Long-Term Social Network Dynamics in the Revival of Organic Mountain Cereals in the Swiss Alps

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Abstract

Cereal cultivation has largely disappeared from high-altitude farming in the European Alps due to livestock specialisation and economic constraints. In the Swiss canton of Grisons, however, the Gran Alpin cooperative has revived organic mountain cereal production since the late 1980s. This study analyses the long-term development of the social networks that supported this revival, with a particular focus on the cooperative's role. Using longitudinal Social Network Analysis (SNA), we examined collaboration and information exchange among actors in three periods (before 1995, 1996–2009, 2010–2022). Data were collected through expert interviews and an online survey, complemented by actor perceptions of influence. The results show that both collaboration and information exchange networks expanded substantially over time. Collaboration became progressively more distributed across actors, while information exchange became more centralised around specific coordinating nodes. Local actors consistently outnumbered non-local actors, and their share increased to nearly 70% in the most recent period. At the same time, non-local actors remained structurally relevant within the value chain. Across all periods, the Gran Alpin cooperative occupied core positions in both networks and ranked among the most central and influential actors. By tracing more than two decades of network development, the study provides rare longitudinal insights into how collaboration, coordination, and actor roles evolve within a regional mountain value chain, highlighting the structural dynamics through which such initiatives are sustained over time.

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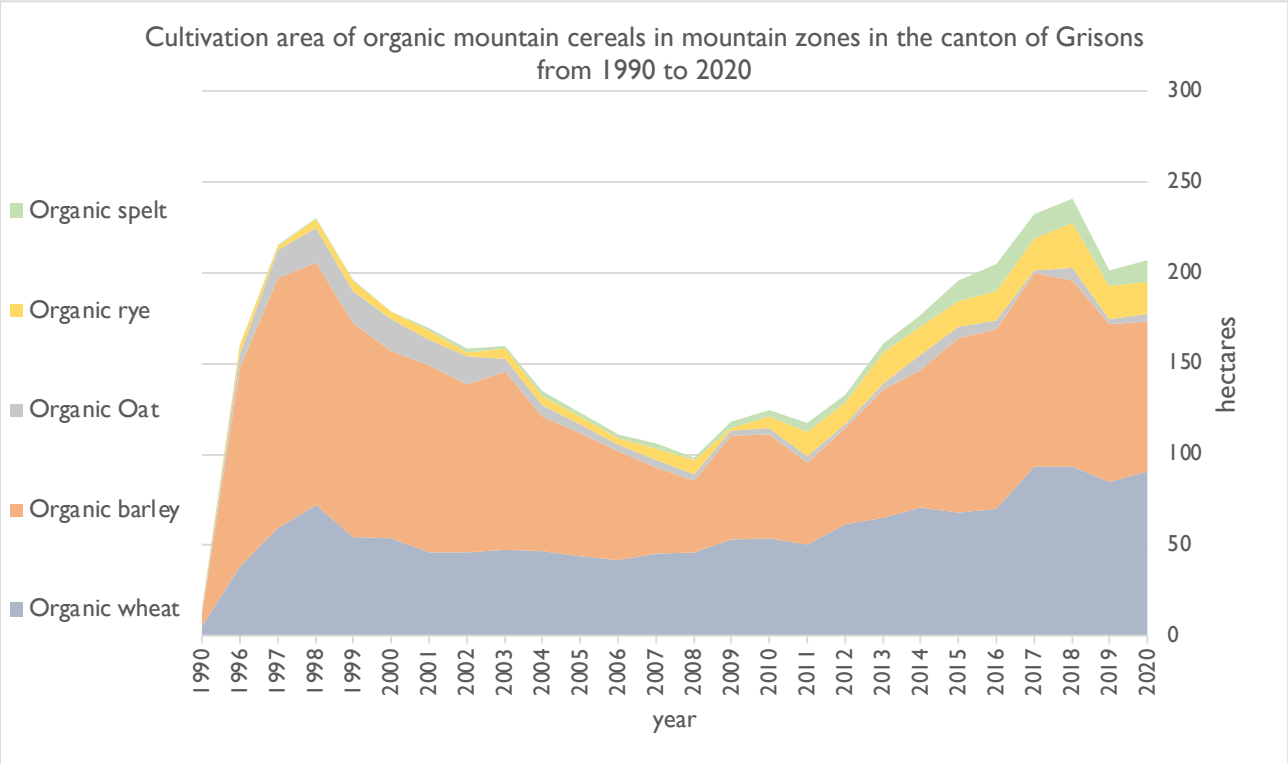
Introduction

Mountain regions, and the European Alps in particular, are among the areas most vulnerable to climate change. Swiss alpine agriculture is already experiencing the effects of rising temperatures, shifting precipitation patterns, and changing growing conditions (Beniston, 2012). These pressures underscore the urgent need for feasible adaptation strategies and resilient farming systems. However, alpine farming systems in Switzerland have become highly specialised in livestock production (Federal Statistical Office, 2025). In contrast, diversified farming systems in mountain areas are increasingly recognised as a key strategy to buffer against environmental and economic shocks (Wyss et al., 2022).

The reintroduction of cereal production in a rural alpine region of Switzerland, namely the canton of Grisons, serves as an example of a successful diversification strategy. This region is characterised by valleys with flat lands and slopes of varying steepness. Large-scale, mechanised cultivation of cereals is not competitive in the Alps because of topographic barriers and lower yields (Rudaz & Debarbieux, 2014). These barriers, along with other factors, have meant that diversified agriculture combining livestock husbandry and crop production was progressively abandoned, despite having been practised for sustenance until the middle of the 20th century (Moschitz & Oehen, 2020).

Historical grain farming in Grisons dates back to 4800 BCE (Schilperoord, 2012) but has declined sharply since the 1980s, when federal cereal subsidies were phased out (Moschitz & Oehen, 2020). In this context, the Gran Alpin cooperative emerged in 1987 to promote mountain cereals as a traditional, sustainable, and diversified production opportunity alongside livestock (Bardsley & Bardsley, 2014). After decades of decline, cereal production in this alpine region has been reintroduced and restructured through the Gran Alpin cooperative, combining historical knowledge with organic standards and market demand for local products. Figure 1 shows a strong increase in land use for the cultivation of organic cereals in Grisons from 1990 to 1997, followed by a decline from 1997 to 2008, with the lowest point in 2008 (Federal Statistical Office, 2022). Since 2008, the cultivation of organic cereals has increased, with wheat and barley being the most cultivated grains (Federal Statistical Office, 2022).

Figure 1: The area under cultivation of organic cereals in Grisons from 1990 to 2020.



Data Source: Federal Statistical Office, 2022

This study analyses the development of social networks that have supported the revival and expansion of organic mountain cereal cultivation in the canton of Grisons, with a particular focus on the role of the Gran Alpin cooperative. Using Social Network Analysis (SNA), we examine patterns of collaboration and information exchange among actors involved in this regional value chain over three distinct time periods since the 1990s.

Although Social Network Analysis (SNA) is increasingly used to examine regional food systems, it remains relatively novel (Rocker et al., 2022). Only a few studies provide insight into how food system networks evolve over time (Brinkley et al., 2021; Forrest & Wiek, 2021). To date, no research has been found that has examined a time period of over 25 years. This is especially true in the context of food-related innovation, where few studies trace the long-term dynamics of collaboration, flows of information, and actor centrality that contribute to resilient systems. In mountain regions, existing research often focuses narrowly on farm-level practices, overlooking how innovation is shaped by interactions across the entire value chain, including processing, retail, and support services. At the same time, while cooperatives are widely recognised as drivers of rural development, their role as central network actors remains underexplored. Finally, studies fail to include the integration of local and non-local actors, despite its importance for balancing place-based trust with access to wider resources, knowledge, and markets. This study addresses these gaps by analysing the evolution of collaboration and information exchange networks surrounding the revival of mountain cereal cultivation in the Swiss Alps, using the Gran Alpin cooperative as a central case.

To address these research gaps, we posed the following research questions:

- How have the structures of collaboration and information exchange networks evolved around organic mountain cereal production in the canton of Grisons since the 1990s?
- Which actors have held central or influential positions within these networks, and how has the social embedding of the Gran Alpin cooperative changed over time?
- How are local and non-local actors integrated into the network, and what patterns emerge in their collaboration and knowledge exchange?

This study examines the long-term development of collaboration and information exchange networks surrounding the organic mountain cereal value chain in the canton of Grisons. By focusing on network structural indicators such as density, centrality, and core-periphery patterns, the analysis documents how collaboration and information were exchanged across more than two decades.

Methodology

This study uses a longitudinal case study design to analyse the development of social networks supporting the cultivation of organic mountain cereals within the Gran Alpin cooperative in the canton of Grisons, Switzerland. The present study employs Social Network Analysis (SNA) methodologies to examine the evolution of collaboration and information exchange patterns among actors over a period of three decades. SNA provides a suitable methodological lens for analysing actor relationships, network structure, and centrality in complex network systems (Borgatti et al., 2024). The analysis draws on survey data collected from key actors involved in the mountain cereal value chain, covering three time periods that reflect key phases in the development of the Gran Alpin cooperative. The following sections outline the data collection process, network construction, and analytical procedures used in this study.

Data collection was carried out in two stages. First, five preliminary qualitative interviews were conducted to gain an overview of the value chain, validate the selected time periods, and identify actors involved in the networks for each respective period. The five interviewees were experts on the canton of Grisons and came from different organisations. Table 1 briefly describes each expert's function and background.

Table 1: The function and background of each expert in the preliminary qualitative interviews

Experts	Function and background information
Expert 1	• science background • worked for the research institution of organic farming • long experience in studying Grisons' organic farming development
Expert 2	• manager of the organic association of the canton of Grisons at the time of the interview
Expert 3	• manager of the Gran Alpin cooperative at the time of the interview
Expert 4	• former manager of Gran Alpin • founder of the association for alpine crops with crop and seed research activities
Expert 5	• consultant for organic and mountain cereal production from Grisons' agricultural education centre

Three time periods emerged from the preliminary interviews for collecting network data:
- First time period: before 1995
- Second time period: 1996–2009
- Third time period: 2010–2022

These periods correspond to different trends in the cultivation of organic mountain cereals, as seen in Figure 2. In the first time period, the cultivated area expanded, whereas it declined in the second period and expanded again in the third period (Federal Statistical Office, 2022). The SNA was thus contextualised with regard to periods of increasing and declining organic cereal production.

To define network boundaries, the recommended strategy by Borgatti et al. (2024) was used: first, an ego-network approach focusing on the Gran Alpin cooperative served as the starting point for mapping the network. Second, actors identified as important in five preliminary interviews with sector experts were included. This dual approach provided a pragmatic balance between analytical feasibility and empirical completeness.

In the second stage of data collection, an online questionnaire was developed to collect data for SNA using REDCap software (Vanderbilt University, 2022). In the analysis of networks within food systems, the examination of information exchange and collaboration networks is a prevailing practice (Rocker et al., 2022). In order to comprehend the patterns of information exchange within the network, actors participating in the questionnaire were requested to specify the recipients of the information they disclosed, and the sources from which they obtained information, for each designated time period. For collaboration networks, the participants were asked to specify the actors with whom they had collaborated during each specified time period. Furthermore, the participants were invited to identify the actors they considered to have had the most significant influence on the development of the mountain cereal value chain in each respective period. The questionnaire was structured in three parts: the first part included general information about their organisation; the second part encompassed network questions within the three time periods; and the third part involved external factors that influenced the networks, such as agricultural policy and land use competition. A pilot questionnaire was tested and reviewed by three researchers not belonging to the network sample. The final questionnaire was sent to all identified actors via email. A reminder was sent after two weeks to all those who had either responded incompletely or not at all.

The data analysis from the questionnaire followed the Graph Theory for SNA, a way to illustrate social networks in which actors are represented as nodes and relationships as ties (Borgatti et al., 2024). The data were transformed into adjacency matrices, which have columns and rows labelled the same way, representing connections with a value of 1 and a lack of connection with a value of 0 (Borgatti et al., 2024). This format is appropriate for SNA, allowing the software to create graphs and calculate other measures (Borgatti et al., 2024). All results were calculated and visualised using UCINET software (Borgatti et al., 2024). Within the software, attributes (characteristics linked to objects) were inserted and directly assigned to the actors.

For consistency, all graphs were drawn with the same attributes. Type of actor and influence were chosen as attributes, with the type of actor represented by different colours, and degrees of influence indicated by the size of nodes. SNA measures such as degree centrality, centralisation, average degree (d), density (D), core-periphery, and core-periphery fit (correlation) as in Borgatti et al. (2024) were calculated. In order to identify key actors (actors with significant influence), data from the questionnaire on particularly influential actors as well as measures of degree centrality and core-periphery were considered. To examine the structural dynamics of the networks, core-periphery structure analysis was conducted using UCINET. This approach identifies a densely connected core group and a more loosely connected periphery, measuring the extent to which the network conforms to this structure using a core-periphery fit coefficient (ranging from 0 to 1) (Borgatti et al., 2024). To explore individual actor positions, centrality measures were analysed as normalised degree (nDegree) centrality for collaboration and out-degree (nOutDegree) centrality for information exchange. While core-periphery structure analysis reveals structural roles in the network as a whole, centrality metrics indicate how prominently individual actors are positioned in terms of their direct connections (Borgatti et al., 2024). High centrality scores were seen as indicating actors playing a central role in facilitating collaboration or disseminating information. In addition to structural and positional metrics, the questionnaire also asked respondents to identify actors they considered particularly influential within the mountain cereal value chain. This qualitative perception of influence adds a third layer of insight, complementing the empirical network measures.

Directed networks were used for information exchange networks in order to detect the flow of information with an arrow, whereas collaboration networks were drawn as undirected.

Networks were visualised according to the three time periods. Following the example of Rocker et al. (2022), actors were divided and visualised according to their role within the value chain (VC actors) and support actors. In the context of data protection, the actors are depicted with distinct attributes, without the disclosure of their precise names. Additionally, local actors (situated in the canton of Grisons) were indicated with darker colours, whereas brighter shades of the same colour represented non-local actors (active throughout Switzerland).

A common challenge in collecting network data via online questionnaires is the issue of missing responses (Rocker et al., 2022). In this study, missing ties were reconstructed under the assumption of reciprocity: that is, if one actor reported a collaboration or information exchange with another, the tie was treated as bilateral. This allowed for the reconstruction of incomplete networks. To mitigate the risk of biased centrality measures, the survey included an additional question asking respondents to identify actors they considered particularly influential, thereby complementing the structural measures with perception-based data.

Results

The following section presents the results of the social network analysis conducted to examine collaboration and information exchange among actors involved in the organic mountain cereal value chain within the Gran Alpin cooperative. The analysis is structured according to the three identified time periods. Key findings are presented in terms of network development, actor centrality, and the evolving roles of local and non-local actors. The results are organised around the two types of relationships examined: collaboration and information exchange, complemented by an analysis of influential actors and core-periphery structures.

Overall, the data revealed a steady increase in the number of actors across the three time periods analysed. As seen in Table 2, 20 actors were identified for the first period (before 1995), 30 for the second period (1996–2009), and 41 for the third period (2010–2022). Across all periods, local actors consistently outnumbered non-local actors, with the disparity becoming most pronounced in the third period, where local actors accounted for nearly twice the number of non-local ones (28 vs. 13). Additionally, the composition of actors

shifted slightly over time: while the first period featured an equal number of value chain and support actors, the second and third periods showed a higher proportion of value chain actors.

Table 2: Number of local, non-local, value chain actors, and support actors in each time period, with percentages in parentheses.

		Before 1995	1996-2009	2010-2022
Total number of actors		20	30	41
Local actors	11 (55%)	19 (63.3%)	28 (68.3%)	
Non-local actors	9 (45%)	11 (36.7%)	13 (31.7%)	
Value chain actors	10 (50%)	17 (57%)	23 (56%)	
Support actors	10 (50%)	13 (43%)	18 (44%)	

Development of the networks of collaboration

The development of collaboration among actors across the three time periods is summarised in Table 3 and visualised in Figure 2, which illustrates the changing structure of the networks, including both value chain and support actors. Overall, the findings indicate a notable intensification of collaborative activity over time. This is reflected in the increasing number of actors involved, a rise in the average degree (i.e., the average number of collaborative ties per actor), and greater network density, all of which suggest a higher frequency of interaction among actors.

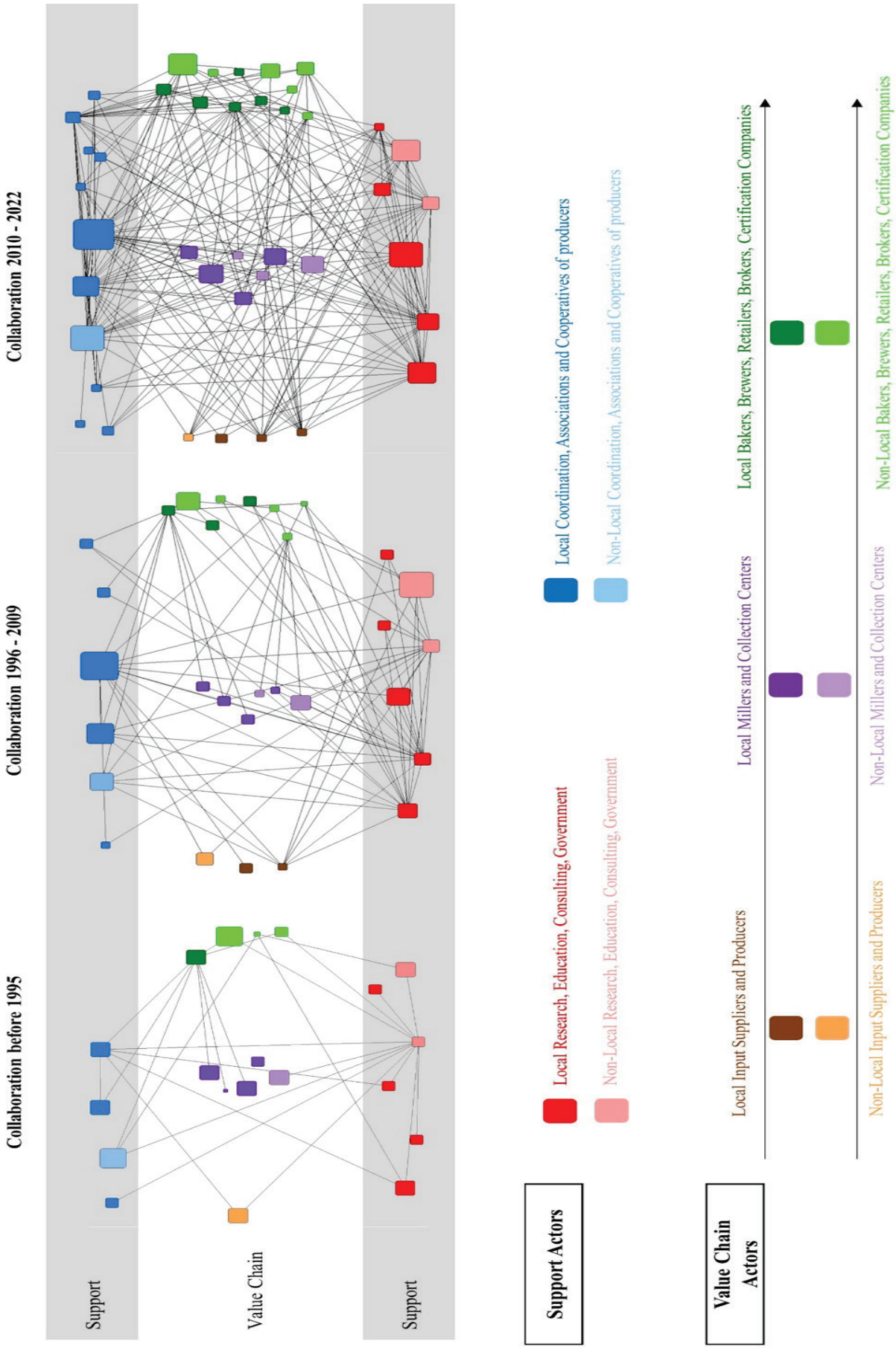
In the first time period (before 1995), the collaboration network comprised 20 actors, with a centralisation score of 0.544. The network density was relatively low at 0.14, indicating that only 14% of all possible collaborative ties were realised. A total of 54 ties were recorded, resulting in an average degree of 2.7.
In the second time period (1996–2009), the number of actors increased to 30. While the centralisation score remained relatively stable at 0.542, the network became more connected: density rose to 0.18, with 160 ties and an average degree of 5.3. This reflects a clear increase in collaborative engagement, even as the overall network grew.

By the third time period (2010–2022), the network had expanded to 41 actors. During this period, the centralisation score decreased to 0.497, suggesting a more evenly distributed pattern of collaboration. Network density increased substantially to 0.25, with 414 ties out of 1,640 possible, and an average degree of 10.1. These figures point to a highly interconnected and increasingly participatory network structure.

Table 3: SNA measures for the collaboration networks of each time period.

Collaboration	No. of actors	Centralisation	Density	No. of possibilities	No. of Ties	Avg. Degree
Before 1995	20	0.544	0.14	380	54	2.7
1996 – 2009	30	0.542	0.18	870	160	5.3
2012 – 2022	41	0.497	0.25	1640	414	10.1

Figure 2: The development of the collaboration networks drawn with NetDraw within the UCINET Software.



Development of the networks of information exchange

The development of information exchange networks over the three time periods is presented in Table 4 and visualised in Figure 3. These networks reflect how actors communicated and shared knowledge, complementing the patterns of collaboration discussed previously. Across all three time periods, the findings reveal a consistent increase in the number of actors involved, the density of information exchange, and the average number of ties per actor. In contrast to the collaboration networks, the information exchange networks became more centralised, indicating the growing importance of particular actors in facilitating knowledge flows within the value chain.

In the first time period (before 1995), the network included 20 actors, with an out-centralisation score of 0.404 and an in-centralisation score of 0.349. The network density was 0.14, corresponding to 54 realised ties and an average degree of 2.7 per actor. These figures suggest a relatively sparse network, with moderate levels of centralisation around a few key sources and recipients of information.

During the second time period (1996–2009), the number of actors increased to 30. The out-centralisation score rose slightly to 0.413, while in-centralisation decreased to 0.306. Network density also increased marginally to 0.15, with 133 recorded ties and an average degree of 4.4.

In the third time period (2010–2022), the network expanded further to 41 actors. Centralisation increased, with an out-centralisation score of 0.612 and an in-centralisation score of 0.586. Network density rose substantially to 0.23, with 374 realised ties and an average degree of 9.1.

Table 4: SNA measures for the information exchange networks of each time period

Information exchange	No. of actors	Out-Centralization	In-Centralization	Density	No. of possible ties	No. of Ties	Avg Degree
Before 1995	20	0.404	0.349	0.14	380	54	2.7
1996 – 2009	30	0.413	0.306	0.15	870	133	4.4
2010 – 2022	41	0.612	0.586	0.23	1640	374	9.1

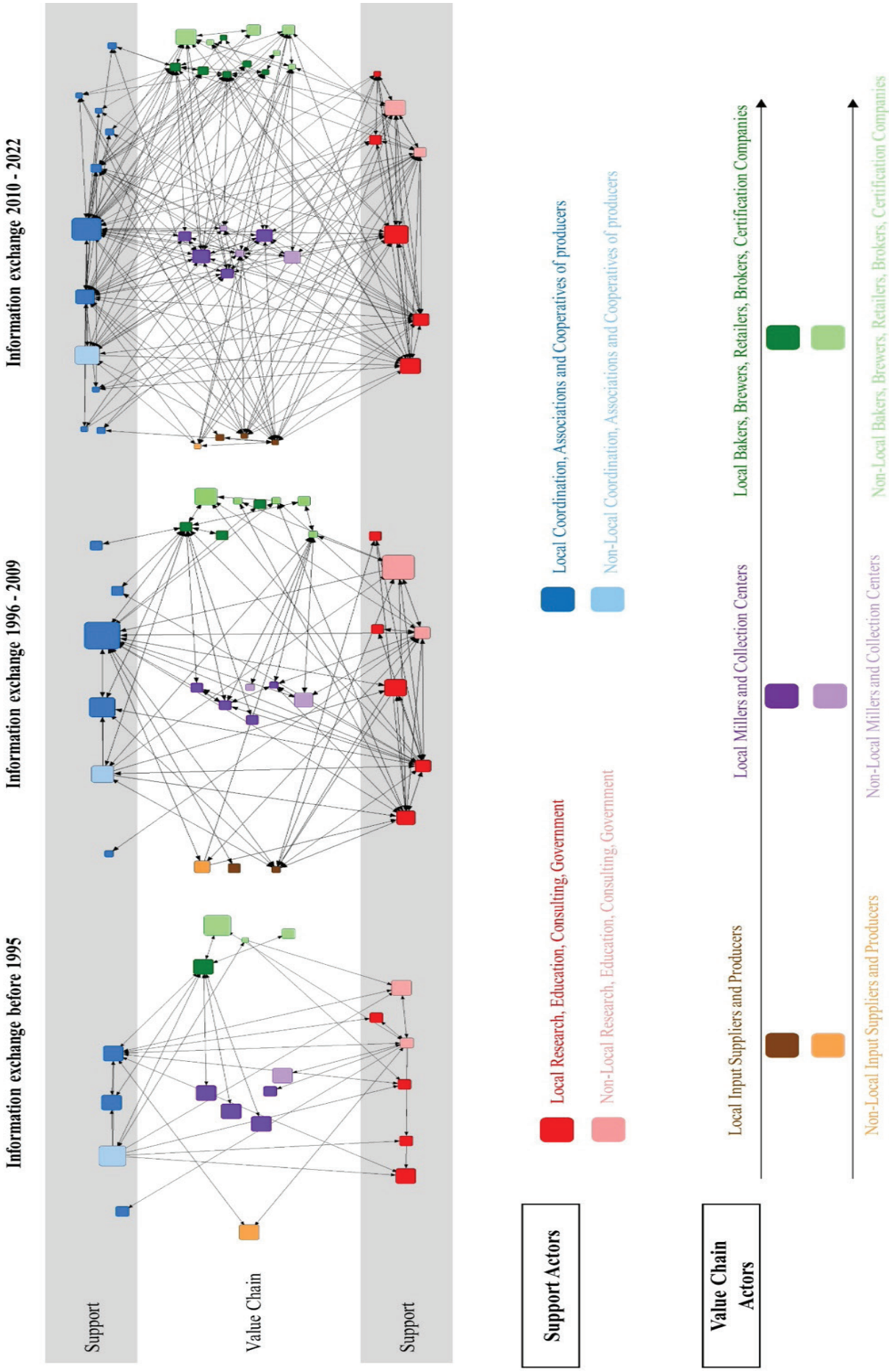
Key Actors and Network Structure: Core-Periphery, Centrality, and Perceived Influence

To better understand the roles and relative importance of actors within the mountain cereal networks, three complementary perspectives were applied: core-periphery structure analysis to examine structural roles, centrality measures to identify positional prominence, and survey-based assessments to capture perceived influence over time. These approaches provide a multi-dimensional view of how actor prominence evolved across the three time periods and help identify those actors most central to sustaining collaboration and information exchange.

Core-Periphery Structures

As shown in Table 5, the collaboration networks exhibited consistently strong core-periphery structures, with fit values rising from 0.70 in the first period (before 1995) to 0.77 in the second period (1996–2009), before slightly decreasing to 0.74 in the third period (2010–2022). The information exchange networks also showed strong fit values, with 0.73, 0.68, and 0.69 across the three periods respectively, indicating a well-structured yet slightly more distributed pattern of information flow.

Figure 3: The development of the information exchange networks drawn with NetDraw within the UCINET Software.



The composition of the core also evolved across time periods, as shown in Table 5. Initially, support actors dominated the core: for instance, in the collaboration network before 1995, 4 of 6 core actors were from support roles. By the third period, however, VC actors accounted for one-third of core members in collaboration and 40% in information exchange, reflecting a gradual broadening of influence from institutional support towards value chain participants such as producers and processors. The Gran Alpin cooperative was consistently identified as a core actor across all networks and time periods, reinforcing its central coordinating role.

Table 5: Core-periphery fit and core actor composition by time period and network type

Time Period	Network Type	Core-Periphery fit (correlation)	Core Actors (n Support, n VC)
Before 1995	Collaboration	0.7	6 (4 Support, 2 VC)
	Information exchange	0.73	5 (4 Support, 1 VC)
1996 – 2009	Collaboration	0.77	8 (6 Support, 2 VC)
	Information exchange	0.68	10 (6 Support, 4 VC)
2010 – 2022	Collaboration	0.0.74	15 (10 Support, 5 VC)
	Information exchange	0.69	15 (9 Support, 6 VC)

Centrality Measures

In the collaboration networks, three actors showed the highest nDegree centralities in the first period (0.63, 0.42, 0.32 (Gran Alpin)), including two local actors (one support and one VC) and one non-local support actor. In the second period, five actors were central (0.69, 0.52, 0.52, 0.45 (Gran Alpin), 0.41), four of whom were local. In the third period, centrality became more evenly distributed, suggesting a trend towards decentralisation. However, three actors showed the highest nDegree centrality (0.725 (Gran Alpin), 0.725, 0.625), all three identified as local support actors. The Gran Alpin cooperative consistently ranked among the most central actors across all three periods.

In the information exchange networks, nOutDegree centrality was used to identify actors most actively disseminating information. In the first period, four actors had high scores (0.53, 0.42 (Gran Alpin), 0.42, 0.42), including both local and non-local support actors. The second period showed a less distinct separation, but five actors still stood out (0.55, 0.45 (Gran Alpin), 0.41, 0.38, 0.31). By the third period, no sharp core was observable, yet several actors from earlier periods remained highly central, with Gran Alpin having the highest score (0.825). Gran Alpin maintained a high nOutDegree score throughout, reinforcing its function as an important key actor.

Perceived Influence

In the first period, two non-local actors were rated as most influential (75% each), with Gran Alpin receiving 50%. However, in the second and third periods, Gran Alpin emerged as the most influential actor, with scores of 80% and 56.5%, respectively. These perceived influence scores show the importance of Gran Alpin alongside other actors.

Discussion

This study analysed the long-term development of collaboration and information exchange networks surrounding the revival of organic mountain cereal cultivation in the canton of Grisons, with a focus on the central role of the Gran Alpin cooperative. The study provides insights into how actor relationships evolve in the context of a rural innovation process. While SNA has increasingly been applied in agri-food system studies (Rocker et al., 2022), longitudinal applications in marginal rural settings remain rare. Our findings contribute to closing this gap by tracing how both the structure and perceived influence of actors shift over time within

a regional agri-food network.

The findings reveal a steady expansion and densification of the networks over time, both in terms of actor participation and the number of collaborative and informational ties, indicating a growing social infrastructure. Similar patterns have been observed by Forrest and Wiek (2021), who describe increasing network complexity and diversification over time in a local cereal economy. More broadly, previous research has emphasised network expansion, actor diversification, and distributed influence as structural characteristics associated with adaptive capacities in agricultural innovation systems (Balázs & Aistara, 2018; Bruce et al., 2021; Hermans et al., 2015; Schermer et al., 2011; Soriano et al., 2023).

The rising number of ties in the collaboration network, combined with the declining centralisation score, indicates that collaboration has become less concentrated around a few central actors and has instead become distributed more broadly across the network over time. This shift reflects a transition towards a network in which a wider range of actors are actively involved in joint initiatives. The increased density in the most recent period further suggests the presence of a well-connected community of practice, involving both value chain and support actors.

In contrast, information exchange networks became more centralised, suggesting a concentration of communication flows through a smaller group of key actors. This dynamic can support coordination, but may also introduce dependency (Borgatti et al., 2024; Isaac, 2012). However, in the case of informational exchange, more centralised networks can be particularly efficient and successful for agricultural innovation systems (Hermans et al., 2015; Isaac, 2012). Additionally, Balázs and Aistara (2018) state that interpersonal sharing of knowledge and social relationships in regional networks are key to successful social innovations in alternative food systems.

The combination of increasing density and rising centralisation in the most recent period indicates that information exchange became both more extensive and more concentrated around specific actors. Structurally, this suggests a configuration in which communication is widely distributed across the network while certain actors occupy coordinating positions. Rather than representing a purely decentralised or hierarchical structure, the network exhibits differentiated roles within an increasingly connected system. Junquera et al. (2022) highlight the importance of local institutions and diverse social contacts in shaping information exchange in mountain farming regions. In the present case, the coexistence of multiple interaction ties alongside identifiable central actors suggests a network in which local embeddedness and coordination are structurally intertwined. The analysis does not assess the quality or effectiveness of these exchanges, but it documents how information flows were organised across actors over time. Taken together, the findings describe a network that became progressively more interconnected while maintaining distinct coordinating nodes within the information exchange structure.

Gran Alpin Cooperative as Network Key Actor

The analysis addressing the second research question shows that the Gran Alpin cooperative consistently occupied a central position across all three time periods and network types. It was repeatedly identified as part of the network core in both collaboration and information exchange networks, ranked among the highest actors in degree centrality measures, and was frequently perceived by respondents as influential. These structural indicators point to a sustained and prominent position within the evolving value chain.
The longitudinal perspective further reveals that Gran Alpin maintained this centrality despite shifts in network size, density, and actor composition. While collaboration became more distributed over time, the cooperative remained structurally well-connected, particularly in information exchange networks, where centralisation increased in later periods. This suggests that Gran Alpin functioned as a stable coordinating node within a changing network environment. The presence of a stable and persistent central actor has been discussed in the literature as a potential anchor for coordination and trust-building in agricultural networks (Bruce et al.,

2021; Schermer et al., 2011; Soriano et al., 2023). While the present study does not measure trust or social cohesion directly, the longitudinal stability of Gran Alpin's central position suggests that the cooperative provided structural continuity within the evolving network. Such continuity may facilitate coordination and sustained interaction over time, although assessing the quality of these relationships would require qualitative investigation. Additionally, previous qualitative research on the mountain cereal initiative has described Gran Alpin as an intermediary organisation linking producers, processors, research institutions, and market actors (Bardsley & Bardsley, 2014; Moschitz & Oehen, 2020). The structural findings of the present study align with these descriptions, as the cooperative appears positioned at the intersection of multiple actor groups. However, the network analysis captures positional prominence rather than internal organisational dynamics or decision-making processes.

Overall, the results indicate that Gran Alpin's role can be understood structurally as that of a persistent central actor mediating collaboration and information exchange across the value chain. While this centrality suggests an important coordinating function, the analysis does not directly assess how this position translated into strategic outcomes, economic performance, or resilience effects. Instead, it documents how one organisational actor maintained structural prominence within a network that otherwise became more diverse and distributed over time.

Local and Non-Local Actor Integration

The results on actor composition show a clear and increasing dominance of local actors within the mountain cereal networks, rising from 55% in the earliest period to nearly 70% in the most recent period. This pattern indicates that the network became more locally anchored over time. At the same time, non-local actors remained present and structurally relevant, despite their smaller number. Previous research on mountain cereal production in Grisons has similarly emphasised the combination of locally embedded actors with non-local partnerships (Moschitz & Oehen, 2020).

The perceived influence scores indicate that some non-local actors held important positions within the value chain, even when they did not appear highly central in the collaboration or information exchange networks. This suggests that influence in the system cannot be reduced to structural centrality alone, and that certain external actors may exert relevance through economic or institutional linkages mediated by Gran Alpin. Such mediation has been described in earlier analyses of Gran Alpin as an intermediary organisation connecting regional producers with national markets (Bardsley & Bardsley, 2014; Moschitz & Oehen, 2020).

The findings point to a structural configuration characterised by strong local embeddedness combined with selective integration of non-local actors. This pattern corresponds to observations in the broader literature on agri-food networks, which highlight the importance of balancing place-based cohesion with access to external resources and markets (Bruce et al., 2021; de Vries et al., 2022; Šūmane et al., 2018).

During interpretation of the results, we observed structural characteristics that resonate with conceptual frameworks such as Learning and Innovation Networks for Sustainable Agriculture (LINSA) (Moschitz et al., 2015) or retro-innovation (Zagata et al., 2020). The longitudinal network analysis revealed sustained interaction over time, increasing actor diversity, and the persistent presence of a stable intermediary. These features correspond to elements frequently associated with LINSA (Moschitz et al., 2015). While this study does not examine learning processes or governance dynamics directly, the documented network configuration suggests structural conditions under which such processes could emerge. Future research combining network analysis with qualitative approaches could explore these dynamics more explicitly.

Similarly, the case involves the revival and reorganisation of cereal cultivation in a region where it had largely declined. This trajectory aligns descriptively with what has been conceptualised as retro-innovation by Zagata et al. (2020). The present analysis demonstrates how this revival became structurally embedded in evolving

collaboration and information exchange networks, leaving further research on its cultural and narrative dimensions to future studies.

Limitations

While this study offers valuable insights into the long-term development of the mountain cereal value chain in Grisons, methodological limitations occurred during data collection and analysis. First, the reconstruction of historical networks relied on retrospective recall and self-reported survey data. As Borgatti et al. (2024) emphasise, network data depend on respondent accuracy and completeness, and missing or incomplete responses may bias the results, particularly for centrality measures, where actors may appear more or less influential than they actually are. Although network boundaries were set and five preliminary interviews validated actor lists and time periods, not all actors could be reached. The resulting networks therefore provide a well-grounded but inevitably partial picture of the system.

Second, while SNA is a powerful tool for uncovering structures of collaboration and information exchange, it is also subject to limitations. As Rocker et al. (2022) note, SNA captures formalised connections but cannot fully account for the quality, depth, or informal dimensions of relationships. Trust, conflict resolution, or tacit knowledge exchange, often crucial in agricultural innovation networks, are not directly measurable through structural metrics such as centrality or density. In this study, qualitative interviews and contextual information were used to address this limitation, but future research could benefit from mixed-method approaches combining SNA with ethnographic or longitudinal qualitative methods. Accordingly, concepts such as resilience, innovation, or adaptive capacity are inferred in this study from structural characteristics that have been associated in previous literature with such processes. The analysis does not measure resilience outcomes, innovation performance, or learning dynamics directly. Rather, it documents network configurations that may create favourable conditions for continuity and adaptation. A more comprehensive understanding of these processes would again require complementary qualitative approaches, including in-depth interviews, ethnographic observation, or longitudinal process tracing.

Third, a methodological decision concerns the treatment of the Gran Alpin cooperative as a single key actor. This choice was made to maintain analytical clarity and because the cooperative is widely recognised by other actors as a collective entity representing farmers, processors, and organisational structures. However, this aggregation inevitably obscures the internal dynamics of the cooperative, such as leadership changes, membership developments, or differences between organisational functions, all of which may have influenced the network's evolution. Critically, this issue should be considered already at the stage of data collection. Conducting additional interviews with central actors would allow a more nuanced reconstruction of how the cooperative's internal processes affected external network relations. Similarly, validating key network findings with these central actors could have provided a stronger empirical basis. Future research on cooperative-based networks should therefore reflect carefully on the appropriate level of analysis and consider several central actors for qualitative data collection. Additionally, future research should disaggregate such organisations into sub-units or roles to capture the internal complexity of cooperative action.

Finally, the scope of the study was intentionally limited to actors directly involved in the mountain cereal value chain. Broader groups such as consumers, tourism stakeholders, or policymakers were not included, even though they likely play a role in shaping the system. This choice was made to allow for a clearer analytical focus in line with the study's research questions, but it also constrains the comprehensiveness of the findings. Expanding the actor perspective in future research would help to capture the wider socio-economic embedding of mountain cereals.

Conclusion

This study examined the long-term development of the mountain cereal value chain in the Swiss canton of

Grisons using a longitudinal social network analysis. The results show that the networks of collaboration and information exchange expanded substantially over the three time periods, becoming denser and more diverse even during phases when cultivation areas decreased or stagnated. Gran Alpin consistently emerged as a structurally central and influential actor across all periods. The cooperative occupied core positions in both collaboration and information exchange networks and was repeatedly perceived as influential by respondents. At the same time, the broader network diversified, with influence and participation extending to a wider range of actors over time.

A key structural finding concerns the evolving composition of the network. Local actors outnumbered non-local actors in all periods, while non-local actors remained integrated as influential participants. The combination of strong local embeddedness and continued non-local linkages characterises the structural configuration of the value chain across the observed periods.

While resilience cannot be directly measured through SNA, the network developed structural features often associated with resilient systems, including higher density, distributed influence, and actor diversity. These features indicate that the system was able to maintain continuity and adapt over time, even under challenging structural and market conditions. By reintroducing cereal cultivation into a landscape dominated by livestock production, the network supported the diversification of agricultural systems and enhanced regional resilience. Although the case is unique in its history and institutional setting, it offers valuable insights for other mountain regions where diversification and resilience efforts are urgently needed in the face of climate and structural pressures. Future research combining structural network analysis with qualitative methods would be necessary to assess how actor networks influence learning processes, strategic adaptation, or economic performance.

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