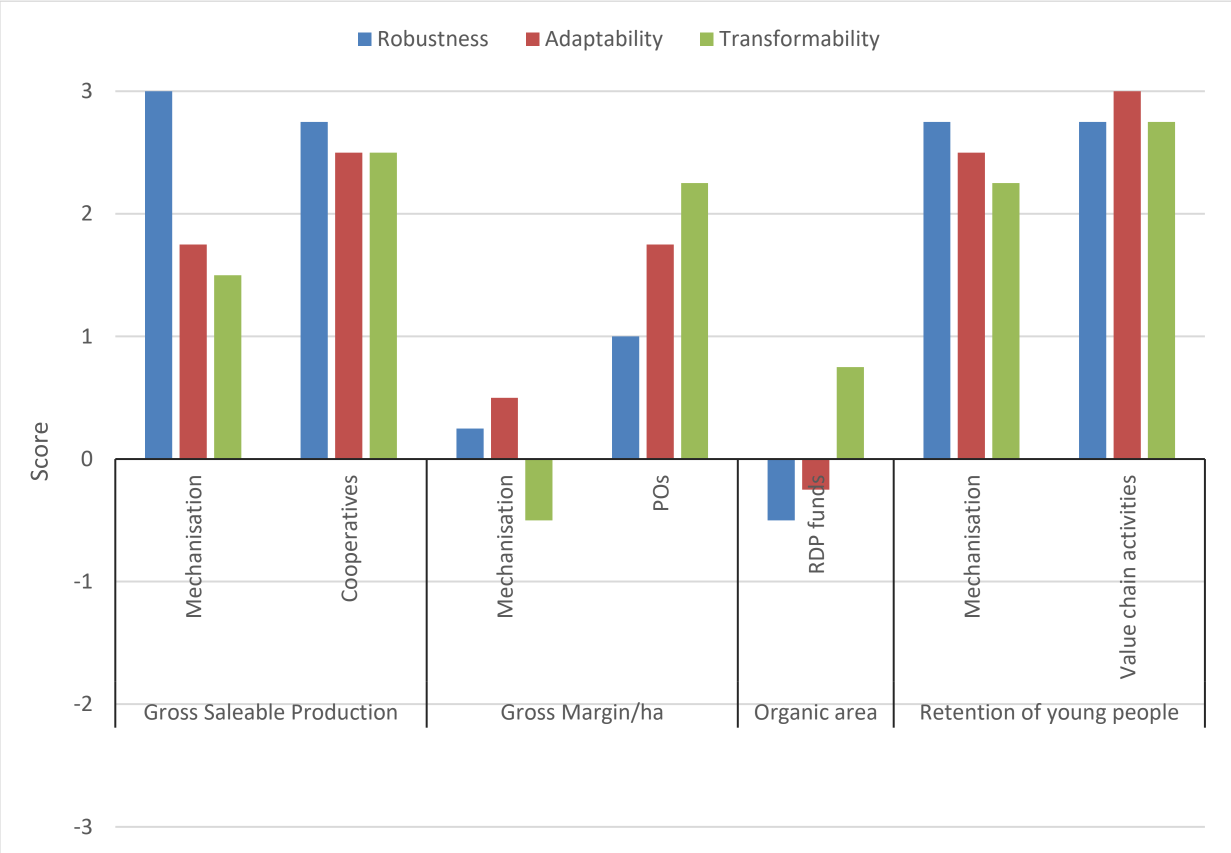

Figure 11: Relationships of the strategies with the resilience capacities (average). Score from -3 to 3: 0 = no relationship; 1 or -1 = weak positive or negative relationship; 2 or -2 = intermediate positive or negative relationship; 3 or -3 = strong positive or negative relationship.

Considering the real contribution of the strategies to the resilience capacities (based on the implementation level combined with the potentital contribution to the capacities), the robustness of the system was strongly positively influenced by mechanisation, according to two groups. Adaptability was also enhanced by this strategy, but with lower strength, whereas its impact on transformability was ambiguous: as the groups were influenced by the indicator they were assessing, the group working on "Gross Margin per hectare" indicated a negative relation

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between mechanisation and adaptability. This suggests that this strategy cannot ensure the adaptability of the system.

An improvement in adaptability and transformability could come from a higher implementation level of cooperatives and value chain activities, which would also further improve the robustness of the system. Hence, this suggests that the long-term resilience of the system can only be pursued trough a collective strategy that is able to influence the system at the post-farm level. An increased use of RDP funds, the strategy with the lowest implementation level, would not have much influence on the capacities, as all potential contributions of this strategy (negative and positive) are close to zero. This suggests that the real contribution of this group of policies should be carefully considered in the governance of the system.

6.2 General resilience attributes

The participants were provided with a list of 13 attributes, and they were asked to evaluate to what extent each of them applied to the system on a scale from 1 to 5: 1) not at all, 2) somewhat, 3) moderately, 4) much, 5) very much. The results are shown in Figure 13 (details in Appendix D).

Overall, the attributes were perceived to be moderately present in the system, with a general average score of 2.9 and most attributes being scored between 2 and 3. Social organisation and profitability were once more the biggest strengths of the system. Other attributes that were highly present in the system were: “Optimally redundant (farms)”, “Spatial and temporal heterogeneity (farm types)”, “Supports rural life”. On the contrary, the attributes with the lowest scores are: “Exposed to disturbance”, “Coupled with local and natural capital (production)”, “Diverse policies”.

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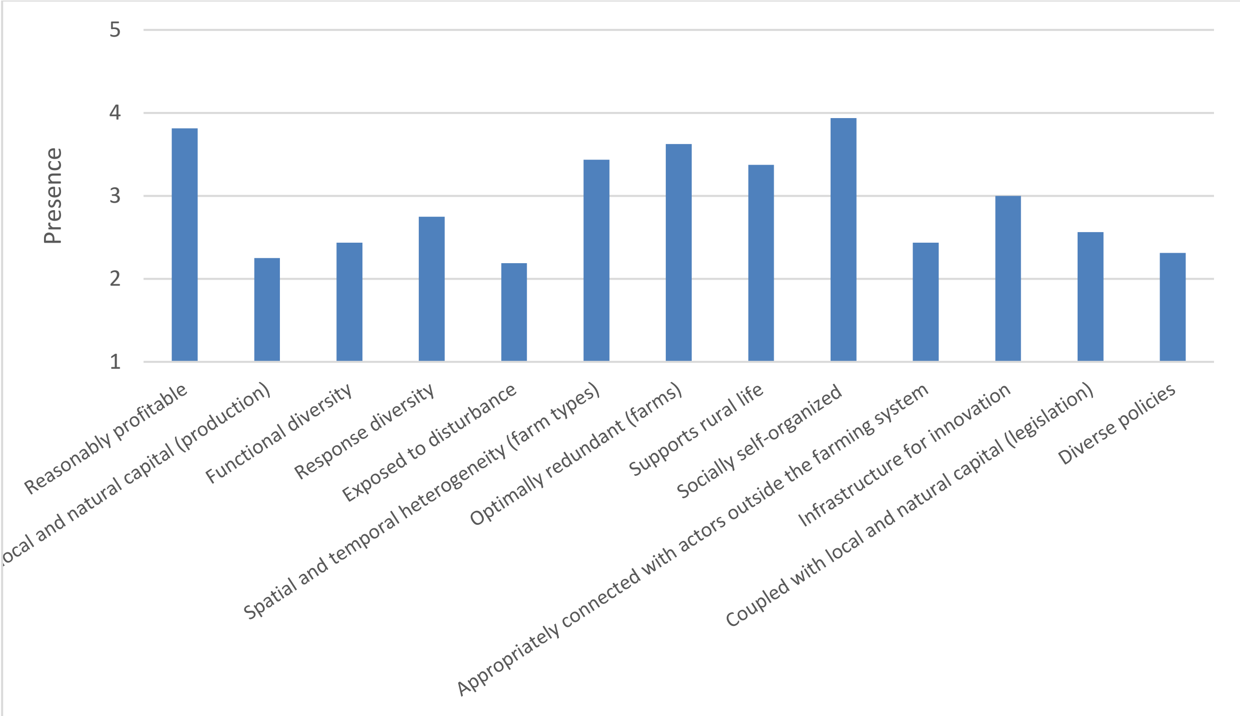

Figure 12: Average scores on how much the resilience attributes are present in the system. Score from 1 to 5: 1) not at all, 2) somewhat, 3) moderately, 4) much, 5) very much.

According to the Resilience Alliance, five principles are related to general resilience: diversity, openness, tightness of feedbacks, system reserves, and modularity (Resilience Alliance, 2010). Based on the results of the scoring, the attributes with the highest scores mainly referred to the principles of system reserves (although mainly concerning reserves of economic capital) and modularity, as the system showed a high level of redundancy and heterogeneity in farm types. Tightness of feedback was well represented in the system by the attribute "Socially self-organised", but the connection with actors outside the farming system were low. Openness was poorly represented in the system, with a medium presence of "Infrastructure for innovation", and a low level for the attribute "Exposed to disturbance". Looking at diversity, the performance of the system appeared to be poor. This stems from the fact that "Response diversity", "Functional diversity", and "Diverse policies" had low scores, while only "Spatial and temporal heterogeneity of farm types" had a high level in the system.

The 13 resilience attributes relate to the four main processes identified in SURE-Farm: agricultural production, risk management, farm demographics, governance (Reidsma et al., 2018). Based on the results of the scoring for the presence of attributes in the system, generally the attributes with the highest presence were those related to farm demographics ("Optimally redundant", "Supports rural life", "Spatial and temporal heterogeneity"), followed by agricultural production (mainly "Reasonably profitable" and "Infrastructure for innovation"), risk management, and governance. However, the two attributes with the highest score referred to agricultural production ("Reasonably profitable") and governance ("Socially self-organised"). This also emerged from the last exercise of the workshop, in which participants were asked to select the three most important attributes. The one which was selected with the highest frequency was "Reasonably profitable", followed by "Socially self-organised". Based on the results of this last exercise, the most important attributes related mostly to agricultural production, followed by risk management, governance, and finally farm demographics.

It was also asked to evaluate the relationship of the attributes with the three resilience capacities. The scoring scale was from -3 to +3, indicating a negative (-) or positive (+), weak, medium, or strong (1, 2, or 3) relationship. 0 indicated no relationship. The result of this scoring is displayed in Figure 14 (details in Appendix D).

All attributes were considered to have a positive impact on the resilience capacities. As a general behaviour, most attributes showed a more positive correlation with robustness, which then decreased for adaptability and again for transformability. Hence the system was seen as robust but not able to adapt to potential significant changes. There were a few exceptions to this, such as "Appropriately connected with actors outside the farming system" (which showed the opposite trend), "Socially self-organized" and "Infrastructure for innovation" (both having the most positive value for adaptability), and "Functional diversity" (lowest score for adaptability). The latter results comes as a natural consequence of the high production specialisation of the system. As all correlations were positive, there was a synergy among the resilience capacities. Moreover, as a general trend the attributes had a strong impact on robustness, medium on adaptability, weak on transformability. Particularly strong synergies could be identified between robustness and adaptability for "Coupled with local and natural capital (production)", and between all three capacities for "Socially self-organized" and "Infrastructure for innovation".

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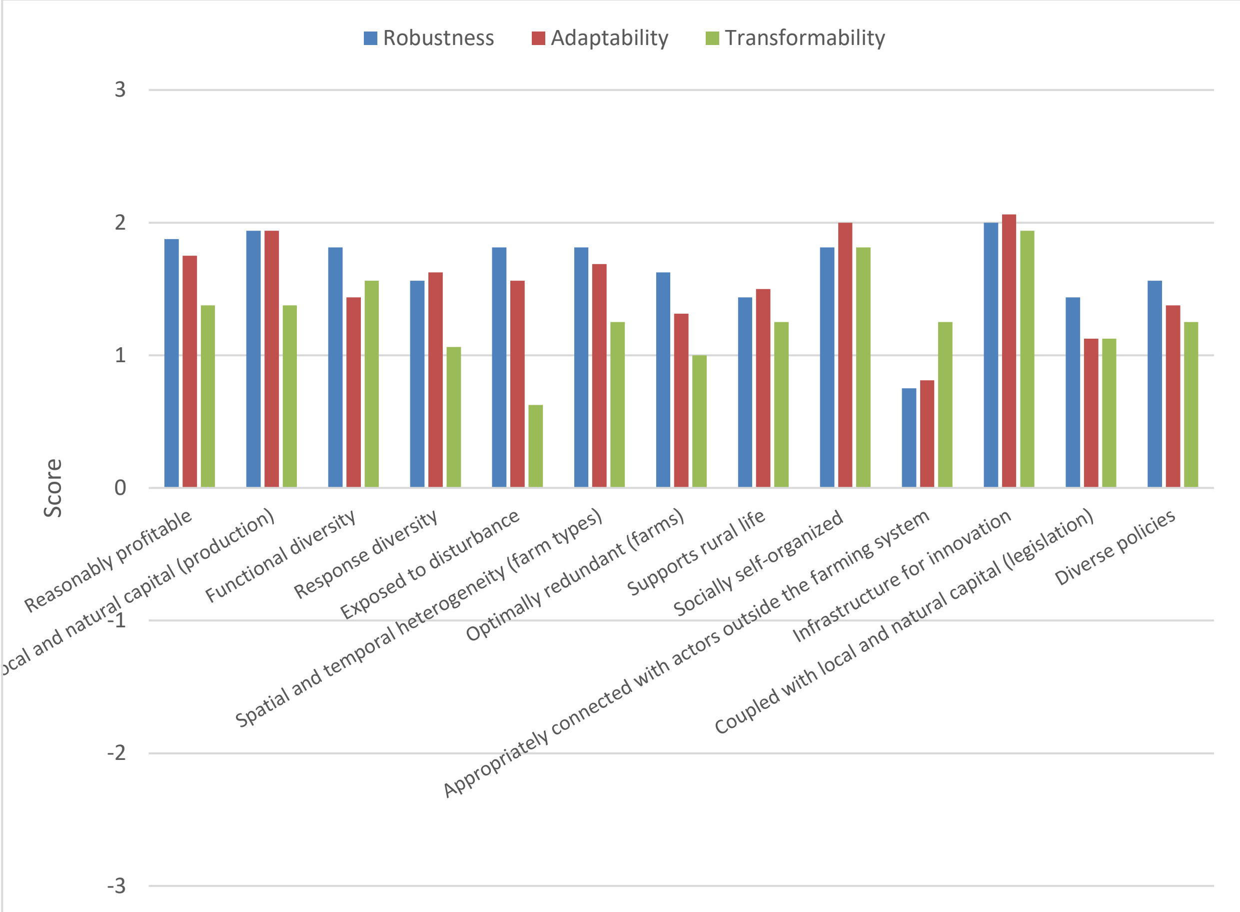

Figure 13: Relationships of the attributes with the resilience capacities (average). Score from -3 to 3: 0 = no relationship; 1 or -1 = weak positive or negative relationship; 2 or -2 = intermediate positive or negative relationship; 3 or -3 = strong positive or negative relationship.

For some attributes, high levels of presence corresponded to a medium positive relation with the resilience capacities, and particularly with robustness. This applied to the attributes “Reasonably profitable” and “Socially self-organised”, whereas “Spatial and temporal heterogeneity (farm types)”, “Optimally redundant (farms)”, and “Supports rural life” were present at relatively high levels (above 3) but had a less strong impact on the capacities, always decreasing from robustness to transformability. In some cases, attributes with low or medium scores also had a low or medium potential impact on the capacities, thus even if implemented at higher level they could not change significantly the resilience of the system. Exceptions to this were the attributes “Coupled with local and natural capital (production)”, “Functional diversity”, “Response diversity”, and “Exposed to disturbance”: these attributes had low presence, but a higher level would have a strong positive impact on robustness and adaptability, and a medium or weak impact on transformability.

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Based on the results of these two exercises, the system can be considered moderately resilient in terms of presence of the attributes. Furthermore it is a robust system, but with limited adaptability and transformability.

7 Discussion

7.1 Functions of the farming system

The identity of the system is defined through the functions related to private goods. The two most important functions according to the workshop participants were "Economic viability" and "Food production". This is reflected in the indicators: the most representative one was "Gross Margin per hectare", followed by "Margin from *in situ* processing activities", "Hazelnut production", and "Hazelnut quality". Therefore, the four most representative indicators refer to the two most important functions. The high ranking of "Margin from *in situ* processing activities" shows the importance of processing for the farming system, which emerged in many discussions during the workshop. On the contrary, functions related to the delivery of public goods resulted to be overlooked in the system, and they were not perceived as important by the stakeholders for improving the performance of the system.

The major economic role of the farming system is affirmed in the literature: hazelnut production dominates the local economy, and it is tightly linked with the industry and with the provision of local services (CCIAA, 2017; Piacentini et al., 2015). As for the low scores for the provision of public goods, the negative environmental impact of hazelnut farming is highly debated. Particularly controversial is the pollution of the Vico lake, a major freshwater reservoir in the area, around which most of the production is concentrated (Franco & Marongiu, 2009). Although the cause of its high pollution and eutrophication has not been proved, some authors associate these problems with hazelnut farming, as the bare soils preferred for mechanical harvesting facilitate erosion (Garnier et al., 2010; Recanatesi et al., 2013). In contrast, the positive effect of perennial crops on soil quality is also recognised in literature, particularly concerning water and nutrient preservation and protection from soil erosion (e.g. Zhang et al., 2011).

7.2 Robustness, adaptability and transformability of the farming system

Overall, the workshop results depict a system which is mainly robust, with lower levels of adaptability and transformability. However, the three resilience capacities operate in different

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time scales: robustness mainly concerns short-term answers to disturbances, whereas adaptation to change happens on an intermediate time scale, and transformations of the system are usually possible over longer time scales (Anderies et al., 2013). This may have influenced the participants' evaluation, as robustness might be easier to perceive, compared to the potential medium- and long-term responses of the system. Based on the workshop results, robustness is mainly enhanced by the high profitability, as well as by the high self-organisation (which increases all three capacities, and particularly adaptability). The transformability of the system is relatively low, as most of the attributes that could enhance this capacity ("Functional diversity", "Appropriately connected with actors outside the farming system") have a low presence.

Most of the past strategies can be included in two groups: strategies related to social connections and value chain, and strategies based on mechanisation. The strategies of the first group include cooperatives, POs, and value chain activities. These strategies can be categorised under the attribute "Socially self-organised"; among them, cooperatives and value chain activities have had a strong positive effect on all three capacities for the farming system. POs have had a low impact on the robustness of the system, and a medium impact on its adaptability and transformability. The strategies based on mechanisation (in relation to different challenges) can be categorised under the attribute "Infrastructure for innovation". The past contribution of mechanisation to the capacities appears to be different depending on the point of view: positive and strong for all three when related to the indicator "Retention of young people in the area", whereas in relation to "Gross Saleable Production" it has highly increased the system's robustness, and it has only partially or little increased adaptability and transformability. In relation to the "Gross Margin per hectare", it has had a weak impact on the capacities of the system, due to the costs that mechanisation implies. Based on these results, it is likely that the participants scored the attribute's impact on the indicator, rather than on the system as requested. One strategy which does not belong to these two groups is the use of RDP funds, which could be categorised under "Diverse policies" and which has an unclear role in influencing the resilience of the system.

The functional and response diversity of the system are particularly low; this is a negative point, as in the literature diversity is often considered to be essential for resilience. It can help to face unexpected negative conditions affecting one part of the system (e.g. a specific crop), provide buffer to shocks, or offer options for transformation; particularly crop and landscape diversity can guarantee services such as pest control (Darnhofer et al., 2010; Di Falco & Chavas, 2015). However, the same authors admit that lower diversity allows for a better exploitation of resources during stable times, and that the economic benefits of diversity still need to be proven empirically,

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as they also depend on local conditions and on the degree of diversification. Moreover, low diversification in economic activities often implies a higher institutional efficiency in providing solutions for farmers. Thus, homogeneity in a system can strengthen its robustness (and partially its adaptability), despite affecting its transformability in the long term (Ashkenazy et al., 2017). Therefore, the low level of diversity in the system can be interpreted as a confirmation of its strong economic orientation and specialisation, and as a factor that further strengthens the system's robustness.

7.3 Resilience and sustainability of the farming system

The farming system performs well for two functions (profitability and production), and it has a medium or poor performance for most of the other functions. Based on this results, it can be stated that the system is mainly managed under the control rationale (see section 1.2; Hoekstra et al., 2018), with optimal performance for profitability and production. This is reaffirmed in the evaluation of the resilience capacities, as robustness (linked with the control rationale) is the strongest one; the scoring of attributes in the system also shows that the control rationale is dominant, as some of the derived system properties (low diversity, low openness) are related to control. However, the system has high modularity, which is associated to the resilience rationale (Hoekstra et al., 2018). Therefore, the farming system is overall resilient, but mostly in terms of robustness; it mainly follows the control rationale, while including elements of the resilience rationale (heterogeneity, redundancy). The system has high specified resilience, against specific kinds of disturbances (Walker & Salt, 2012). For instance, machinery and social organisation allow to face labour-related and economic challenges. However, the high level of specialisation increases the vulnerability to other types of perturbations, such as environmental ones (e.g. pests and climate change): the areas of the province with the highest density of hazelnut cultivations experience a high incidence of the hazelnut weevil *C. nucum*, due to the low diversity (Franco et al., 2005; Pancino & Franco, 2009). Moreover, the dependence on a single production sector with heavy down-stream market concentration (confectionary industry) makes the system vulnerable to disturbances that require transformation (Darnhofer et al., 2010; Di Falco & Chavas, 2015; Dono & Franco, 2002), and perturbations are likely to happen more often as the system specialises and its dynamics are modified (Hoekstra et al., 2018).

Hazelnut production seems to overlook natural resources, as shown by the low performance of indicators related to "Natural resources" and "Biodiversity & habitat", and by the low level of the attribute "Coupled with local and natural capital (production)". Moreover, in the production chain, the raw products (hazelnuts) and the final products are very distanced, as the confectionary industries are outside of the system (Franco & Marongiu, 2009). According to Sundkvist et al. (2005), feedbacks between production, ecosystems, and consumers should be tight in a sustainable food system. The authors argue that several factors can limit the tightening of feedbacks, including intensification and specialisation in production, geographic distancing, and concentration of actors for specific economic activities. These factors are present in the Viterbo hazelnut farming system. Additionally, some of the environmental consequences of hazelnut farming can affect the production in the long term, as is the case of irrigation: as hazelnut is a drought-sensitive crop (conditions of water stress can affect plant development and yield), irrigation is widely practiced in the area, particularly during the first few years after planting (Bignami, 2002; Rugini & Cristofori, 2010). Given the increased dry conditions in the area (Hoerling et al., 2012), the use of irrigation systems could deplete water resources and affect hazelnut production in the long term. Based on these arguments, the sustainability of the system can be considered to be low. However, the environmental impact of hazelnut farming is controversial. Briamonte (2001) defines hazelnut as the ideal crop for preserving landscape quality in Viterbo. In the past, the system has adjusted to growing environmental concern: according to Bignami (2002), in the early 2000s a high percentage of farmers complied with environmental measures requiring reduced fertiliser applications. Additionally, the use of grass covers (either through a controlled growth of spontaneous species, or through the introduction of specific species e.g. leguminous plants) has become widespread as a way to control weeds while preventing soil erosion (Avanzato & Raparelli, 2002; Bignami, 2002). Moreover, the Lazio Region has restricted the use of pesticides in the area of the Vico lake, favouring the implementation of integrated pest management practices to reduce lake pollution from agriculture (Varvaro & Fabi, 2013). Therefore, the system could be able to adjust again in the future and increase its environmental sustainability.

7.4 Options to improve the resilience of the farming system

Several factors emerged from the workshop as increasing past and present system's resilience, thus these factors can be expected to play a role in further improving the resilience of the system. Mechanisation is one of the most important of them. It made hazelnut farming less physically demanding, particularly with regard to harvesting, which is the most intense phase of the process. The harvesting costs were reduced thanks to the introduction of self-propelled machinery (Rugini & Cristofori, 2010). As it emerged from the workshop, this has had a positive effect in terms of production, quality, profitability, and attractiveness for young people. Another element improving past and present resilience is the strong social organisation in the system, which was mentioned in the workshop as increasing farmers' bargaining power with the industry. The focus on quality emerged in the workshop as a strategy that still has not brought a great advantage to the system, but that is expected to have a positive effect in the future. The benefits of quality production for the system are unclear. The definition of the "Tonda Gentile Romana" under the PDO scheme, as well as the inclusion in the local brand "Tuscia Viterbese" for traditional products of the province, are often mentioned in literature as a strength of the system (Adua, 2002; Piacentini et al., 2015; Rugini & Cristofori, 2010). However, while the inclusion in a protected denomination scheme has had a strong positive impact in other hazelnut systems in Italy (particularly in Piedmont), the same benefits might not occur in all systems. In Viterbo, the lack of local processing industries and of local traditional products based on hazelnuts reduces the impact of the PDO trademark, as hazelnuts are processed by big confectionary industries outside of the system (Briamonte et al., 2001). Apart from the strategies that were implemented in the past, the participants in all three methodologies stressed the importance of developing local processing activities in the future, so that the added value of the product could be retained in the system. This is supported in the literature: Franco et al. (2014) suggest that in the areas of the Viterbo province in which the local economy mainly depends on hazelnut production, policy measures should be taken to promote vertical integration, bringing the value chain at the local level. This would in turn increase the local concentration of marketing activities, both for the national and international market (Briamonte et al., 2001; Franco et al., 2014).

The implementation of the above-mentioned strategies in the future would probably reinforce the robustness and the strong economic role of the system, but it would not improve the other resilience capacities nor strengthen the coupling with natural resources. On the contrary, enhancing system diversity could improve system resilience in the long term (Darnhofer et al., 2010; Di Falco & Chavas, 2015). Moreover, according to the workshop results, on-farm strategies mainly enhance robustness, whereas shared strategies are more linked to transformability and adaptability. Hence, an increase in these two resilience capacities can be achieved by focusing on shared strategies.

7.5 Position of the farming system in the adaptive cycle

Based on the original paper on resilience attributes by Cabell & Oelofse, the farming system could be located between the exploitation and the conservation phases in the adaptive cycle (Cabell & Oelofse, 2012; Holling & Gunderson, 2002; Walker et al., 2004). According to the workshop participants, several attributes which link to these phases are highly present in the system (e.g. "Reasonably profitable", "Spatial and temporal heterogeneity", "Optimally redundant"). The identified past strategies also confirm this, as they are mainly based on exploiting resources and specialising in successful activities, whereas no strategy concerns an adjustment or reorganisation of the system (Darnhofer et al., 2010). While the high level of heterogeneity suggests that the system is closer to the exploitation phase, other elements indicate a position at the end of the conservation phase, closer to release (e.g. the high level of redundancy) (Cabell & Oelofse, 2012; Darnhofer et al., 2010). Moreover, the system has specialised and expanded in the past few years (Bignami, 2002; Pancino & Franco, 2009), which suggests that it has undergone exploitation and conservation (Darnhofer et al., 2010); since the expansion has already included less suitable areas in the province, the system has exploited the available resources and it might be close to its maximum potential growth, which would imply a position in proximity to the release phase (Bignami, 2002; Darnhofer et al., 2010).

However, several elements could enable the system to extend the conservation phase or to successfully go through a reorganisation. Despite the high level of specialisation, different stakeholders are inclined to an innovation of the system: the workshop participants claimed the importance of starting new economic activities (particularly local processing), and the infrastructure for innovation was scored as one of the most present attributes in the system. Innovation could reduce system rigidity and help to defer release (Fath et al., 2015). Rigidity could also be reduced through a high level of diversity, which can protect the system from collapsing (Cabell & Oelofse, 2012; Fath et al., 2015). Even though the workshop results showed that diversity is currently low in the system, a future increase in system's diversity could avoid a collapse. In addition, the high economic reserves of the system could help to undergo a reorganisation: even though they could facilitate a release (as they increase the rigidity of the system), they could provide resources for the reorganisation phase (Cabell & Oelofse, 2012; Fath et al., 2015).

7.6 Methodological challenges

Overall, the stakeholder workshop was successful: the participants were active and interested in giving a contribution during the discussions, and their feedback was generally positive (see Appendix F). The main challenge during the workshop was to keep the participants' attention high, especially considering the abstract nature of the topic. Moreover, some of the workshop exercises were complex, particularly the scoring of the correlations between resilience attributes

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and resilience capacities. The results of this scoring show that the exercise might have been misunderstood, as almost no participant gave negative scores (see Figure A3, Appendix D). As pointed out by one participant in the evaluation survey (see Appendix F), this scoring was particularly difficult because it required a certain level of conceptualisation and pre-knowledge on resilience. Another limitation was that the participants were not invited randomly, due to the need to have a balanced representation of NGOs and producers belonging to different POs. Most participants already knew each other; thus, they might have provided a uniform vision of the system. At the same time, this facilitated an active participation of the stakeholders to the discussions from the beginning of the workshop.

To keep the participants' attention high during the workshop, the number of displayed graphs was reduced, avoiding complex graphs that would have required more time for a deeper analysis. Moreover, the bar graph on the scoring of functions (see Figure 2) was first shown for all participants and then per stakeholder group, to facilitate the understanding of the results. As a further improvement, a few slides were added at the beginning of the presentation on the general project and methodology, and particularly on the use of focus groups. This was done to make the participants feel more involved and motivated to be active during the workshop. More details on the workshop challenges and improvements are listed in Appendix E.

It is difficult to draw conclusions on the full reliability of the participants' perceptions. As limited data on some aspects of the farming system are available, only part of the results of the group exercise could be compared with existing information. To validate the stakeholders' contributions, it would have been useful to include during the workshop some control questions with answers known to the SURE-Farm team, related to available data. This would have allowed for a cross-validation, based on which it would have been possible to have an idea of the reliability of each participant.

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8 Conclusion

The stakeholder workshop allowed to assess the current and past sustainability and resilience of the Viterbo hazelnut farming system. In terms of sustainability, the system is very specialised, and it has a strong economic and productive role, but it overlooks natural resources, which performs only moderately.

Looking at resilience, the system is mainly robust, whereas its adaptability and transformability are lower. Hence a control rationale prevails in the system's management, with maximum performance for two main functions. However, elements of a resilience rationale are also present, such as a high level of redundancy and heterogeneity. The system is located in the conservation phase of the adaptive cycle, and several elements (i.e.past exploitation of available resources, high redundancy) suggest that it is close to the release phase. However, some of the characteristics of the system (i.e. high innovation, high economic reserves) could enable it to extend the conservation phase, or to successfully reorganise after a release.

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Appendix A. Workshop memo

The workshop was held in a room of approximately 45 m^2, provided with five tables for the participants organised with a herringbone pattern, one table in the front for the SURE-Farm team (e.g. to collocate the laptops, forms to be distributed, etc.), comfortable chairs, one projector. Apart from an initial problem with low heating, the room was generally comfortable and adequately furnished. The limited size of the room allowed to have a close contact among all participants and facilitated the discussions, although during the group activities the volume was a bit too high. A catering company provided a small snack during the first coffee break and a full lunch, with high-quality food. Overall, the participants' attitude was very positive: participants were very active during the whole workshop, most of them participated to the discussions and provided useful comments. The level of attention of the participants was perceived to remain generally high during the entire workshop.

Start time: 09.38

End time: 16.00

Total break time (estimation): 75 minutes.

Table A1: Stakeholder overview.

Organization	Function	Stakeholder group
PO C.P.N. (cooperative of hazelnut producers)	President of C.P.N.	Farmers
Freelancer, UNITUS	Agronomist and researcher	Others
Own company	Hazelnut Farmer	Farmers
Freelancer, UNITUS	Agronomist and researcher	Others
Cupidi farm	Organic farmer	Farmers
Freelancer	Agronomist	Others
Biodistretto via Amerina (NGO)	Member of Biodistretto via Amerina	Others
PO Coopernocciole (hazelnut cooperative)	Director of Coopernocciole	Industry
Lazio region, Agro Camera	Ex regional agricultural minister and general director of Agro Camera	Others
Own company	Hazelnut Farmer	Farmers
Chamber of Commerce of Viterbo	Administration officer	Government
PO Coopernocciole	President of Coopernocciole	Industry
Own company, associated with Assofrutti	Hazelnut farmer	Farmers
Municipality of Sutri VT	Municipal councilor	Government
PO Nocciola Italia	Member of PO Nocciola Italia	Industry
Own company	Hazelnut farmer	Farmers
Freelancer	Agronomist	Others
Own company	Hazelnut farmer	Farmers
Slowfood (NGO)	Member of Slowfood	Others
Municipality of Caprarola	Mayor of Caprarola	Government
Own company	Organic hazelnut farmer	Farmers

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Appendix B. Details on ranking and rating the functions and indicators

Table A2: Importance of the functions. Mean and standard deviationper stakeholder group and for all participants. 100 points needed to be divided among 7 functions.

	Farmer		Government		Industry		Others		All	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Food production	26	6	20	0	30	0	25	14	25	9
Bio-based resources	8	5	7	3	6	4	11	4	8	4
Economic viability	31	9	32	18	27	6	39	18	33	13
Quality of life	15	5	13	6	13	6	10	2	13	5
Natural resources	8	4	7	8	13	8	6	3	8	5
Biodiversity & habitat	7	4	5	9	6	4	4	2	6	4
Attractiveness of the area	6	5	17	6	5	0	5	3	7	6

Table A3.1: Capacity of indicators to represent the functions. Mean and standard deviation per stakeholder group and for all participants (original values). The names of some indicators have been abbreviated.

	Original values									
	Farmer		Government		Industry		Others		All	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Hazelnut production	55	9	47	15	43	12	56	25	52	17
Hazelnut quality	45	9	53	15	57	12	44	25	48	17
Shell production for heating	76	24	58	18	88	8	64	18	71	21
Pruning waste for energy	24	24	42	18	12	8	36	18	29	21
Gross Margin/ha	57	18	32	8	60	10	55	18	53	17
Public support to agriculture	24	11	18	3	20	0	20	6	21	8
Margin from *in situ* processing	21	23	50	10	20	10	25	14	26	19
Number of employed people	51	26	33	14	37	25	45	21	45	23
Percentage of women	12	9	15	13	27	6	18	11	16	11
Health of agricultural workers	37	29	52	3	37	21	37	20	39	22
Groundwater availability	58	14	22	16	63	23	59	16	54	20
Water quality in the area	43	14	78	16	37	23	41	16	46	20
Diversification in land use	35	26	77	6	35	26	37	27	42	27
Number of organic farms	65	26	23	6	65	26	63	27	58	27
Touristic flow	32	19	40	17	15	9	33	18	31	18
Retention of young people	68	19	60	17	85	9	67	18	69	18

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Table A3.2: Capacity of indicators to represent the functions. Mean and standard deviation per stakeholder group and for all participants. Transformed values including the importance of the function and the number of indicators per functions, to allow for direct comparison between indicators across the functions.

	Corrected values									
	Farmer		Government		Industry		Others		All	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Hazelnut production	28	5	19	6	26	7	28	13	26	9
Hazelnut quality	23	5	21	6	34	7	22	13	24	9
Shell production for heating	12	4	8	2	10	1	14	4	12	4
Pruning waste for energy	4	4	6	2	1	1	8	4	5	4
Gross Margin/ha	53	17	30	7	48	8	65	21	53	19
Public support to agriculture	22	10	17	3	16	0	23	7	21	8
Margin from *in situ* processing	19	22	48	10	16	8	29	16	26	19
Number of employed people	22	12	13	5	15	10	14	6	17	10
Percentage of women	5	4	6	5	11	2	6	3	6	4
Health of agricultural workers	16	13	20	1	15	8	11	7	15	10
Groundwater availability	9	2	3	2	17	6	7	2	8	5
Water quality in the area	6	2	11	2	10	6	5	2	7	3
Diversification in land use	5	3	8	1	4	3	3	2	5	3
Number of organic farms	9	3	2	1	8	3	6	2	7	3
Touristic flow	4	2	13	6	2	1	3	2	5	4
Retention of young people	9	2	20	6	9	1	6	2	9	5

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Table A4: Performance of indicators. Mean and standard deviation per stakeholder group and for all participants. Legend: 1-1.9 = red, 2-2.9 = orange, 3-3.9 = light green, 4-4.9 = dark green.

	Corrected values									
	Farmer		Government		Industry		Others		All	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Hazelnut production	4.4	0.6	4.7	0.6	4.3	1.1	3.7	0.5	4.2	0.8
Hazelnut quality	3.5	0.6	4.0	0.0	4.7	0.7	4.1	1.1	4.0	0.9
Shell production for heating	3.6	0.6	3.7	0.6	3.7	0.8	4.0	0.7	3.8	0.7
Pruning waste for energy	1.6	0.6	3.7	1.2	1.7	1.3	2.9	0.9	2.3	1.3
Gross Margin/ha	4.0	0.0	3.7	0.6	4.0	0.5	4.3	0.5	4.0	0.5
Public support to agriculture	2.9	1.0	2.7	0.6	3.0	1.1	3.3	1.0	3.0	0.9
Margin from *in situ* processing	1.8	0.6	2.0	1.7	3.3	1.4	3.7	1.0	2.7	1.5
Number of employed people	3.5	0.6	3.7	1.2	3.7	0.4	4.1	0.9	3.8	0.8
Percentage of women	1.4	0.6	1.3	0.6	2.3	1.3	3.1	0.7	2.1	1.2
Health of agricultural workers	2.8	0.0	2.7	0.6	3.0	1.0	2.6	0.9	2.7	0.8
Groundwater availability	2.9	0.0	2.3	0.6	3.0	1.4	2.6	0.4	2.7	0.8
Water quality in the area	2.6	0.0	2.3	1.5	3.0	1.2	2.1	0.9	2.5	1.0
Diversification in land use	1.6	1.2	1.0	0.0	1.7	1.1	2.3	1.1	1.8	1.0
Number of organic farms	2.4	0.6	2.0	1.0	2.7	1.1	2.9	0.7	2.5	0.9
Touristic flow	1.8	1.2	1.7	0.6	1.7	0.9	2.1	0.9	1.9	0.9
Retention of young people	2.5	1.2	3.0	1.0	3.3	0.5	3.4	0.9	3.0	0.9

Table A5: Performance of the functions (derived from the performance of indicators). Mean and standard deviation per stakeholder group and for all participants. Legend: 1-1.9 = red, 2-2.9 = orange, 3-3.9 = light green, 4-4.9 = dark green.

	Corrected values									
	Farmer		Government		Industry		Others		All	
Function	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Food production	4.0	0.8	4.3	0.3	4.5	0.5	3.9	0.7	4.1	0.7
Bio-based resources	3.0	0.6	3.7	0.1	3.1	0.4	3.7	0.9	3.3	0.7
Economic viability	3.2	0.3	3.0	0.7	3.6	0.3	3.9	0.4	3.5	0.5
Quality of life	2.9	0.8	2.9	0.8	3.2	0.3	3.4	0.6	3.1	0.7
Natural resources	2.8	0.5	2.3	1.0	3.0	0.0	2.4	1.3	2.6	0.9
Biodiversity & habitat	2.1	0.3	1.6	0.6	2.3	0.7	2.6	1.0	2.2	0.7
Attractiveness of the area	2.3	0.9	2.6	0.8	2.8	1.0	3.0	0.6	2.6	0.8

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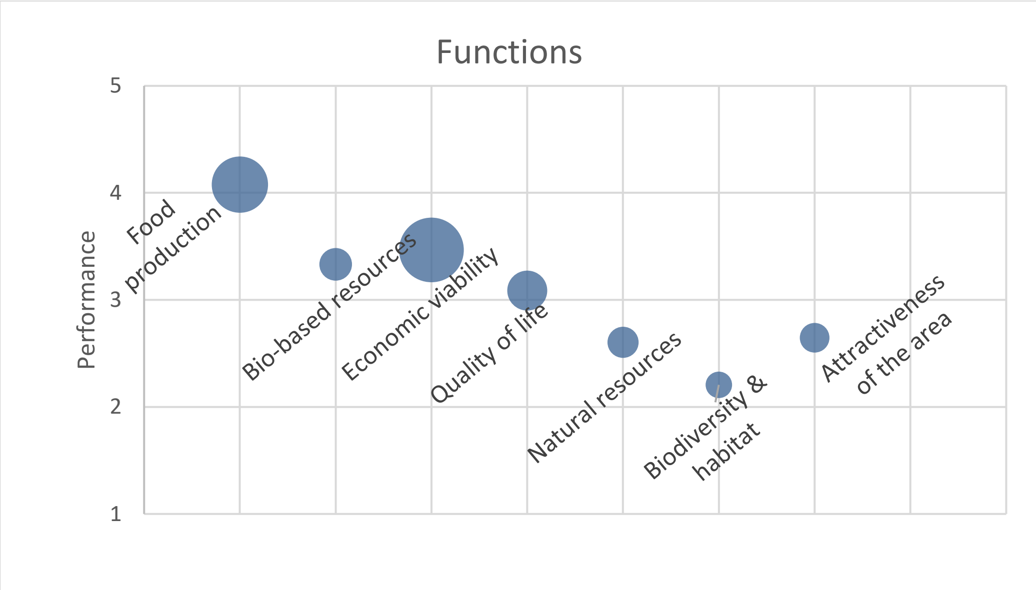

Figure A1: Performance of the functions (on the vertical axis, from 1 to 5) and their importance (size of the bubbles) relative to each other.

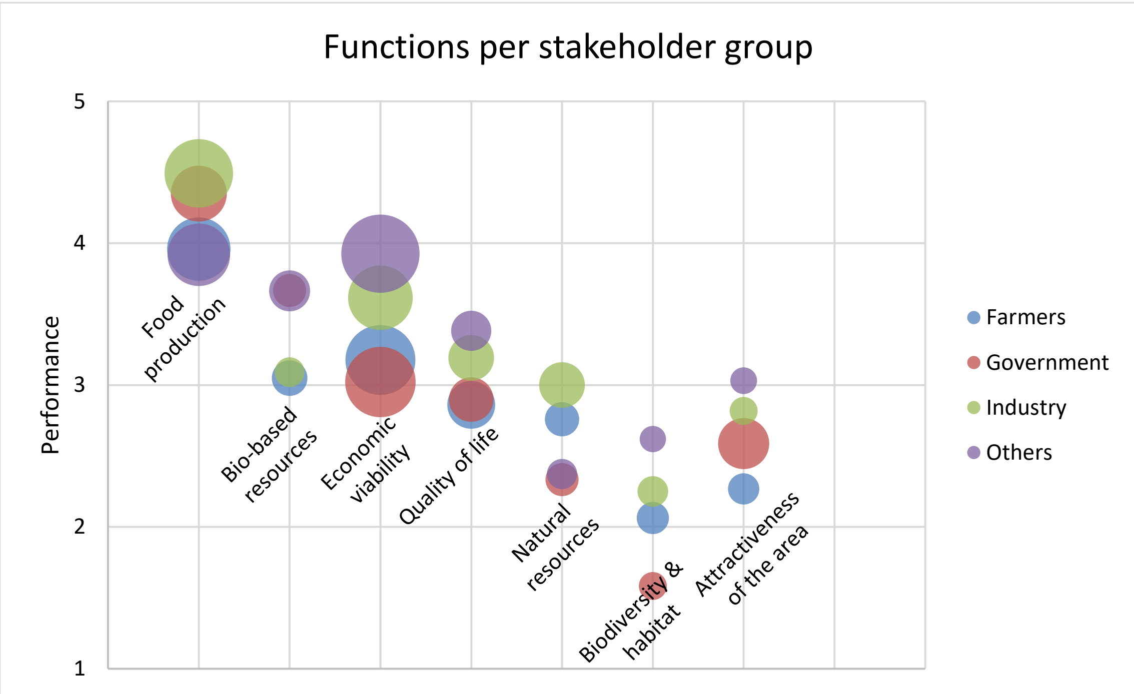

Figure A2: Performance of the functions (on the vertical axis, from 1 to 5) and their relative importance (size of the bubbles), per stakeholder group.

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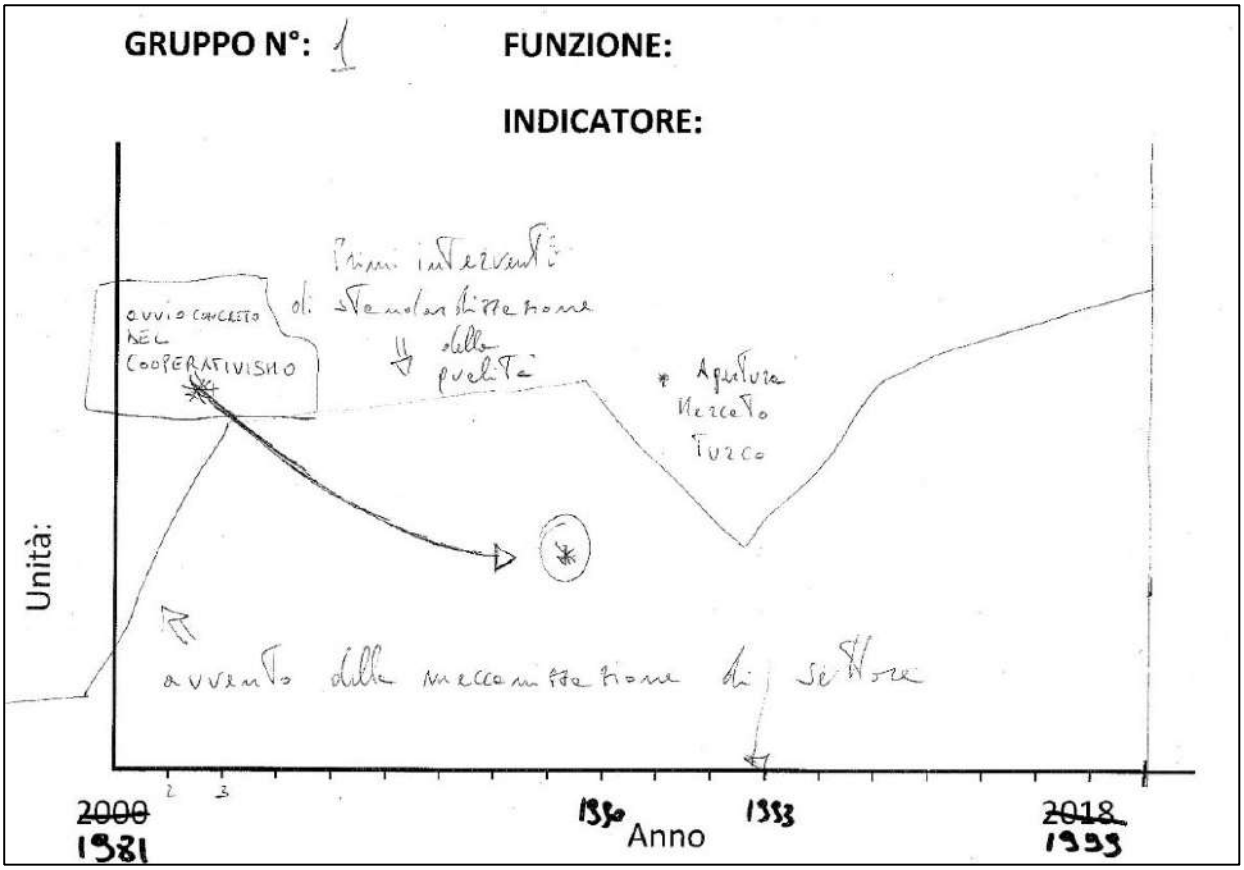
Appendix C. Dynamics of main indicators

For each group, the original drawings are reported in this Appendix, with a short description of the indicator dynamics.

Group 1: Gross Saleable Production



From 1981 the indicator rises, thanks to mechanisation. Afterwards its growth slows down, due to the first interventions for quality standardization. Around 1990, the opening of the Turkish market determines a drop, and it is associated to the real beginning of cooperatives. After 1993 the indicator rises again, because of a further machinery development (self-propelled machines).

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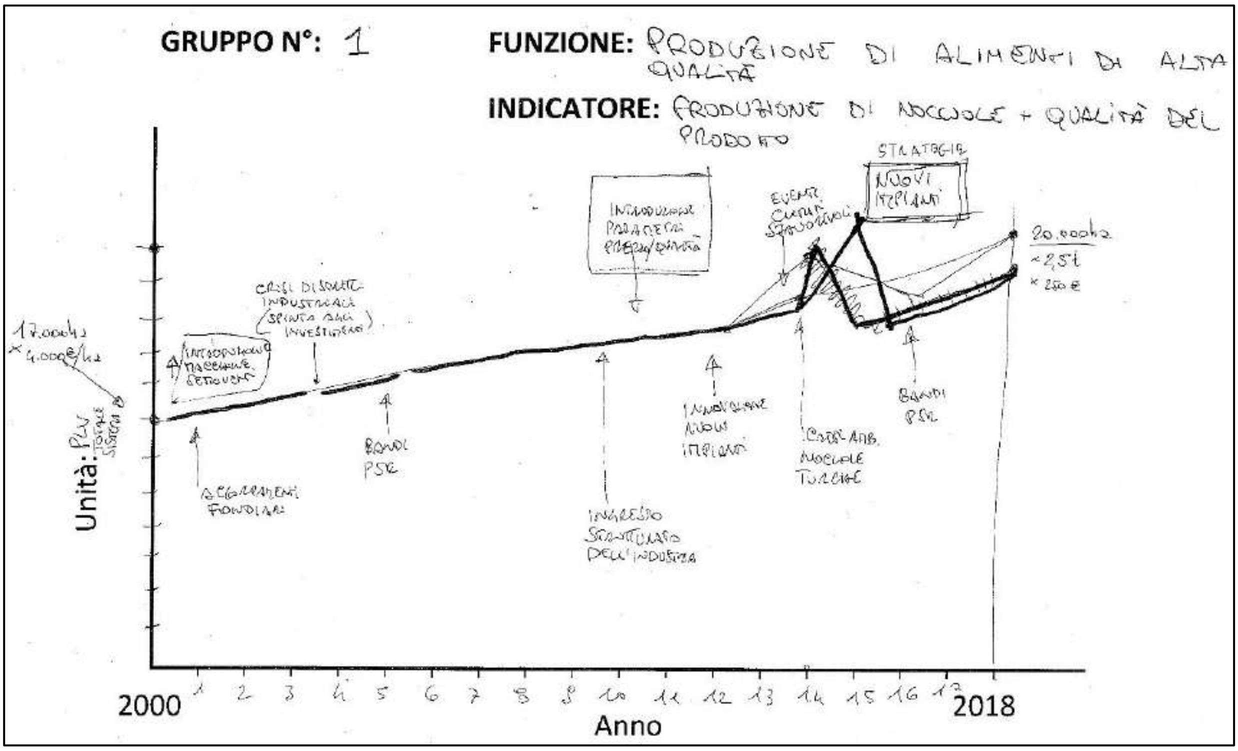
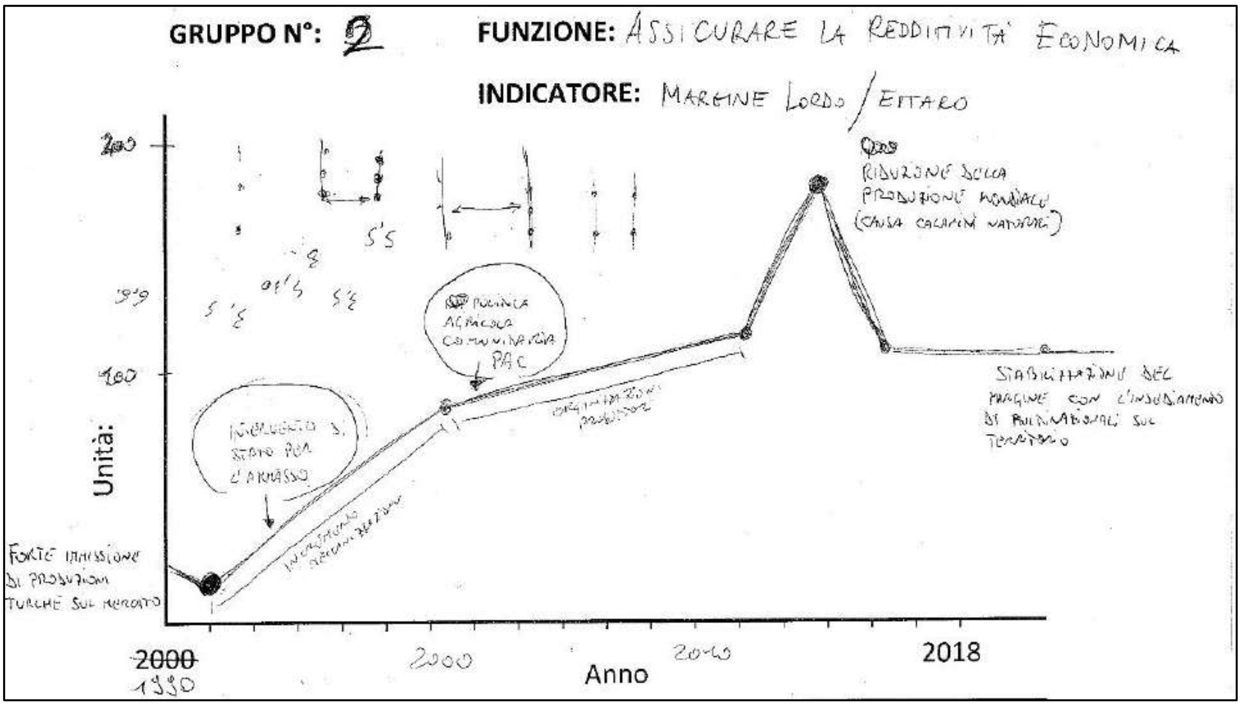


Between 2000 and 2014 the Gross Saleable Production increases steadily. Many events during these years contribute to maintaining this growing trend: at first it is pushed by the introduction of self-propelled machinery and by the inclusion of small farms in bigger farms. In the period 2003-2004, a crisis of other industrial districts leads to investments in hazelnut. Around 2005 the first RDP tenders are launched. Around 2009-2010, the incoming of the industry is associated to the introduction of qualitative parameters and to innovation (including new plantations). Around 2014, a frost in Turkey makes the price of hazelnuts increase, therefore new plantations are established. After a peak in the indicator in these years, it goes back to the normal growing trend, again favored by RDP tenders.

Group 2: Gross Margin per hectare



Starting from 1990, the Gross Margin is initially low due to the incoming of the Turkish production on the market. Around 1993 the production increases, due to a strong mechanisation and to the intervention of the State (collecting products and redistributing them on the market). After 2000, there is a slower but still increasing trend, favored by the European contributions provided through the RDP. Around 2014 the indicator shows a peak, since adverse natural conditions determine a reduction in the global production. After the peak, the indicator stabilises, thanks to the settlement of multinationals on the territory.

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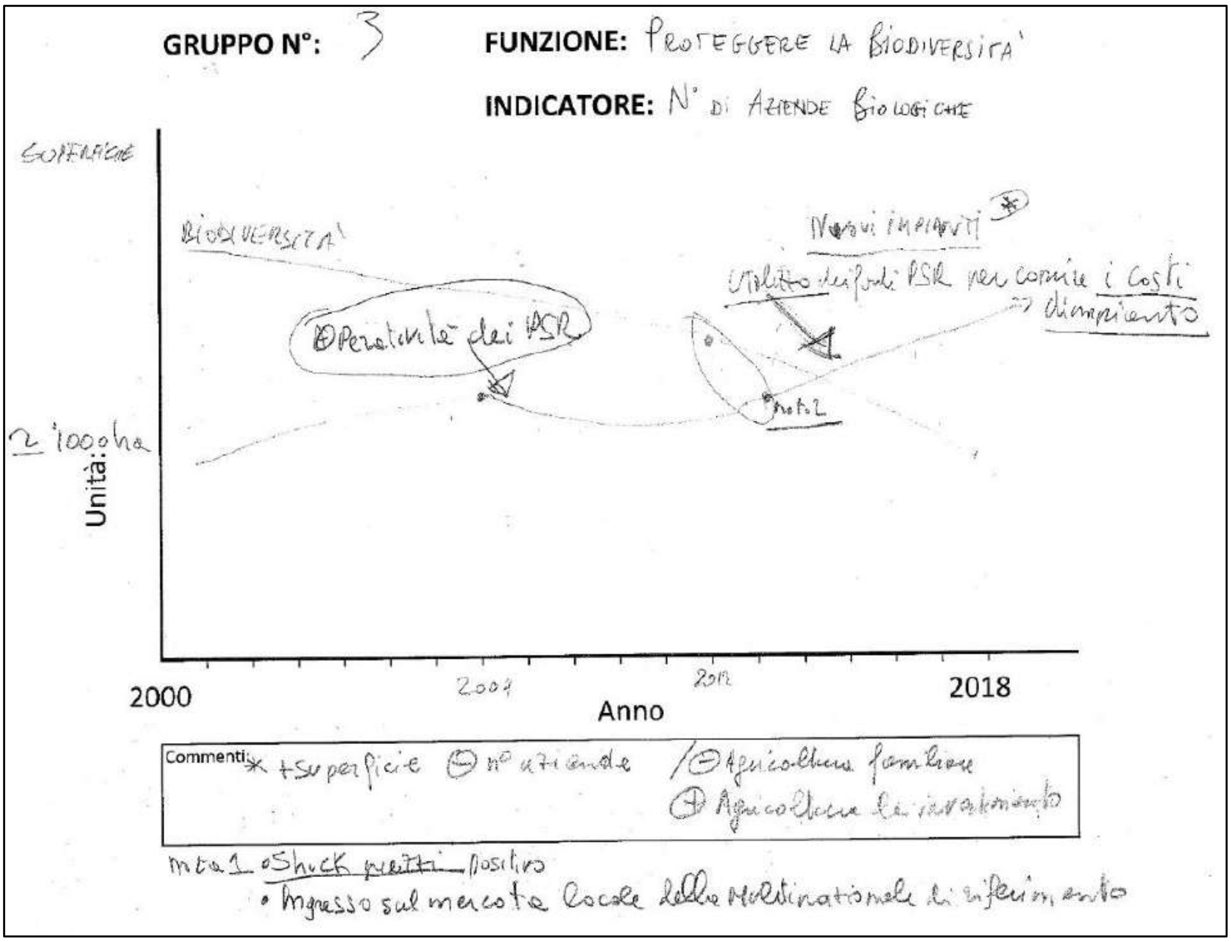
Group 3: Organic area



From 2000, the indicator slowly increases until 2007, when the RDP becomes operative. Between 2007 and 2012, the organic area is generally lower but also oscillating, depending on the launching of tenders. Around 2012, a frost in Turkey determines an increase in prices, and it is associated to the incoming of a big multinational company. This leads to the creation of new plantations, with the use of RDP funds for organic production to cover the planting costs. Biodiversity generally decreases over time, in a more pronounced way after 2012.

In the comments: tendency for an increase in surface and decrease in the number of farms, due to a decrease in family farms and an increase in investment farms. This is the reason why the group decided to describe the dynamics of the organic area instead of the number of organic farms.

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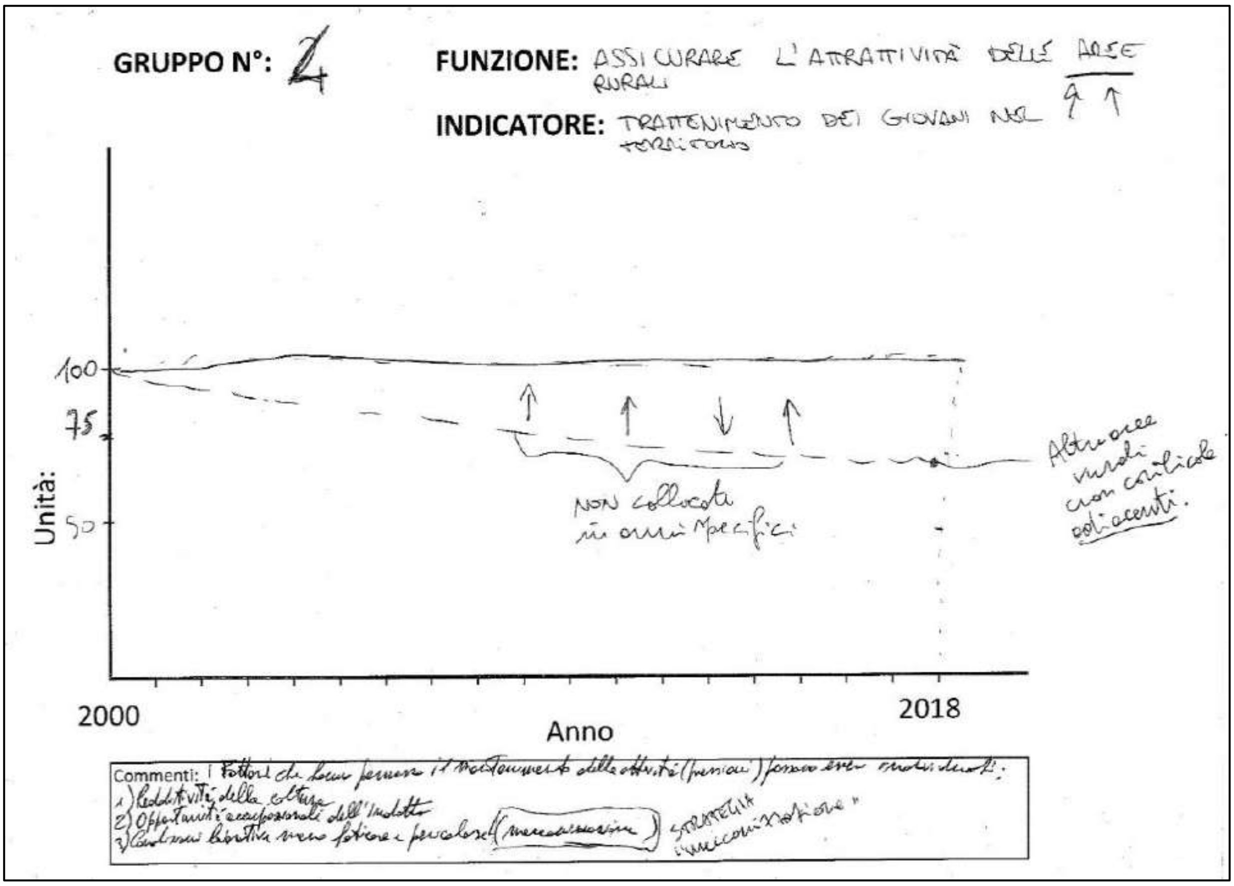
Group 4: Retention of young people in the area



The continuous line corresponds to the actual trend of the indicator, having no variation over time. The dashed line represents a hypothetical trend, in the case of no hazelnut cultivation (it is not specifically bound to certain years). The decreasing trend would have been caused by an outmigration of young people to other rural areas close by (not producing hazelnuts).

In the comments: the factors that allowed the maintenance of activities included crop profitability, job opportunities in the value chain, better working conditions (less tiring and less dangerous) thanks to mechanization.

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Appendix D. Details on scoring strategies and resilience attributes

Table A6: Implementation of the strategies, and their potential contribution to the resilience capacities. Mean and standard deviation.

				Potential contribution to resilience capacities					
		Implementation score		Robustness		Adaptability		Transformability	
Selected indicator	Strategy	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Gross Saleable Production		**4.3**	**0.5**	**2.9**	**0.7**	**2.1**	**1.1**	**2.0**	**1.8**
	Mechanisation	4.8	0.5	3.0	0.5	1.8	0.6	1.5	0.6
	Cooperatives	3.8	0.5	2.8	0.8	2.5	1.3	2.5	1.5
Gross Margin/ha		**4.8**	**1.1**	**0.6**	**2.1**	**1.1**	**1.8**	**0.9**	**0.9**
	Mechanisation	4.8	1.1	0.3	2.1	0.5	1.8	-0.5	0.9
	POs	4.8	0.7	1.0	0.5	1.8	0.5	2.3	0.5
Organic area		**3.4**	**0.5**	**-0.5**	**0.5**	**-0.3**	**0.6**	**0.8**	**0.5**
	RDP funds	3.4	0.5	-0.5	0.5	-0.3	0.0	0.8	0.5
Retention of young people		**4.3**	**0.7**	**2.8**	**0.4**	**2.8**	**1.7**	**2.5**	**1.7**
	Mechanisation	4.8	0.5	2.8	0.0	2.5	2.5	2.3	2.4
	Value chain activities	3.8	0.5	2.8	0.5	3.0	0.6	2.8	0.6
Grand Total		**4.2**	**0.9**	**1.4**	**1.8**	**1.4**	**1.7**	**1.5**	**1.5**

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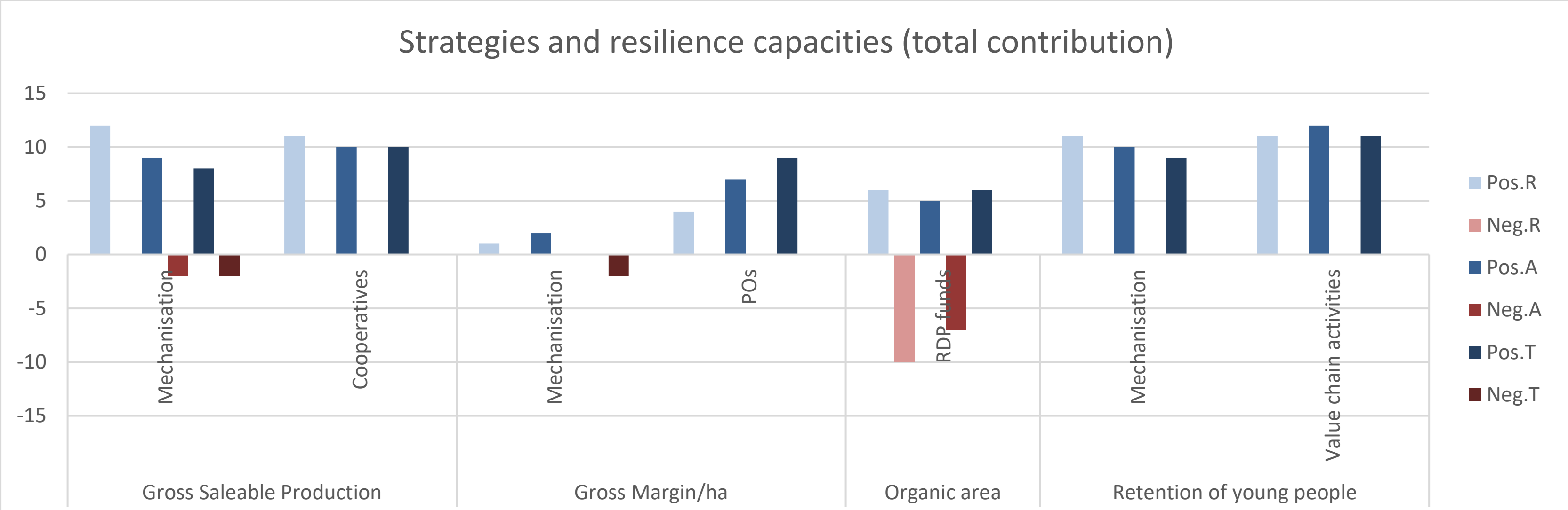

Figure A3: Total positive and negative contribution of each strategy to the resilience capacities. Sum of scores from -3 to 3: 0 = no relationship; 1 or -1 = weak positive or negative relationship; 2 or -2 = intermediate positive or negative relationship; 3 or -3 = strong positive or negative relationship.

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Table A7: Level of the attributes in the farming system. Mean and standard deviation per stakeholder group and for all participants.

	Extent to which attribute applies in the farming system							
	Farmer		Industry		Others		All	
Resilience attribute	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Reasonably profitable	3.7	0.5	4.0	0.4	3.8	0.0	3.8	0.4
Coupled with local and natural capital (production)	2.1	0.9	2.7	1.0	2.2	0.6	2.3	0.9
Functional diversity	2.6	1.1	2.0	0.8	2.5	1.0	2.4	1.0
Response diversity	2.9	0.9	3.0	0.5	2.5	0.0	2.8	0.7
Exposed to disturbance	2.3	1.0	2.3	0.9	2.0	0.6	2.2	0.8
Spatial and temporal heterogeneity (farm types)	3.4	1.3	3.7	1.4	3.3	1.2	3.4	1.2
Optimally redundant (farms)	4.1	1.2	3.3	1.2	3.2	1.5	3.6	1.3
Supports rural life	3.6	1.0	3.7	0.6	3.0	1.2	3.4	0.9
Socially self-organized	3.7	1.1	4.0	0.8	4.2	1.0	3.9	0.9
Appropriately connected with actors outside the farming system	2.6	1.3	2.0	0.5	2.5	1.0	2.4	1.0
Infrastructure for innovation	3.4	0.8	2.7	0.5	2.7	0.6	3.0	0.7
Coupled with local and natural capital (legislation)	2.7	0.8	2.7	0.5	2.3	0.6	2.6	0.6
Diverse policies	2.4	0.5	2.7	0.6	2.0	0.6	2.3	0.6

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Table A8.1: Contribution of the attributes to the resilience capacities. Mean and standard deviation per stakeholder group and for all participants (part 1: Farmers, Industry). The Government category was included in Others in this phase.

	Extent to which resilience attributes can potentially contribute to resilience capacities in the farming system											
	Farmers						Industry					
	Robustness		Adaptability		Transformability		Robustness		Adaptability		Transformability	
Resilience attribute	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Reasonably profitable	1.4	1.8	1.7	1.1	1.0	1.6	1.0	1.0	0.3	0.6	1.0	1.7
Coupled with local and natural capital (production)	1.7	0.8	1.3	0.8	0.6	2.2	0.7	0.6	1.7	0.6	0.7	1.5
Functional diversity	1.1	1.8	0.7	2.0	0.7	2.1	1.3	1.2	0.7	0.6	1.7	0.6
Response diversity	1.3	1.3	1.4	1.5	0.6	1.0	0.3	1.2	0.7	0.6	2.0	1.0
Exposed to disturbance	1.7	1.3	1.0	0.8	0.1	0.7	1.3	1.2	1.0	1.0	1.7	1.2
Spatial and temporal heterogeneity (farm types)	1.6	1.4	0.9	1.2	0.9	1.6	1.0	0.0	1.7	1.2	1.3	1.5
Optimally redundant (farms)	1.7	1.5	0.7	1.4	0.3	1.5	1.0	1.0	0.7	1.2	0.7	1.2
Supports rural life	1.0	1.7	1.0	1.2	0.4	1.6	0.0	1.0	0.3	0.6	0.7	0.6
Socially self-organized	1.7	1.6	1.9	0.9	1.6	1.5	1.7	0.6	2.3	0.6	2.0	1.0
Appropriately connected with actors outside the farming system	0.9	1.5	0.9	0.9	1.6	0.8	-1.0	2.0	-1.3	1.5	0.7	2.1
Infrastructure for innovation	2.1	1.1	2.0	0.8	2.1	1.1	1.7	0.6	1.7	0.6	1.7	1.5
Coupled with local and natural capital (legislation)	1.3	1.7	0.6	1.5	1.0	1.8	0.3	0.6	0.3	0.6	0.7	0.6
Diverse policies	1.3	1.4	0.6	1.1	0.7	1.0	-0.3	0.6	0.3	0.6	0.3	0.6

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Table A8.2: Contribution of the attributes to the resilience capacities. Mean and standard deviation per stakeholder group and for all participants (part 2: Others, All). The Government category was included in Others in this phase.

	Extent to which resilience attributes can potentially contribute to resilience capacities in the farming system											
	Others						All					
	Robustness		Adaptability		Transformability		Robustness		Adaptability		Transformability	
Resilience attribute	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Reasonably profitable	2.8	0.4	2.5	0.8	2.0	1.3	1.9	1.5	1.8	1.2	1.5	1.4
Coupled with local and natural capital (production)	2.8	0.4	2.8	0.4	2.7	0.5	1.9	1.0	1.9	0.9	1.9	1.4
Functional diversity	2.8	0.4	2.7	0.5	2.5	1.2	1.8	1.5	1.4	1.6	1.7	1.6
Response diversity	2.5	0.8	2.3	0.8	1.2	1.5	1.6	1.3	1.6	1.3	1.2	1.1
Exposed to disturbance	2.2	1.3	2.5	1.2	0.7	2.4	1.8	1.2	1.6	1.2	1.6	0.6
Spatial and temporal heterogeneity (farm types)	2.5	0.8	2.7	0.5	1.7	2.4	1.8	1.2	1.7	1.3	1.8	1.3
Optimally redundant (farms)	1.8	1.5	2.3	1.2	2.0	1.5	1.6	1.4	1.3	1.4	1.6	1.0
Supports rural life	2.7	0.5	2.7	0.5	2.5	0.5	1.4	1.6	1.5	1.3	1.5	1.3
Socially self-organized	2.0	1.5	2.0	1.5	2.0	1.5	1.8	1.4	2.0	1.1	1.4	1.8
Appropriately connected with actors outside the farming system	1.5	1.4	1.8	1.2	1.2	2.3	0.8	1.7	0.8	1.6	1.7	1.3
Infrastructure for innovation	2.0	1.3	2.3	0.8	1.8	1.2	2.0	1.0	2.1	0.8	1.1	1.9
Coupled with local and natural capital (legislation)	2.2	1.0	2.2	1.0	1.5	1.0	1.4	1.4	1.1	1.4	1.4	1.1
Diverse policies	2.8	0.4	2.8	0.4	2.3	1.2	1.6	1.5	1.4	1.4	1.3	1.3

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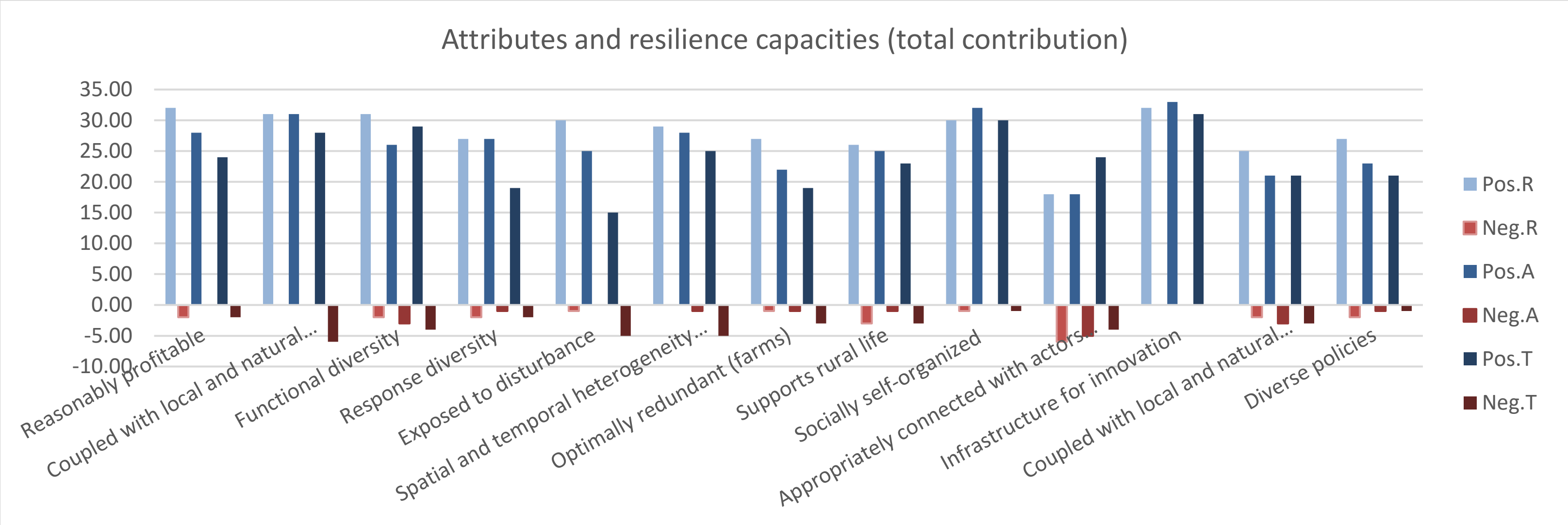

Figure A4: Total positive and negative contribution of each resilience attribute to the resilience capacities. Sum of scores from -3 to 3: 0 = no relationship; 1 or -1 = weak positive or negative relationship; 2 or -2 = intermediate positive or negative relationship; 3 or -3 = strong positive or negative relationship.

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Appendix E. Workshop challenges and improvements

In the list below, details on the workshop challenges and improvements are provided.

1) There was a relatively high number of participants (21 in the beginning, of which five left), but it was still feasible to handle the Excel data during the workshop. In order to do so, two people from the team were working with Excel (one reading the data and one writing them). However, it was decided to reduce the number of graphs to show during the workshop, particularly eliminating the graph on the performance of indicators (as the performance was also shown in the bubble graph), and those showing the resilience capacities in correlation with strategies and attributes (as these graphs were less readable, and they would have required long explanations). Reducing the number of graphs was helpful to keep the participants' attention high throughout the whole workshop.

2) The biggest difficulty for the participants was the evaluation of the strategies within the four groups. The participants focused mainly on the dynamics of the indicators and they struggled to identify strategies, despite the presence of one moderator for each group. Therefore, the strategy identification m might deserve more time to debate than what was given.

3) For the essential functions, it was decided to show the results first in total (average of all participants) and then by class. This allowed to compare the two graphs, which was interesting and easier for the participants to understand.

4) A few initial slides were added with an explanation of the project, of the concept of resilience, and of the methodology (e.g. focus groups for qualitative analysis). There was one main speaker during the workshop, but other members of the team took part to the presentation in some moments. This also helped to keep a high level of attention.

5) The selection of four indicators for the group activities took longer than expected (around 45 minutes), but it generated an interesting discussion among the participants. Therefore, being flexible with the timing of the different parts was useful to leave space for spontaneous discussions.

6) The groups were decided before the workshop. This helped to speed up the group phase, and it allowed to have balanced groups in terms of stakeholder distribution. For the discussion on the dynamics of indicators, pictures of the papers from each group were projected. One member of each group presented the results, so this phase was very interactive. Participants were happy to present the results of the groups.

7) During the group activity some participants suggested to enlarge the time span, by considering in the indicator graph also the nineties, when some relevant changes happened. Being the farming

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system based on a perennial crop, it was considered a good idea to allow to sketch the graph covering a longer time period.

8) Before each exercise, the main research question was added on the Power Point presentation. This made it easier for the participants to understand the purpose of each exercise.

9) During the workshop, two computer were used: one with the main presentation and one with a Power Point file connected to the Excel file, showing the graphs.

10) It was decided to send an evaluation survey to all participants about the workshop, also in view of the workshop that will be held next year. The results are summarized in Appendix F.

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Appendix F. Self-assesment of the workshop performed by participants

After the workshop, an evaluation survey was sent to the participants through Google Forms. The aim of the survey was to have feedback on the workshop, specifically concerning:

1. General evaluation.
2. How much the workshop met the participants' expectations.
3. Usefulness of the workshop.
4. Clearness of the covered topics.
5. Evaluation of the participation of different stakeholders.
6. Workshop duration.
7. Uncovered topics that the participants would have liked to address.
8. Availability for a workshop on the future of the farming system.
9. Suggestions for the future workshop.
10. General considerations.

The results are summarized in table A9. Among the 21 workshop participants, 9 responded to the survey. The results showed a high level of satisfaction of the respondents, as most participants considered the workshop useful and in line with their expectations, and the participation of different types of actors was evaluated very positively. What could be improved was the clearness of the topics addressed during the workshop, as 44% of the participants defined them as "somewhat clear". As for the duration of the workshop, it was generally considered adequate, and only in one case too long. One respondent specified that, even though the duration itself was adequate, there were too many forms to fill in.

All the respondents declared their availability to participate to a similar workshop on future perspectives. Some interesting points emerged from the open questions 7, 9, and 10. One respondent said he/she would have liked to address more clearly issues related to the price market. Suggestions for the future workshop were to focus on the management and effects of communitarian aid, and to carry out a historical in-depth analysis of the hazelnut system in the years between the 60s and the 90s, as this period was characterised by radical changes in the supply chain which had an influence on the resilience of the system. For question 10, one respondent reported that he/she found it difficult to assign scores to the three resilience capacities, and it was highlighted that the workshop stakeholders participated as experts of the hazelnut system, not as resilience experts.

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Table A9: Evaluation of the workshop.

1. General evaluation of the workshop		**2. Did the workshop reflect your expctations?**	
Very good	78%	To a great extent	56%
Good	22%	Somewhat	44%
Poor	0%	Very little	0%
Very poor	0%	Not at all	0%
3. Do you think the workshop was useful?		**4. Did you find that the covered topics were clear?**	
To a great extent	78%	To a great extent	56%
Somewhat	22%	Somewhat	44%
Very little	0%	Very little	0%
Not at all	0%	Not at all	0%
5. How do you evaluate the participation to the workshop of different types of actors from the system?		**6. What do you think of the workshop duration?**	
Very positively	67%	Too long	11%
Positively	33%	Adequate	78%
Neutral / No opinion	0%	Other (please specify)	11%
Negatively	0%		
Very negatively	0%		
7. Are there topics that were not addressed and that you would have liked to address? If so, please specify		**8. Would you be available to participate to another similar workshop on the future of the hazelnut farming system, in about a year?**	
Yes	11%	Yes	100%
No	89%	No	0%
		Maybe	0%
9. Regardless of whether you will be able to participate or not, do you have any suggestions to improve the next workshop?		**10. Apart from possible suggestions, would you like to share with the organisers any considerations on the experience?**	
Yes (please specify)	22%	Yes (please specify)	11%
No	78%	No	89%

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