Innovations in Cooperatively Organized Breeding Networks: Analysis of Cluster Structures in Dairy Cattle Breeding in Germany

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Abstract This article examines the innovation activity of cooperatives in dairy cattle breeding and especially the links between profitability, organization, and innovation in the case of Germany. The combination of an explorative approach and multivariate data analysis, of case studies and data from the official estimation of breeding values, is intended to provide a better understanding of the interdependencies. Our cluster analysis suggests a positive effect of network activity and innovation activity on the profitability of breeding companies. Our results imply that network organizations should be supported by the members. The insights on small cooperatives with a high number of shares per member reveal a second way that could combine the benefits of networks and small cooperatives: the establishment of networks and their splitting in strategic groups with a size-related distribution of shares per member.

1 Introduction

The future needs of the world food market challenge the Agribusiness. Changing consumer habits, national interests, and an increasing world population demand the adjustment of production. Animal breeding, standing at the beginning of the supply chain, contributes by providing improved breeds which meet the consumers' needs (Höhler and Kühl 2015; Höhler 2016). The resulting strong demand for high-quality genetics is accompanied by increasing globalization, enhanced innovative efforts (Napel and Veerkamp 2015), and tougher competition (Herold et al. 2012a) in the breeding market.

In 2012, livestock production accounted for 39% of the net production value in world agriculture. An important product segment is the production of fresh cow milk (FAO 2015b). Milk yield per cow is steadily increasing (FAO 2015a). This is

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especially remarkable as dairy cattle breeding is mainly organized by cooperatives (Bo 2005; Funk 2006), enterprises owned by a society of many independent downstream farmers. Cooperatives are seldom thought of as being a driving force for innovation. They rather often develop away from the traditional cooperative structures. Ownership rights are relaxed in the face of environmental and structural changes, increasing globalization and competition (Chaddad and Cook 2004). Nevertheless, breeding cooperatives with their traditional cooperative structures are still outperforming other organizational forms, particularly in Germany. Pelhak (2011) describes their position in the German market as a quasi-monopoly. As the theoretical considerations of Höhler and Kühl (2015) suggest, breeding cooperatives possess several economic advantages in cattle breeding compared to IOFs. Members provide genetic material in the form of breeding animals. The cooperatives choose the best animals and use them to produce semen. The free rider problems which are often discussed within the context of other sectors do not seem to exist. This is probably due to the special structure of the value chain and the related incentive mechanisms (Höhler and Kühl 2015). Genetic material is duplicated and sold back to the breeders. Breeders and cooperatives simultaneously act as buyers and suppliers within the market for genetic material.

Breeding within cooperatives allows the exchange of knowledge and information between its members while eliminating double marginalization. Innovation driving aspects are based on the pooling of risks, the reduction of information deficits, the exploitation of scale effects, the development of strategic resources, as well as the internalization of spillover effects (Höhler and Kühl 2015). Höhler and Kühl (2015) examine the revenue maximization of breeding cooperatives compared to IOFs from a theoretical point of view. The access to information about the members' breeding animals offers an economic advantage for cooperatives. More open information and constant interaction between the participating groups are considered as advantages for technological innovation (Teece 1996). Each member is able to use the advances made by the others and develop by himself. The underlying network structure, that is the differences, similarities and connections between agents, is crucial for the emergence of collective innovation, its speed, and the innovative performance at the aggregate level (Cowan and Jonard 2003; Teece 1996). While some breeding cooperatives address the abovementioned developments by an increase in network activity through cooperation with other breeding cooperatives, others still conduct their own breeding and marketing programs.

The impact of organization on innovation and thus on success in increasingly concentrated markets for intermediate products with limited protection of property rights offers an interesting field of research. Both, animal breeding and breeding success as the related intermediate good contribute to the adaption of production to changing demand conditions. Therefore, a deeper understanding of the connections and operating modes is necessary (see also Höhler 2016). We pose the following research questions:

– Are there any differences between the innovation activity, the organization, and the economic success of the established cooperatives that can provide strategic advantages?
– Can the organization in networks positively influence the innovation activity of cooperatively organized cattle breeding?
– How does the innovation activity influence a breeding cooperative's success?

This article examines the impact of organization on innovation activity in dairy cattle breeding and consequently the impact of innovation activity on profitability. Moreover, the increasing network activities between the cooperatives are taken into consideration. Case studies present an appropriate method for examining these complex relationships in a rather small sample of firms (Vissak 2010; Yin 2014). The combination of an explorative approach and multivariate data analysis, of case studies and data from the official estimation of breeding values, is intended to provide a better understanding of the interdependencies. We focus on Germany as animal production has above average relevance for the country's agricultural production value and so has the underlying innovation process. The market is characterized by the coexistence of independently operated cooperatives and network organizations of cooperatives. Differences between the organizations and consequences for their members, strategic possibilities, and policy implications are identified.

In order to understand the organization of animal breeding, the article begins with the explanation of the goals and tasks of breeding cooperatives. Section 3 provides a literature review. In Sect. 4, the explorative research approach is presented. Section 5 presents the results and the article ends with a conclusion.

2 Goals and Tasks of Breeding Associations

Breeding success is the sum of genetic improvements achieved at the level of the single breeders. The breeding population is the base for the selection of valuable breeding animals. Its size also influences breeding success. However, the increase in milk yield can be attributed to many factors (Höhler 2016). Examples are improved management skills and enhanced methods of feeding (Rendel and Robertson 1950).

The influence of breeding can be determined via breeding values. Breeding values describe the heritable influence of animals on their descendants' performance. They are estimated using performance data from the entire population as well as information on the progeny of the animal. The overall breeding value combines all relevant breeding values under consideration of their importance for the breeding goal of the population: breeding values for milk production, useful life, conformation, fertility, udder health, and calving traits. These breeding values consist of the evaluations of single characteristics. A breeding value of 100 refers to the average whereas values above 100 are desirable. The estimation includes a correction for environmental effects (DHV 2014). Recently published breeding values also contain genomic values based on the evaluation of animal genetic material. The overall breeding value has increased steadily (VIT 2015) which shows that the rise in milk yield is also a result of the breeding cooperatives' successful breeding work (Höhler 2016).

In Germany, systematic breeding via breeding organizations began at the beginning of the twentieth century (Pelhak 2011). Besides the achievement of scale effects in breeding organization, cooperative breeding associations facilitated the protection of developments and breedings of single breeders (Rothschild and Newman 2002). Breeding based on appearance and performance was complemented by the use of herdbooks. They contain pedigree data on the breeding animals and their descent.

The value chain in cattle breeding contains two reciprocally connected stages: breeding cooperatives and breeders. Breeding cooperatives coordinate breeding activities, select valuable breeding animals and buy them from their members, sell semen, and thus generate and spread innovation. They are oriented toward the breeding goals. Furthermore, they keep herdbook records, market genetic material, and consult their members. The members are buyers and sellers of genetic material. They use semen to produce dairy cattle, sell their valuable animals to the breeding cooperative, and participate in the breeding program. Furthermore, they provide equity capital, knowledge, skills, and information. Their activities influence the breeding success to different degrees and thus affect the future benefits and costs for all members (Höhler 2016).

In addition, the members have rights and obligations according to the cooperative law as well as the statutes of the breeding cooperative. They are obliged to acquire shares and pay a deposit on them, to take part in the breeding program, provide information about diseases as well as performance. In return, they are allowed to participate in the residual income and elect representatives (Höhler and Kühl 2015).

The German animal breeding law describes a breeding association in paragraph 2 as a corporate merger of breeders in order to promote animal breeding. A corporate merger can be realized in various legal forms. In most cases, breeding associations operate under the legal form of a cooperative. According to paragraph 6, every breeder in the breeding association's scope of activity has the right on admission. Herold et al. (2012b) understand the idea of cooperative breeding associations as a self-supply with high-quality breeding animals as well as the achievement of a joint genetic gain.

Over a long period, success of breeding associations was measured by genetic progress. However, breeding associations have tasks beyond the pure breeding work. These additional tasks can be evaluated with economic performance indicators. Grandke (2002) suggests that bulls have a significant influence on a breeding association's economic success. The share of top 50 bulls in the German estimation of breeding values is an indicator for their marketability and is thus proposed as an indicator of a breeding association's success. A single breeder is, moreover,

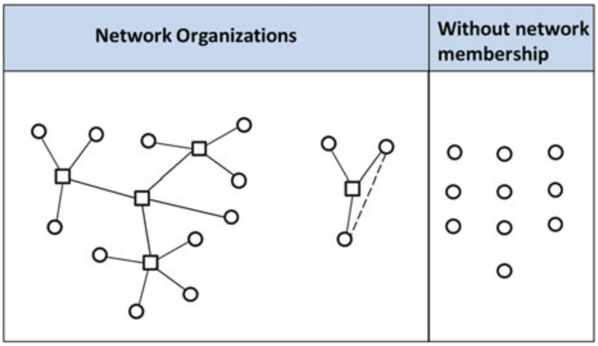

Fig. 1 Organizations in German cattle breeding 2015. Based on own research and Höhler (2016)

interested in improved milk yield and thus increased turnover as well as improved functional traits and decreased production costs (Höhler 2016).

Networks of breeding cooperatives are characterized by a pooling of breeding and marketing activities of the participating breeding firms. They are often organized in the legal form of a limited liability company (e.g., Masterrind GmbH, Rinderzucht Berlin-Brandenburg GmbH). As networks of firms, they coordinate in order to minimize costs and create value (Ménard 2004). The following (Fig. 1) shows the connections in 2015 between the breeding cooperatives whose breeding animals were listed in the German estimation of breeding values in December 2014 for black-and-white Holstein (VIT 2014). For the sake of completeness, their networks are also included even if they have no placement. The sector consists of exclusive groups. Each circle presents one company. The breeding companies in the right part do not belong to a higher-level network. The breeding companies in the left part have joint breeding networks. They can be described as star network according to Goyal (2009). The core contains a single node. The network organizations are pictured as squares which are connected to the member organizations. Three networks operate a joint network. The right network is characterized by an additional bilateral partnership between two of its members.

3 Cooperatives and Innovation Activity

The number of members provides information on the size of the cooperative in terms of the number of claimants. The higher the numbers of members, the larger is the base for the selection of valuable breeding animals and the resulting likelihood for innovation. Galizzi and Venturini (1996) found a positive relationship between size and innovation for US firms in the food industry: large firms have higher innovation rates than smaller firms. Our first proposition is:

Proposition P1 *The size of the breeding cooperatives has a positive influence on their innovation activity.*

Property rights are distributed among the members of the breeding cooperatives. As owners of the animals, breeders have the right to use the genetic material for breeding and the right to sell it (Tvedt et al. 2007). The property rights regarding their own breeding animals belong to the members whereas breeding success as the sum of genetic improvements belongs jointly to all of them. Property rights in a cooperative can be approximated by the members' shares. Their absolute height equals the number of individual claims toward the cooperative (Höhler 2016). An examination of breeding cooperatives' statutes (Höhler and Kühl 2015) shows that members often have to subscribe additional shares with an increase in the number of their first inseminations. The number of shares per member thus is an indication of the property rights allocation and the potential influence of single members on the breeding activities of the cooperative. Though members with more shares still have one vote, the patronage refund is divided according to patronage and a high number of first inseminations indicates a higher share of breeding animals in the whole population compared to the average member.

In the context of other sectors, cooperatives are seldom thought of as being a driving force for innovation (Höhler and Kühl 2015). According to Porter and Scully (1987), their reduced innovative efforts are mainly caused by their imperfect property rights structure. According to Cook (1995), free rider problems result if property rights are untradeable, unassigned, or insecure. Members do not bear the full costs and do not get the full profits arising from their actions. As a result, a lack of incentives inhibits investments in the cooperative. Furthermore, enhanced innovative efforts and increasing competition drive down the semen prices (Ogden and Weigel 2007) and thus the incentives for innovation. As a consequence of sector characteristics, intellectual property protection schemes like patents or copyrights do not protect or recoup expenses of the breeding companies' innovations sufficiently (Ogden and Weigel 2007). Classic breeding methods are widespread and thus not considered as innovative. A breeding animal cannot be replicated easily, which is why patents do not work either. But these schemes can also trigger underinvestment. In contrast to innovation barriers due to vaguely defined property rights, Heller and Eisenberg (1998) describe an "overallocation" of property rights. Too many owners block each other. This leads to the "tragedy of the anticommons" and an underuse of a common property resource. If a user needs access to multiple patented inputs to create the intended product, an underinvestment in desirable innovative activities is likely. The relationship between the allocation of property rights and innovation activity is thus unclear. We state a positive influence in our second proposition:

Proposition P2 *The allocation of property rights within the breeding cooperatives has a positive influence on their innovation activity.*

Why do farmers cooperate in innovation networks even though they can be considered as competitors? Braguinsky and Rose (2009) discuss the "neighboring farmer effect": farmers share information on innovations as they know that the output of any farmer is too small to change the market price. The effect can occur within a "sufficiently competitive market structure" (Braguinsky and Rose 2009,

p. 364). Höhler and Kühl (2015) analyze the impact of the internal relations between members and breeding cooperatives as well as the related decision rights on the revenue functions of the members. They show that member production decisions in the short run are equivalent to the decision behavior in a perfectly competitive market. In the long run, breeding cooperatives face a quality control problem. According to Höhler and Kühl, the cooperation of breeders facilitates the exchange of information on breeding and produces efficiency gains. Moreover, the breeding population can be seen as a strategic resource. Its rarity, limited imitability, and the lack of substitutes provide competitive advantages for the breeding cooperatives (see also Barney 1991).

D'Aspremont and Jacquemin (1988) show the influence of cooperation in research and development (R&D) in industries with few firms and R&D spillover effects on R&D expenditures. Spillover effects are caused if knowledge from one firm flows freely to other firms without being charged. D'Aspremont and Jacquemin analyze a two-stage game in a duopoly with a R&D and a production stage. They distinguish two forms of cooperation:

1. Cooperative research efforts bring competitors together. In the "precompetitive stage," they share basic information and efforts in the R&D stage but remain competitors on the product markets. A main intention is to protect intellectual property.
2. The second type of cooperation is an extended collusion between competitors, creating common policies at the product level. This extension is justified with difficulties of protecting intellectual property. The cooperating firms also control together the processes and products which result from their collaboration.

Transferred to breeding cooperatives, this means that cooperatively organized breeding as well as the higher-level networks of breeding organizations can be interpreted as cooperations in R&D (see also Höhler 2016).

By comparing situations with and without cooperation, D'Aspremont and Jacequemin show that the first type of cooperation increases expenditures in R&D and quantities of production if the spillover effect is large enough. In addition to spillover effects, network resources are crucial for the success of a network (Dyer and Hatch 2006; Wernerfelt 1984). Some authors demonstrate the positive effect of network effects on innovation (Dyer and Hatch 2006; Ahuja 2000). Sharing of risks, exploitation of scale effects, access to new markets, a new positioning in competition, as well as the sharing of R&D expenditures are considered as additional advantages of networking (2000). Suzumura (1992) criticizes the findings of D'Aspremont and Jacequemin. He emphasizes the competing effects of cost reduction through R&D and reduced R&D incentives through spillovers. Dyer and Hatch (2006) explain that knowledge transfers through networks entail the risk that knowledge spillovers to competitors with the same suppliers destroy the value of the transfer. Moreover, coordination problems and additional coordination costs may arise (Hagedoorn et al. 2000). The mentioned results lead us to our third proposition:

Proposition P3 *The cooperation of breeding cooperatives within a network has a positive influence on their innovation activity.*

Geroski (1994) finds a positive effect of the number of innovations on a firm's profitability. He considers that innovators are likely to be more flexible and adaptable than non-innovating firms. Their organizational structures seem to fit the challenges of change. At the same time, each innovation affects the structure of the market (Langinier and Moschini 2002). The success of breeding cooperatives influences the patronage refund. A positive feedback between the innovation activity and the incentivizing effect of patronage refund might exist. However, the above elaborated property rights problems might inhibit the incentivizing effect.

Proposition P4 *The innovation activity has a positive effect on the breeding cooperatives' success.*

Proposition 4 implies that size and network activity also have a positive impact on the breeding cooperatives' success.

Overall, there are innovation inhibiting as well as innovation driving aspects of cooperative organization. Property rights problems, the resulting free rider problem, and the lack of protection by traditional property right protection schemes point to an insufficient innovation activity of cooperatives. The cooperation in networks is likely to have a positive influence on innovation activity. Besides, innovation activity and profitability seem to be positively related (see also Höhler 2016).

Empirical results on the impact of networking on R&D in breeding cooperatives are missing so far. As the indicated relationships have not yet been examined for dairy cattle breeding and the necessary operationalizations are missing, we employ an explorative approach.

4 Methodology and Data

In order to examine the relationships between the different variables, we want to apply the case study approach proposed by Eisenhardt (1989). It allows the building of theories, constructs, and propositions from single or multiple cases. As an explorative approach, it builds on the examination of each variable as a separate entity. Afterwards, pairs of variables and their relationships are analyzed. Finally, groups of variables are examined via multivariate models. Data analysis should be based on a literature review and characterized by both, openness and skepticism (Hartwig and Dearing 1979). The methodology and sampling of the cases should be carefully justified (Vissak 2010).

Our sample contains eight cases from the population of breeding cooperatives and their networks in Germany, two networks of cooperatives and six cooperatives.[1] Different expressions of the network activity allow multiple comparisons.

[1]The same data set is also used in the German contribution Höhler (2016).

Therefore, cases were selected out of a sample of 30 firms according to average and extreme manifestations of this variable. Two cooperatives are not organized within a network, two cooperatives are member in one network and two are member in two networks as well as in a bilateral partnership. The investigated cases cover 68.7% of the top breeding animals in the official estimation of breeding values (black-and-white Holstein, December 2014). Our approach differs from previous studies on networking firms which often dealt exclusively with successful networks (Hagedoorn et al. 2000).

4.1 Measurement

For our data collection, we use multiple sources. The prior specification of constructs helps to measure them more accurately. Innovation is measured as the number of placements in the official estimation of breeding values as well as their ranking. As Geroski (1994) points out, innovation counts are a natural measure for examining innovative activity. Success is measured by profitability indicators which are calculated based on annual accounts. Organization is approximated by the number of members, the number of shares as well as the number of shares per member. Thereby, we consider scale effects as well as effects of the property rights distribution in our analysis. The websites of the breeding cooperatives are used as a source of information on network activity. Based on the related categories, we look for similarities and differences within and between the groups. Figure 2 shows the key figures as well as their assignment to the constructs.

Further developed representation according to Höhler (2016).

4.2 Descriptive Statistics

Table 1 shows our cases sorted by cooperation intensity. Cooperation intensity is determined by the number of ties within networks. The second column provides information on the type of network. Furthermore, the table contains the number of members and the number of shares in 2012 and 2013. For the network organizations, the number of network members is provided. The table shows that the cooperation intensity as well as the number of members and shares vary considerably from one cooperative to another. With one exception, all of the cooperatives lost members between 2012 and 2013. This is due to the structural change in agriculture. In some cases, the number of shares nearly equals the number of members, whereas in other cases, especially in the non-networking cooperatives, the number of shares is significantly higher than the number of members.

Table 2 provides information on annual profit, cash flow, and turnover in 2012 and 2013 (in thousand Euros). Based on data from the annual accounts, cash flow

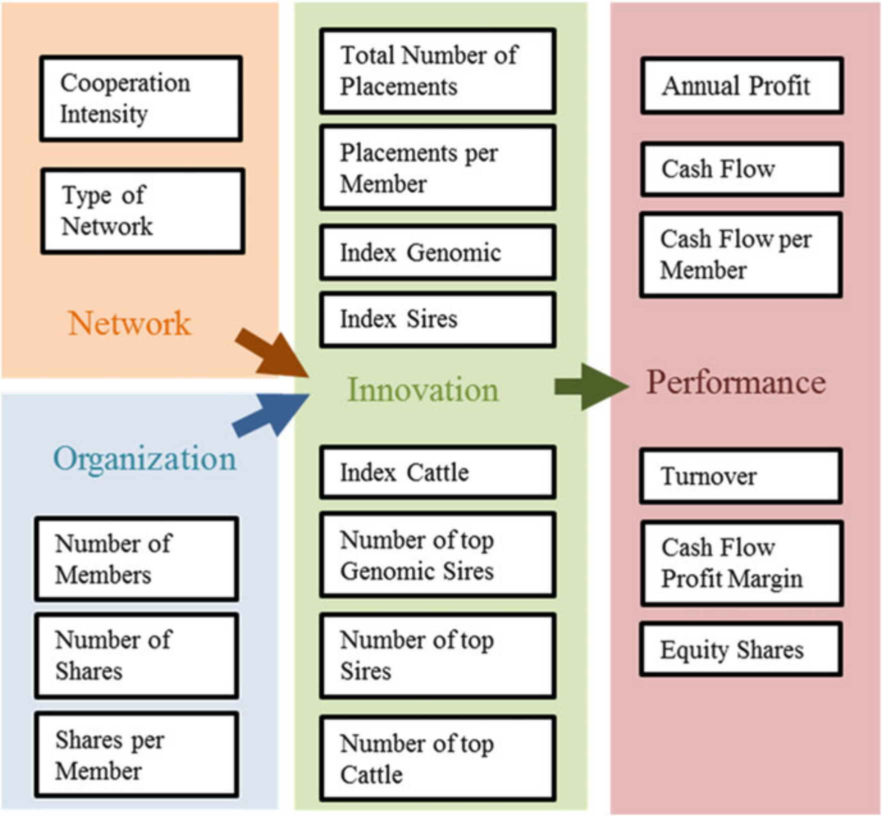

Fig. 2 Figures of the constructs to be analyzed

Table 1 Network and organization characteristics of the sample in 2012 and 2013

		Number of members		Number of shares	
Name	Type of network	2012	2013	2012	2013
Case 1	Network organization	3	3	–	–
Case 2	Network organization	3	4	–	–
Case 3	Bilateral partnership and one network	855	862	9206	9169
Case 4	Bilateral partnership and one network	25,612	25,281	25,771	25,446
Case 5	Member in one network	5608	5455	6341	6394
Case 6	Member in one network	17,434	17,316	17,727	17,604
Case 7	No membership	2171	2086	52,469	51,977
Case 8	No membership	2531	2458	22,616	22,220

Based on Höhler (2016)

Table 2 Annual profit, cash flow, and turnover (in thousand Euros) of the sample in 2012 and 2013

Name	Annual profit		Cash flow		Turnover	
	2012	2013	2012	2013	2012	2013
Case 1	772	817	1165	1261	12,541	12,790
Case 2	1894	1234	–[a]	2675	119,523	125,085
Case 3	322	457	889	777	13,241	12,857
Case 4	486	398	834	1082	23,136	22,249
Case 5	398	486	1468	1245	21,686	22,094
Case 6	559	289	2348	3219	44,686	44,334
Case 7	248	428	828	723	15,091	14,874
Case 8	190	520	2935	1168	62,243	62,275

Based on Höhler (2016)
[a]Not available

Table 3 Cash flow per member, turnover per member, and cash flow profit margin for the cases 2012 in 2013

Name	Cash flow per member (in € per member)		Turnover per member (in € per member)		Cash flow profit margin (in %)	
	2012	2013	2012	2013	2012	2013
Case 1	388,387	420,397	4,180,323	4,263,376	9.3	9.9
Case 2	–[a]	668,835	39,841,080	31,271,167	–[a]	2.1
Case 3	1039.93	901.88	15,487.10	14,915.65	6.7	6.1
Case 4	32.56	42.80	903.34	880.07	3.6	4.9
Case 5	261.78	228.20	3866.97	4050.15	6.8	5.6
Case 6	134.68	185.91	2563.17	2560.27	5.3	7.3
Case 7	381.55	346.47	6951.13	7130.39	5.5	4.9
Case 8	1159.67	475.14	24,592.20	25,335.76	4.7	1.9

Based on Höhler (2016)
[a]Not available

was calculated by correcting annual profit for noncash expenses and income. It is a measure of the net inflow of liquid funds.

To improve comparability, Table 3 shows the figures in terms of the number of members. Network organizations and cooperatives cannot be compared as their members are different in their legal form and number. In our analysis, we focus on the cooperatives and thus treat the number of the network organizations' members as missing values.

The cash flow profit margin equals the cash flow divided by turnover. It indicates the percentage of turnover which is available for investments, credit repayments, and patronage refund. Table 3 indicates differences between the firms which were not presented in Table 2. For example, case 4 and case 5 have a similar turnover but differ significantly in their turnover per member.

Data on innovation was obtained from the official estimation of breeding values which is conducted by Vereinigte Informationssysteme Tierhaltung (VIT 2014), a provider of IT solutions for animal production. The values for the German top lists are published three times a year for black-and-white Holstein and red-and-white Holstein. They provide top lists for the categories sires (active, daughter-proven), sires [genomic (gen.)], sires (daughter proven with 98% certainty) and for cattle. For the operationalization of innovation activity, we counted the placements in the lists in December 2014 for black-and-white Holstein (Höhler 2016). Black-and-white Holstein was chosen as it is the biggest population within the German performance tested cattle population (VIT 2015). The time lag between the variables for profitability and organization on the one hand and innovation activity on the other hand was chosen because of the time lag between the breeder's activity and the listing of the resulting animal in the official estimation of breeding values (Höhler and Kühl 2015).

We calculated an index value based on the ranking (see Table 4). Placements were given points from n = number of places to 1, in descending order. The total amount of points per firm was weighted by the number of total places and based on 100. The index ranges from 0 to 100. The higher the value, the better is the average placement of the firm. In addition, we calculated the number of placements per member (see also Höhler 2016). The row for case 5 contains additional information on the corresponding network organization's placements. They are not part of our examination as case 5 is an independent breeding cooperative with a minor share (25%) in the network.

Table 4 Innovation activity of the sample (black-and-white Holstein, December 2014)

Name	Top cattle	Top sires	Top sires gen.	Placements per member	Index value cattle	Index value sires	Index value sires gen.
Case 1	27	18	21	–[a]	43.9	63.2	47.4
Case 2	93	71	91	–[a]	47.6	52.3	52.5
Case 3	12	18	17 with case 4	0.035	55.6	44.2	44.7
Case 4	29	15	17 with case 3	0.002	56.2	41.9	44.7
Case 5	34	13	19	0.010	50.5	38.1	47.8
+ Network	–	+66	+36	–	–	47.4	52.1
Case 6	102	26	43	0.010	51.7	51.8	49.1
Case 7	85	26	24	0.065	53.1	52.5	48.8
Case 8	12	26	17	0.018	42.6	46.0	47.3

[a]Was not calculated due to the mentioned differences in legal form and number
Based on Höhler (2016)

5 Analysis and Results

For a first analysis, we used the nonparametric correlation coefficient Spearman's Rho. The significant correlation coefficients with values above 0.5 are shown in Table 5:

Of particular note are the various correlations within the placements and indices of the innovation construct. For example, the average placement in genomic sires is positively associated with the number of genomic sires, the number of sires, as well as the number of total placements. The correlations within organization indicate that particularly small cooperatives (measured by the number of members) have a high number of shares per member. The annual profit is negatively correlated with the turnover per member.

Additional correlations between the constructs are reported in Table 6. The number of shares per member is positively correlated with the number of placements per member. The number of members is negatively correlated with the placements per member as well as with various profitability figures related to the number of members.

Among the variables within the construct "Profitability," only the annual profit has several significant correlations with variables of other constructs. It is negatively correlated with the number of shares per member and weakly positively correlated with various innovation variables. Cooperation intensity is solely correlated with the annual profit. Their correlation is positive.

Based upon the various correlations within the construct of innovation activity, a factor analysis is run in order to reduce the number of dimensions. Two factors are identified (see Appendix 1). Factor 1 (innovation activity 1) is associated with all of

Table 5 Selected nonparametric correlations within the examined constructs by their affiliation to the constructs

	Correlation (Spearman's Rho)
Within innovation	
Top sires genomic × total placements	0.988***
Index value genomic × total placements	0.988***
Index value genomic × top sires genomic	0.957***
Top cattle × total placements	0.867***
Index value genomic × top cattle	0.861***
Top cattle × top sires genomic	0.859***
Index value sires × top sires	0.626*
Index value genomic × top sires	0.624*
Within organization	
Shares per member 2013 × number of members 2013	−0.943***
Within profitability	
Annual profit 2013 × turnover per member 2013	−0.886**

Significance levels: ***0.01, **0.05, *0.1
Based on Höhler (2016)

Table 6 Selected nonparametric correlations between the examined constructs by their affiliation to the constructs

	Correlation (Spearman's Rho)
Between organization and innovation	
Shares per member 2013 × placements per member	1.000***
Number of members 2013 × placements per member	–0.943***
Between organization and profitability	
Number of members 2013 × cash flow per member 2013	–0.943***
Number of members 2013 × annual profit per member 2013	–0.943***
Number of members 2013 × turnover per member 2013	–0.829**
Shares per member 2013 × annual profit 2013	–0.771*
Between profitability and innovation	
Annual profit per member 2013 × placements per member	0.886**
Cash flow per member 2013 × placements per member	0.829**
Annual profit 2013 × total placements	0.671*
Annual profit 2013 × top sires genomic	0.659*
Annual profit 2013 × top cattle	0.623*
Between profitability and network	
Annual profit 2013 × cooperation intensity 2013	0.752**

Significance levels: ***0.01, **0.05, *0.1
Based on Höhler (2016)

the placement variables as well as the index values for sires and sires genomic. Factor 2 (innovation activity 2) is solely associated with the index value for cattle. For the following analysis, we use factor 1. It contains information on the quantity (number of placements) as well as on the quality (index values) of innovation activity.

On the basis of the considerations and results above, innovation activity 1, annual profit, and cooperation intensity 2013 are chosen for a cluster analysis. Based on the variables and a hierarchical cluster analysis, we identify two clusters out of the eight firms (Table 7). The variables are z-standardized in order to reduce biases. The cluster analysis is based on the average linkage between groups.

The forecasting power of the cluster solution is checked with a discriminant analysis. The discriminant function (see Appendix 1.2) shows significant differences between the groups. The standardized canonical discriminant function coefficients indicate that all variables likewise influence the discriminant values. Innovation activity 1 has the highest influence on the group assignment.

The comparison of the clusters shows that networks have higher values in innovation activity than the other, cooperatively organized firms within the sample. The average annual profit in Cluster 2 also lies above Cluster 1.

An additional cluster analysis of Cluster 1 is intended to provide further insights. We choose annual profit, cooperation intensity and innovation activity, as well as the variable "shares per member." We identify three clusters (Table 8), whereas Cluster 2 contains only one case.

Table 7 Cluster solution by annual profit, cooperation intensity, and innovation activity 1

	Cluster 1	Cluster 2
Cases	Case 3, Case 4, Case 5, Case 6, Case 7, Case 8	Case 1, Case 2
Cooperation intensity	Low to medium	High
Average annual profit	496,272.40 €	1,333,103.27 €
Average innovation activity 1	−0.34	1.01

Based on Höhler (2016)

Table 8 Cluster solution for the cooperatives by annual profit, cooperation intensity, innovation activity 1, and shares per member

	Cluster 1	Cluster 2	Cluster 3
Cases	Case 3, Case 4, Case 5	Case 6	Case 7, Case 8
Cooperation intensity	Medium	Low	No
(Average) annual profit	455,763.77 €	1,172,326.86 €	219,008.10 €
(Average) innovation activity 1	−0.86	0.77	0.04
(Average number of) shares per member	4.3	1.02	17

Based on Höhler (2016)

A discriminant analysis (see Appendix 1.3) reveals that especially innovation activity determines the group assignment. A reverse causality is possible though not testable with this method. Case 6 has a high innovation activity whereas cluster 1 shows a negative coefficient. The firms in Cluster 3 do not belong to a network. Both of them have a high number of shares per member. Their average annual profit is below Cluster 1, but the average innovation activity based on factor 1 is positive. A comparison of the number of members shows that the firms in Cluster 3 have similar values (on average 2272), whereas Cluster 2 has 17,316 members and Cluster 1 ranges from 862 to 25,281 members (see also Höhler 2016).

6 Conclusion and Outlook

The aim of our article was examining the innovation activity of the German cattle breeding and especially the connections between profitability, organization, networking, and innovation. As a result of a literature review, we formulated several propositions.

The first position states a positive relationship between the size and the innovation activity of breeding cooperatives. The correlations between the constructs demonstrate that especially smaller cooperatives achieve more placements per member. However, the factor innovation activity 1 is not correlated to the number of members. Proposition 1 is not supported. The absolute value of innovation is not influenced by the number of members. In contrast to our proposition, small cooperatives exhibit a higher innovation activity per member. As the correlations between the examined constructs show, the size of the cooperative is also negatively related to various indicators of profitability per member.

The second proposition states that the allocation of property rights within breeding cooperatives positively influences their innovation activity. Differences in the property rights structures become evident in the correlation of the number of members and the number of shares: smaller cooperatives often issue a higher number of shares per member. The number of shares per member is positively correlated with the placements per member. The higher number of shares per member and thus a possibly better allocation of property rights to the members is not reflected in a higher innovation activity 1 compared to other cooperatives. Proposition 2 can nevertheless be confirmed. It can be clarified with regard to the innovation activity per member. A higher number of shares per member has a positive influence on the innovation activity per member. The higher number of shares for breeders with a higher number of breeding animals seems to improve the allocation of property rights and thus contribute to the cooperatives' innovation activity. It may also explain the unexpected results with regard to proposition 1.

In our third proposition, we state a positive influence of cooperation on innovation activity. High cooperation intensity is not directly correlated with high innovation activity. Though, it is related to a high absolute annual profit. The absolute annual profit is in turn related to several innovation variables. Proposition 3 cannot be confirmed with regard to correlations between the variables. A moderating effect of network activity on the relationship between innovation and profit is likely.

Furthermore, we state a positive effect of innovation activity on the breeding cooperatives' success. A high number of total placements is correlated with a high annual profit. Furthermore, the number of top sires genomic and top cattle shows a positive correlation to the annual profit. Proposition 4 is supported. As Geroski (1994) already discovered, a high number of innovations is positively linked to a firm's profitability.

The cluster analysis confirms the positive relationship between network activity and profitability of breeding companies as well as their impact on innovation. The network organizations reveal a high innovation activity. Cluster 1 has a lower innovation activity, which could be due to the property rights problems of cooperatives mentioned in the literature. The establishment of network organizations offers technological advantages by increasing the selection base. It can reduce transaction costs and facilitate a joint value creation in the sense of a team production (Höhler and Kühl 2015). Spillover effects are internalized and incentives for innovation activity are provided. Cooperation may also be viewed as a means to improve the competitive position of the participating cooperatives and to keep their market shares or increase it. From the perspective of strategy research, companies in a network are able to combine advantages of differentiation, size, and focus (Hagedoorn et al. 2000).

The higher number of total placements per member may justify the existence of small cooperatives with a high number of shares per member. If political actions aim at strengthening the competitiveness of German breeding associations, cooperations, as well as small cooperatives are to be promoted. This would result in an increasing innovation activity and a stimulation of further breeding success. However, there is also the risk of a monopoly with an increase in cooperation (see also Höhler 2016). In contrast, however, the international competition is still increasing.

The members of the breeding cooperatives have, according to Sect. 2, influence on the strategic direction of the organization. Our results imply that network organization should be supported by the members. The insights on small cooperatives reveal a second way that could combine the benefits of networks and small cooperatives. The establishment of networks and a splitting of the network in strategic groups with a size-related distribution of shares per member could provide a strategic advantage for breeding cooperatives. The grouping of breeders may lead to groups which equal the small cooperatives in our sample and to a higher profitability per member. Possible selection criteria are shown by Höhler and Kühl (2015).

Our considerations can be expanded by additional firms in the sample as well as the data from the estimation of breeding values for red-and-white Holstein. Thus, the possible distortion of the results due to the selection of particular firms (selection bias) can be reduced. Moreover, additional years can be added in order to increase the validity and generate prognoses on future developments. In addition, the support of the propositions by expert interviews appears to be a promising supplement (see also Höhler 2016). Besides network structures, the market structure, hierarchies within the networks, and their organizational culture can be considered promising determinants of innovation.

Appendix 1

Data sources	
Companies in the sample	
Landesverband Thüringer Rinderzüchter eG	www.ltr.de
Masterrind GmbH	www.masterrind.com
Rinder Union West eG	www.ruweg.de
Rinderproduktion Berlin-Brandenburg GmbH	www.rinderzucht-bb.de
Rinderzuchtverband Schleswig-Holstein eG	www.rsheg.de
Zucht- und Besamungsunion Hessen eG	www.zbh.de
Osnabrücker Herdbuch eG	www.ohg-genetic.de
Verein Ostfriesischer Stammviehzüchter eG	www.vostov.de
Annual reports	www.unternehmensregister.de
Networks	
Alpengenetik	www.alpengenetik.eu
Nord-Ost-Genetic	www.nog.de
Rinderallianz	www.rinderallianz.de

(continued)

Additional companies	
Besamungsstation Greifenberg	www.besamungsstation.eu
Besamungsverein Neustadt a.d. Aisch	www.bvn-online.de
Göpelgenetik	www.goepelgenetik.de
Holstein Austria	www.holstein.at
Rinderbesamungsgenossenschaft Memmingen	www.rbgmm.de
Rinderunion Baden-Württemberg e.V.	www.rind-bw.de
Rinderzucht Sachsen-Anhalt eG	www.rsaeg.de
Rinderzuchtverband Franken	www.rzv-franken.de
Vereinigung der Südtiroler Tierzuchtverbände	www.vstz.it
Zuchtverband Schwarzbunt Rotbunt Bayern	www.holstein-bayern.de

1.1 Factor Analysis

KMO- and Bartlett-Test

Degree of sample suitability according to Kaiser-Meyer-Olkin		0.626
Bartlett test for sphericity	Approximate chi-square	25.939
	df	15
	Significance according to Bartlett	0.039

Rotated Component Matrix

	Component	
	1	2
Top cattle	0.712	0.591
Top sires	0.934	−0.038
Index value sires	0.484	−0.024
Index value cattle	−0.070	0.974
Top sires genomic	0.933	0.175
Index sires genomic	0.952	0.048

Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. The rotation converged in three iterations

1.2 Discriminant Analysis for Cluster Solution 1

Wilks' Lambda

Test of function(s)	Wilks' Lambda	Chi-square	df	Significance
1	0.082	11.255	3	0.010

Standardized Canonical Discriminant Function Coefficients

	Function
	1
Innovation activity 1	1.825
Annual profit	−1.737
Cooperation intensity	1.713

1.3 Discriminant Analysis for Cluster Solution 2

Wilks' Lambda

Test of function(s)	Wilks' Lambda	Chi-square	df	Significance
1–2	0.002	12.312	6	0.055
2	0.069	5.346	2	0.069

Standardized Canonical Discriminant Function Coefficients

	Function	
	1	2
Innovation activity 1	1.003	0.988
Annual profit	0.703	−0.593
Cooperation intensity	0.936	0.031

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