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FoPIA-Surefarm Case-study Report Sweden

Work Performed by Partner No. 6, Swedish University of Agricultural Sciences SLU

Gordana Manevska-Tasevska, Jens Rommel, Stefan Merza and Lisa Höglind

(Contact: Gordana Manevska-Tasevska; gordana.tasevska@slu.se)

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SUMMARY

Swedish egg and poultry farms produce high-value livestock products. The sector faces a number of resilience-related challenges. A workshop with farmers, NGO, processors and suppliers' representatives and policy-makers was conducted to study these. Egg and broiler production face different challenges. For both sectors, the challenges are mainly production-related. Egg producers can benefit from the increasing demand for organic eggs and are subject to fewer regulations (e.g., related to slaughtering that affect broiler farms). Demand for organic poultry meat is small and erratic, and the overall demand for conventional poultry meat recently decreased after a long period of growth. Profitability is a key challenge for both sectors, whereas negative impacts on animal welfare and the environment do not occur to a great extent, as national animal welfare standards are high, and production is largely detached from land use, and manure is of high value and demanded locally. Tight networks between actors ensure a high degree of "tightness of feedbacks." The farming system could benefit from greater "modularity," "diversity," and improved risk management to better cope with risks related to price and demand fluctuations.

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1 Introduction

1.1 The case-study area

Historically, poultry farms in Sweden have been developing in the plain districts in the southern and the central part of the country. In these areas, most of the country's cereal production is located, and cereals are a key input in poultry production. The case study comprises five (out of eight) of Sweden's NUTS-2 regions: SE11 – Stockholm, SE12 – Östra Mellansverige, SE21 – Småland med öarna, SE22 – Sydsverige, and SE23 – Västsverige. The region "Southern Sweden" is recognised for its agricultural activity. While it occupies one third of the country's area, in 2016, 85% of the utilised agricultural area, and 75% of the agricultural holdings registered in Sweden were situated in this region, employing 80% (in 2013) of the regular labour engaged in agriculture. The contribution to the gross agricultural output was 88%. Although the landscape and the soil quality are heterogeneous, the region is highly recognised for its fertile plain districts, especially in the NUTS-2 SE12, SE22 and SE23, with dominating cereal production (45% in 2018). Private person/family farms are most common, owning/managing about 90% and 85% of the total agricultural land, respectively. Corporate farms own/manage only about 5% of the total agricultural land. The average farm size in 2016 was 53 ha. Compared to southern Sweden, farms in the remaining parts of Sweden as a whole were significantly smaller, with an average holding size of 28 ha. The respective average farm size at country level was 41 ha. Three typical farm types were identified by local experts (Bijttebier et al., 2018): TFT1: Medium sized farms with 50-100 ha/ run as family farms with arable land (field crops, cereals); TFT2: Medium sized farms 50-100 ha, run as family farms with cattle (meat and grazing, around 100-150 animals); TFT3: Medium sized farms 50-100 ha, run as family farms with cattle farms (dairy farms, around 100-150 cows).

The Swedish case study of high value egg and broiler production consists of two separate sectors, including different actors. The poultry production in Sweden is dominated by a few large chicken production and egg producing companies which contract several farmers, often on long-term contracts. However, farmers are not assigned a particular feed supplier and are free to buy their feed and/or to produce it on farm. While egg producers are allowed to sell eggs in on-farm shops, broiler producers follow slaughter regulations.

The commercial poultry sector in Sweden is dominated by egg and broilers production for the domestic market. The share of the domestically produced eggs/broiler meat of the total eggs/poultry consumption in Sweden in 2016 were 94.1% and 67.3%, (Jordbruksverket, 2018a, b) respectively. The rest is mostly imported from the Nordic and Western European countries. Finland, Denmark, Poland, and Germany are key exporters of eggs, whereas Denmark, the

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Netherlands, and Germany are important exporter of broiler meat. Over the last years, egg consumption has greatly increased. The total consumption of eggs in 2016 was 148.3 thousand tons, as compared to 119.9 in 2007 (an increase of approximately 20 %). Similarly, the per capita consumption of eggs has increased from 12.2 to 14.9 kg (+ approximately 20%). Over the same period, the per capita consumption of poultry meat has increased from 16.7 (in 2007) to 23.6 kg (in 2016, + approximately 40 %) which was also associated with an increase in imports (from 55.1 in 2007 to 96.7 thousand tons in 2016, + approximately 75 %).

Despite the large and increasing demand for poultry products in Sweden, the sector and the case study region are facing numerous challenges (Zawalińska, 2018), related to: i) fast changes in the consumers preferences (animal welfare, food quality) and thereby requirements for changes in the production systems – technology (adoption of free-range poultry systems, adoption of organic poultry production); ii) vulnerability to acute animal health issues (pathogens) (Sweden is among the countries with the lowest level of antibiotics use per slaughtered kg of meat (ca. 12 mg per slaughtered kg of meat, compared to an EU average of 152 mg per slaughtered kg of meat); iii) regulations; iv) different standards for domestic and imported products, making the domestic production less competitive especially for the export market; v) depopulation of rural areas; vi) generational change problems; vii) nutrition balance problems etc. Key challenges to a resilient farming system are summarised in Table 1.

Table 1. Resilience challenges for the poultry sector in Sweden.

	Economic	Environmental/ health/climate	Socio-demographic	Institutional
Shocks	Volatile prices	Water shortage		
	Scandals	Water excess		
		Pathogens, disruptions in supplies		
Long-term impact	Low value added at farm level	Nutrition balance	Changes in consumer preferences	Different standards for domestic and imported products
	Access to capital	Climate change	Generation change	Changes in the CAP
			Access to labor	Changes in regulations
			Social life	

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1.2 Workshop details

The workshop on Participatory Impact Assessment was organised on 22 January 2019 in Stockholm. To ensure participation from as many stakeholders as possible, the workshop took place in the building of the Federation of Swedish Farmers (LRF – Lantbrukarnas Riksförbund), where many of the invited stakeholders have their offices. The conference room was well equipped, with a capacity for 17 participants. The workshop started at 9.45 with a "fika" (Swedish coffee break) and ended by 15.30 (as required by some of the participants). In total, nine participants attended the workshop, out of which six participants contributed to the impact assessment.

For the workshop, most of the relevant actors representing the Swedish poultry sector, both for the egg- and the broiler production were contacted: branch organizations *(*Svenska ägg and Svensk fågel), the Federation of Swedish farmers (LRF), and the largest cereal cooperative (Lantmännen), industry (Kronfågel, Svensk standard), an NGO for animal protection (Djurskydd), farmers (egg and broiler producers), and policy representatives. Participants were initially contacted mid-December by phone. Invitation letters with further details (the venue etc.) were sent on January 10th. Although January 22 seemed to be a perfect date after the New Year, we realised that due to the christmas/new year holidays the conversation with the respective stakeholders was difficult, as many of them had some days between 15th of December to January 15th. From the discussions we had afterwards, November would fit much better for future workshops.

The branch organization for the Swedish egg producers took responsibility to invite their members (aiming at 3-5 farmers). However, after two reminders, only one egg producer confirmed his participation. We also received confirmation for attendance from LRF, Kranfogel, and Svensk standard, but their attendance was cancelled a day before the workshop, not giving us sufficient time to find replacements. For the first workshop, broiler production was somewhat underrepresented, as only one broiler producer attended the meeting. Apart from the one broiler producer, none of the invited stakeholders from the broiler site participated at the meeting. An additional meeting with a broiler production representative was organised after the workshop, and some of the egg producers contributed their knowledge of the related sector during the workshop.

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2 Farming system

Feedback on the proposed visualisation of the farming system

This section of the workshop started by presenting the SURE-farm concept of the farming system *(Meuwissen et al., 2018)*, where the farming system represent the sector's main actors and their relationships. The initially constructed farming system visualisation as proposed by the SURE-Farm team is presented in Figure 1. After the presentation, participants were invited to select actors that belong to different circles (inner, middle, and outer), based on the mutual dependence that they have with the farms.

From the beginning there were a lot of concerns on the definition of the "farming system". Stakeholders' standpoint was that farms are the only actors that belong to the first inner circle, and all the others should be distributed across the remaining two circles (middle and outer), as they said: "The decisions are made on the farm level, and farms need to be in the centre." The discussion continued after we provided further explanation for the concept "farming system". After a while, stakeholders' discussion started to move in the direction of changing actors' positions and changing their places.

The updated farming system visualisation after the feedback provided from the participants is presented in Figure 2. Given the updated visualization, two actors (regional insurance and the local credit union) from the inner circle, were considered not relevant and were, thus, excluded. These actors were replaced with farmers' union, producer organizations, suppliers, and neighbours (all moved from the middle to the inner circle). According to the workshop participants (stakeholders' representatives), producer organizations should be in the inner circle (maintain close ties with farms), but in practice they are often not. They argued that agricultural organizations should have closer bi-directional relationships with farmers. In the long run, a group of farms/organizations (together) may be in a better position to influence authorities and decision-makers. Also, large-scale processors (slaughterhouses, packing houses) should belong to the inner circle, but they do not depend on single farms, as the farms depend on them. In addition, slaughterhouses can by-pass local farms by imports (e.g., organic eggs from Finland). The importance of local food stores was different for the egg and broiler producers. Stakeholders pointed out that local food stores are of larger importance for the egg producers, as their product is final. Retail and consumers were moved from the outer to the middle circle. According to the stakeholders, consumers indirectly affect the sector's decisions, thus consumers should be in the middle circle, but at the same time, consumer are to some extent affected by the domestic supply.

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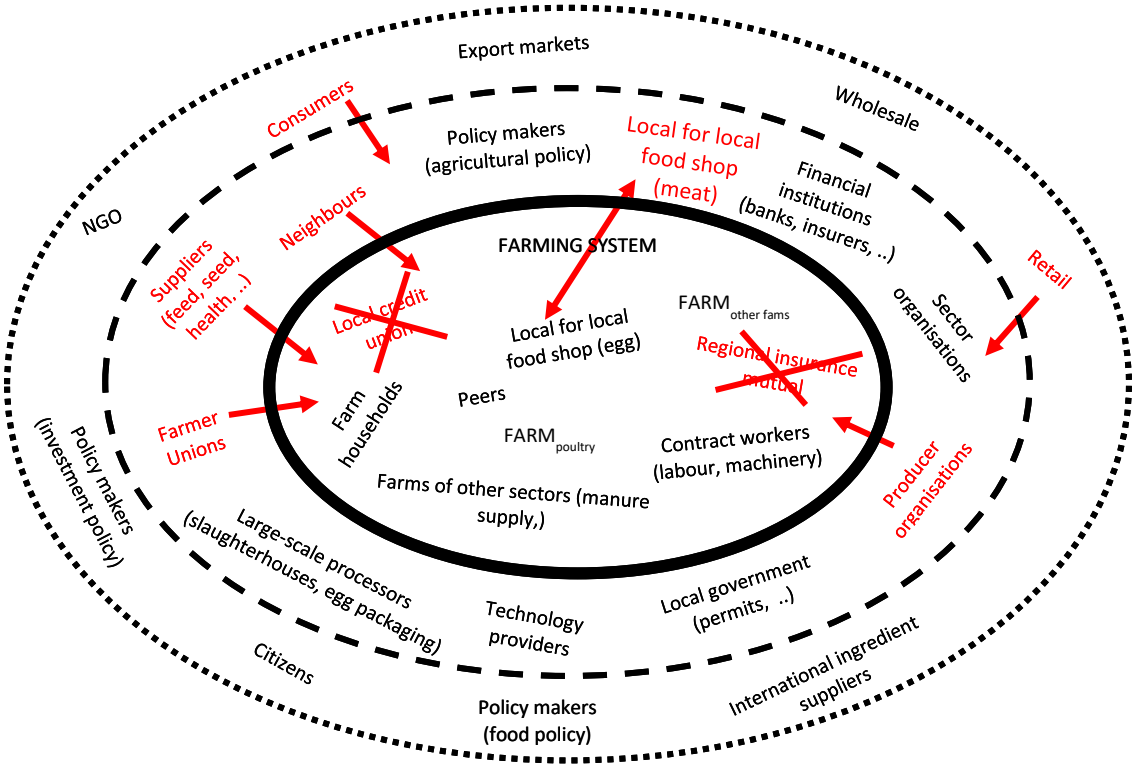
Figure 2: Updated farming system visualisation after feedback from participants (main changes are highlighted in red).



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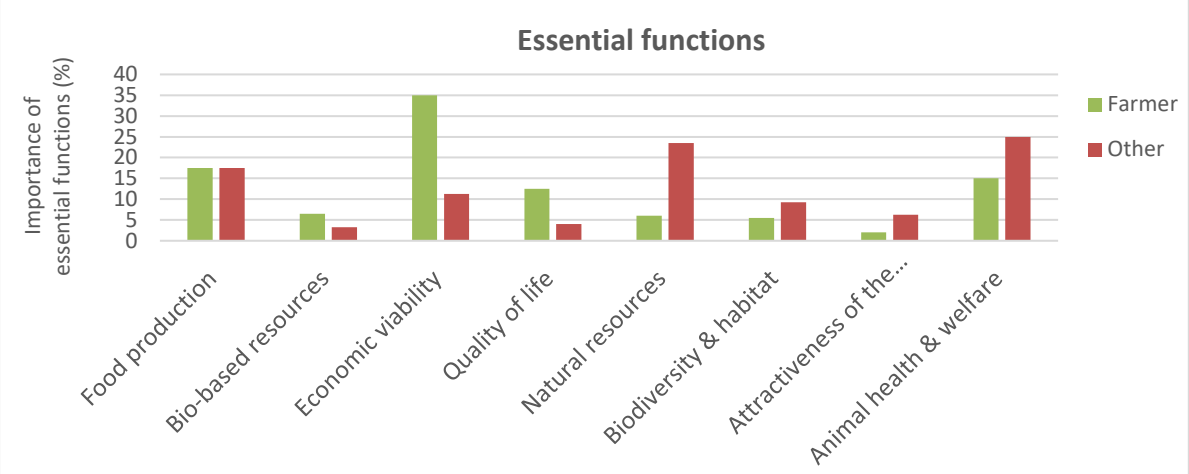
3 Essential functions

Scoring on the essential functions

Given the instructions provided for this section, stakeholders were asked to rank the essential functions (EF) according to their importance. In total, eight EF were considered: food production, bio-based resources, viable income (all representing private/commodity outputs), quality of life, biodiversity, countryside attractiveness and animal welfare (all representing public goods). For the scoring, 100 points were distributed across the eighth EF. More points were given to the most important EF. Results aggregated by stakeholder (group) are given in the bar chart below (Figure 3). In addition, details on means and standard deviations of EF per stakeholder (group) and for all participants with their scorings per EF are provided in Table 2, Appendix 3. All EF were defined by SURE-farm (Herrera et al., 2018).

Figure 3: Bar chart with scoring per essential function, aggregated by stakeholder group. (n=6)



Given the results, “Food production”, “Viable income”, “Natural resources” and “Animal health & welfare” appeared to be among the most important EF. While the importance for “food production” was rather identical across the stakeholders (18 points), farmers’ representatives prioritised viable income (35 points), the remaining stakeholders were mostly interested in the protection of “natural resources” (24 points), and “animal health welfare” (25 points). However, the standard deviation for animal welfare is rather high, due to a high score (60 points) by one participant. Lowest scores from farmers’ perspective were given to the “attractiveness of the countryside” (2). “Bio-based resources” and “quality of life style” were the least important for the remaining stakeholders (with 3 and 4 points respectively).

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4 Indicators of essential functions

4.1 Indicator importance

In total, 29 indicators suggested by the FoPIA team and the participants were evaluated. The indicators were selected based on the literature and the practice, i.e., the production characteristics of the poultry sector, as viewed by the stakeholders. For the evaluation procedure, 100 points were distributed for each EF. The results (scores for the importance per indicator, aggregated by stakeholder group) are presented in Figure 4 and in Table A3.

For the first EF, "food production," "total production" and "product price" were selected as key indicators. However, *farmers* and the other stakeholders differed quite substantially in their scorings: *Farmers* are rather interested in the "product price", whereas for the other stakeholders, "total production" is the most important indicator of food production.

Farmers and the other stakeholders also had different opinions regarding the importance of the indicators of animal welfare. While *farmers* selected "antibiotics use", the other stakeholders thought that the total "number of farms fulfilling the criteria proposed by animal health/welfare programs" is a better indicator.

The importance of indicators representing the remaining EF, "bio-based resources", "viable income", "quality of life natural resources", "biodiversity", and "attractiveness of the country-side" was balanced between farmers and the other stakeholders. Based on the results, "manure production" was selected as the most important by-product; "profit per m^2" was the most important indicator for "viable income"; "labour availability" was assessed as the most beneficial for "quality of life"; "nutrition loss" was the most important for sustainable management of "natural resources"; whereas "land area" with "nature-friendly management" was assessed as most beneficial for "biodiversity". The "attractiveness of the countryside" was expected to be secured by "good access to public services".

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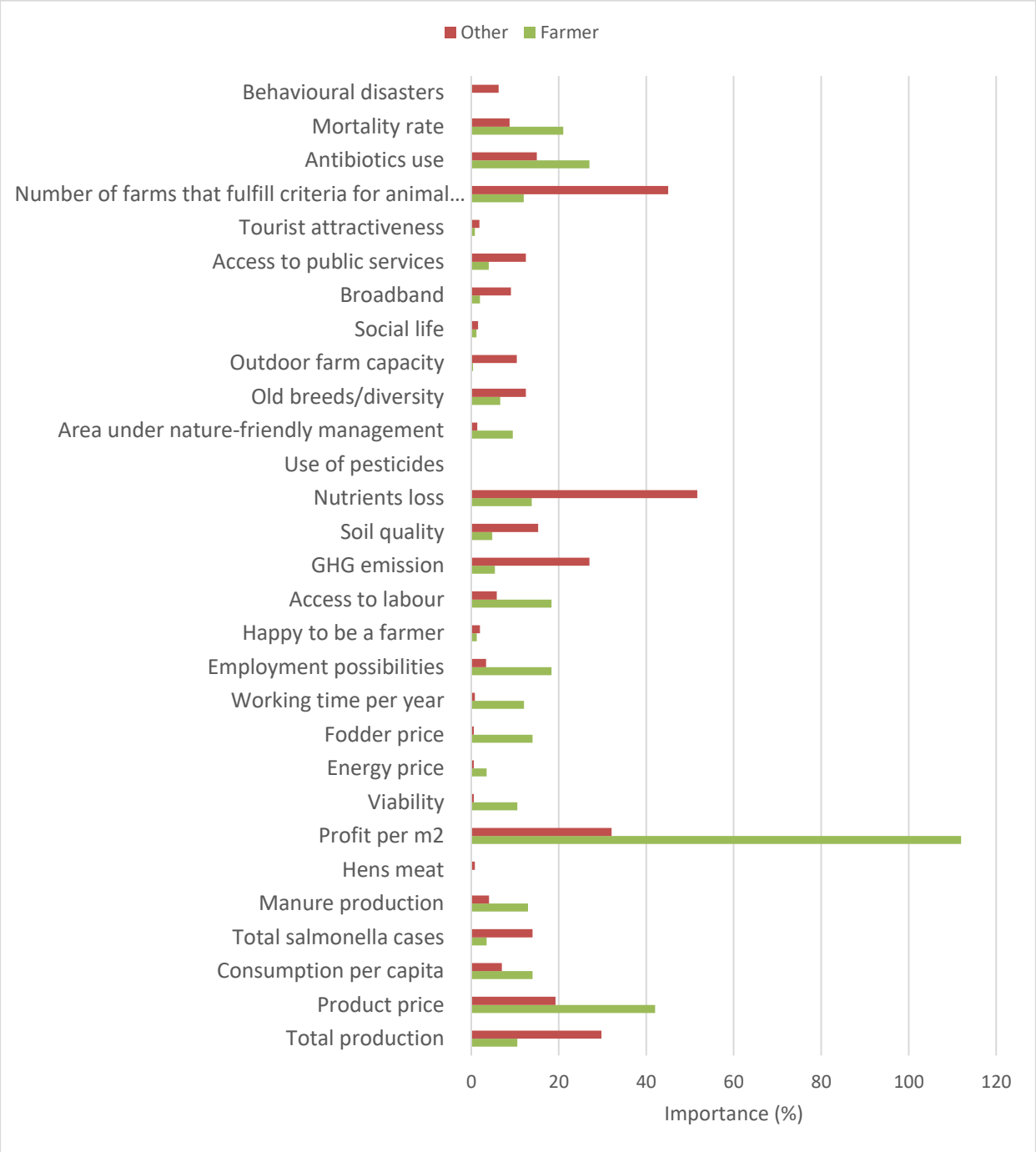
Figure 4: Bar chart with scoring of importance per indicator, aggregated by stakeholder group. Per EF, 100 points were distributed across indicators. Scores of indicators are transformed taking into account importance and number of indicators of the essential functions. (n=6)



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4.2 Indicator performance

After assessing the importance of the indicators, the same set of 29 indicators was evaluated on their performance. Indicators were scored on a scale from 1 to 5, where 1 = very low, 2 = low, 3 = medium, 4 = good and 5 = perfect. Results of the scoring of indicator performance are presented in Figure 5, Figure 6, and in the Appendix Table A4.

In general, indicators such as "product price", "profit per m²", "price of fodder and energy", "work load", and "access to public services" were given the lowest performance scores (below 3) from all stakeholder groups. In contrast, the best performance scores (above 4) from all stakeholder groups were given for the "total production" volume, "salmonella control", "fulfilment of the criteria for animal welfare", "animal health control", "GHG emissions", and "employment possibilities". Across the EF, indicators representing the "viability of incomes" and the "attractiveness of countryside" also received the lowest scores.

The bubble graphs in Figure 6 and Figure 7 present the average scores on performance of the indicators and the EF, respectively, indicating their importance (given the size of the bubble) relative to each other. Given the results for "total production", "product price", "profit per m²", "nutrition loss" and "number of farms fulfilling the criteria for animal programs" are among the indicators that received much attention (Figure 6). "Food production", "economic viability", "natural resources", as well as "animal health and welfare" were identified as most important EF (Figure 7 and Figure A1).

4.3 Indicator selection

Given the small number of participants, all stakeholders continued to work as one group. After the scoring of the indicator performance, they were asked to select one indicator per production specialisation (i.e., for egg and broiler production) and to do a comparison. Their choice was the total production of organic eggs and broilers. The reasoning behind the selection of these two indicators was the large increase in demand for organic products over the last years, and to show that organic egg and broiler production face different development trajectories.

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Figure 5: Bar chart with average scores on performance per ***indicator (from 1 to 5),*** *aggregated by stakeholder group. (n=6)*

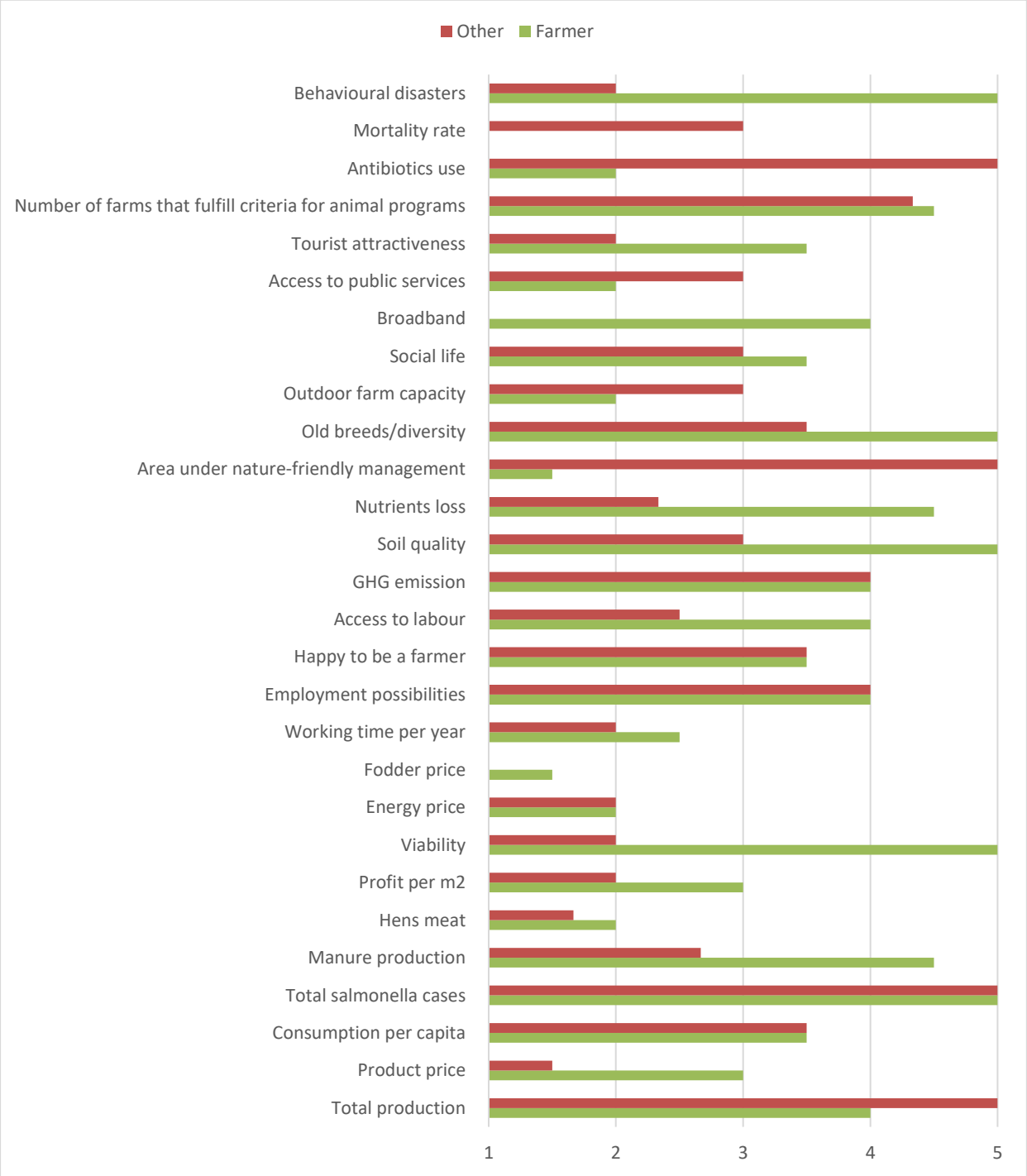

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*Figure 6: Bubble graph presenting average scores on performance of **indicators (from 1 to 5)**, while also indicating their importance (size of bubbles) relative to each other. (n=6)*

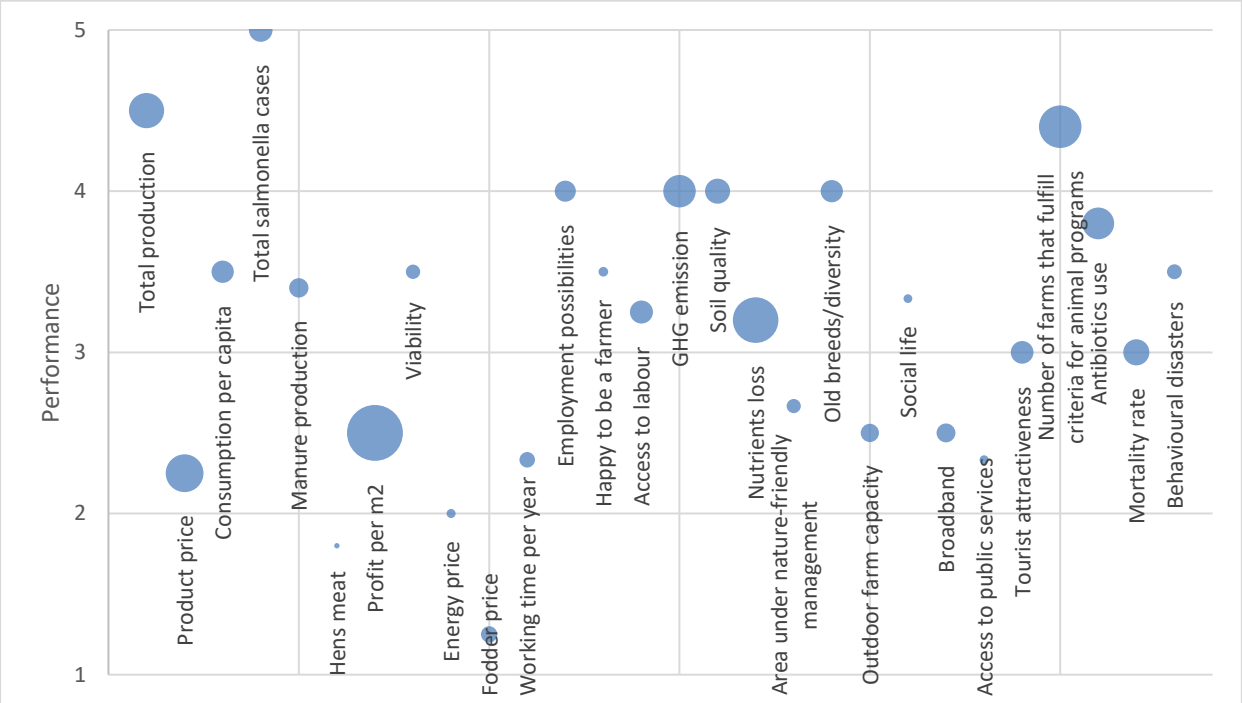
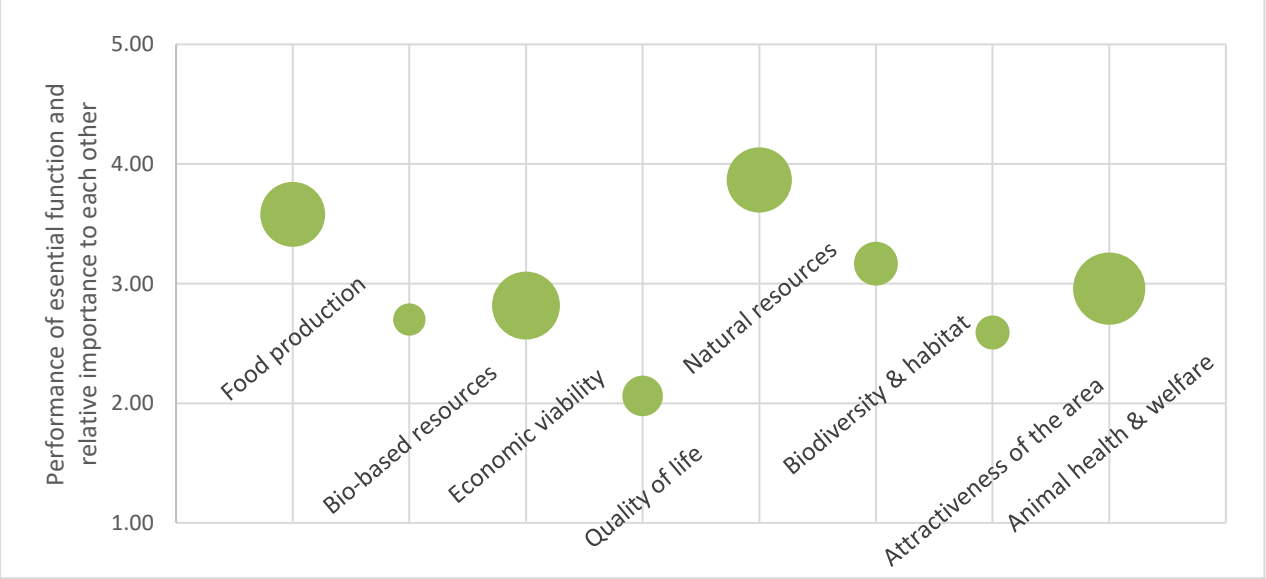


*Figure 7: Bubble graph presenting average scores on performance of **essential functions (from 1 to 5)**, while also indicating their importance (size of bubbles) relative to each other. (n=6)*



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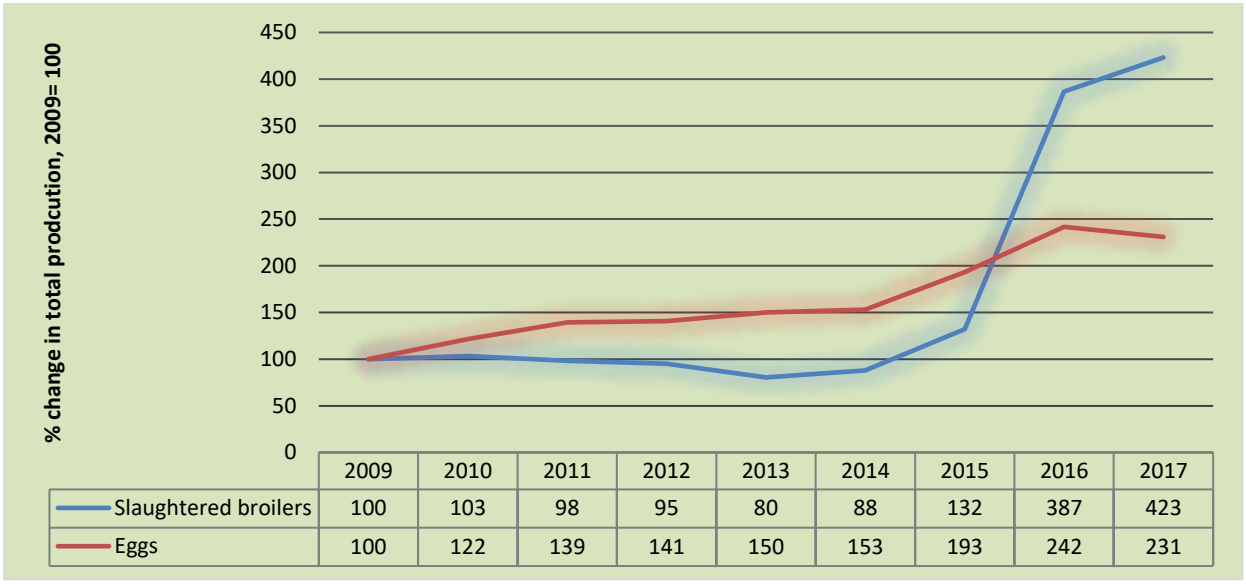
5 Resilience of indicators

5.1 Historical dynamics of main indicators

Since 2000, the poultry sector in Sweden is undergoing fast technological changes, adopting to animal welfare, ethical and food quality requirements relevant for sustainable production. Organic farming and the consumption of organic products are considered closely related to sustainable production, and organic products are assumed to have health benefits which results in an increase in demand. For instance, compared to 2009, in 2017, the total amount of organically produced eggs has increased by ~230% (from 8,831 tons to 20,383 tons), whereas the total weight of slaughtered broilers has increased by 423% (from 394 tons to 1,667 tons, cf. Figure 8). In 2017, the share of organic eggs in total egg production was 17.2%, compared to a share of only 1.1% of organic production in broiler farming.

Figure 8: Total production of organic eggs and total number of slaughtered organic broilers. The figure represents the % change in the respective production, with 2009 as a base year. Statistical data were from 2009 onwards.



	2009	2010	2011	2012	2013	2014	2015	2016	2017
Slaughtered broilers	100	103	98	95	80	88	132	387	423
Eggs	100	122	139	141	150	153	193	242	231

5.2 Challenges that caused the dynamic of main indicators

The dynamic of technology transformation is mainly driven by the demand for organic products. In Sweden the consumption of organic products is to a large extent nationally driven, via policies for organic food consumption in the public sector. For instance, the share of organically certified products (KRAV certified, or EU products) in the public sector is 35%.

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Given the rapid increase in demand, farmers faced difficulties with the need for technological change: old buildings were too small, broilers grew too slow because the same hybrids were used for organic and conventional production. On top of that, after all the investments and technology adaptations, the demand for organic broiler meat started to decrease (in 2018). Stakeholders commented that the payback period for the investments is long, but trends move fast and are volatile. Economic stability was mentioned as supportive for the adaptation, but not all farmers have that possibility. Stakeholders argued that relative to eggs, organic chicken meat is an expensive product, and therefore it is more difficult to sell it. It was agreed that most consumers believe that *"it is enough to be Swedish but not necessarily has to be organic."*

5.3 Strategies to deal with or benefit from the challenges

In order to meet the demand for organic eggs and broiler meat, new buildings were built, followed by technological change. In Sweden, conversion to organic farming for poultry production implies that 20% of the fodder needs to be produced on the farm, thus converting the land from conventional to organic was also a related activity to consider. Acquiring the skills necessary to be an organic farmer, were also part of the strategies applied. From the industry perspective, during the period when the egg supply did not meet the demand, organic eggs were imported from Finland.

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6 Resilience attributes

6.1 Case-study specific strategies

Figure 9 shows the level of implementation of strategies for producing organic eggs and broiler meat. It shows that knowledge sources are available and that they are used to a good extend. The technological change goes faster for egg production. In Sweden conventional and organically produced meat is produced from the same breed, implying that strategies such as selecting alternative breeds cannot be applied.

Figure 9: Bar chart showing the level of implementation of strategies, where 1 = not applied, 2 = slightly applied, 3 = moderately applied, 4 = adequately applied, 5 = perfectly applied. (n=group discussion)

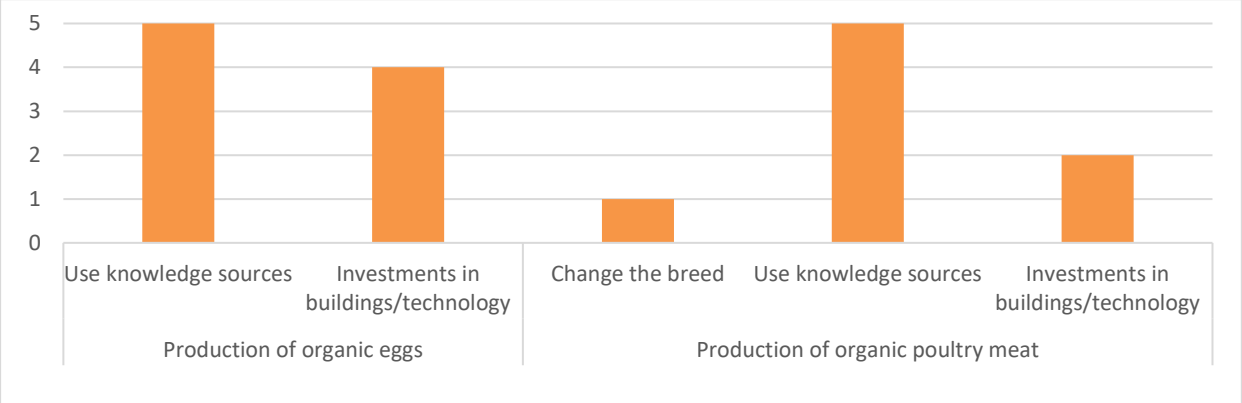
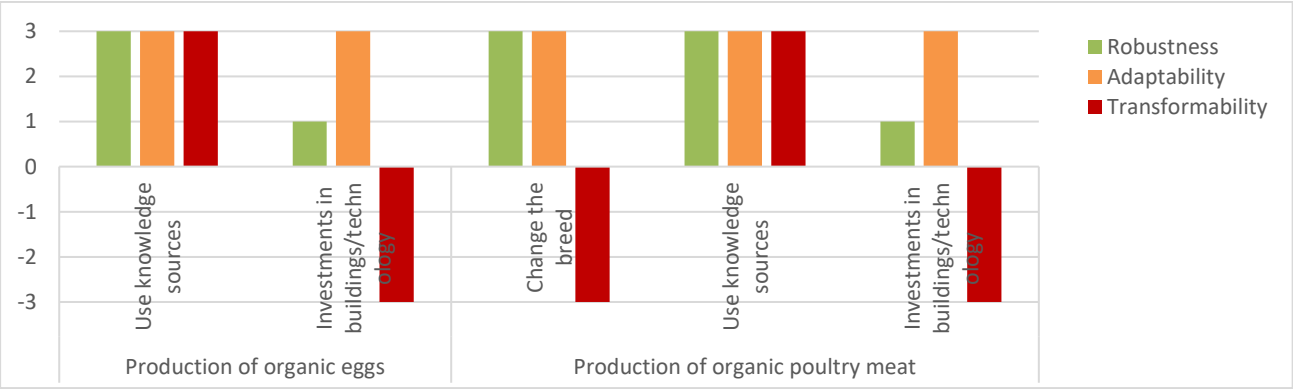


Figure 10: Bar chart showing the average scoring of the effects of strategies on robustness, adaptability, and transformability, A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 a intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship (n=group discussion)



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In both specialisations, appropriate knowledge management was viewed as enhancing for the three resilience capacities: robustness, adaptability, and transformability. However, capital investments were expected to restrain the transformability of the farming system (see Figure 10). Changing the breed for eco poultry meet also shows a trade-off between robustness and adaptability with transformability.

6.2 General resilience attributes

As mentioned previously, due to the small number of participants in the workshop and their interest to discuss/evaluate the attributes together, all stakeholders continued to work as one group. Moreover, some of the attributes were irrelevant for part of the participants. Thus, they did not feel in a position to provide an answer on their own. Following the instructions for the presentation, stakeholders were provided with information for the different resilience attributes (Cabell and Oelofse, 2012) and the explanation statements. After the presentation, the discussion continued with separate evaluations for each attribute until a common understanding of the meaning and the performance were reached.

Figure 11 shows the current performance level of resilience attributes, where the lowest scores were given to “profitability”, “response diversity”, and “support for rural life”. “Coupling with local and natural capital”, “functional diversity”, “optimal redundancy” and “coupling with local and natural capital” were among the attributes with the highest performance. However, the precision for evaluating the attributes is rather uncertain as some of the attributes were approached from different perspectives (egg or broiler production, organic vs. conventional etc.). It was even more complicated to decide in which way the attributes affect robustness, adaptability, and transformability.

It seems like stakeholders were more confident to talk about the profitability, and they had strong arguments that profitability would support robustness, and facilitate adaptability, but restrain the decision for the system to transform. The coupling with local and natural capital was also evaluated as a restraining factor for the transformability of the farming system. The remaining attributes were evaluated as supportive for the resilience indicators, all with performance levels between 1 and 2.

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Figure 11: Bar chart showing current performance levels of resilience attributes, where 1 = not applied, 2 = slightly applied, 3 = moderately applied, 4 = adequately applied, 5 = perfectly applied.

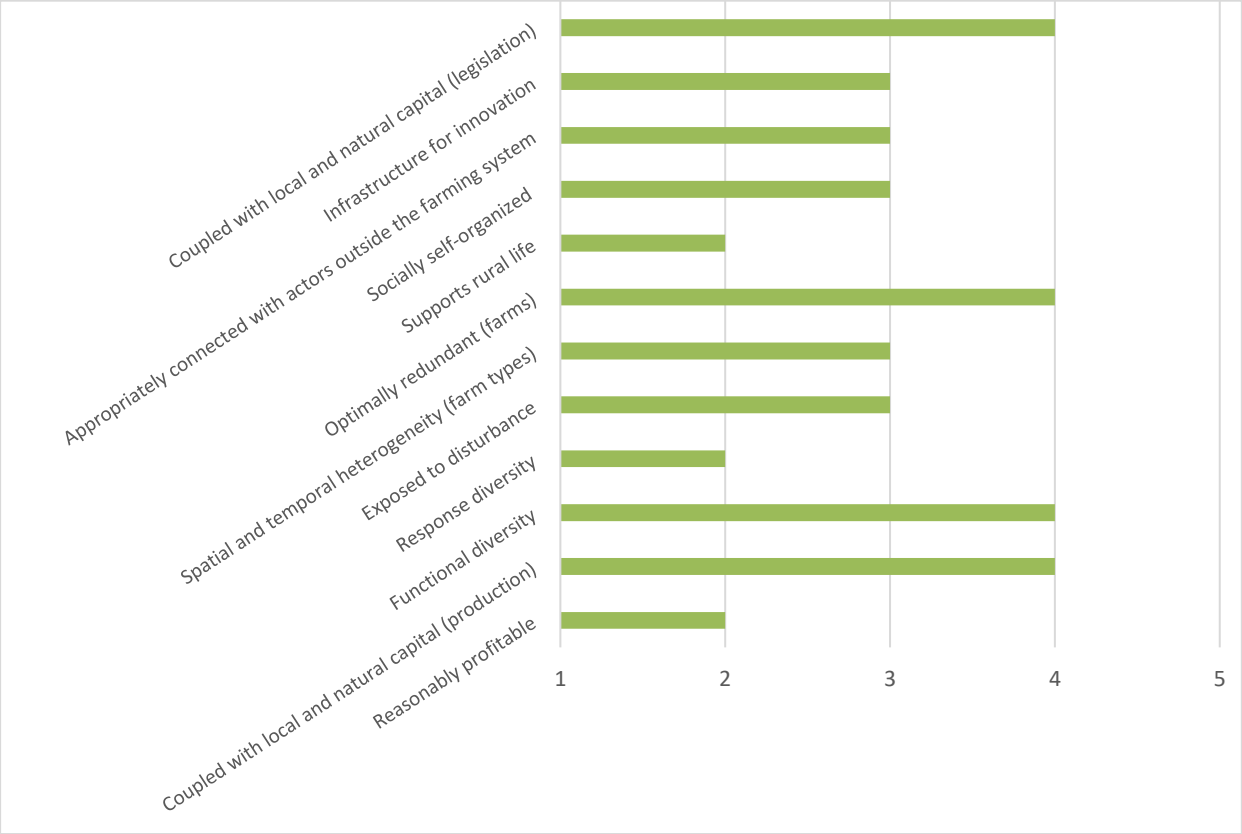
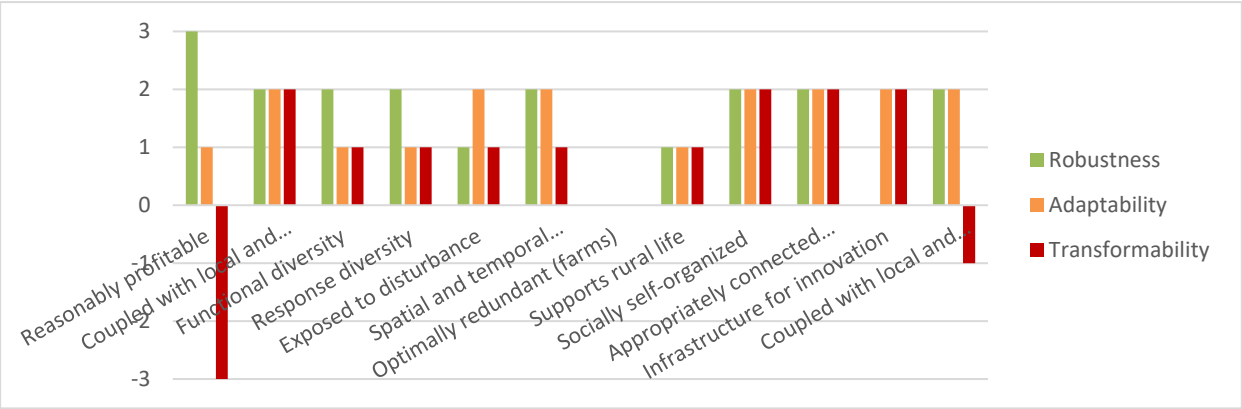


Figure 12: Bar chart showing average scorings of perceived effects of attributes on robustness, adaptability, and transformability. (n=group discussion)



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7 Discussion and conclusion

The farming system is mainly perceived though the production capacity and profitability, with key indicators being the "farm-gate price" (for farmers), the "total production" (for other stakeholders), and "profitability per m²" (for all). Environmental aspects and public goods play a small role in the farming system, in the sense that generally the sector is rather detached from land-use and the environment (at least if it is compared to dairy production or pig production clusters). Labour issues and social indicators also played a rather minor role in the discussion, as these things are rather driven by competing farms from other sectors and not seen as driven by the poultry sector.

Unlike in other livestock production systems, there are no severe problems with manure, and the overall impact on the environment is perceived as low. On the other hand, consumer demand for organic products is driving many of the developments – especially for the egg sector. Requirements for organic and on-farm fodder production could then also have smaller impacts at the landscape levels, biodiversity etc. Animal welfare and health are considered important by all stakeholders (one participant viewed this as very important), emphasizing the existence of high standards in Sweden.

The farming system is considered to be fairly robust on many dimensions. A key exception is "profitability". It is very difficult to run a profitable farm, especially in fast changing environment. In broiler production, quickly changing trends and erratic demand for organic products limit the opportunities for transformability (convert to organic production). In contrast, there is a fairly stable, large, and increasing demand for organic eggs which opens possibilities to transform for egg farmers. In conclusion. In conclusion, agricultural production is the main process related to farming system resilience issues.

A key strategy is to acquire new knowledge on how to raise animal health and welfare, as well as compliance with organic production regulation. Farmers who learn about these aspects and who can raise the capital to invest in larger stables etc. have good opportunities to raise their profitability, especially in the egg sector.

In conclusion, profitability and business-related indicators and resilience attributes are key for the case study. Other resilience attributes are indirectly influenced by consumer demand, but they are not necessarily seen as essential. There are some synergies between environmental goals and transformation to organic production. Decision-makers should be aware of the challenges in this regard which are access to knowledge on new technologies and – to a smaller extent – access to capital.

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A key challenge to the generic resilience attribute "openness," for the broiler sector, is the erratic demand. As much of the demand for organic products in Sweden is driven by the public sector (e.g., for catering purposes), ensuring some stability over longer periods of time and perhaps delivery contracts can help addressing some of these challenges at the governance levels. There are also some implications for long and short-term risk management. In the long run, diversification of production and modularisation may help to smoothen out some of the demand volatility at a farm or farming system level. In the short-run, common tools like delivery contracts or futures may be an option for some farms.

Overall, "modularity" and "diversity" are rather low which makes the system vulnerable. Farms are highly specialized and entry barriers in terms of human capital limit entry and exit. On the other hand, there are plenty of "system reserves" and a high "tightness of feedbacks." Rural areas are generally rather well-equipped with public services in the study area (at least compared to other rural areas in Europe), and actors maintain tight networks in which information is exchanged effectively and efficiently.

For future workshops, to keep stakeholders interested in the project and in attending workshops, it would be important to reduce the amount of tedious scoring exercises/focusing on numbers in favour of more open discussion and a more qualitative approach. Overall, it was very difficult to keep people's interest for more than three hours.

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Appendix A: Workshop memo

The participatory assessment workshop was organised on 22 January 2019 in Stockholm in the building of the Federation of Swedish Farmers (LRF - Lantbrukarnas Riksförbund). The conference room was well equipped, with a capacity for 17 participants.

Participants were expected to arrive, at 9.45 and we started with "fika" (welcome sandwiches and coffee). The official working part started at 10.00. As required by some of the participants, the workshop finished by 15.40. During that time two breaks were included; the first 1 hour for lunch, and the second 30 minutes for coffee and fruits.

In total, 9 participants attended the workshop, out of which six participants contributed to the impact assessment. The stakeholders' group participating in the workshop included: two farmers, a representative from Svenska ägg, Lantmännen, Djurskydd, and the AgriFood Economics Centre.

Table A1. Stakeholder's overview

Stakeholder	Number of participants	Comments
Farmer	2	One broiler and one egg producer
NGO	1	Djurskydd
Farming cooperative	1	Lantmännen
Industry	1	Svenska ägg
Policy	1	AgriFood Economics Centre
Total: 6		

The workshop was not recorded, but one member of the FoPIA team had a responsibility to take notes. The remaining two members divided the roles to hold the presentation/lead the discussion, and to register data collected from the questionnaires that were distributed during the various sessions.

For the first workshop broilers production was under represented, only one broiler producer attended the meeting. Additional meeting, with a broiler production representative was organised after the workshop, but for planning purpose for the next workshop.

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

Table A2. Mean and standard deviation of scores per EF per stakeholder (group) and for all participants. 100 points were divided to 8 EF. Highest results of mean in bold, lowest with under script. (n=6)

	Farmer		Other		All	
Essential function (EF)	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Food production	18	11	18	15	18	13
Bio-based resources	7	5	3	4	4	4
Viable income	**35**	7	11	13	19	16
Quality of life	13	4	4	5	7	6
Natural resources	6	6	**24**	18	**18**	17
Biodiversity	6	6	9	7	8	7
Countryside attractiveness	2	3	6	9	5	8
Animal welfare	15	7	**25**	25	**22**	20

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Table A3. Importance of indicators per stakeholder group; original values and transformed values to include importance of the function and number of indicators per function. Transformed values allow for direct comparison between all indicators across all functions.(n=6)

	Transformed values						Original values.					
	Farmer		Other		Total		Farmer		Other		Total	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Total production	11	5	30	27	23	23	15	7	43	39	33	33
Product price	42	0	19	17	27	17	60	0	28	24	38	25
Consumption per capita	14	0	7	10	9	8	20	0	10	14	13	12
Total salmonella cases	4	5	14	6	11	7	5	7	20	8	15	10
Manure production	13	0	4	3	7	5	100	0	83	29	90	22
Hens meat	0	0	1	2	1	1	0	0	17	29	10	22
Profit per m2	112	40	32	22	59	48	80	28	95	9	89	17
Viability	11	15	1	1	4	8	8	11	2	3	4	7
Energy price	4	20	1	1	2	11	3	4	2	3	2	3
Fodder price	14	6	1	2	5	7	10	14	2	3	5	9
Working time per year	12	5	1	1	5	3	24	13	7	12	14	14
Employment possibilities	18	2	3	3	8	8	37	5	28	19	32	14
Happy to be a farmer	1	2	2	4	2	3	3	4	17	29	11	22
Access to labour	18	2	6	6	10	8	37	5	48	33	44	24
GHG emission	5	1	27	23	20	21	23	4	29	25	27	19
Soil quality	5	6	15	31	12	31	20	28	16	11	18	15
Nutrients loss	14	7	52	10	39	10	58	25	55	33	56	28
Area under nature-friendly management	9	9	1	13	4	11	58	60	4	8	26	42
Old breeds/diversity	7	1	11	13	9	11	40	57	51	50	47	46
Outdoor farm capacity	0	2	9	3	6	3	3	4	44	51	28	43
Social life	1	2	2	8	1	7	15	21	6	13	9	14
Broadband	2	1	9	2	7	2	25	21	36	30	33	26
Tourist attractiveness	1	4	2	12	2	11	10	14	8	10	8	10
Access to public services	4	13	13	12	10	12	45	7	20	9	30	15
Number of farms that fulfil criteria for animal programs	12	0	45	0	34	0	35	21	12	13	21	19
Antibiotics use	27	0	15	0	19	0	50	57	50	24	50	32
Mortality rate	21	0	9	0	13	0	20	28	60	30	44	34
Behavioural disasters	0	0	6	0	4	0	0	0	8	14	5	11
0	0	0	0	0	0	0	0	0	0	0	0	0

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Table A4. Mean and standard deviation of scoring on performance of indicators per stakeholder group and for all participants. Indicators were scored from 1-5, where 1=very low, 2=low, 3=medium, 4=good and 5=perfect. (n=6)

	Corrected values					
	Farmer		Other		Total	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Total production	4.0	1.4	5.0	0.0	4.5	1.0
Product price	3.0	2.8	1.5	0.7	2.3	1.9
Consumption per capita	3.5	0.7	3.5	2.1	3.5	1.3
Total salmonella cases	5.0	0.0	5.0	0.0	5.0	0.0
Manure production	4.5	0.7	2.7	0.6	3.4	1.1
Hens meat	2.0	0.0	1.7	0.6	1.8	0.4
Profit per m2	3.0	2.8	2.0	0.0	2.5	1.7
Viability	5.0	0.0	2.0	0.0	3.5	2.1
Energy price	2.0	1.4	2.0	0.0	2.0	1.0
Fodder price	1.5	0.7	1.0	0.0	1.3	0.5
Working time per year	2.5	0.7	2.0	0.0	2.3	0.6
Employment possibilities	4.0	1.4	4.0	0.0	4.0	0.8
Happy to be a farmer	3.5	0.7	3.5	0.7	3.5	0.6
Access to labour	4.0	1.4	2.5	2.1	3.3	1.7
GHG emission	4.0	1.4	4.0	1.0	4.0	1.0
Soil quality	5.0	0.0	3.0	0.0	4.0	1.4
Nutrients loss	4.5	0.7	2.3	1.2	3.2	1.5
Area under nature-friendly management	1.5	0.7	5.0	0.0	2.7	2.1
Old breeds/diversity	5.0	0.0	3.5	0.7	4.0	1.0
Outdoor farm capacity	2.0	0	3.0	0.0	2.5	0.7
Social life	3.5	0.7	3.0	0.0	3.3	0.6
Broadband	4.0	0.0	1.0	0.0	2.5	2.1
Access to public services	2.0	0.0	3.0	0.0	2.3	0.6
Tourist attractiveness	3.5	0.7	2.0	0.0	3.0	1.0
Number of farms that fulfil criteria for animal programs	4.5	0.7	4.3	1.2	4.4	0.9
Antibiotics use	2.0	1.4	5.0	0.0	3.8	1.8
Mortality rate	0.0	0.0	3.0	0.0	3.0	0.0
Behavioural disasters	5.0	0.0	2.0	0.0	3.5	2.1

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Table A5. Mean and standard deviation of scoring on performance of essential functions per stakeholder (group) and for all participants. Derived from scoring of importance and performance of Indicators (n=6).

	Corrected values					
	Farmer		Other		Total	
Idicators	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Food production	3.5	0.5	3.7	0.0	3.6	0.3
Bio-based resources	2.1	0.5	3.5	0.4	2.7	0.9
Viable income	1.6	0.0	4.0	0.0	2.8	1.7
Quality of life	1.0	0.7	3.1	1.4	2.1	1.5
Natural resources	3.3	0.0	4.5	0.0	3.9	0.8
Biodiversity	3.2	0.0	3.1	0.0	3.2	0.0
Countryside attractiveness	2.3	0.0	2.9	0.0	2.6	0.5
Animal welfare	3.0	0.0	0.0	0.0	3.0	0.0

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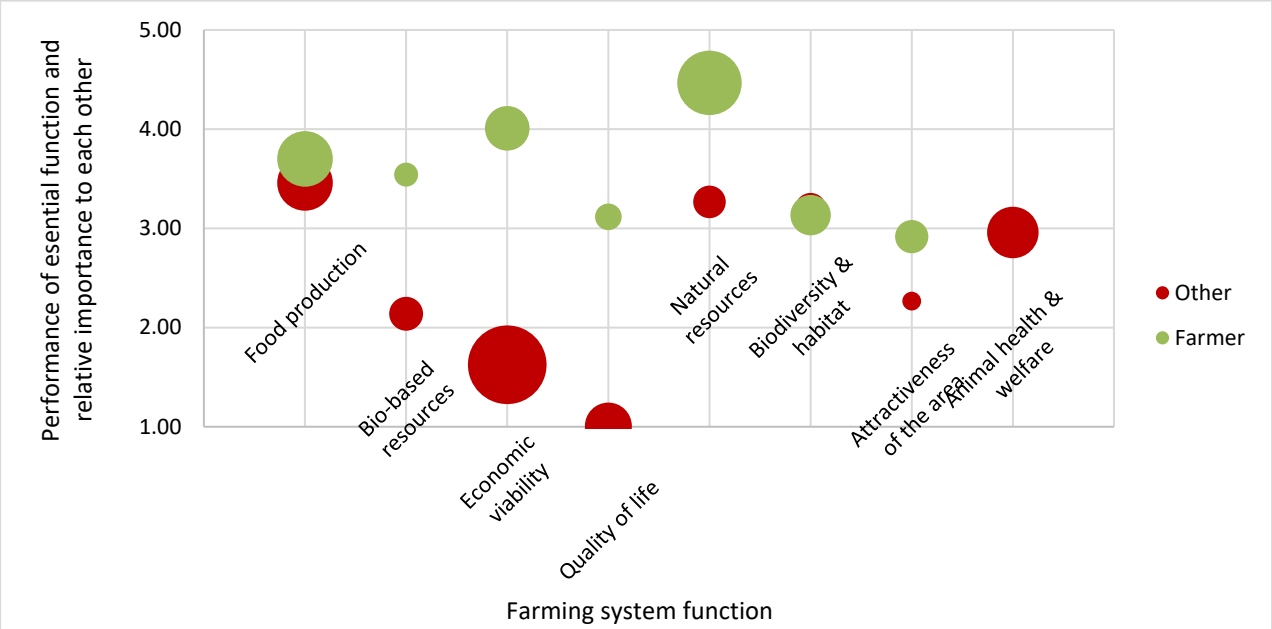
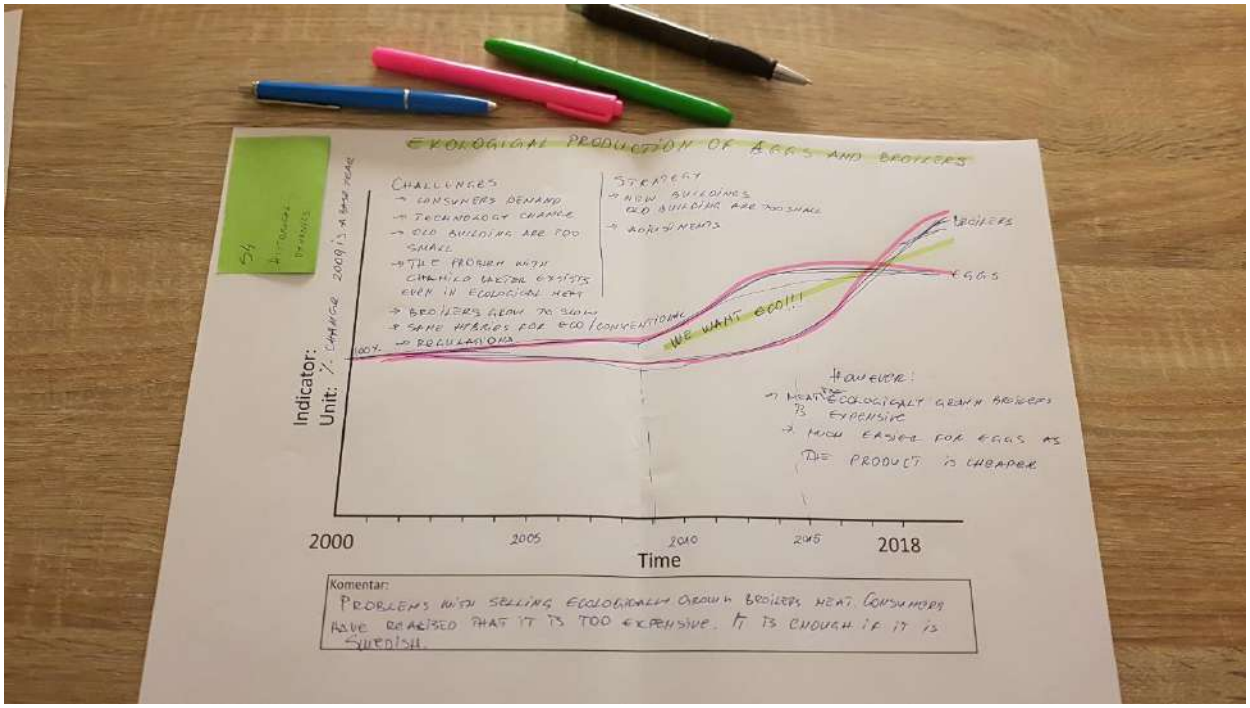
*Figure A1. Bubble graph presenting averaged scores on performance of **essential functions (from 1 to 5)**, while also indicating their importance (size of bubbles), relative to each other, across the stakeholders (n=6).*



Appendix C. Dynamics of main indicators



Stakeholders sketched and discussed the development of organic poultry production in Sweden, i.e production of organic eggs and organic poultry meat (the red lines), during 2000-2018. Changes were explained to be initiated by large market pressure for "more" organic production "*we want eco*". Both, challenges and strategies undertaken by the *farmers* and the remaining stakeholders were disused.

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Appendix D. details on scoring strategies and resilience attributes

Table A6. Implementation scores of strategies

Table A6. Mean (and standard deviation) of implementation scores of strategies and their potential contribution to robustness, adaptability and transformability. (n=group discussion)

		Potential contribution to resilience capacities							
		Implementation score		Robustness		Adaptability		Transformability	
Selected indicator	Strategy	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Production of organic eggs	Use knowledge sources	5.0	0.0	3.0	0.0	3.0	0.0	3.0	0.0
Production of organic eggs	Investments in buildings/technology	4.0	0.0	1.0	0.0	3.0	0.0	-3.0	0.0
Production of organic poultry meat	Change the breed	1.0	0.0	3.0	0.0	3.0	0.0	-3.0	0.0
Production of organic poultry meat	Use knowledge sources	5.0	0.0	3.0	0.0	3.0	0.0	3.0	0.0
Production of organic eggs	Investments in buildings/technology	2.0	0.0	1.0	0.0	3.0	0.0	-3.0	0.0

Note: all stakeholders had the discussion as a group, thus standard deviations ware not calculated.

Table A7. Mean and standard deviation of performance scores of resilience attributes, per stakeholder group and for all participants. (n=group discussion)

	Extent into which attribute applies in FS					
	Farmer		Other		Total	
Resilience attribute	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Reasonably profitable	2.0	0.0	2.0	0.0	0.0	0.0
Coupled with local and natural capital (production)	4.0	0.0	4.0	0.0	0.0	0.0
Functional diversity	4.0	0.0	4.0	0.0	0.0	0.0
Response diversity	2.0	0.0	2.0	0.0	0.0	0.0
Exposed to disturbance	3.0	0.0	3.0	0.0	0.0	0.0
Spatial and temporal heterogeneity (farm types)	3.0	0.0	3.0	0.0	0.0	0.0
Optimally redundant (farms)	1.0	0.0	1.0	0.0	0.0	0.0
Supports rural life	2.0	0.0	2.0	0.0	0.0	0.0
Socially self-organized	3.0	0.0	3.0	0.0	0.0	0.0
Appropriately connected with actors outside the farming system	3.0	0.0	3.0	0.0	0.0	0.0
Infrastructure for innovation	3.0	0.0	3.0	0.0	0.0	0.0
Coupled with local and natural capital (legislation)	4.0	0.0	4.0	0.0	0.0	0.0

Note: all stakeholders had the discussion as a group, thus standard deviations were not calculated.

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Table A8. Mean and standard deviation of resilience attribute's contribution to robustness adaptability and transformability, per stakeholder group and for all participants. (n=group discussion)

	Farmer						Other						Total					
	Robustness		Adaptability		Transformability		Robustness		Adaptability		Transformability		Robustness		Adaptability		Transformability	
Resilience attribute	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Reasonably profitable	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coupled with local and natural capital (production)	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	1.0	0.0	-3.0	0.0	3.0	0.0	1.0	0.0	-3.0	0.0
Functional diversity	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0
Response diversity	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	1.0	0.0	1.0	0.0	2.0	0.0	1.0	0.0	1.0	0.0
Exposed to disturbance	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	1.0	0.0	1.0	0.0	2.0	0.0	1.0	0.0	1.0	0.0
Spatial and temporal heterogeneity (farm types)	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	2.0	0.0	1.0	0.0	1.0	0.0	2.0	0.0	1.0	0.0
Optimally redundant (farms)	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0	0.0	1.0	0.0	2.0	0.0	2.0	0.0	1.0	0.0
Supports rural life	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Socially self-organized	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Appropriately connected with actors outside the farming system	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0
Infrastructure for innovation	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0
Coupled with local and natural capital (legislation)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0	0.0	0.0	0.0	2.0	0.0	2.0	0.0

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Appendix E: Workshop challenges and improvements

One problem was to get hold of stakeholders. It was not clear to them how they would benefit from participating and how a long travel could be justified. It takes a lot of good will from someone to sacrifice a whole day in addition to travel time for research purposes. As the case study does not have strong seasonality, it is perhaps also more difficult to find times where farmers are not busy (which is difficult in livestock anyway).

The workshop was too long. We did not a have the feeling that participants could benefit much from it. Although we tried our best to create a welcoming atmosphere, to provide food and drinks, to offer travel costs, and to have breaks whenever people felt a need for them, it felt a bit like we would exploit stakeholders by asking for so much of their time. One key improvement would be to cut down the time drastically, also because we had the feeling that after three to four hours people are exhausted even with plenty of breaks. Overall, people enjoyed open discussion guided by a facilitator much more than filling forms and scoring. Especially, after a few forms. stakeholders lost interest in the numbers and even questioned if there was anything useful to learn from these numbers. The time for discussion is very limited if one should seriously focus on filling all the form. Overall, the amount of forms to be filled was perceived as way too much. For the last session on challenges and strategies. we discussed the issues as one group. Participants were not willing to fill in the forms individually anymore. For some of the participants (NGO representatives) many of the essential functions were irrelevant.

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