

1 **Long title:** Combining sustainability and resilience assessment of a Regional Food System: evaluating  
2 an innovative Swiss alpine valley

3 **Short title :** Assessing resilience and sustainability in a Regional Food System

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35 [Abstract](#)

36 The Swiss food system faces complex economic, social, and environmental challenges concurrent  
37 with a consensus among citizens, scientists, and institutions advocating for a transition toward  
38 sustainable food production. We argue that resilient and sustainable Regional Food Systems have a  
39 spillover effect on global food system sustainability and resilience. This study focuses on the regional  
40 level, assessing the resilience and sustainability of Valposchiavo's food system, an innovative Swiss  
41 alpine valley, utilizing a novel assessment framework developed through an extensive literature  
42 review and the integration of some of the numerous existing assessment tools. Semi-structured  
43 interviews with 51 stakeholders representative of the Regional Food System reveal that Valposchiavo  
44 has a resilient and sustainable food system. The agricultural sector's resilience and sustainability  
45 outperform the ones of the processing, retail, and restaurant sectors. Valley institutions show  
46 commitment to sustainable development but perform poorly in stakeholder support and  
47 organizational structure. Our holistic approach, encompassing resilience and sustainability for the  
48 regional food system as a whole, provides context-specific recommendations and is replicable in  
49 other regions.

50

51 [Author Summary](#)

52 The agricultural sector, processing units, retail, restaurants, and consumers form what we refer to as  
53 the food system. This intricate network faces increased environmental fluctuations, rise in  
54 production costs and societal demands for affordable and healthy products. To face them, food  
55 systems must become more resilient while remaining sustainable. This paper proposes an innovative  
56 approach to quantitatively evaluate both resilience and sustainability of all types of actors of a  
57 regional food system. Beyond existing approaches that focus on either sustainability or resilience,  
58 our approach provides a comprehensive assessment. The method is based on face-to-face interviews  
59 of a sample of individuals. We have set-up a set of indicators, that allow to conclude with  
60 recommendations tailored to the region. Valposchiavo's food system demonstrates resilience and  
61 sustainability, albeit with disparities among the sectors. Specifically, agricultural sector's resilience  
62 and sustainability outperform the ones of the processing, retail, and restaurant sectors. Despite a  
63 strong commitment to sustainable development from local institutions, there is a need of support for  
64 stakeholders to shift to more sustainable and resilient ways of performing their businesses.

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## 75 1. Introduction

76 The Swiss food system confronts multifaceted economic, social, and environmental challenges (1)  
77 that pose a significant risk to the long-term viability of farming, resulting in shortages and escalating  
78 food prices, thereby exposing a segment of the population to the threat of food insecurity.

79 Concurrently, there is a growing consensus among citizens, scientists, and institutions advocating for  
80 a transition towards more sustainable modes of food production (2,3). Consequently, the imperative  
81 arises to establish resilient food systems capable of withstanding disruptions without overstepping  
82 planetary boundaries.

83 The effects of these global challenges vary significantly depending on the context (4), either  
84 mitigating or exacerbating them (5). Many discussions highlight how small-scale initiatives can  
85 contribute to significant change (6–9). Therefore, regions are an excellent scale for the pathways of  
86 change. Regional Food Systems (RFS), a system in which as much food as possible to meet the  
87 population's needs is produced, processed, distributed, and purchased within the region (10),  
88 becomes particularly interesting to ensure food system resilience and sustainability. Regional Food  
89 Systems have fixed boundaries and can be coordinated by territorial governance (11,12), in contrast  
90 to Local Food Systems, whose boundaries are most often defined as a radius that moves with the  
91 observer (10).

92 Assessment plays a crucial role in enhancing food systems by highlighting strengths and identifying  
93 areas for improvement. Various institutes have designed tools for assessing farm sustainability  
94 (13,14) or resilience exclusively (4,15,16) while others assess both aspects within a single value chain  
95 (4), excluding other essential products of the RFS. Therefore, developing a tool to simultaneously  
96 analyze the resilience and sustainability of RFSs that can help the food system transition remains a  
97 complex task.

98 In response to the posed challenge, we have developed an innovative approach involving surveys to  
99 assess RFS, integrating all value chains and the associated actors. Designed to be user-friendly and  
100 requiring minimal training, our approach ensures prompt comprehension of results.

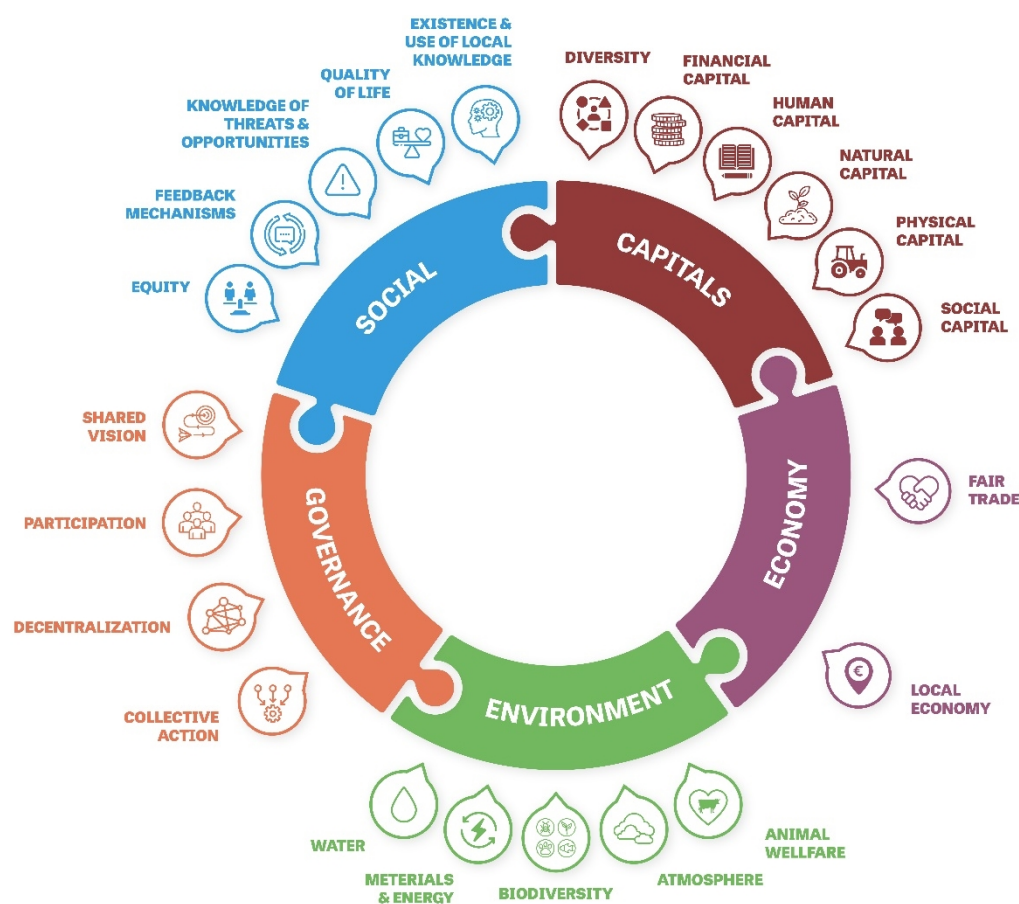
101 To analyze the resilience and sustainability of RFS, we adapted the urban resilience framework (17),  
102 finding many similarities between the two domains primarily in their characterization as social-  
103 ecological systems (SES) (18–20). Consequently, the system can be unbundled into 3 core subsystems  
104 interacting with each other.

- 105 • the system, physical structures, and ecosystems
- 106 • the agents involved in the food system activities ranging from production to consumption  
107 and
- 108 • the institutions, which may be formal or informal, overt or implicit (21–23).

109 Although sustainability is inherently associated with positive connotations (24), resilience can  
110 possess dual attributes (25). One illustration is the capacity of degraded ecosystems to maintain  
111 stability, albeit undesirably, resisting both improvement and degradation (25). Thus, it is crucial to  
112 consider sustainability and resilience as complementary concepts to ensure that food systems  
113 remain stable in a desirable state (26). In this study, we define resilience as the food system’s ability  
114 to produce and distribute food under changing conditions and to do so in a sustainable way in both  
115 the short term and the long term.

116 When evaluating the sustainability and resilience of the RFS, each component—agents, institutions,  
117 and the system itself—is assessed independently. The resilience of agents is evaluated based on the  
118 presence and stability of a buffer capacity, the existence and encouragement of self-organization,  
119 and the occurrence of learning (27). On the other hand, sustainability assessment encompasses  
120 environmental integrity, social well-being, economic resilience, and effective system governance  
121 (28).

122 As sustainability and resilience share common ground in certain aspects, such as water withdrawal,  
123 soil quality, and profitability, both frameworks are concurrently analyzed. To facilitate this dual  
124 assessment, we have integrated these frameworks into a new theoretical model (**Error! Reference**  
125 **source not found.**, Supplementary material 1), allowing a comprehensive examination of the RFS  
126 regarding sustainability and resilience.



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128 Fig. 1 Conceptual framework for the assessment of the resilience of RFS actors

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Source: own elaboration

130 Highlighting the distinct roles of institutions in contrast to the agents within the food system  
131 (comprising farmers, processing and distribution companies, and consumers), a novel framework has  
132 been introduced (Table 1). This framework systematically examines how institutional actors influence  
133 and shape responses to shocks and stresses across the system. Within this dynamic, institutions can  
134 act as facilitators and supporters or impose constraints and inhibition.

135 We draw upon the four dimensions (28) previously utilized for assessing individual agents:  
 136 environmental integrity, social well-being, economic resilience, and effective system governance. In  
 137 assessing the efficacy of system governance, we refer to the framework developed by (17). This  
 138 framework illustrates the characteristics of institutions that foster resilience: clear rights and  
 139 entitlements to use critical resources, transparent and polycentric decision-making process,  
 140 facilitation of information flow, and facilitation of the application of new knowledge. We regrouped  
 141 these characteristics into a dimension called Governance Structure. Several of these principles are  
 142 mentioned in (29) and expounded upon through metrics that we could use to enhance the  
 143 framework dedicated to analyzing institutional actions regarding resilience and sustainability. We  
 144 regrouped the previous sub-dimensions into two groups: governance structure for those concerning  
 145 the operation of institutions and support actions for the others (environmental integrity, social well-  
 146 being, economic resilience).

Dimensions	Sub-dimensions	Definition	Examples
Governance Structure	Rights & Entitlements	“Structures of rights and entitlements do not systematically exclude specific groups from access to critical systems or capacities. They enable groups to form and act and foster access to basic resources”	Fresh food is affordable and available for all region inhabitants, regardless of their standard of living and geographical location.  Community groups may be able to organize around food access (community-supported agriculture, community gardening...)
	Facilitate Information Flow	“Agents have access to relevant information to determine effective actions and make strategic adaptation choices”	Standards and norms are clear, publicly, and readily available.  Government agencies can access and use scientific information to set up standards and strategies.

	Application of New Knowledge	“Institutions encourage inquiry, application of evidence, critical assessment, and application of new knowledge”	Support of extension and advisory services. Collaboration between research centers and food system actors.
	Transparent & Polycentric decision making	“Decision-making processes related to key urban systems are transparent, representative, and accountable. Diverse stakeholders have a way of providing input to decisions. Dispute resolution processes are accessible and fair”	Formal or informal systems are in place to mediate disputes. Land and subsidy allocation follows clear and legal procedures. Investments in food structures and events reflect the desires of the inhabitants
Support Actions	Environmental Considerations	Incentives and laws toward stakeholders to minimize adverse environmental impacts and foster positive effects	Maintain diversity and redundancy, support action that limit atmosphere, water, land, impact, reduce materials and energy consumption, and foster biodiversity, as well as animal welfare
	Culture & Health Support	Promoting local food culture and supporting food system actors' well-being through healthy diets, equity, and fair-trading practices	It includes supporting food festivals or events and maintaining local traditional knowledge. Well-being can be promoted through public canteens where institutions have a say in diets and purchases
	Economic support	Institutions offer economic support for investment or as a	Support the installation of renewable energies and community-supported agriculture.

		buffer in case of temporary difficulties	Guarantee loans in case of difficulties
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147 Table 1 Sustainability and resilience dimensions of RFS institutions

148 Source: Quotations from (17), other definitions and examples adapted from (17,29,30)

149 This paper aims at (i) assessing the state of resilience and sustainability of a Swiss alpine food system,  
150 and (ii) identifying leverage points or potentials for increasing resilience and sustainability in this  
151 regional food system. Through this pilot assessment, it aims at (iii) contributing to the  
152 operationalization of resilience and sustainability thinking in research on food systems.

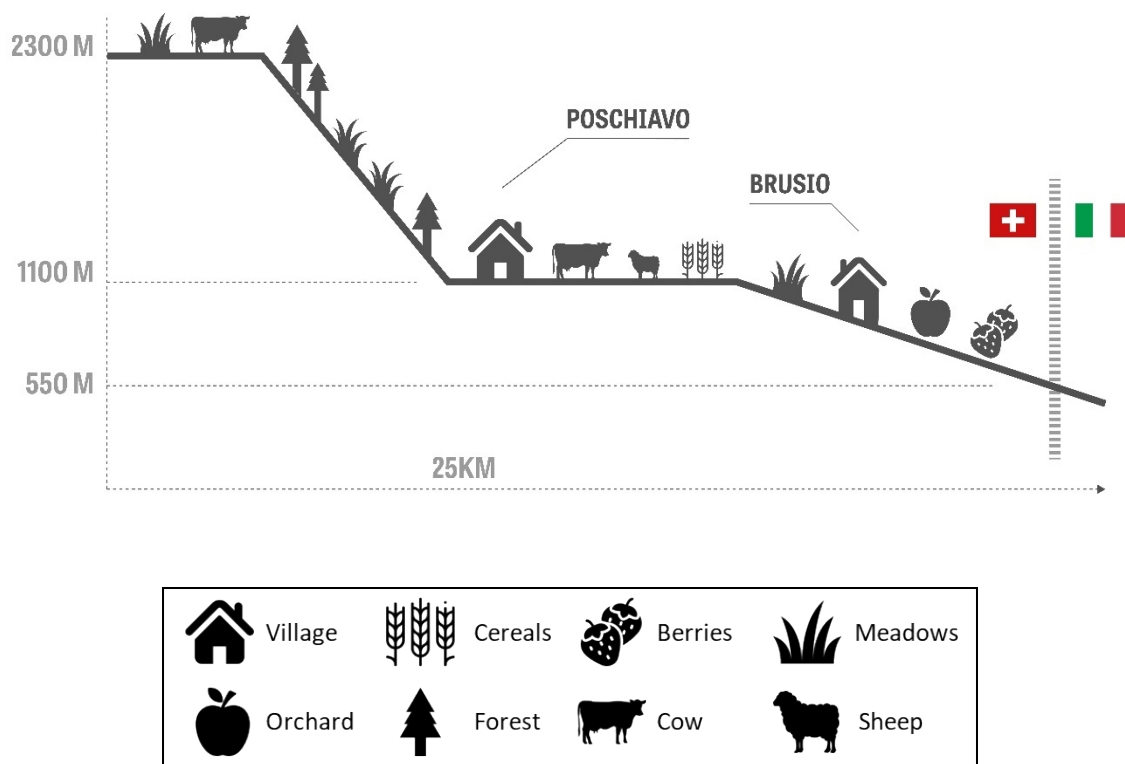
## 153 2. Material and methods

### 154 2.1 The Valposchiavo as an exemplary remote and innovative Alpine Valley

155 With over 90% certified organic farmers and a strategy to trigger the development of regional value  
156 chains, Valposchiavo stands as a unique region. Consequently, in recent years, several research  
157 studies have been undertaken (31–35). The valley's unique attributes (geographical and cultural  
158 isolation, UNESCO World Heritage certification, and high share of organic farming), coupled with the  
159 substantial body of contemporary literature and the networks cultivated with stakeholders in prior  
160 research endeavors, render Valposchiavo an optimal candidate for piloting an assessment of the  
161 resilience of RFS).

162 The Valposchiavo, situated in the canton of Grisons in Southeast Switzerland, is isolated from the rest  
163 of the country by the Bernina pass (2,328 meters above sea level) to the North, while its southern  
164 border connects with Italy. With a length of 25 kilometers and a width of less than 1.5 kilometers on  
165 the valley floor, Valposchiavo had a population of around 4,600 in 2021. A temperature precipitation  
166 gradient is noticeable from the Bernina pass down through the valley. Aside from the elevated alpine  
167 region around the Bernina Pass, the prevailing climate is generally mild. The diverse topography  
168 creates microclimates that support various farming systems (36).





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Fig. 2 Transect N-S of the Valposchiavo

## 172 2.2 Construction of the assessment approach

173 We conducted a synchronic assessment of the stakeholders of the RFS, whose geographical

174 boundaries are those of the valley: the Valposchiavo, also referred to as “Regione Bernina”. All the

175 interviews were taken face-to-face using a semi-directive method between May and August 2022.

176 The resilience of RFSs has been assessed through a series of surveys designed for each food system

177 agent (37) including farmers, processing companies, retail companies, restaurants, consumers and

178 representatives from regional institutions. The survey instrument finely captures quantitative and

179 qualitative data, encompassing responses on a Likert scale and open-ended questions. Regardless of

180 the scale type —ordinal, nominal, or interval— the responses are systematically transposed onto a

181 score within an ordinal measurement scale ranging from 0 to 100. A score of 0 signifies null or very

182 low performance, while 100 represents the highest level of achievement.

183 During the subsequent data analysis phase, survey questions are mapped against pertinent sub-  
184 dimensions outlined in the conceptual framework presented above to analyze each component of  
185 the RFS resilience.

#### 186 *2.2.1 Farmers survey based on FAO tools*

187 Building the survey questions primarily relies on the Swiss adaptation of the SHARP tool, a self-  
188 assessment tool for evaluating farmers' resilience (38,39). We used the conceptual framework  
189 presented above for the survey results analysis. The SHARP tool, customized for Switzerland, the  
190 focal point of this study, is not only open-source, facilitating accessibility and adaptation, but has also  
191 been extensively utilized (39). Upon comparing the SHARP tool with the SAFA Guidelines (28), a  
192 framework designed to evaluate farmers' sustainability, it was found that one-third of the indicators  
193 in SAFA align with those in SHARP. However, essential indicators such as animal welfare, waste  
194 management, and women's empowerment were notably absent in SHARP. Questions from the  
195 SMART tool (14) have occasionally been incorporated to enhance the assessment of specific aspects.

#### 196 *2.2.2 Other food system agents survey draws from several disciplines*

197 No pre-existing tool was identified for evaluating the resilience nor the sustainability of downstream  
198 value chain actors. Consequently, a novel instrument was developed, integrating insights from 13  
199 theoretical frameworks. The resilience component drew inspiration mainly from the work of (40).  
200 Other used frameworks are (37,41–44). The sustainability component incorporated several  
201 perspectives from the United Nations Environment Program (45) and the City Region Food System  
202 Indicator Framework from the RUAF Foundation (46). More rarely, we have used the following  
203 frameworks : (47–51)

### 204 **2.3 Sampling**

#### 205 *2.3.1 Clustering approach at farm level*

206 Capturing the diversity of farming systems through a typology is crucial for understanding them (52).  
207 To build it, we relied on area and livestock data of each farm provided by the cantonal department

208 for agriculture and geoinformation. Through this method, it is only possible to capture farms that  
 209 receive subsidies. We made sure that all the farms of the valley receive subsidies.  
 210  
 211 In the provided database, there are more than 100 crop and animal categories, which we  
 212 consolidated into 12 production categories (supplementary material n°2) before applying the  
 213 Hierarchical Classification on Principal Component (HCPC) method (53). This method resulted in 5  
 214 groups, with one encompassing 75% of the region's farms, primarily small ones. We conducted a  
 215 second round of clustering to refine the identification of farms within this dominant group. The  
 216 resulting groups (Table 2) and the selected farmers for interviews were then reviewed and adjusted  
 217 in consultation with the valley's farmers' union president. We interviewed 13 farms.

<b>Description of the farm</b>	<b>Area (ha)</b>	<b>N° of farms in this category</b>	<b>Sampled</b>
Berries and Arboriculture	~10	2	1
Medium size mixed farms (grassland, cereals, horticulture, beef, dairy, sheep)	13 - 60	29	4
Medicinal and aromatic plants	~50	2	2
Large farm (cereals, beef, and dairy)	>100	1	1
Small farm (arboriculture)	1 - 3	2	0
Small sheep breeder	0.5 - 2	10	1
Small farm (cereals, grassland, and other animals)	0.2 - 2.5	6	1

Horses breeder	0.5	3	0
Small beef producer	1 – 2	7	1
Small milk producer	1 – 2	7	1
Small Mixed farms	0.1 – 1.5	67	1

218 Table 2 Clustering of the farms of the Valposchiavo

219 2.3.2 Snowball sampling for processing and retail companies

220 Interviewees were selected using a snowball sampling  
 221 method, starting with the farmers' buyers and  
 222 ensuring that the value chains and locations were  
 223 adequately represented.  
 224 Companies disconnected from regional value chains  
 225 that could not be reached through snowball sampling  
 226 have also been included in a second round of  
 227 interviews to reflect reality better.

228 Of the 19 processing and/or retail companies in the  
 229 valley, 10 sell or produce 100% Valposchiavo products.

230 We interviewed 7 of them. We also interviewed 5 companies that do not produce or sell products.

100%(Bio)Valposchiavo: regional development project aiming at strengthening regional food value chain through cooperation between regional agriculture and tourism.

100% Valposchiavo: territorial brand for products and dishes which ingredients are grown and transform in the valley.

100% Valposchiavo charter: restaurants must offer at least 3 dishes labeled by the 100% Valposchiavo brand.

Fait sü in Valposchiavo The product must undergo at least one main manufacturing process in Valposchiavo and at least 75% of the added value must be generated in Valposchiavo.

Type of company	Produce/sell 100% Valposchiavo products	N° of companies in this category	Sampled
Processing	Yes	2	2
	No	2	1
	<i>Total</i>	<b>4</b>	<b>3</b>
Retail	Yes	2	1

	No	5	3
	<i>Total</i>	<b>7</b>	<b>4</b>
Processing & Retail	Yes	6	4
	No	2	1
	<i>Total</i>	<b>8</b>	<b>5</b>

231 Table 3 Description of the process and retail companies in the Valposchiavo

232 Source: own elaboration

233 Of 12 interviewees, 3 are exclusively processors, 5 process food and sell at least a share directly in  
 234 their shop, and 4 are only retailers.

235 2.3.3 Random sampling for food service industry

236 Due to the importance of gastronomic tourism in the region and its role in the regional economy, it is  
 237 necessary to include restaurants in the regional food system. Through their choices, they influence  
 238 the development of regional value chains (for example the development of a 100% Valposchiavo  
 239 mozzarella for pizzas).

240 The gastronomy sector is considerably more pronounced in Poschiavo's municipality than in Brusio.  
 241 We completed 6 interviews with different restaurants in several settlements of the valley. 3 signed  
 242 the “100% Valposchiavo” charter and the 2 remaining planned to do so in the coming months or  
 243 year. The last one did sign “100% The Valposchiavo” and did not plan to do so.

244 From Brusio, we interviewed one restaurant that has not signed the 100% Valposchiavo charter and  
 245 does not plan to sign it.

246

<b>Signed the 100% Valposchiavo charter</b>	<b>N° of companies in this category</b>	<b>Sampled</b>
Yes	13	3
No	10	3

247 Table 4 Description of the restaurants in the Valposchiavo

248 Source: own elaboration

249 2.3.4 Ethnocentrism survey to non-representative sample of consumers

250 Consumers are the final actors in value chains and are vastly over-represented compared to other  
251 stakeholders. Consequently, we are not seeking to assess their resilience since the disappearance of  
252 one of them will have a negligible impact on the RFS. Instead, we aim to evaluate their influence on  
253 the RFS. Through their food choices, consumers considerably influence how food is produced,  
254 processed, packaged, and sold (54). Consumers' purchases must be regionally grown and  
255 transformed to influence the RFS to which they belong. To measure consumers' supply of food  
256 produced as close to home as possible and their willingness to buy regional food, we used the  
257 concept of ethnocentrism.

258 Ethnocentrism is based on the assumption that people who identify strongly with their nation or  
259 region prefer domestically produced food over imported food (55). Following the CETSCALE method  
260 (56), consumers were asked to indicate their level of agreement with each statement using a 7-point  
261 Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

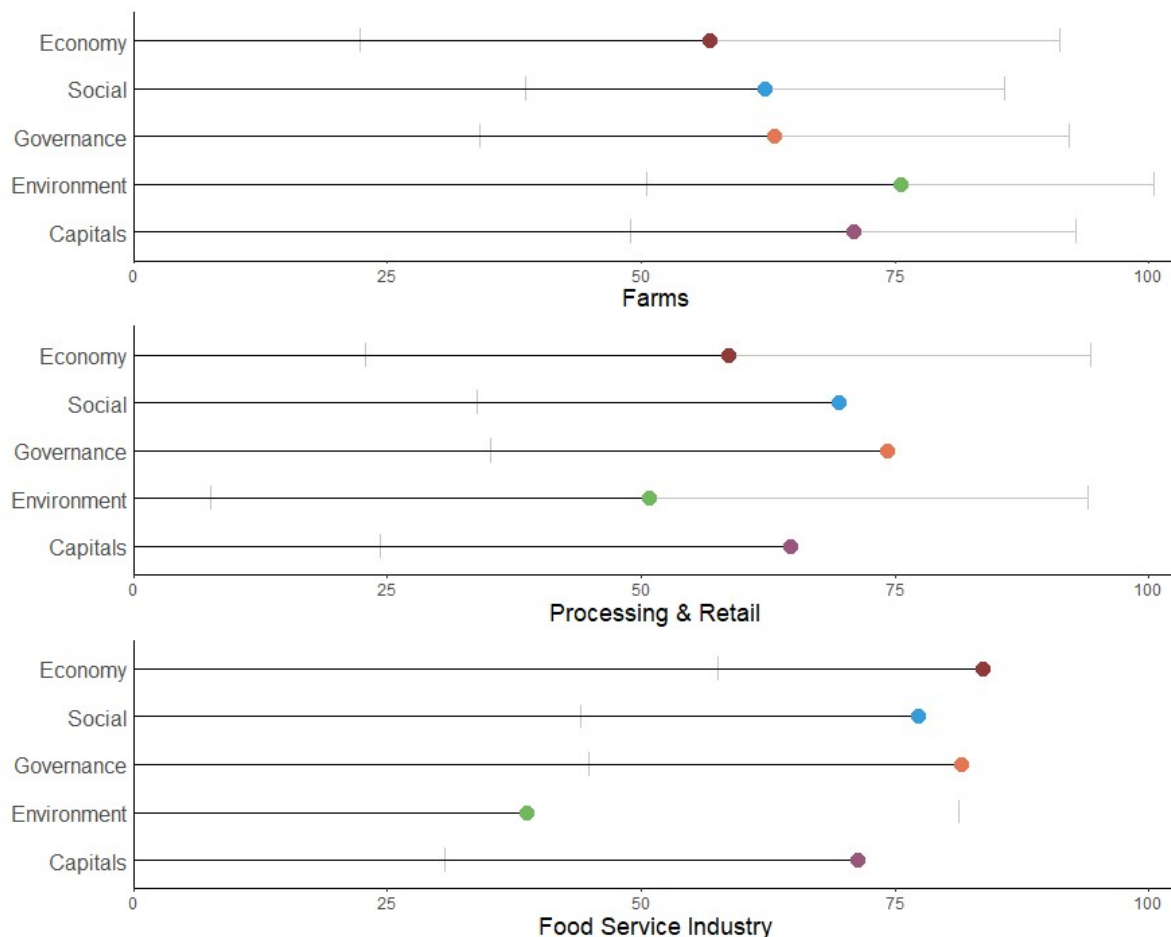
262 Consumers interviewed were selected randomly among clients in front of 2 grocery shops in the  
263 village of Poschiavo during an afternoon on a regular weekday. 15 consumers out of 4,500  
264 inhabitants in the valley (57) accepted to be interviewed.

265 2.3.5 Reasoned sampling for the institutions

266 We conducted interviews with the policy sector, including the tourism director of the region, the  
267 person responsible for the development of the *Regione Bernina*, and the coordinator of the 100%  
268 (Bio) Valposchiavo regional development project. To provide insights from a political standpoint, we  
269 also interviewed a communal counselor from Poschiavo and the mayor of Brusio.

## 270 3. Results

### 271 3.1 Synthesis



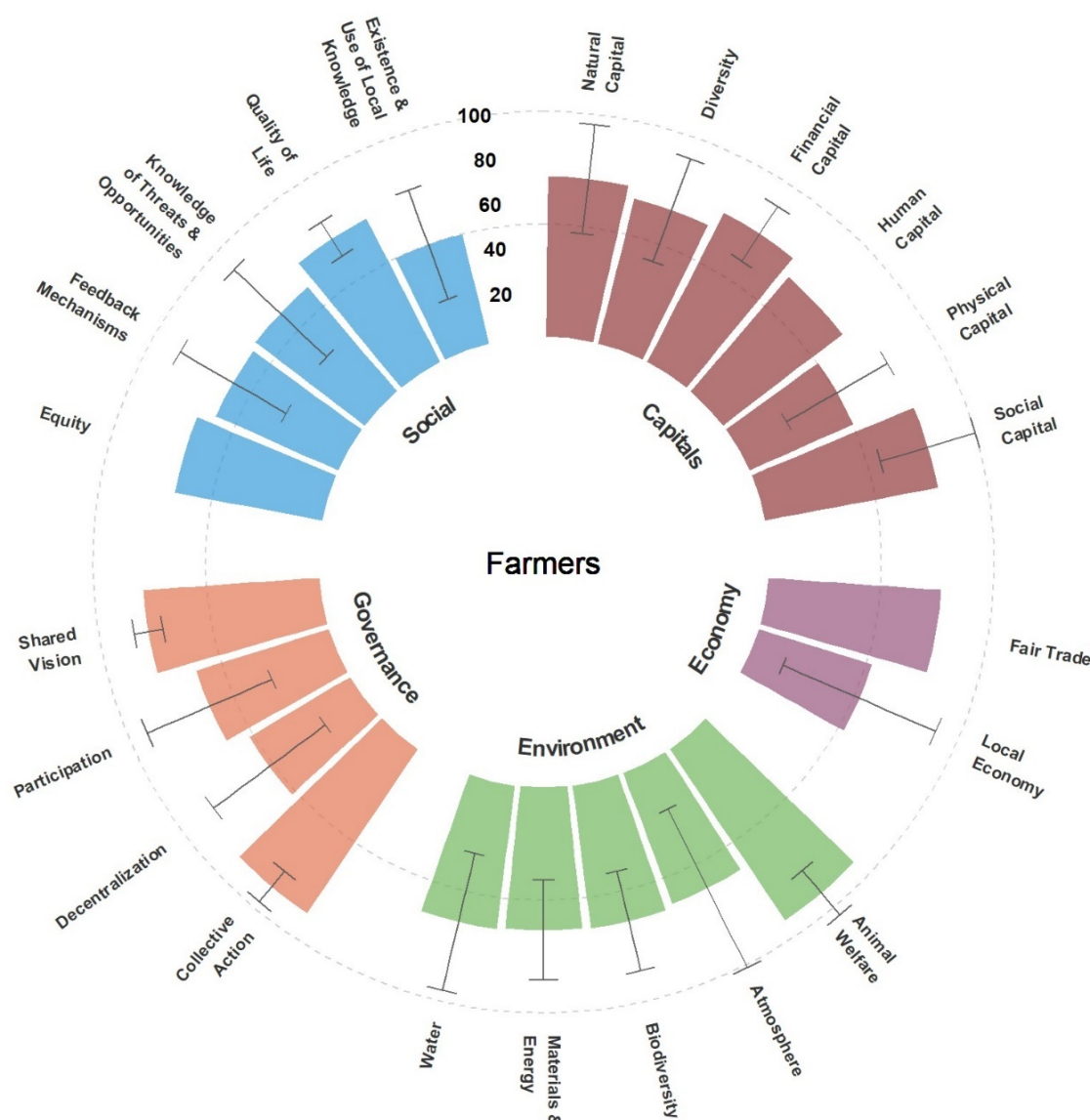
272  
273 Fig. 3 Scores for the 5 dimensions of resilience of regional food system actors (excluding consumers).  
274

275 Error bars represent the standard deviation.

276 The evaluation of the resilience of 13 farms in the Valposchiavo across the five dimensions defined in  
277 the theoretical framework showed a great performance regarding their resilience; indeed, scores  
278 range from 57/100 to 76/100. Scores for processing and retail companies are more balanced but still  
279 depict remarkable resilience, ranging from 51/100 to 74/100. The food service industry severely lacks  
280 resilience in the *Environment* dimension (39/100) but is excellent when looking at the other  
281 dimensions as all scores are above 70/100.

281 The remarkable success of actors in the Social and Governance dimensions can be partly attributed  
282 to the 100% (Bio) Valposchiavo initiative. This project aims to strengthen the local agrifood value  
283 chains and enhance the population's socio-economic well-being by utilizing territorial resources and  
284 by establishing a territorial brand. This project, in addition to the high level of cooperation between  
285 farmers and the elevated trust within local value chains significantly helps the RFS to be resilient  
286 regarding *Social* aspects and contributes to its good governance.

287 **3.2 Farmers**



288  
289 Fig. 4 Scores for the resilience of farms (N = 13). Error bars represent standard deviation



290 Farmers in the Valposchiavo region demonstrate satisfactory performance, consistently achieving  
291 scores above 50/100 across all sub-dimensions, with notable excellence in *Animal Welfare* and  
292 *Collective Action*.

293 They score over 66/100 in nearly all *Capitals*, indicating an ability to withstand crises. The  
294 comparatively lower score for *Physical capital* (50/100) can be partially attributed to land insecurity  
295 as a substantial portion of their land is leased, and few have certainties about its long-term  
296 availability. Their farms demonstrate a noteworthy *Financial Capital* (75/100), facilitated by selling  
297 organic products at premium prices, which they perceive as sufficiently lucrative for their operations,  
298 as evidenced by the high *Fair Trade* sub-dimension score of 77/100.

299 The region's climatic conditions, characterized by cold and rainy weather, coupled with  
300 predominantly pasture-based land use, contribute to high scores in all *Environment* sub-dimensions,  
301 ranging from 62/100 to 92/100. Additionally, the valley's hydropower generation and widespread  
302 organic certification further reduce their environmental footprint.

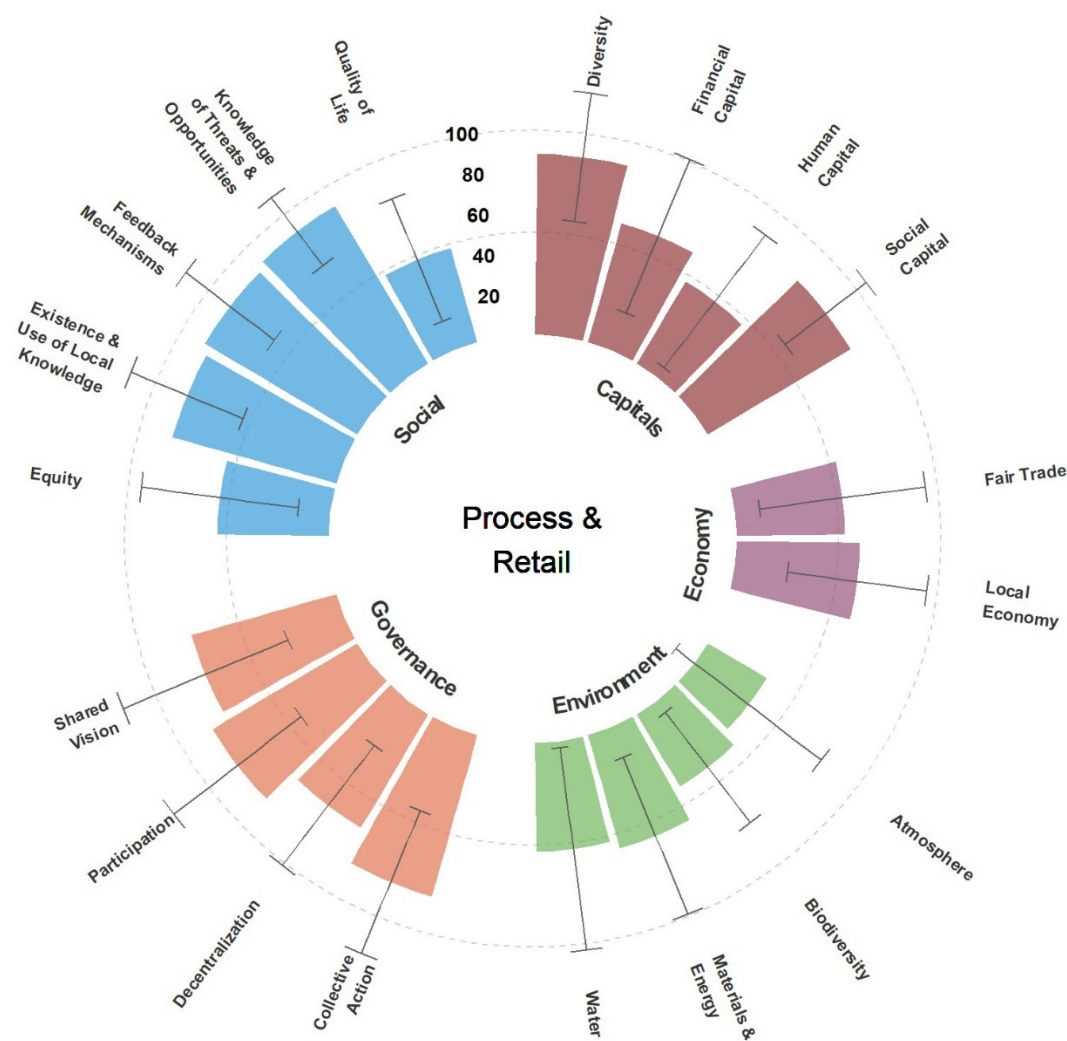
303 Despite the 100% (Bio) Valposchiavo project, a tangible manifestation of a *Shared Vision* (78/100) for  
304 the RFS, a significant portion of agricultural production, mainly beef and cheese, is marketed outside  
305 the valley. This export-oriented approach is reflected in a score of 53/100 for *Local Economy*, which  
306 would probably be worse without the project focusing on strengthening local agrifood value chains.

307 The extended participation of farmers in the project, in addition to an intense collaboration and  
308 participation in several interest groups, professional or not, explains the excellent score of 88/100 in  
309 *Collective Actions*.

310 Valposchiavo's farmers are mostly independent regarding fertilization, procurement of young  
311 animals, and feed. However, they are very dependent on subsidies and inputs such as oil, workforce,  
312 or vegetal seeds, mitigating the score of *Decentralization & Independence* to 52/100.

313

### 3.3 Processing and Retail



314

315 Fig. 5 Scores for the resilience of process & retail companies (N = 12). Error bars represent  
316 standard deviation.

317 The processing and retail companies in the Valposchiavo demonstrate remarkable resilience  
318 capacities, scoring above 50/100 across most sub-dimensions. Renowned for its oeno-gastronomic  
319 tourism (32), Valposchiavo's 100% (Bio) Valposchiavo project exemplifies a collaborative initiative  
320 involving agriculture, local trade, and tourism, significantly enhancing the resilience of processing and  
321 retail entities. The project enjoys support from various associations, including farmers' associations  
322 from Poschiavo and Brusio, the local trade association, and the gastronomy association. These

323 entities share a *Collective Vision* (74/100) for the future of the RFS and actively promote the  
324 *Participation* (82/100) of local companies.

325 Tourism plays an important role, enabling processing companies to leverage *Local Knowledge*  
326 (83/100) by producing traditional recipes like buckwheat pasta and black bread. This initiative  
327 supports the *Local Economy* (60/100) while fostering connections with restaurants and retail  
328 establishments to establish robust local agrifood value chains. The collaboration among retailers,  
329 processors, and restaurants contributes to the high *Social Capital* (81/100) observed in these  
330 companies.

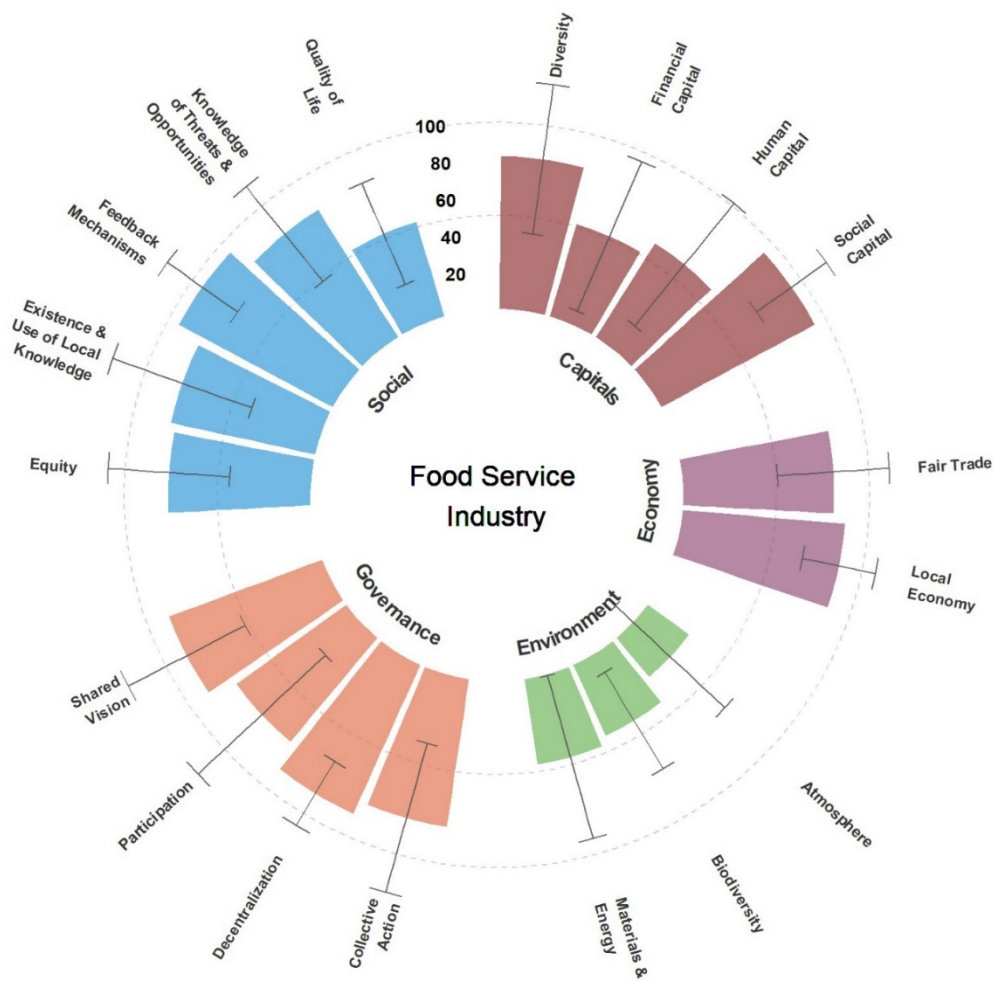
331 Yet, processing and retail companies face challenges in the *Environment* sub-dimensions, showing  
332 below-average performance scores ranging from 33/100 to 58/100. Insufficient measures are in  
333 place to reduce energy and water consumption, as well as minimize packaging usage, impacting  
334 *Water* (53/100), *Atmosphere* (33/100), and *Material & Energy* (58/100) sub-dimensions. The  
335 presence of organic products, mainly sourced regionally, significantly influences *Biodiversity*  
336 (41/100), while companies obtaining them from outside the region, often due to price or availability  
337 considerations, negatively impact their performance on the *Local Economy* subdimension.

338 The limited share of organic products further influences the *Quality of Life* (39/100), aggravated by  
339 companies infrequently offering fresh local products at affordable prices. Enhancements in *Equity*  
340 (55/100) and *Human Capital* (47/100) could be achieved through increased participation of women  
341 in production and decision-making processes. The low attendance to extension or continuing  
342 education days diminishes the potential to rely on *Human Capital* to withstand crises.

343 Despite these challenges, processing and retail companies excel in the other social subdimensions  
344 such as *Feedback Mechanism* (87/100) or *Knowledge of Threats and Opportunities* (90/100). Indeed,  
345 all companies reported exchanging frequently with their customers and suppliers, actively seeking  
346 insights into markets, funding, and projects to adapt their business strategies in response to  
347 emerging threats and opportunities.

348

### 3.4 Food Service Industry



349

350 Fig. 6 Scores for the resilience of the food service industry (N = 6). Error bars represent standard  
351 deviation

352 The food service industry of Valposchiavo can be considered resilient against shocks and stresses as  
353 companies consistently score above 50/100 across most sub-dimensions. However, challenges  
354 persist in the *Environment* dimension where scores range from 27/100 to 46/100. In restaurant  
355 kitchens, insufficient measures to reduce energy and water consumption, along with the limited  
356 presence of organic dishes on menus, contribute to a *Quality of Life* score of 53/100. The wage levels  
357 and dish prices also influence this dimension.

358 The 100% (Bio) Valposchiavo project and the oeno-gastronomic tourism boost Social, Economic, and  
 359 Governance dimensions. This initiative embodies a *Shared Vision* (88/100) for the future of the RFS,  
 360 fostering *Local Economy* (88/100) and encouraging *Participation* (73/100) of restaurants in shaping  
 361 the desired future.

362 The *Human Capital* sub-dimension (59/100) lower score is attributed to the lack of participation in  
 363 ongoing education and in challenges to find qualified workers within the valley. The significant share  
 364 of women in decision-making roles positively contributes to this score.

365 Regarding *Financial Capital* (51/100), the score is driven by the absence of long-term supplier  
 366 contracts, considered a potential risk. Additionally, moderate debt levels and a global increase in  
 367 business revenue over the previous 5 years contribute to this Capital.

368 3.5 Consumers

Item Statement	Mean (/7)	Standard Deviation
I have the impression that in The Valposchiavo, there is a common direction on the kind of food we have and we want to make in the future	5,6	1,3
Products from outside the Valposchiavo should only be bought when Poschiavin equivalents are not available	5,5	1,6
Products from the Valposchiavo come first and foremost	5,2	1,7
A true Poschiavin should always buy products made in The Valposchiavo	5,3	1,6
A Poschiavin should not buy products from outside the region since it harms Poschiavin companies and causes unemployment	4,7	1,9
It may cost me in the long run, but I prefer to support Poschiavin products	6,0	1,4

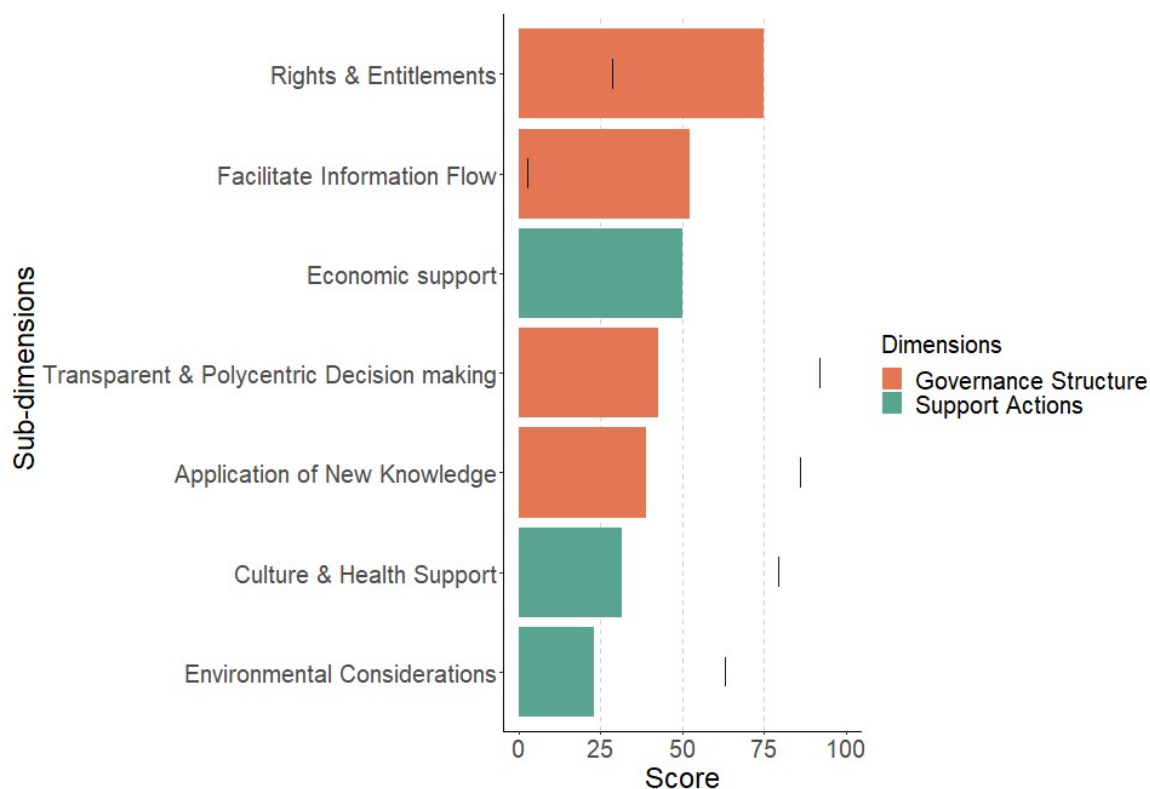
Poschiavin consumers who purchase products made in other regions are responsible for the job losses of fellow Poschiavin	5,1	2,0
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369 Table 5 Questions and scores of ethnocentrism of The Valposchiavo consumers (N = 15).

370 Adapted from (58)

371 The response of Poschiavin consumers indicates a high degree of ethnocentrism and, therefore, a  
 372 high willingness to consume local products even if it costs them in the long run. This is confirmed by a  
 373 survey conducted by regional institutions on 250 inhabitants in May 2020, which shows that almost  
 374 all interviewees are willing to pay more for local products.

375 [3.6 Institutions](#)



376  
 377 Fig. 7 Scores for the resilience of regional institutions (N = 5). Error bars represent standard deviation

378 The resilience of the RFS is inadequately supported by Institutions, with satisfactory scores in only  
 379 one sub-dimension and scores below 50/100 in four out of the seven subdimensions.

380 Regional institutions excel in *Rights and entitlements* (75/100). This is attributed to the support for  
381 actors starting new businesses, especially women, minorities, or youth. Regardless of company size,  
382 stakeholders have an equal chance to participate in decision-making.

383 While direct financial support from institutions to stakeholders is lacking, they do provide valuable  
384 time and advice for building projects. Unfortunately, there is a scarcity of monitoring for the  
385 effectiveness of the offered support. In addition, the absence of a designated person responsible for  
386 the region's food strategy limits information accessibility despite claims of widespread  
387 communication about new projects or opportunities. The deficiency in actions to *Facilitate*  
388 *Information Flow* is reflected in the score of 53/100.

389 *Economic Support* (50/100) for small enterprises in the food system is limited, except for renewable  
390 energy installations. However, financial and advisory assistance is available for food-related  
391 community initiatives, such as festivals and educational activities, as evidenced by the "Field to  
392 Table" program for school children.

393 While regional institutions in the Valposchiavo inadequately address the nutritional well-being of  
394 their residents—failing to provide assistance for low-income families to obtain fresh and locally  
395 grown food, thereby potentially causing food insecurity—they, on the contrary, actively support the  
396 culinary culture in the valley. The promotion of food festivals and the emphasis on local value chains  
397 are at the core of the tourism marketing of the valley.

398 On the one hand, regional institutions insufficiently support the food-related health of their  
399 inhabitants. There is no support for low-income families to access healthy food, which could lead to  
400 food insecurity for some inhabitants of The Valposchiavo. In addition, regional policymakers do not  
401 actively promote dietary awareness campaigns. On the other hand, regional institutions strongly  
402 support the food-related culture in the valley: food festivals and local value chains are the core of the  
403 tourism marketing of the valley. These factors together result in a *Cultural and Health Support* score  
404 of 32/100.

405 Regarding the *Environmental Considerations* (40/100), regional institutions have taken some  
406 measures to promote waste reduction. There is financial support for installing solar panels by the  
407 municipalities or a higher policy level (cantonal or federal government). However, there are currently  
408 no specific laws or incentives at the regional level to reduce energy or water consumption in the food  
409 system actively and, therefore, to reduce its environmental impact.

410 There is a *Transparent and Polycentric Decision Making* (44/100), as every stakeholder can  
411 participate in the decision-making process, and each has the same power. Nevertheless, the lack of a  
412 structured strategy for food loss and waste prevention and the facilitation of access to healthy,  
413 locally grown food for low-income families hampers the subdimension's performance.

414 The 100% (Bio) Valposchiavo project is monitored, but a systematic approach to track the results  
415 over a more extended period is lacking. Regular feedback on the project could foster new knowledge.

416 Communication on the results could enhance the *Application of New Knowledge* (37/100) and  
417 *Facilitate the Information Flow*.

## 418 4 Discussion

419 This section showcases (i) the results of the assessment of the Valposchiavo food system and (ii)  
420 identifies leverage points for enhancing the resilience and sustainability of the RFS. It also shows the  
421 improvement to be made to go from pilot project to finished product.

### 422 4.1 Evaluation of the resilience of the regional food system

423 In the following text, we will analyze how the cultural, agronomic, and economic characteristics of  
424 the Valposchiavo contributed to the resilience of its food system.

#### 425 **A sustainable development approach.**

426 Since 2008, the UNESCO World Heritage designation of the railway connecting the valley to Italy and  
427 Switzerland has evoked a sense of pride among residents, motivating them to safeguard the valley's  
428 *natural* (e.g. landscapes) and *physical* (e.g. infrastructures) *capital*. This distinction catalyzed a *shared*  
429 *vision* of a sustainable approach to the development of their region (32) triggering the launch of the



430 100% (bio) Valposchiavo project in 2019, which aims to promote regional value chains and organic  
431 products (31). Furthermore, empirical evidence from interviews indicates that this endeavor has  
432 promoted the *social capital* of RFS actors, fostering increased collaboration — a phenomenon  
433 corroborated by (33) — and *collective action* at the regional scale, thereby fortifying the resilience of  
434 the RFS.

#### 435 **Organic farming is a long tradition in the valley**

436 Organic farming, an agriculture “inspired by natural processes and cycles” (59) is rooted in a long  
437 tradition in the valley since the 1980s. As of 2022, over 90% of the cultivated land is certified by Bio-  
438 Suisse (33). Interviews showcased that organic farming increases the *natural* and *agronomic capital*  
439 of cultivated lands', reduces the farms' *material and energy* consumption, and limits their impact on  
440 the *atmosphere*. Moreover, it promotes reliance on *local and traditional knowledge* while improving  
441 farmers' health and *quality of life*. Organic farming directly fosters the resilience of all the  
442 environment sub-dimensions and, indirectly, other sub-dimensions from the economic and social  
443 dimensions.

#### 444 **Cultural shared values bring visibility and spill-over effects on other sectors**

445 Several authors (31,32,34) corroborate our observations in the Valposchiavo: the valley hosts a rich  
446 and lively cultural tradition centered on food, leveraging *its local traditional knowledge* and  
447 organizing cultural activities around it. Festivals celebrating regional specialties like black bread,  
448 chestnuts, and wild herbs, alongside a living museum showcasing ancient rural life or culinary events,  
449 such as pizzocheri-making, exemplify this tradition. These events directly foster the resilience of the  
450 RFS by making use of its *traditional knowledge*. In addition, it increases the visibility of the valley,  
451 attracting more tourists.

#### 452 **Local organic food consumption has multifaceted consequences.**

453 As a result of these festivals, the UNECO certification, and the 100% local (bio) Valposchiavo project,  
454 Valposchiavo became a trendy niche tourism destination (33) known for its 100% Valposchiavo

455 territorial brand. This has led to a surge in *financial capital* businesses and an overall economic  
456 upturn in the *local economy*. Although not explicitly stated by interviewees, the development of this  
457 type of tourism may have indirectly promoted *fair-trade practices* in the valley, incentivizing the  
458 regional food industry to purchase local products at a higher price and avoiding price competition  
459 with lowlands and foreign producers. The region boasts a *diverse* agriculture to meet the demand for  
460 the many 100% Valposchiavo labeled products directly contributing to the *economic* and *governance*  
461 dimensions of the resilience. Additionally, the predominance of organic farming in the valley  
462 enhances environmental sustainability, which is unique to this region, as local food production  
463 doesn't always have a positive environmental impact. (60).

464 These factors should not mask some limitations which are still under works:

465 **Increasing local food consumption, a difficult solution to reduce the vulnerability**

466 The 100% Valposchiavo project, promotes regional supply chains and enhances resilience for many  
467 companies, yet also poses vulnerabilities, particularly in reliance on tourism revenue for some  
468 enterprises. Interviews, supported by (33), highlight the project's role in fostering business  
469 *independence* from external factors but also inadvertently shifting dependence to tourism, reducing  
470 overall resilience. Addressing this may involve increasing local food consumption by inhabitants and  
471 not only by tourists. Competition from cheaper and more diverse products across the Italian border  
472 is a constant challenge that put pressure on the local food system, especially between local supply  
473 and demand.

474 **A greater need in workforce**

475 The regional development initiative amplifies challenges concerning *human capital*. Numerous  
476 businesses, including farms, processing facilities, and restaurants, face difficulties attracting skilled  
477 workers. Dependence on cross-border workers presents a vulnerability, as experienced during the  
478 COVID-19 pandemic when border closures disrupted workforce mobility. Additionally, there is a

479 notable lack of engagement in ongoing education or extension programs among both managers and  
480 employees, which could otherwise improve performance in diverse areas, such as *energy* efficiency.

#### 481 **Challenges for environmental consideration**

482 It is noteworthy that in a region emphasizing organic farming and environmental conservation,  
483 stakeholders beyond farmers and institutions exhibit limited environmental performance. Despite  
484 our surveys evidencing the widespread adoption of organic farming, hydroelectric energy, and  
485 regional food production among businesses across sectors, efforts to mitigate greenhouse gas  
486 emissions and conserve energy and water are notably absent. One possible explanation is that facing  
487 abundance, there is a perceived lack of necessity for restriction. While processors and retailers  
488 demonstrate efforts in waste recycling, initiatives to reduce waste, such as through mindful  
489 packaging choices, are seldom pursued. These characteristics impede the resilience of the RFS.

#### 490 **Equity and wages in the food system**

491 In the context of the 100% (bio) Valposchiavo initiative or the valley's organic food emphasis, not all  
492 aspects of food system resilience are directly correlated. Although many companies employ women,  
493 their participation in decision-making roles tends to be limited. While implementing a quota for  
494 women in decision-making may not be as relevant for small-scale companies such as those in  
495 Valposchiavo as it is for larger corporations, efforts should be made to enhance *equity* throughout  
496 regional value chains to promote overall resilience. Our analysis did not reveal significant wage  
497 disparities between men and women in the region. Nevertheless, it is notable that Valposchiavo  
498 remains one of Switzerland's economically poorest regions of Switzerland (61). Despite assertions  
499 from managers regarding adherence to local wage norms, there exists a potential for social  
500 desirability bias to influence responses. The regional development initiative holds potential to uplift  
501 salaries in the area by fostering a robust local economy, thereby potentially enhancing residents'  
502 *quality of life* and fortify their resilience.

## 503 4.2 Increasing resilience and sustainability of the food system: role of 504 governance and policies

505 Enhanced institutional efforts are imperative to fortify the resilience of the food system. While  
506 institutions possess a sound *structure*, they provide limited *support* to food system stakeholders. For  
507 instance, although a hospital exists, municipal and regional authorities fail to communicate  
508 information regarding diet and health effectively. Furthermore, regarding environmental  
509 stewardship, institutions offer minimal assistance in enhancing energy and water efficiency and  
510 minimizing waste generation of structures. However, there are positive strides as institutions are  
511 actively engaged in certifying the valley as Switzerland's first organic region.

### 512 **Integrated food policy for more coherence**

513 The United Nations Environment Program (45) suggests that an integrated food policy may become  
514 increasingly important for the resilience and sustainability of food systems. Currently, as confirmed  
515 by (31), the region predominantly views food through an agricultural lens, neglecting the myriad of  
516 interconnected food-related issues such as education and health. To address this, appointing a  
517 dedicated overseer for a comprehensive approach in Valposchiavo could be advantageous. Presently,  
518 while a single individual manages the 100% (Bio)Valposchiavo project, there is no overarching  
519 authority responsible for the entire food strategy of the region. Mandates are compartmentalized  
520 across agriculture, tourism, and industry. Furthermore, monitoring mechanisms to assess the  
521 project's impact are notably absent, though initiatives are underway to initiate the monitoring soon,  
522 as reported by the project manager. Such monitoring would facilitate the *application of new*  
523 *knowledge* to public policy and tourism. The region would benefit from additional policies related to  
524 food waste prevention or dietary health, particularly within the *environmental* sector, as this would  
525 enhance its resilience.

### 526 **Facing the lack of human capital**

527 One prominent difficulty farmers, processing and retail companies, and restaurants face is a lack of

528 *human capital*. Key concerns include the necessity for expanded ongoing education opportunities  
529 among stakeholders and the difficulties encountered in securing qualified personnel, leading to a  
530 reliance on cross-border workers. One potential solution involves broadening the scope of the  
531 competence center for ongoing education role to encompass educational offerings relevant to food-  
532 related occupations for stakeholders. Meanwhile, policymakers acknowledge the recruitment  
533 challenges and the importance of cross-border labor. In response, regional government and  
534 municipalities are implementing initiatives to attract Italian workers to settle in Switzerland while  
535 concurrently enhancing the region's appeal to young professionals (62).

### 536 **Partially addressing the consequences of climate change**

537 Interviewees highlighted changes compared to their youth, such as glacier retreat, a higher tree line,  
538 and new crops, mainly olive trees, cultivated in the valley. As of 2022, none of the interviewees have  
539 reported adverse impacts from climate change. However, concerns persist regarding water scarcity  
540 from glacier melt and amplified natural hazards. Institutions have yet to formulate strategies to  
541 effectively address the repercussions of climate change on the valley. The "Valposchiavo 2040 Vision"  
542 (63) singularly addresses water scarcity as a consequence of the climate crisis. Still, institutions need  
543 to translate this vision into an actionable plan extended to other consequences like increased natural  
544 hazards to enhance valley resilience in the forthcoming plan.

### 545 **4.3 Limitation and next steps**

546 Building the institutions assessment survey proved to be our endeavor's most difficult aspect. While  
547 a vast body of literature explains the best theoretical governance models for resilient and sustainable  
548 organizations (43,64–67), we encountered a scarcity of studies on the governance of food systems in  
549 Northern countries (17,29,30). Moreover, we encountered difficulties in fully capturing the diversity  
550 and richness of the interviews through closed-ended questions. Despite our efforts, we only partly  
551 overcame this challenge, as most of the gathered information could not be transformed into scores  
552 and had to be analyzed qualitatively. We recommend collaborating with policy analysis experts to  
553 refine the survey and improve reliability.

554 The approach for consumer assessment differs from that of other agents in that we focus on  
555 assessing consumers' food security and the implications of their purchasing decisions on the system  
556 rather than analyzing their resilience. Achieving a balance between minimizing sampling bias to  
557 encompass opinions of consumers purchasing locally and abroad, spanning various age groups and  
558 economic strata, while also managing the time required to reach participants and the survey length  
559 posed significant challenges. Moreover, reluctance among many citizens to divulge their health  
560 status to unfamiliar individuals further complicated the data collection process. Therefore, we  
561 advocate for a reevaluation and suggest leveraging available regional-level data, if accessible, to  
562 supplement the required information. Unfortunately, in Valposchiavo, such data were unavailable.

563 To fine-tune the approach, verify its adaptability to other contexts, and deliver a more precise state  
564 of the system, we recommend testing this assessment tool in diverse regions of Switzerland, such as  
565 the "Plateau" or the Jura. Additionally, leveraging external data sources, especially health data, is  
566 recommended to further fortify the tool's reliability. These data could be sourced from a national  
567 platform like the one Les Greniers d'Abondance established in France (68). This platform could  
568 consolidate valuable information and facilitate communication regarding food system resilience to  
569 the public and institutions.

## 570 5. Conclusion

571 Overall, our approach has proven to contribute successfully to operationalizing RFS resilience  
572 assessment, highlighting that Valposchiavo's food system is resilient and sustainable. The framework  
573 provides an adequate measurement of the situation and highlights the weakest elements of the  
574 system in which policy interventions are particularly necessary. In Valposchiavo, it highlighted that  
575 processing & retail companies and restaurant practices are not environmentally sustainable enough  
576 while having good performances in the economic and social dimensions. Capitals to withstand crises  
577 were evaluated to be moderate. One must remember that sustainable development and resilience

578 building are a never-ending process, and a maximum score on all dimensions is neither attainable nor  
579 realistic.

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