Project acronym: SURE-Farm
Project no.: 727520

Start date of project: June 2017
Duration: 4 years

FoPIA-Surefarm Case-study Report Poland

Work Performed by Partner No. 15, IRWiR PAN, Instytut Rozwoju Wsi i Rolnictwa

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

INDEX

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

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

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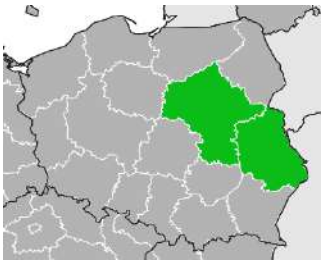
Abstract

As SURE-Farm Working Package 5 (WP5) aims to analyse the integrated impact of resilience-enhancing strategies on the selected farming systems in the 11 Sure-Farm case studies, one of the key elements to deliver the research basis and necessary data is the Framework for Participatory Impact Assessment adapted for SURE-Farm (FoPIA-SureFarm) and its integral parts, one of which being the stakeholders' workshops. Research results from the first workshops conducted across the 11 case study areas in the EU will be synthesized in the SURE-Farm Deliverable 5.2 (due June 2019). Polish case study area focuses on Mazovian region and concerns one of key local farming systems – horticulture. In order to analyse the local peculiarities of farm resilience a FoPIA workshop with 20 stakeholders has been carried out in Poland in March 2019 by the IRWiR PAN team.

1 Introduction

1.1 Case study



Mazovian region (org. EUFADN "Mazowsze i Podlasie") located in Central-East part of Poland includes two NUTS2 regions: PL92 (Mazowieckie) and PL81 (Lubelskie).

This region is traditionally dominated by horticulture, determined by its diversified landscape. Depending on particular area the key hard fruits are: apples, pears, plums, cherries, sweet cherries, to less extent peaches and apricots; among the soft fruits: strawberries, raspberries, currants (black and red), and gooseberries. Most popular vegetables chosen for cultivation by farmers are onions, carrots, cabbages, cucumbers, tomatoes, and sugar beets.

The typical farm types defined for the Mazovian case study area include the following five, based on the SURE-Farm Deliverable 3.1 (Bijttebier et al., 2018):

- TFT1: small farms (<10 ha) + Family farms + Arable farming (Field crop farms).
- TFT2: medium farms (10-30 ha) + Family farms + Arable farming.
- TFT3: medium farms (10-30 ha + Family farms + Milk farms.
- TFT4: small farms (<10 ha) + Family farms + horticulture (fruits or/and vegetables).
- TFT5: small farms (<5 ha) + Family farms + poultry farm (farming based on purchased fodder inputs).

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These farm types were identified by the IRWiR PAN team based on statistical and Polish FADN data, combining them with the typology characteristics defined in the SURE-Farm project (farm size, managerial ownership, horizontal specialisation, intensity).

The key farming system relevant for the Polish case study in the SURE-Farm project is the TFT4. Horticultural production is mainly carried out by farms with less than 10 ha, most being family farms. There is a growing interest in the creation of producer groups (e.g. joint investments in storage facilities) among fruit and vegetable farms, yet currently the network of horizontal integration connections in agriculture is in general poorly developed, with the exception of some fruits production (e.g. apples). The soft fruit market is also poorly organized, due to the lack of horizontal and particularly vertical integration links. There are very frequent distortions in this market, manifested by drops in purchase prices, at some points reaching levels below costs (e.g. apples, black currants). Farms are also confronted with a lack of seasonal workers. Fruit and vegetable production as well as growing of industrial plants (tobacco, hops, herbs, sugar beets) requires high labour inputs, yet in recent years the demand for seasonal workers significantly exceeds supply, which influences the development of production (Bijttebier et al., 2018).

Key challenges faced by the farming system (see Table 1) were identified in the process of workshop's preparation and are divided into 1) non-permanent shocks and 2) long-term pressures, both structured according to four types of challenges – economic, environmental, social and institutional.

Table 1. Identified challenges

Challenges	Economic	Environmental	Social	Institutional
Non-permanent shocks	Fluctuation of prices of agricultural products	Extreme weather conditions	Periodical lack of seasonal workers	Variability of laws and regulations
	Weak competition arising from underdeveloped horizontal cooperation		Social resistance against large-scale animal farms	Changes of requirements regarding emissions of pollutants and animal welfare

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Long-term pressures	Weak organisation of soft fruits market compared to other markets (milk or meat)	Decrease in the content of organic matter in soils	Historical fragmentation of Polish agriculture in Southern and Eastern regions	Lack of institutional support for horizontal cooperation between farmers
		Shortage of water resources	Lack of defined farm successors	
		Threat of erosion		

1.2 Workshop

The workshop was held in the village of Widniówka, Krasnystaw district, Lubelskie voivedeship (Poland) on 6th of March 2019 in the premises of Rural Chamber of Culture and Tourism, used locally for various social events.

There were a total of 24 stakeholders present, yet the ones who actively participated in the workshop equal 20 people. While all except one has stayed till the end of the workshop, some of the exercises were missed by some stakeholders, as they have decided to leave for a short while and return later on. In order to be as precise as possible the number of observations has been included in the descriptions of according tables and figures included in the report.

According to the gender distribution, there were 15 males and 5 females. While a more equal gender distribution was targeted, gathering such number of stakeholders for a lengthy workshop turned out as difficult, even though the season in which the workshop was held was not as busy for horticultural farmers.

Identification of stakeholders allowed to define three groups: *Farmer* (10), *Government* (4) and *Other* (6). *Industry* group was not possible to be singled out, as there were no stakeholders who could be identified as such.

The *Other* group included three people who held positions at or were members of Farmers' Union of Poland, one researcher from the Institute of Agricultural and Food Economics - National Research Institute (Warsaw), one person being the head of NGO aimed at environmentally-friendly activities in agriculture and one person having a background of working at State Veterinary Inspection, but also being a pro-bono activist and lecturer.

At the same time some of the stakeholders in different groups had multiple backgrounds, namely holding positions in state or local authorities, but also being active farmers. Such and other combinations were thought to be beneficial for the workshop's output, as such stakeholders

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perceive existing issues from various sides, understanding both practical issues at farm level and peculiarities of regulations, seeing farming system as a whole, feeling the interactions between different types of actors.

A workshop memo with details on the participants can be found in Appendix A.

2 Farming system

The farming system (FS) and its environment presented on Figure 1 reflects the proposed visualisation of a typical farming system that has been developed by SURE-Farm consortium.

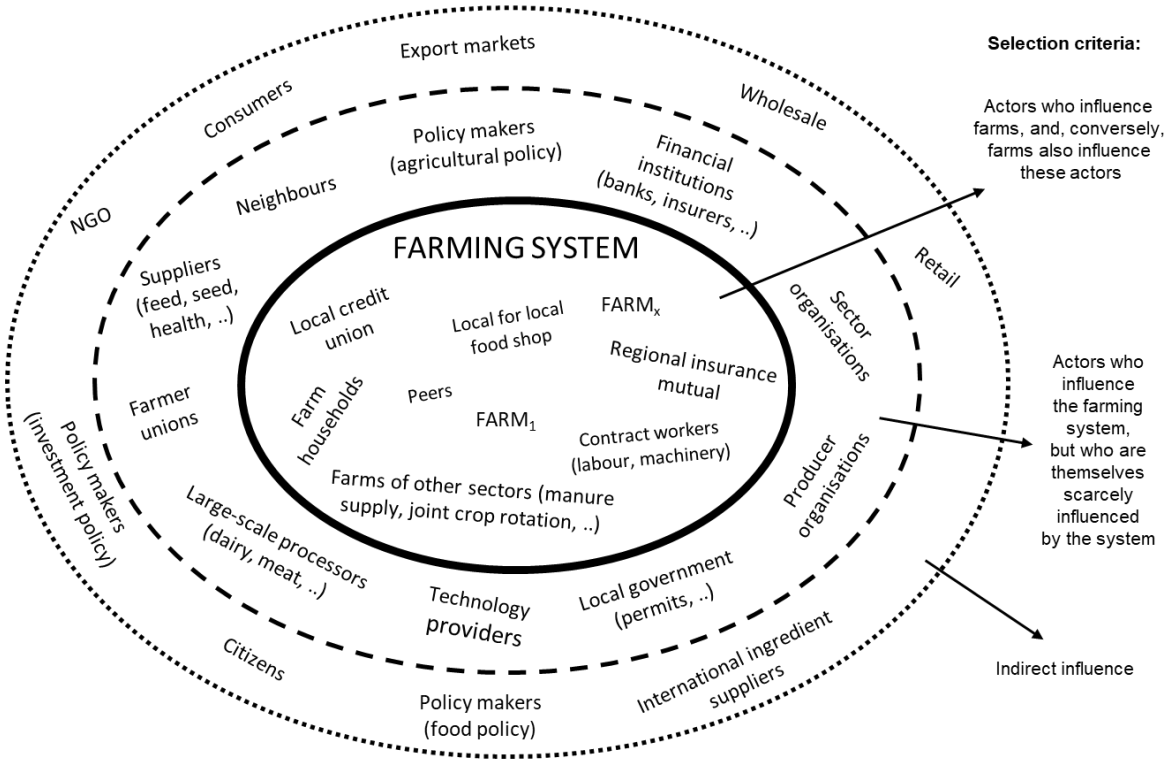

Figure 1. Initial farming system visualisation as proposed by SURE-Farm consortium

In order to most accurately reflect the fruit and vegetable farming system of the Mazovian region modifications have been made following the IRWiR PAN analysis and discussion during the workshop, due to which several actors were replaced or moved based on detection of a different type of their influence in particular case study, few were removed or combined (e.g. the policy makers).

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As the result of modifications (Figure 2), the FS itself includes horticultural (fruit and vegetable) farms, farm households, land owners, hired workers, local retailers, local wholesalers, as well as producer groups and cooperatives.

The actors who influence the farming system, but who are themselves scarcely influenced by the system include processors, banks and financial institutions, farmers organisations (unions), suppliers of inputs (e.g. fertilisers, pesticides), regional and national retailers, agricultural media (newspapers and journals, websites – e.g. farmer.pl, agropolska.pl), advisory (extension) services (state and private), local authorities (e.g. issuing permits).

The third circle, depicting the actors of indirect influence upon the FS, yet with strong effect nevertheless, includes EU policy makers (e.g. though CAP), national public administration (e.g. Ministry of Agriculture and Rural Development), export markets, consumers, citizens, environmental NGOs, social NGOs and researchers (e.g. Institute of Rural and Agricultural Economics - NRI, Institute of Soil Science and Plant Cultivation – NRI and other).

As there is a substantial influence of agro-scientific community on farming practices through dissemination by agricultural media, both these actors were added.

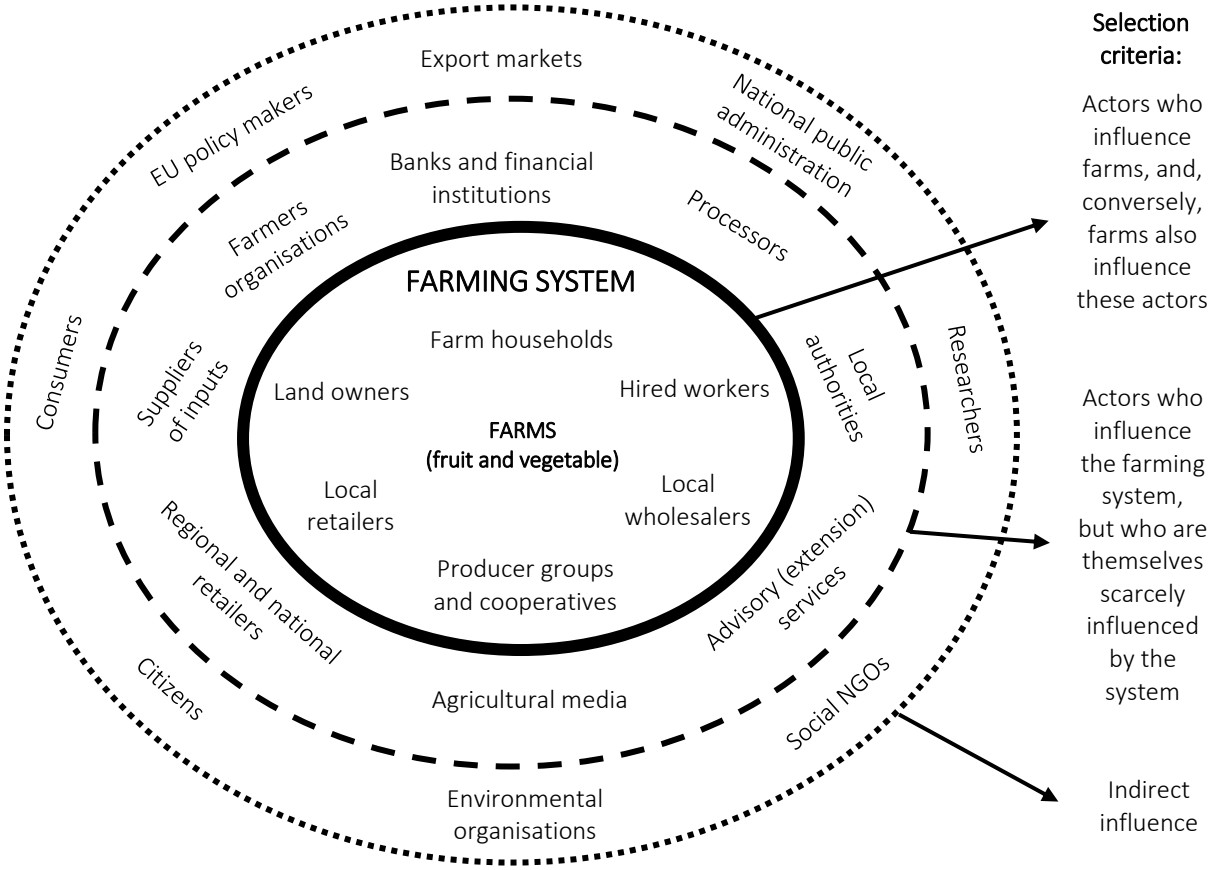

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Figure 2. (Updated) farming system visualisation after feedback from participants

3 Essential functions

While the horticulture sector researched in Poland isn't directly influenced by the essential function named "Ensure animal health and welfare", it was decided that the indirect ties are present and especially in terms of chosen indicators (the number of bee colonies, changes in livestock population influencing manure quantity and utilisation, antibiotic consumption per livestock unit) the cross-influence between the horticulture sector and the animal health and welfare are a valid issue for the research. Therefore in the Polish case study all 8 essential functions were taken into account.

Based on overall stakeholders' opinions, the most important functions delivered by the farming system are the "Economic viability" (26 points) and "Food production" (20 points). During the discussion it was also clear that economic issues, as the prices, income and costs are key factors in the farming system and have the strongest influence upon its actors. "Quality of life" has received 14 points and was voiced out as the one function that strictly connected to the previous two functions. Other essential functions were rated as having a lower importance, such as "Attractiveness of the area" (10 points), "Bio-based resources" and "Animal health & welfare" (8 points each), with the lowest scored function being the "Biodiversity & habitat" (5 points).

Stakeholders' attitude towards these functions differed according to their groups. While all groups were homogenous concerning the high importance of the "Economic viability" and "Food production" functions, the farmers were the ones who focused on "Economic viability", while the "Food production" was chosen by such groups as *Other* and *Government*. The representatives of the *Other* and *Government* groups were also more willing to define higher importance of the public functions, including environmental protection. Therefore stakeholders representing these two groups were emphasizing the role of "Natural resources", "Biodiversity & habitat", "Animal health & welfare" compared to farmers. The *Government* group was the one that outlined the importance of "Bio-based resources" and "Attractiveness of the area" more than the other two groups of stakeholders.

A detailed table with all values of means and standard deviations (SD) for this questionnaire can be found in Appendix B (Table A2).

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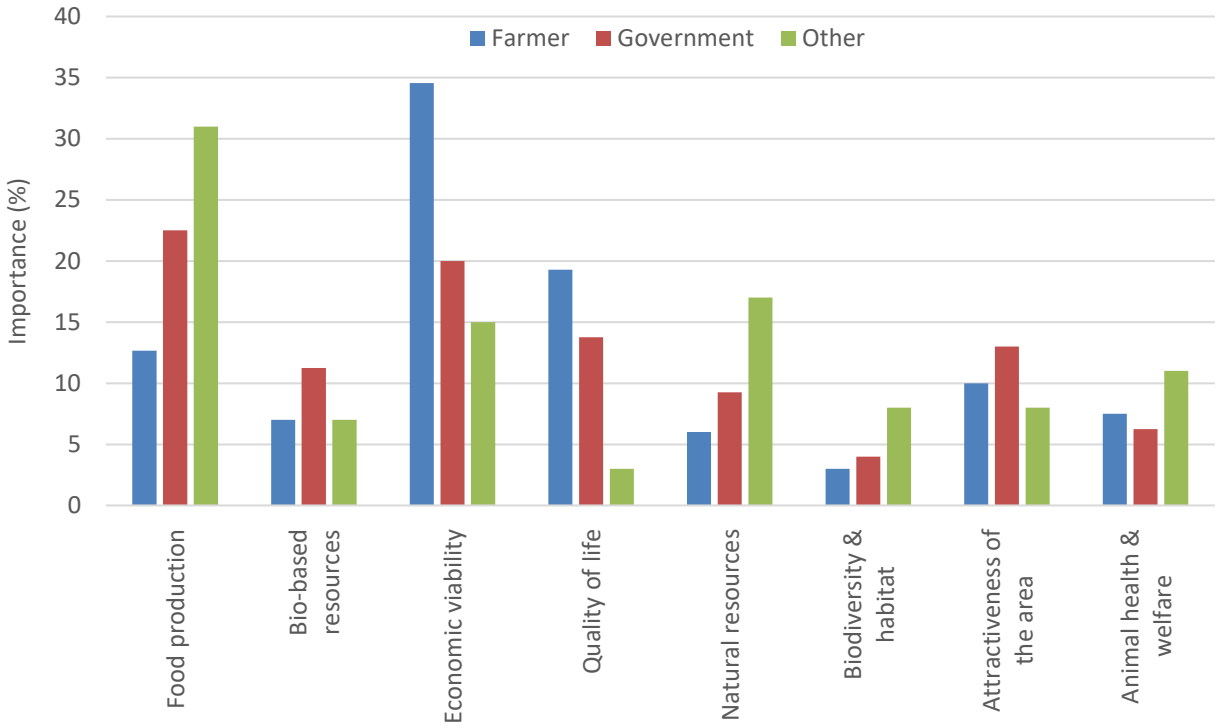

Figure 3. Bar graph with scoring per function, aggregated by stakeholder group. 100 points needed to be divided over 8 functions (n=19)

4 Indicators of essential functions

4.1 Indicators

All of the indicators prepared by IRWiR PAN researchers (Table 2) have been presented to the audience one by one and shortly discussed. For each essential function three indicators were selected based on expertise, publications and available statistical data.

Overall the stakeholders agreed to importance of most selected indicators as being appropriate to reflect and assess the key issues. As the discussion initiated, the "Food production" function was discussed the most. During the discussion it was pointed out by the stakeholders that while the apples and onions are more representative for the overall horticulture sector in Poland, the farms in the particular area of their residence and agricultural activities are specialising on other products (such as black currant, raspberry, rheum, sugar beet), therefore they would rather select these crops as the ones being able to reflect key issues of food production for their farming system. This initiated farther discussion leading to explanation that the stakeholders will

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be able to define the indicators they feel are more relevant for their farming system during the next questionnaire.

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

Functions (purpose)	Indicators	Stakeholders
Private goods		
Deliver healthy and affordable food products *(Food production)*	Purchase prices for apples (PLN/kg)	Fruit farmers, industry
	Purchase prices for onions (PLN/kg)	Vegetable farmers
	Area of ecological farmland with a certificate (ha)	All farmers, government, NGO
Deliver other bio-based resources for the processing sector *(Bio-based resources)*	Biomass production - straw (t/ha)	Arable farmers, government
	Average selling price of wood (PLN/m3)	All farmers, government
	Share of fruit cultivation (% of sown area)	All farmers, government
Ensure economic viability (viable farms help to strengthen the economy and contribute to balanced territorial development) *(Economic viability)*	Price relation of agricultural products to agricultural production costs (%)	All farmers
	Price of NPK fertilizers (PLN/kg)	All farmers
	Labour costs (PLN/hour)	All farmers; government
Improve quality of life in farming areas by providing employment and offering decent working conditions *(Quality of life)*	Percentage of population having access to sewerage network (%)	All farmers
	Unemployed registered in the countryside (thousands of people)	All farmers, government
	Dynamics and relations of nominal incomes per capita of rural and urban residents (%)	All farmers
Public goods		
Maintain natural resources in good condition (water, soil, air) *(Natural resources)*	Changes in land use	All farmers, government
	Indicator of surface water availability per capita	All farmers, government
	Dynamics of the gross balance of nitrogen and phosphorus and gross value added of agricultural production	All farmers, government
Protect biodiversity of habitats, genes, and species *(Biodiversity & habitat)*	Quantity of common birds in the agricultural landscape and forest birds	All farmers, government, NGOs
	Protected areas as% of total area	All farmers, government, NGOs
	Number of wild game - boars (thousands of pcs)	All farmers, government, NGOs
Ensure that rural areas are attractive places for residence and tourism (countryside, social	Balance of migration in rural areas (people)	All farmers, government
	Agritourism farms (number of units)	All farmers, government
	Concentration of air pollution	Government, NGO

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structures) *(Attractiveness of the area)*		
Ensure animal health & welfare *(Animal health & welfare)*	The number of bee colonies (pcs)	All farmers, government
	Changes in livestock population per 100 ha of UAA	All farmers
	Antibiotic consumption per livestock unit	All farmers, government, NGOs

4.2 Indicator importance

In order to define the importance of indicators the stakeholders were to distribute 100 points among indicators representing each essential function. They were also given an option to add one additional indicator to each function if they felt it would better (or additionally) reflect the delivery of this particular function by the farming system. Figure 4 shows the results of the scoring, corrected accounting for the scoring of the function and for the number of indicators per function (Corrected value = function scoring * indicator scoring / 100 * number of indicators under that function). Tables with means and standard deviations for both original and corrected values aggregated by stakeholder groups are presented in the Appendix B (Tables A3.1 and A3.2).

The indicator that received the highest score of 43 was the "Price relation of agricultural products to agricultural production costs (%)" then came the "Purchase prices for apples (PLN/kg)" and "Area of ecological farmland with a certificate (ha)", both achieving 27 points. The forth top indicator was the "Dynamics and relations of nominal incomes per capita of rural and urban residents (%)" with a score of 26.

The "Price relation of agricultural products to agricultural production costs (%)" and the "Dynamics and relations of nominal incomes per capita of rural and urban residents (%)" was selected primarily by the *Farmer* group, again supporting the conclusion about the primary importance of economic (income) issues for this group. The representatives of the *Government* group have also highlighted the importance of these two indicators as the primary ones.

The *Other* group have mainly outlined the importance of the indicators related to the "Food production" function, but also to functions concerning the delivery of public goods. Such indicators as "Changes in land use", "Indicator of surface water availability per capita", "Concentration of air pollution" and "The number of bee colonies (pcs)" were selected as the next most important ones (practically all belonging to the area of environmental condition and protection).

Low scores were given by all stakeholder groups to "Quantity of common birds in the agricultural landscape and forest birds", "Number of wild game - boars (thousands of pcs)", "Antibiotic consumption per livestock unit". It is possible that these indicators were close by their meanings to

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other ones, e.g. to "Land use", which is a somewhat aggregated indicator reflecting numerous narrow processes and changes.

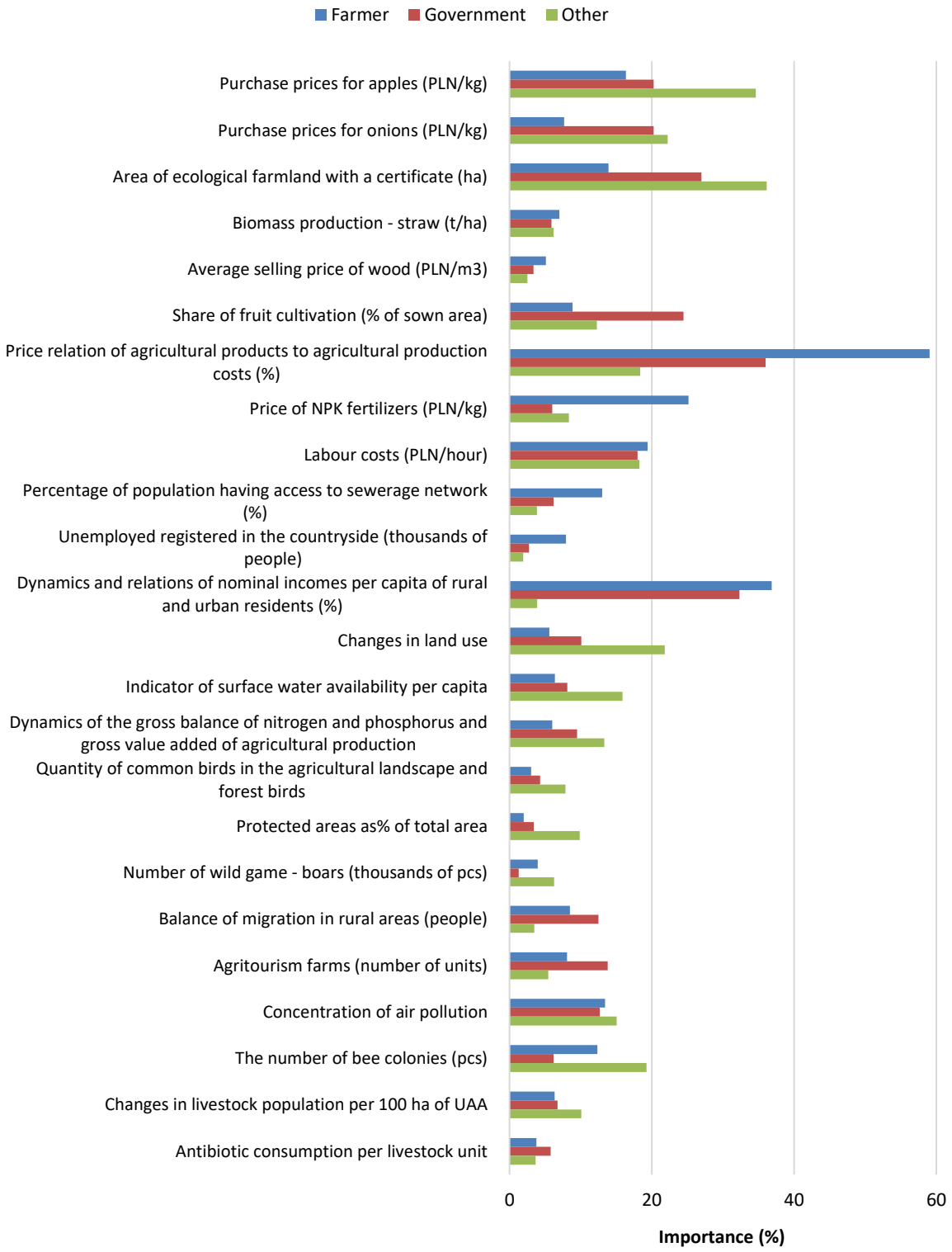

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Figure 4. Bar graph with scoring of importance per indicator, aggregated by stakeholder group. Per function, 100 points were divided over the indicators (n=18). Values are transformed to include the importance and number of indicators of the function that the indicators represent

Overall for each essential function the following indicators were selected as the most appropriate:

- "Food production": two indicators ("Purchase prices for apples (PLN/kg)" and "Area of ecological farmland with a certificate (ha)") received same high total score. The group of *Other* has emphasized on them the most, then came the *Government* representatives and the *Farmer* group was the last to select them. "Area of ecological farmland with a certificate (ha)" was preferred by the *Government* and the *Other* groups the most.
- "Bio-based resources": share of fruit cultivation was selected as the key indicator, with the *Government* group making the most impact upon the score. The "Biomass production – straw (t/ha)" and "Average selling price of wood (PLN/m3)" received low ranking from all groups of stakeholders.
- "Economic viability": "Price relation of agricultural products to agricultural production costs (%)" was chosen as the most representative indicator by all groups, with the *Farmer* group making the most impact upon the score. Farmers also were the ones who emphasized the relevance of the "Price of NPK fertilisers (PLN/kg)" compared to other groups, while all stakeholder groups have agreed the "Labour costs (PLN/hour) is quite a representative indicator for economic viability.
- "Quality of life": the most representative indicator was "Dynamics and relations of nominal incomes per capita of rural and urban residents (%)" as the differentiation in income level exist in rural and urban Poland. The *Farmer* and *Government* representatives have selected it as the most relevant.
- "Natural resources": "Changes in land use" was selected as the most representative, yet stakeholder groups differed in this opinion – the *Farmer* group shared this thought the least, then came the *Government* group and finally the *Other* group (making the most impact upon this score). Same order of groups was present with all other "Natural resources" indicators, with the *Other* group leading in prioritizing the indicators.
- "Biodiversity & habitat": the "Quantity of common birds in the agricultural landscape and forest birds" and the "Protected areas as % of total area" both were selected as the most meaningful. It was the *Other* group that voiced such opinion, while the other two groups defined all indicators as having low relevance.

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- "Attractiveness of the area", the indicator "Concentration of air pollution" was selected as the most representative one by all stakeholder groups, while the "Balance of migration in rural areas (people)" and "Agritourism farms (number of units)" were selected primarily by the *Government* group.
- "Animal health & welfare": "The number of bee colonies (pcs)" was overall the leading indicator, with the *Other* and *Farmer* groups primarily making such choice.

In addition to the indicators defined by the IRWiR PAN researchers during the exercise the stakeholders have added some additional ones, especially in the case of such essential functions as:

- "Food production": 15 (out of 20) participants added their indicators, but since they were rather general and at the same time inhomogeneous, they were not added to the list at this stage (9 proposals concerned average prices of agricultural products and/or soft fruits (without definition of the particular products), 1 concerned raspberries, 1 – black currant, 1 – price of organic cabbage, 1 – use of pesticides, 1 – meat and milk, 1 – production of energy);
- "Natural resources": total of 7 proposals were distributed between environmental protection measures (agricultural land, forestry, state financial support);
- "Biodiversity & habitat": total of 6 proposals concerned either the quantity of wild animals (without specification), protection of wetlands and forests;
- "Attractiveness of the area": 5 answers were distributed between financial support of rural development (2 proposals), landscape diversity (1), population density (1), and recreation (1).

Other essential functions were supplemented by overall 4 or less proposals, which differed greatly, not allowing to conclude any particular and widely supported idea for an indicator to reflect it.

4.3 Indicator performance

In the next stage participants were asked to evaluate the current performance of the indicators (sheet S3), on a scale from 1 to 5: 1) very poorly performing, 2) poorly performing, 3) not good not bad, 4) well performing, 5) perfectly performing. Figure 5 represents the results of this exercise, while more details are available in Appendix B (Table A4).

Compared to importance of functions overall results of indicator performance differed, as the indicators concerning public goods have received higher scores. The top performing indicators were the "Share of fruit cultivation (% of sown area)" and the "Protected areas as % of total area",

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receiving the scores of 3.1, followed by "Concentration of air pollution" (2.9), "The number of bee colonies (pcs)" (2.8) and splitting the last top score of 2.6 were the "Quantity of common birds in the agricultural landscape and forest birds" and "Agritourism farms (number of units)". The stakeholders see rather good trends in changes of environmental protection, rural development in terms of ecological conditions.

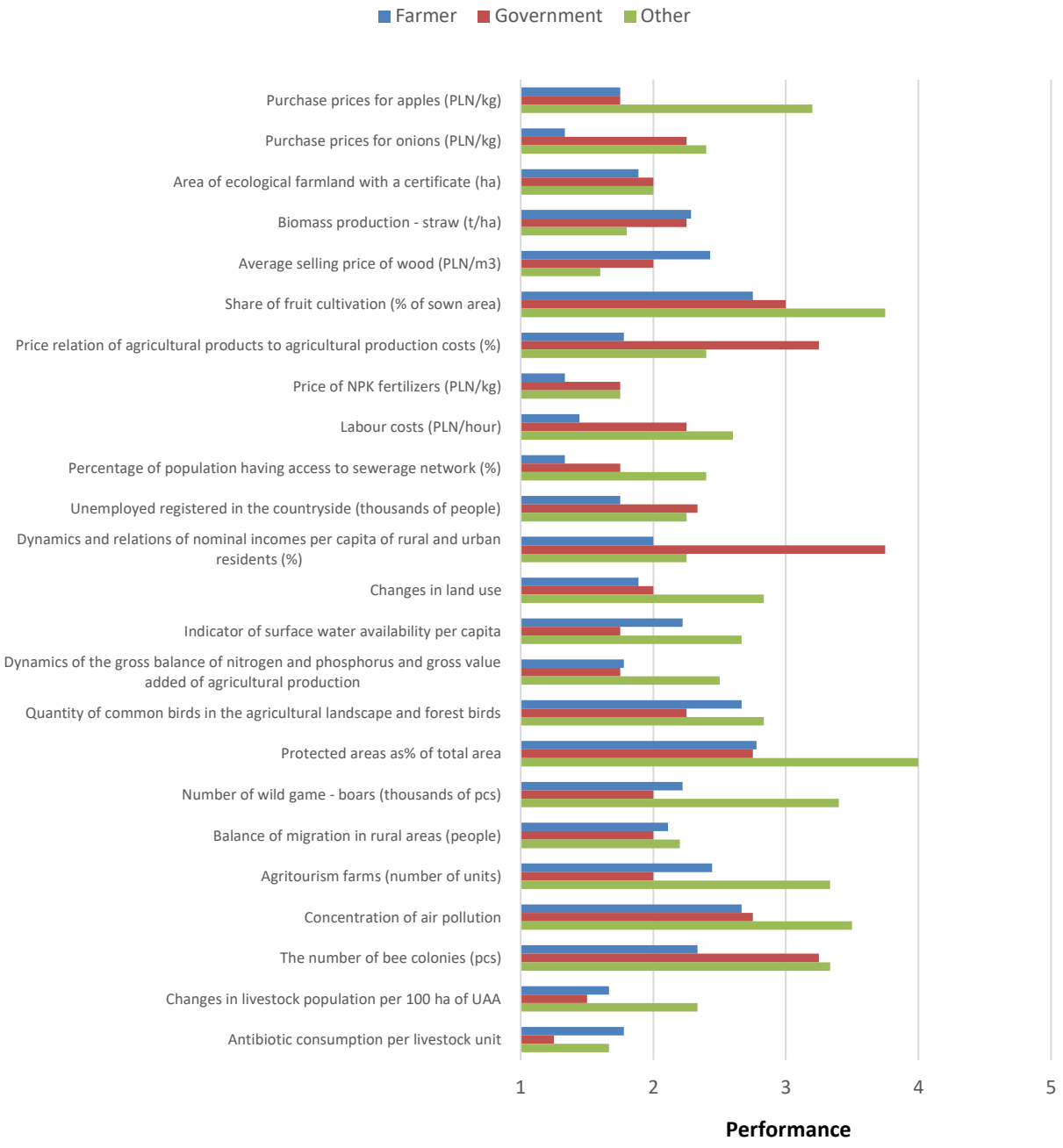

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Figure 5. Bar graph with scoring of performance per indicator (from 1 to 5), aggregated by stakeholder group (n=19). Score from 1 to 5: 1) very poorly performing, 2) poorly performing, 3) moderately performing, 4) well performing, 5) perfectly performing

While the groups of participants emphasizing these indicators were mostly *Government* and *Other*, the *Farmer* group has supported these statements as well, contributing to the positive scores of the most of environmental indicators.

The bottom-line of the analysis shows that even the indicators receiving the highest scores were still in the range from 2 (poorly performing) to 3 (not good not bad). The delivery of private goods in total was scored with an average of 2.1, yet the worst performing indicator was the "Price of NPK fertilizers (PLN/kg)", followed by "Antibiotic consumption per livestock unit" (1.6).

The *Farmer* group was most dissatisfied with the performance (all scoring as 1.3) of: "Purchase prices for onions (PLN/kg)", "Price of NPK fertilizers (PLN/kg)" "Percentage of population having access to sewerage network (%)". The *Government* group was more optimistic (with an average evaluation of 2.2) and giving the lowest scores to performance of "Antibiotic consumption per livestock unit" (1.3), "Changes in livestock population per 100 ha of UAA" (1.5). The *Other* group was yet more optimistic in the overall evaluation (giving an average of 2.6 score), yet defining "Average selling price of wood (PLN/m3)" (1.6) and "Antibiotic consumption per livestock unit" (1.7) as worst performing indicators.

Performed analysis allowed to define the performance of particular essential functions, while simultaneously reflecting their importance (Figure 6).

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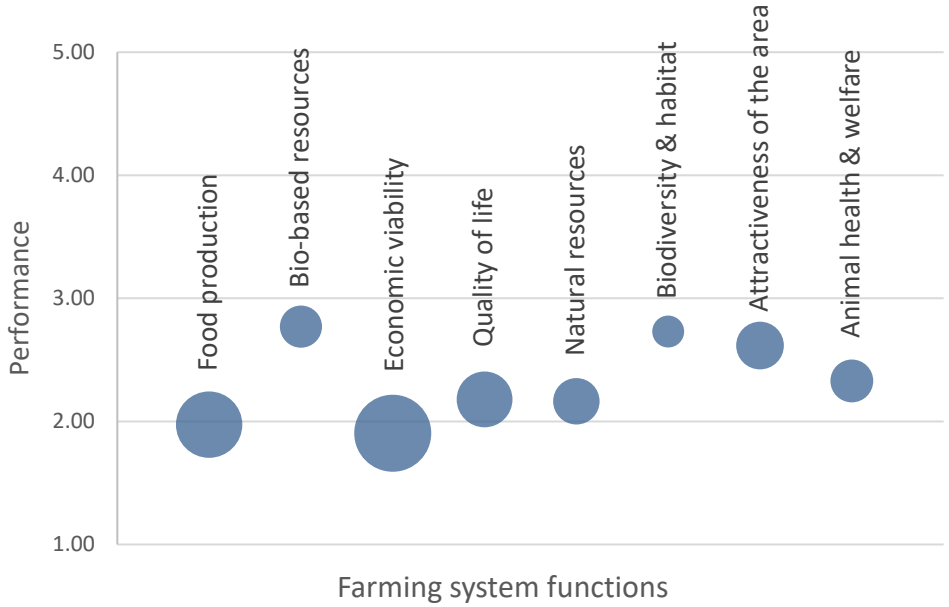

Figure 6. Bubble graph presenting averaged scores on performance of functions (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other (n=19)

4.4 Indicator selection

Based on the aggregated data a synthesis of both importance and performance of selected indicators was conducted (Figure 7). In order to select indicators for farther analysis a discussion was initiated, which again brought to the attention the participants' suggestions concerning the "Food production" indicators, as this essential function seemed to most participants as the most relevant for overall picture of agricultural activity in the farming system.

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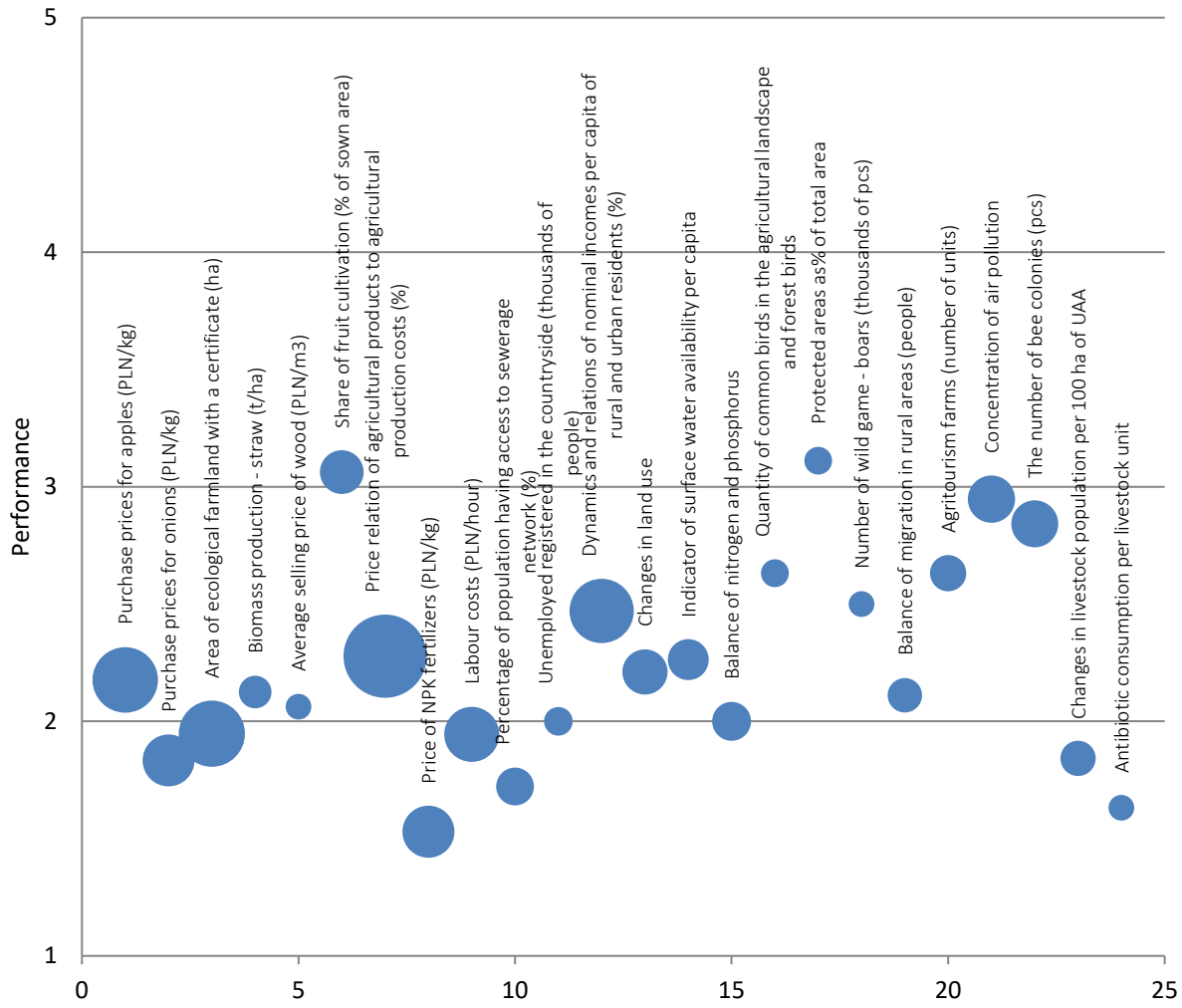

Figure 7. Averaged scores on performance of indicators (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other (n=19)

The bubble graph presenting averaged scores on performance of essential functions, aggregated by stakeholder group, is presented in Appendix B (Figure A1).

In the process of discussion a total of four indicators were selected for the group analysis:

- price of black currant,
- price of raspberry
- price of sugar beet,
- biodiversity.

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5 Resilience of indicators

The participants were asked to split into groups, while maintaining a similar representation of different stakeholders (*Farmer*, *Government*, *Other*). A total of 5 groups have been created, in order to achieve targeted representation most of participants have change their seats and joined the group analysing the indicator of their choice. As there were many farmers dealing with black currant, two groups have decided to work with an indicator "Price of black currant" (Group 1 consisting of 4 people and Group 3 consisting of 5 people). Group 2 has chosen an indicator "Price of raspberry" (6 people) and Group 4 was most interested in "Price of sugar beet" (3 people). One person has decided to do the exercise personally, as nobody else was willing to select the same indicator (biodiversity). One other person had to leave the workshop before the beginning of this exercise, therefore leaving 19 people continuing to work on this exercise.

5.1 Price of black currant

Groups 1 and 3 have sketched the dynamics of black currant prices, they have agreed to the selected timespan of 2000-2018, as it was reflecting both the changes before the accession of Poland to the European Union, as well as 14 years of EU membership.

Below are presented the figures reflecting the dynamics of black currant prices, the first one prepared by the IRWiR PAN researchers based on official statistical data (Figure 8), then the second and third ones based on the drawings of the stakeholders of Group 1 (Figure 9) and Group 3 (Figure 10).

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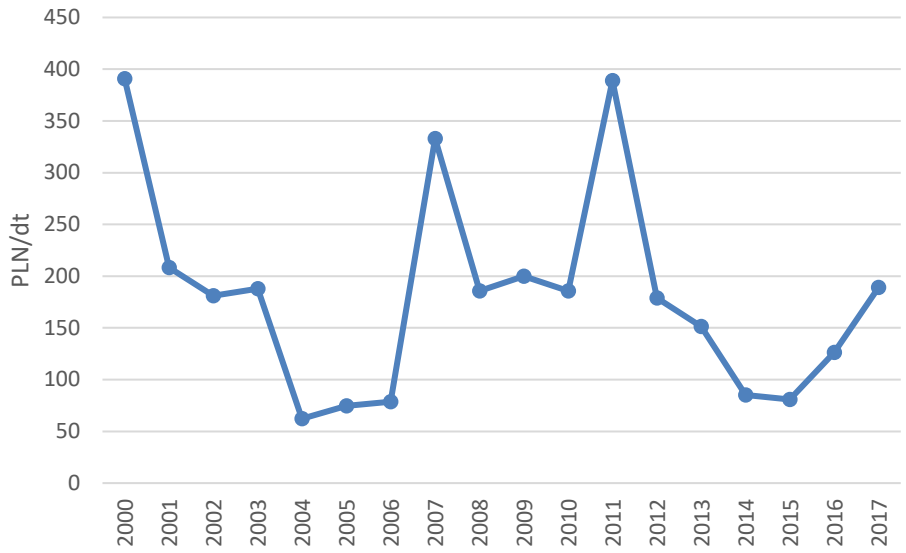

Figure 8. Price of black currant

Source: Central Statistical Office of Poland.

Typical for horticulture sector, the price of black currant has been fluctuating, the key trends being the constant and quite rapid decline before the EU accession, then a significant increase in 2007, followed by decline in the next year and an even more significant increase in 2011. From that year up until the 2015 the price was gradually lower, since which upward dynamic has been noted again.

While Poland is the largest producer of black currants in the European Union, the domestic market is very unstable with occasional short-term improvements (increases in purchase prices). Such increase (as in 2007 and 2011) cause raising interest of the farmers, rushing to join the beneficial production, therefore causing the purchase prices to collapse in subsequent periods, when all the new plantations come to harvest time (Antoń-Jucha, 2018). Lack of locally available supporting infrastructure (such as storage facilities) make the soft fruit market extremely volatile and dependent of the daily situation, since the producers are often forced to sell their produces right away, not being able to wait for a more beneficial market conditions.

Not without significance is the fact that the low demand for black currants is caused by the low demand for its processed products, which especially in high yield years due to inability of processing plants to buy and store all the market causes significant price decreases (SadyOgrody, 2018).

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Price volatility causes a long-lasting reduction trend in black currant cultivation area in Poland, however, differences in the annual level of yields in particular years lead to market price breakdowns. Black currant prices were high in 2007 and 2011. This was extremely unbeneficial for the entire industry, because in the next years the situation was getting worse, leading to farmer losses. In 2017, the price was slightly higher, and this was due to the fact that the overall output was lower due to spring frosts. Currently (in 2017) the average production of black currant in Poland is 130 thousand tonnes, yet according to the National Association of Black Currant Farmers, it should be ca. 100 thousand tonnes to be profitable (Antoń-Jucha, 2018).

The reason for the price reductions is usually the high output of black currants in Poland. Central Statistical Office estimated the black currant production increase of 30% to the average of 2013-2017. Poland has become the largest producer and exporter of black currants in the world. This is why changes in harvest outputs are decisive for the purchase prices of these fruits. The reason for low prices is also the weak demand for black currants from the processing sector, which is caused by insufficient development of consumption of products processed from black currants. Eurostat data shows that exports of frozen currants from Poland in the last 4 years (2013-2017) increased by only 0.8 thousand tonnes. Black currant cultivation area in Poland equalled 33 thousand ha in 2012 (according to the Institute of Agricultural and Food Economics – National Research Institute) and has been shrinking from 2013 at a rate of ca. 2% per year. However, so far due to vast annual fluctuations in yields, the impact of the decreasing cultivation area is almost invisible (SadyOgrody, 2018).

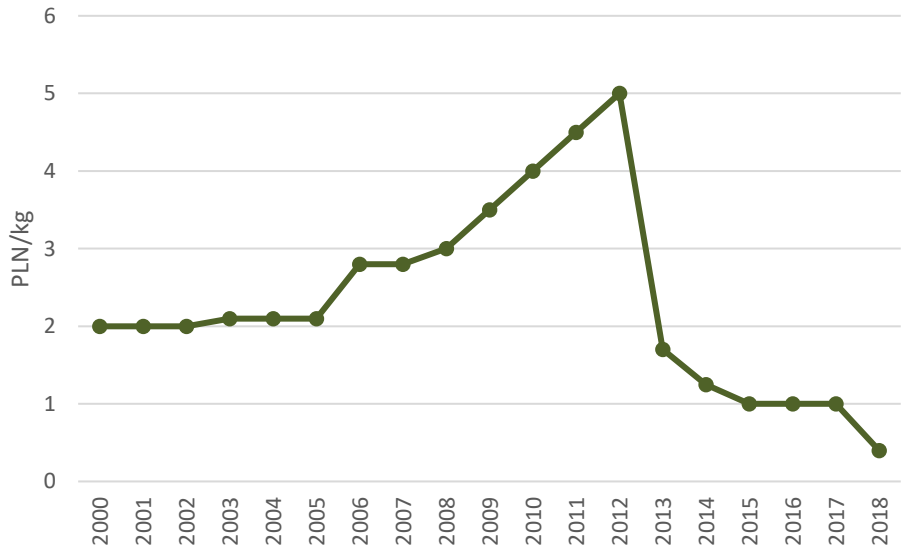

Figure 9. Price of black currant based on Group 1 stakeholders' opinions

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Group 1 stakeholders have noted the key events: accession to the EU in 2004 which influenced a price shift a year after and constant growth till 2011 (EU market could absorb more Polish products, and the local price went up). The 2011-2012 growth was strengthened by the atmospheric conditions (draughts, ground frosts). After this peak more farmers started cultivating black currant, which led to drop in prices, which is still the case.

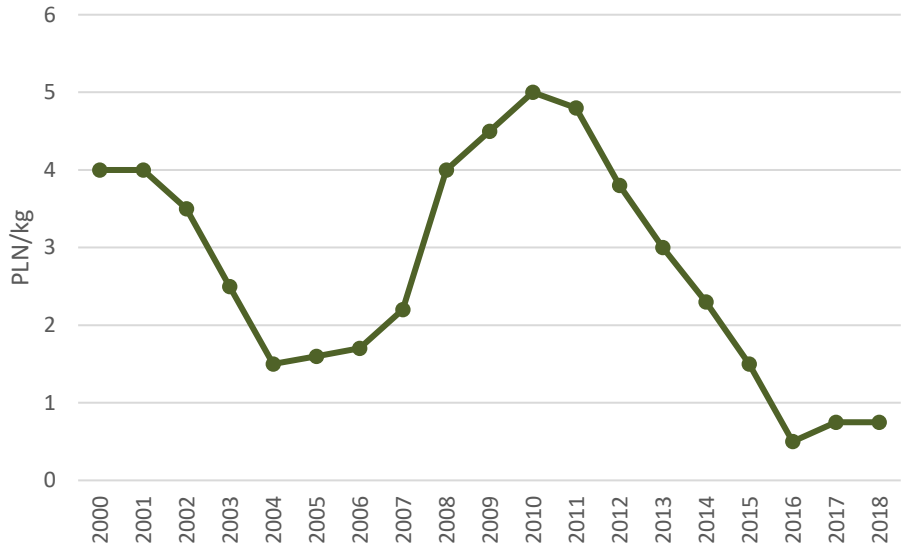

Figure 10. Price of black currant based on Group 3 stakeholders' opinions

Group 3 stakeholders have noted the key issues causing the drops in prices. These included the lack of coherent policy concerning production and processing of fruits, lack of cooperation and therefore possibility for small farmers to deliver their products to the market, lack of storage facilities, lack of enough local Polish fruit processing plants. Main causes for price growth were the rising demand limited supply on Polish and/or EU markets.

5.2 Price of raspberry

Group 2 has chosen the price of raspberry as their indicator, and have described it quite well, as they have noted numerous consecutive drops and increases, which was indeed the case. The price of soft fruits is extremely dependent of weather conditions and the yield, which have tremendous impact upon prices. Overall, the raspberries have been showing a growing price trend, with few significant decreases over the analysed timespan.

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Below are presented the figures reflecting the dynamics of raspberry prices, the first one prepared by the IRWiR PAN researchers based on official statistical data (Figure 11), then the second one based on the drawings of the stakeholders of Group 2 (Figure 12).

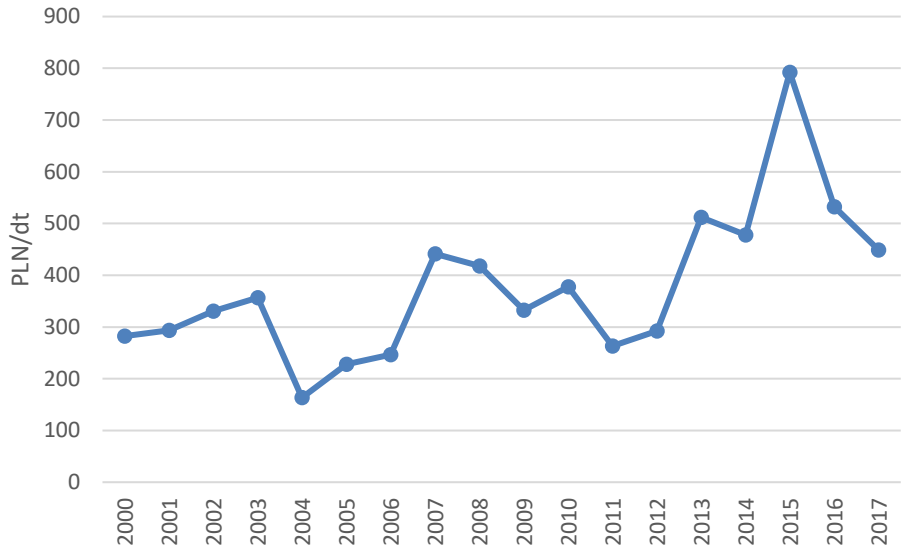

Figure 11. Price of raspberry

Source: Central Statistical Office of Poland.

The upward trend in the raspberry market in the first analysed decade resulted from the continuing growth of demand on global markets concerning this product. Global export of fresh raspberries increased from an average of 65 thousand tonnes in 2001-2003 to 145 thousand tonnes in 2010-2012, in value terms – from 158 to 714 million USD. Analysis of the average annual growth rate showed that in the years 2001-2012 the total volume of raspberry exports increased by 10% per annum, while their value grew at an annual rate of 20% (Zaremba, 2014). Short-term collapse of prices in 2004 could be explained by the introduction of European quotas for the exports of raspberries to Russia – Polish farmers suspected a price collusion of the processing industry and have been organising protests (Ważny, 2004).

Other sources indicate that the raspberry market is highly dependent on the type (quality) of the dominant raw product purchased by the wholesalers. In Polish raspberry exports the dominating place have the industrial raspberries (meant solely for processing). Therefore the drop in exports from Poland with simultaneous growth of production was caused mainly by the EU subsidies for

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industrial raspberries, which increased their utilisation by the domestic processing plants (Zaremba, 2014).

It should be also noted that Polish farmers have developed in their specialisation over the last 15 years in the production of soft fruits, the market infrastructure and the distribution channels have improved significantly. The last years had beneficial weather conditions and therefore high yield of soft fruits, influencing the output and the market prices.

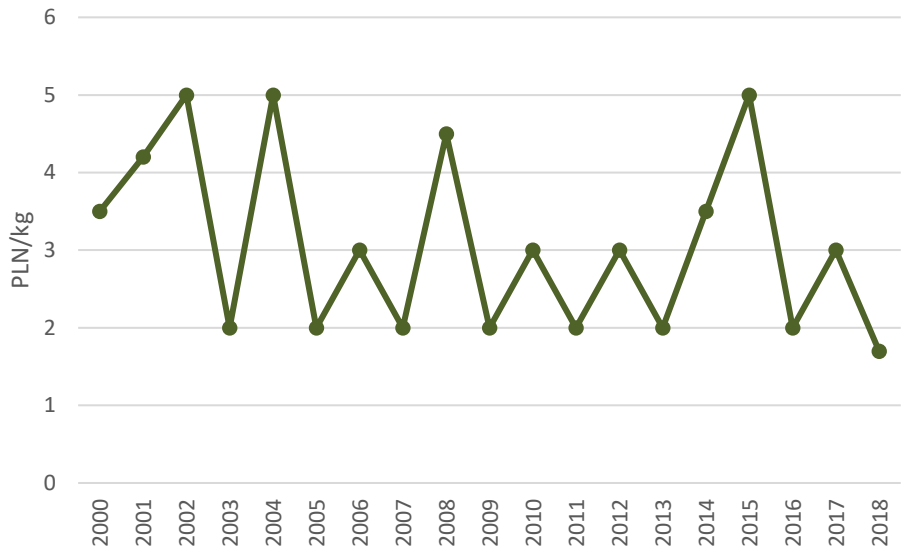

Figure 12. Price of raspberry based on Group 2 stakeholders' opinions

According to Group 2 stakeholders the changes on the raspberry market were constant and frequent, each change influencing the drastic rises or drops. Accession to the EU (the expectations) have caused the price to grow, yet the accession itself brought drop in prices as the demand was not as expected. The 2007-2008 price peak appeared due to supply decrease of raspberries in the EU, the 2016 – draughts and low harvest of raspberries in Poland, 2017 – ground frosts. The current (2018) price was noted at 1.7 PLN/kg, being one of the lowest in analysed history and caused by uncontrolled imports from the EU, lack of available loans, limits in the "de minimis" support concerning covering debts arising from taxes and ground rents.

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5.3 Price of sugar beet

Group 4 has selected the price of sugar beet, being the typical vegetable for the particular area of the farming system. The prices and challenges connected to the sugar beet production are closely related to the functioning of the sugar industry. This industry has quite specific development issues, as it was historically highly regulated and managed by the state, only in 1990-s being privatised, yet what came simultaneously was the ongoing bankruptcy and closure of numerous sugar production facilities, being unable to withstand low sugar prices on the global market. State regulations of the sector are a long-going tradition, such as the minimal price for sugar or sugar production quotas.

Below are presented the figures reflecting the dynamics of sugar beet prices, the first one prepared by the IRWiR PAN researchers based on official statistical data (Figure 13), then the second one based on the drawings of the stakeholders of Group 4 (Figure 14).

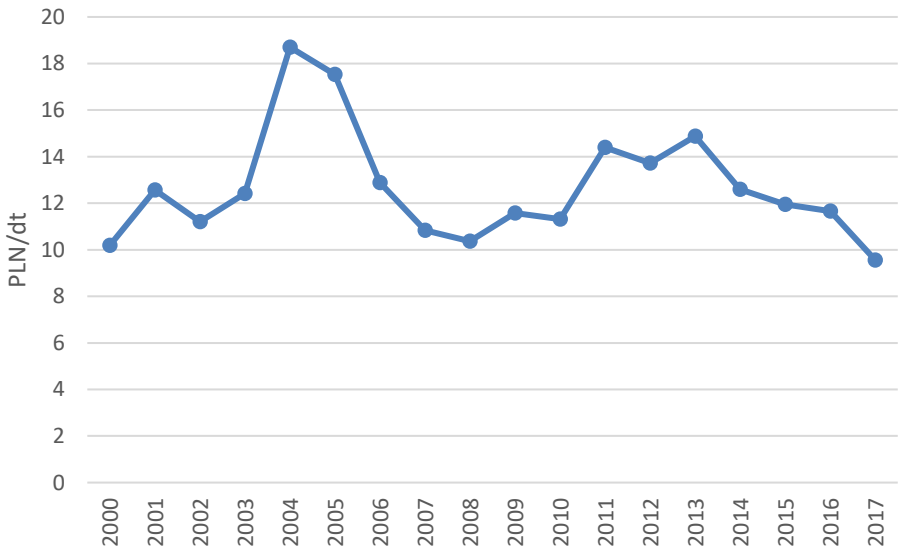

Figure 10. Price of sugar beet

Source: Central Statistical Office of Poland.

In the analysed period of 2000-2017 the first major price jump of 2004/2005 was caused by high profitability of sugar beet production and arose interest of the farmers, which have been investing is expansion of this product's cultivation. Yet with the accession to the EU and introduction of the so-called "sugar reforms" of 2006 the minimal prices for sugar beets was lowered, the drop in

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profitability was to be compensated by the CAP payments. As this decrease of minimal prices for sugar beets have occurred simultaneously with the dropping exchange rate for Euro, it lead to decline of their market prices as well. What is important to stress is that the EU reform of the sugar market introduced on July 1, 2006 assumed a reduction in production of sugar in the EU by 6 million tonnes per year till 2010 aiming at 12 million tonnes (Artyszak & Kucińska, 2008).

The effects of the reform influenced the purchase prices of beets in subsequent years. Around 2009 (also in the other EU countries) associations of beet farmers have negotiated a rise in purchase prices of raw sugar beets (Krajowy…, 2009). A threat that with such a low price of sugar beets Poland would become a sugar importer has started to occur. Concentration of the sector has been taking place, as the statistics showed the number of beet producers decreasing and the cultivation areas per producer increasing during 2009-2011. Since 2009 the condition of the sugar industry can be described as very good one in terms of profitability, which allowed the sugar industry contract the sugar beet producers at higher prices. In 2011, the prices of sugar on the domestic market were high, as in the retail trade the price increase reached ca. 48%. High prices also continued in the first months of 2012, despite the large production in the 2011/2012 campaign.

The main factor stimulating the price increase was the beneficial situation on foreign markets, which was reflected by relatively high world sugar prices (Kowalski, 2013). The price fluctuations in the next years resulted from changes on the global sugar markets (Krzysiak, 2011). One of the results of these changes was the switch of agricultural producers to other crops in the and constant overall decrease of cultivated areas under sugar beets in the analysed period, up until 2016, when the area started to increase again (by ca. 13% in 2016 compared to the previous year).

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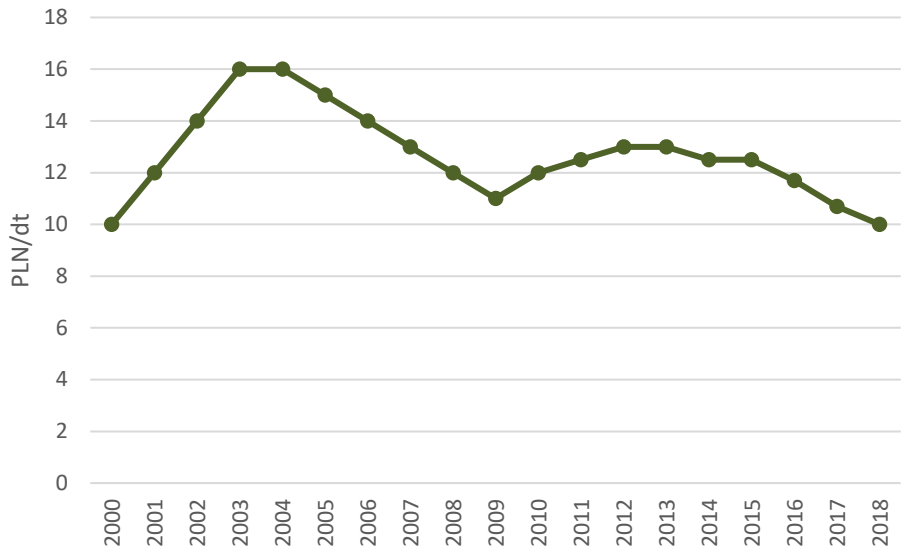

Figure 14. Price of sugar beet based on Group 4 stakeholders' opinions

According to the Group 4 stakeholders the year 2000 has started a growth trend due to privatisation of the Polish sugar production sector, yet the accessions to the EU in 2004 has opened Polish markets for European sugar, leading to decline in prices. Farther price growth was caused by regulatory restrictions on production of sugar, yet the fall of global sugar prices is annually influencing the decrease of Polish sugar beets.

5.4 Biodiversity

One person being the Group 5 has taken the challenge to reflect and analyse the changes concerning environmental indicator, namely the "Quantity of common birds in the agricultural landscape and forest birds".

Below are presented the figures reflecting the dynamics in quantity of common birds in the agricultural landscape and forest birds, the first one prepared by the IRWiR PAN researchers based on official statistical data (Figure 15), then the second one based on the drawings of the stakeholder of Group 5 (Figure 16).

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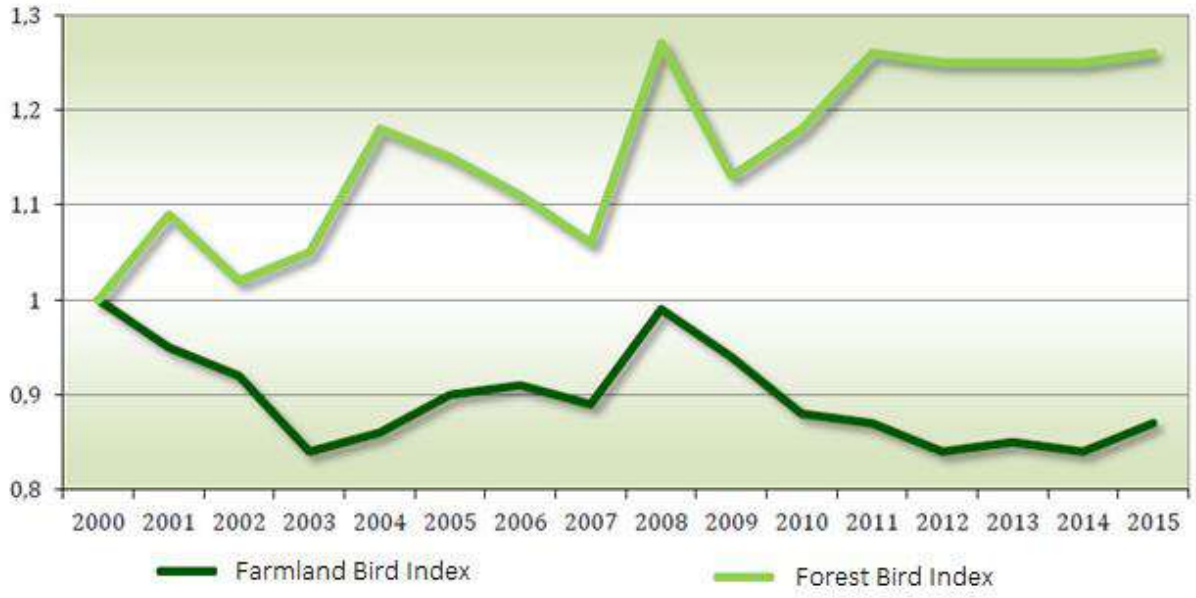

Figure 15. Quantity of common birds in the agricultural landscape and forest birds

Source: Green Economy Indicators in Poland 2017.

The indicator chosen by the stakeholder to reflect biodiversity and environmental issues was the "Quantity of common birds in the agricultural landscape and forest birds". Based on the Farmland Bird Index and Forest Bird Index it is possible to trace the changes in the quantity of birds in the agricultural landscape and forests in Poland. The situation with the forest birds shows slow, yet steady improvement, key strategies influencing the changes being the environmental protection measures (e.g. Natura 2000). The situation with the farmland birds is the opposite, and practically due to intensification of agricultural production and use of fertilisers and pesticides the trend doesn't show much improvement. The current CAP, which implements the Greening measures since the 2015 is not yet possible to trace in the statistics. The next CAP (2021-2027) is planned to have an even stronger environmental impact, yet these changes are to be seen and analysed in the future.

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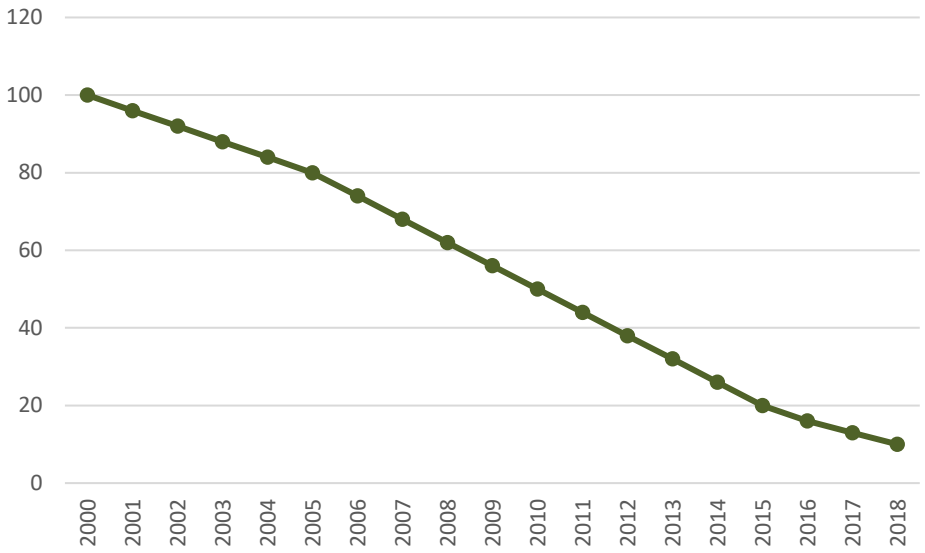

Figure 16. Dynamics of biodiversity based on Group 5 stakeholder's opinion

According to the Group 5 stakeholder, biodiversity (reflected by the "Quantity of common birds in the agricultural landscape and forest birds" indicator) is constantly declining in Poland due to intensification of agricultural production, direct payments stimulate constant consolidation and enlargement of farms, enlargement of farms leads to decrease of production diversification and focusing on monocultures, large farms are more market-oriented and use more pesticides, GMO. These processes are amplified by the global climate change and increasing pollution of the environment.

Key issues causing these negative biodiversity changes are: lack of actions and constraints aimed at environmental protection in the direct payments' system; bureaucracy limiting farms from implementation of ecological approaches and lack of systemic support for ecological farming.

6 Resilience attributes

6.1 Case-study specific strategies

The stakeholders in four groups talked about the challenges that are faced, and will be faced in the future, by the horticulture farming system in the CS region and for each challenge they identified specific strategies and proposed resilience indicators related to those strategies – see Table 3 below.

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Table 3. Challenges and strategies per indicator

Challenge	Strategy	Indicator
Knowledge about global market	State support	1) Price of black currant
Fluctuation of prices		
Development of for organic farming		
Underdeveloped horizontal cooperation	Horizontal cooperation	
Fluctuation of prices		
Creation of measures' system for local development	Marketing	
Underdeveloped horizontal cooperation		
Fluctuation of prices		
Decrease of risks	Insurance	
Regulation of losses and damages in the event of natural disasters		
Price stabilisation	Vertical cooperation	
Fluctuation of prices	Enduring	
Fluctuation of prices	Diversification	
Costs of production	Diversification	2) Price of sugar beet
Costs of production	Enduring	
Decline of biodiversity	Marketing	3) Biodiversity
Decline of biodiversity	State support	
Weak organisation of soft fruits market compared to other markets (milk or meat)	Marketing	4) Price of raspberry

Overall, stakeholders identified from 1 to 7 specific strategies per indicator of resilience. Groups 1 and 3 tackling the prices of black currant made the most input altogether substantiating 7 strategies. From methodological point of view it is important to stress that some strategies appeared more than one in answers of particular stakeholders, therefore to avoid "double effect" of such answers and minimise possible distortions of the analysed scores, the scores of such stakeholders were taken as an average. This was mainly the case for the "Marketing" and "State support" strategies. While the primary distribution of strategies did not include "Insurance" (at first being included as integral part of "State support") and two distinct types of cooperation (horizontal and vertical) at first being treated as "Cooperation", a deeper analysis of stakeholders' answers and comments allowed to single out these quite outstanding and important strategies.

Generally, the first most applied strategy that occurred was "Diversification", which was adopted in reply to economic challenges i.e. fluctuation of prices (score 3 for indicator 1) and raising costs of production (score 5 for indicator 2). Second most commonly applied strategy was "Marketing" (it was present for three indicators), however its average score of application was 2.3, which was lower

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than in case of "Enduring" strategy (which score was higher, 2.5 on average). However, the later strategy was applicable for only two indicators. "Enduring" strategy addressed only economic challenges (fluctuation of prices and costs of production) while the "Marketing" strategy had application to wider range of challenges: Creation of measures' system for local development, Underdeveloped horizontal cooperation, Decline of biodiversity, Weak organisation of soft fruits market compared to other markets (milk or meat), Fluctuation of prices (see the Table 3 above).

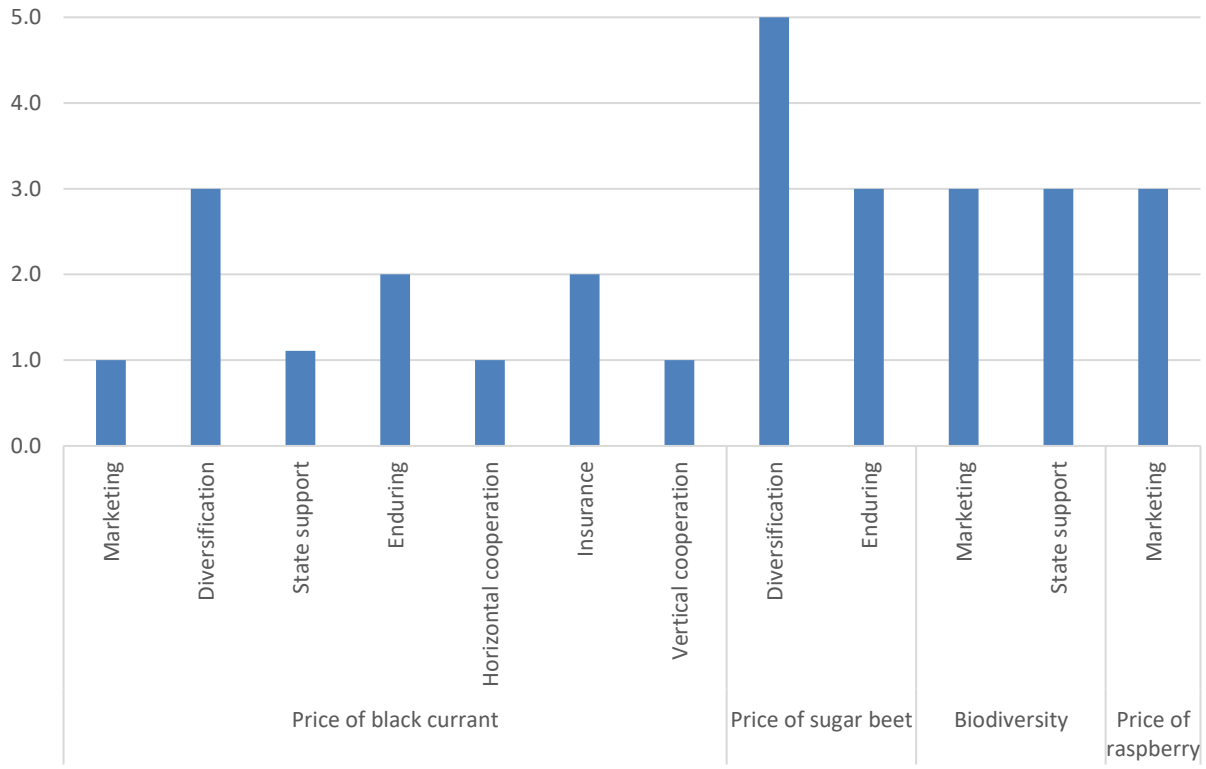

Figure 17. Bar graph showing level of implementation of strategies (n=14): 1 = not applied, 2 = slightly applied, 3 = moderately applied, 4 = adequately applied, 5 = perfectly applied

The next most applied strategy was the "State support" (with score 2.1) which addressed quite a large range of challenges from environmental to economic ones, such as: Decline of biodiversity, Fluctuation of prices, Decrease of various risks, lack of Knowledge about global market. What is important to point out that during the discussion the stakeholders have put much strength on importance of state support and were expecting it to aid them in most of existing issues.

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"Insurance" scored 2.0 based on estimation of two stakeholders and appeared both times in context of black currant prices. The challenges associated with this strategy were the Decrease of risks and Regulation of losses and damages in the event of natural disasters. Again, as is case of "State support", during the discussion concerning it was emphasised that not only insurance is critical to minimise the risks, but that the government should aid in the insurance issues, among other compensating insurance premiums to farmers.

Last but not least strategy outlined was the cooperation divided into "Horizontal cooperation" and "Vertical cooperation" both with an average score of 1.0. Challenges associated with "Horizontal cooperation" are the Underdeveloped horizontal cooperation (primarily producer groups, which were voiced out by the stakeholders) and Fluctuation of prices (as the cooperatives usually implement measures to minimise the negative market effects, e.g. by building storage and cold storage facilities for fruits). "Vertical cooperation" was perceived as Price stabilisation based on contractation.

Stakeholders also assessed the contribution of each of the above mentioned strategies to the three resilience capacities: robustness, adaptability and transformability of their farming system.

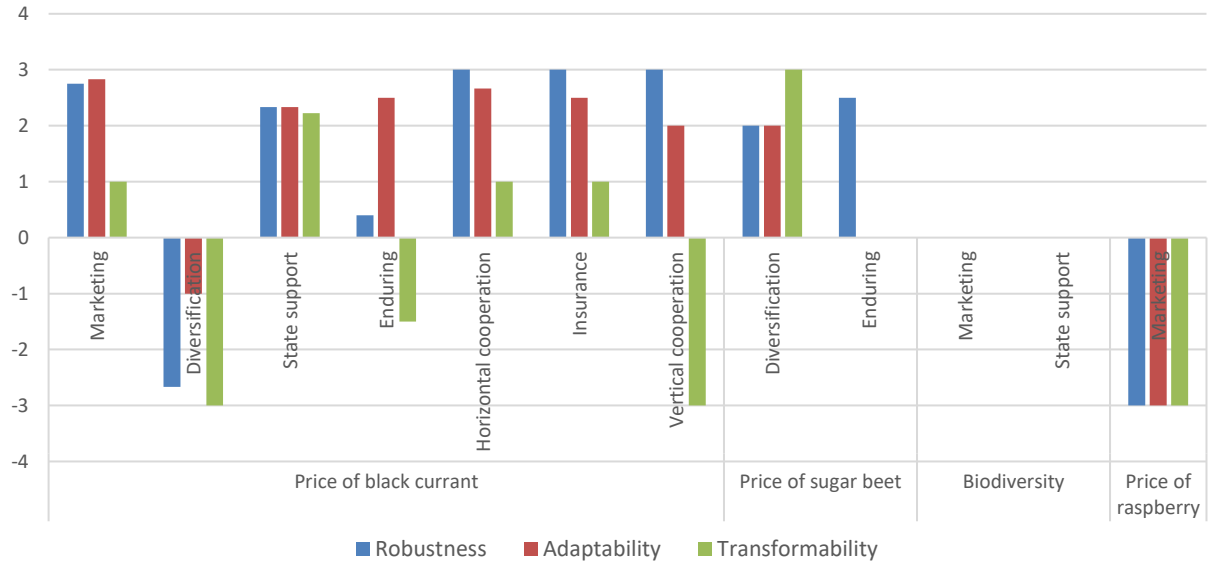

Figure 18. Bar graph showing average scoring of effect of strategy on robustness, adaptability and transformability of the farming system (n=14). A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 a intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship

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Strategies supporting resilience capacities – synergies and trade offs

As for the **Robustness**, the most supporting strategies are: "Horizontal cooperation", "Vertical cooperation", "Insurance", "Marketing" and "State support". The cooperation strategies increase robustness through the system of compensation (if some farms are in trouble the other make up for them in the whole farming system). "Insurance" and "State support" create a buffer for the sector, besides in view of stakeholders the most welcome state support is in form of price stabilisation by interventions at the market, which otherwise is very unstable.

As for the "Marketing" strategy, it was an interesting fact that for indicator 1 (price of black currant) it was strongly supportive, but for some other indicators (Price of raspberry) it was the opposite. So it means that this strategy not always works, and it depends on which challenges are faced by the system. "Marketing" was good for robustness in cases of indicator "Price of black currant" where the challenges were Creation of measures' system for local development; Underdeveloped horizontal cooperation and Fluctuation of prices. However, this strategy did not work for robustness when the challenges was Weak organisation of soft fruits market compared to other markets (milk or meat) (in case of price of raspberry).

"Enduring" strategy could also be an obvious strategy for robustness, as continuation through difficulties is based on assumption that in synergy with "State support" and in hope of changing economic conditions into more favourable it is worth to sustain production for some time. Stakeholders. Yet it was selected as having a high positive effect on Robustness only in case of sugar beet, while the stakeholders analysing the challenges of black currant production have defined it as having a neutral relevance.

As for **Adaptability**, the top supporting strategies are "Horizontal cooperation" and "Insurance", followed by "Enduring" and "State support" strategies. Cooperation forced some adaptation to standards of the collaboration (quantity of production, quality, timing) and the insurance was still a strong measure to adapt to changing environment. "Enduring" and "State support" were defined as having weak positive relationship. In particular with the "State support" it could be explained as actions towards enabling adaptability though CAP support, which subsidises investments in new technologies and machines. On some strategies the stakeholders' opinions differed greatly, such was the case with the "Marketing". The ones analysing the challenges faced by the production of black currants have noted the influence of "Marketing" among highest, while the total opposite situation concerned the producers of raspberries.

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Transformability turned out to be the most controversial of the resilience capacities, as some of the strategies supporting this capacity received opposite evaluation, as was the case with diversification. Nevertheless, the most supportive strategy in case of Transformability is the "State support".

"Diversification" scored opposite means in cases of strategies faced by production of black currant and sugar beet, in the first case highest possible and in latter – lowest possible score. In general diversification is trying new things, engaging in new activities (both economic and social), as well as experimenting with new actions/directions (e.g. new type of production, new activities on the farm). That brings both activity diversification and income diversification. However, similarly as in case of "Marketing" strategy for Robustness, Adaptability does not always support transformability it can also hinder it. So it all depends, which challenge this strategy addresses. "Diversification" support transformability when the challenge is concerning the Costs of production, however, when the challenge is Fluctuation of prices then this strategy actually hinders the Transformability. That is an interesting outcome, because costs of production (i.e. costs of inputs) are usually more stable over time so if they increase that is usually a long term trend. On the contrary, Fluctuation of output prices is more random and unpredictable. So "Diversification" seems to be good for transformability if it responses to long term unfavourable trends, otherwise it is not really good for it. One stakeholder said that changing production activity very often was very time and money consuming, and he realised that he would come up with the same outcome if he does not do it just wait for reverse changes without any adjustments.

As far as the "State support" is concerned, which received the highest average score of 1.1 (again, scoring differed by the type of analysed product), the challenges included Knowledge about global market, which could be beneficial for transformation and Development of for organic farming, which could aid horticulture farmers in their transformation.

Strategies hindering resilience capacities – synergies and trade offs

It is interesting that there are two strategies which are ambiguous – they may hinder or support all three capacities at once: that is "Diversification" and "Marketing". So their outcome depends on certain conditions, i.e. what challenge they address. A explained above, what decides whether certain strategy is beneficial or not for the resilience capacity depends on the challenge that it addresses. So "Diversification" strategy is not good either for Robustness, Adaptability and Transformability if it is applied to address the Fluctuation in output prices (as in case of indicator "Price of black currant"). That is because "Diversification" usually means investments and trying new things which is costly and time consuming while fruit and vegetable prices are very unstable

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(depending not only on production conditions but also changing tastes and moods of consumers) so they can revert while the investment is already in place so it is counter effective. Similarly, "Marketing", is hindering all three capacities if it is applied to solve the problem of weak organization of markets (as in case of indicator "Price of raspberry"), that is simply not the appropriate way to overcome the problem and does not help for either of the capacities. Last but not least, the "Enduring" strategy seems unambiguous, it always hinders Transformability and that is explained by the fact that just surviving (enduring) is in opposition to acting (adapting or transforming) so by definition this strategy does not help in Transformation whichever is the challenge or indicator.

6.2 General resilience attributes

Overall performance of provided 13 resilience attributes was assessed by stakeholders as very low, i.e. average score was 1.96 (on scale of 1 to 5, where 1 means not at all and 5 means very much) with most attributes being scored between 1 and 2. The best performing attributes (scored between above 2) were on the first place: "Production coupled with local and natural capital" (3.0), on the second place: "Spatial and temporal heterogeneity (farm types)" and "Socially self-organised" (both scored 2.29) and on the third place "Functional diversity" (2.27).

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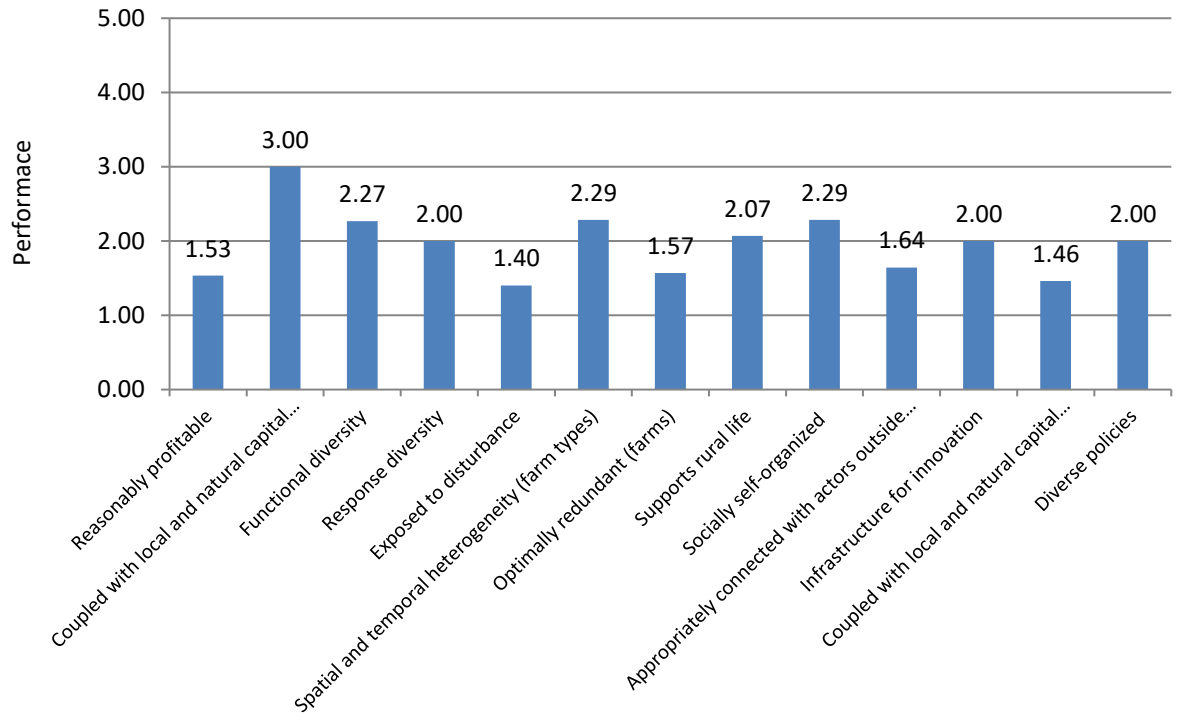

Figure 19. Bar graph showing current performance level of resilience attributes (n=16). Performance is scored as 1 = not at all, 2 = small extent, 3 = moderate extent, 4 = big extent, 5 = very big extent

As for 5 resilience principles - diversity, openness, tightness of feedback, system reserves and modularity - the highest scored attribute "Production coupled…" refers to **system reserves**. The next one, "Spatial… heterogeneity" is in line with **modularity** while the other equally scored "Socially self-organised" is in line with **tightness of feedback** – as there exist fruit and vegetable producers groups, so there is connection within and outside of the system. Quite well represented in the system was **diversity** represented by "Functional diversity" (2.27) and Diverse policies (2.0). Openness was weak in the horticulture system, especially if represented by Exposed to disturbance (the lowest score of all attributes, 1.40) and slightly better represented by Infrastructure for innovation (2.0).

As for resilience attributes in relation to four SURE-Farm processes – agricultural production, risk management, farm demographics, governance – they top 4 attributes relate to all those four processes, i.e. 1) "Production coupled" relate to agricultural production; 2) "Spatial … heterogeneity" to demographics, 3) "Socially self-organised" to governance and 4) "Functional diversity" to risk management. So it seems that system quite equally distributes its attributes among processes, at least those most highly scored.

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It was assessed also how the attributes relate to three resilience capacities – see Figure 15.

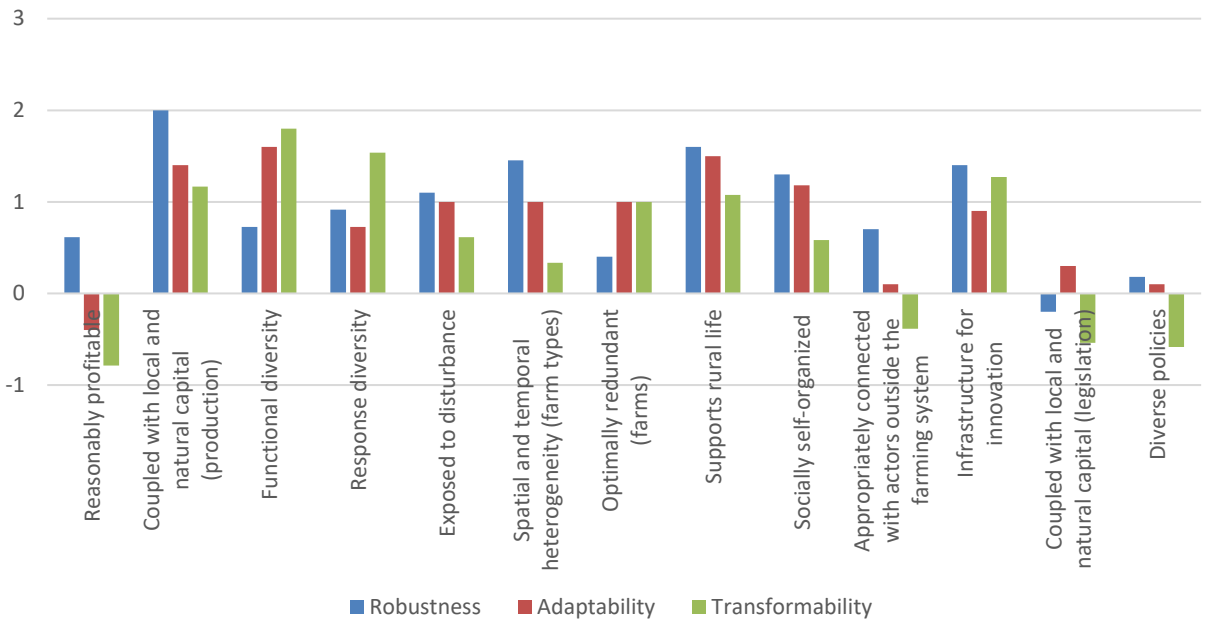

Figure 20. Bar graph showing average scoring of perceived effect of attribute on robustness, adaptability and transformability (n=16). A 0 implies no relationship, a 1 a weak relationship, a 2 a relationship of intermediate strength, and a 3 is a strong relationship

That effect was assessed by the stakeholders on a scale from -3 to +3 where sign shows the direction of effect and the number explains the strength (1 weak to 3 strong, 0 meaning no effect). Generally they gave quite low scores for the effects which was probably related partially to currently bad economic situation in the sector. They perceived that the highest effect of attributes was on **Robustness** (average score 0.9), then lesser on **Adaptability** (score 0.8) and the least on **Transformability** (score 0.5).

The "Marketing" **Robustness** was of such attributes as: "Production coupled with local and natural capital" (2.0), "Supports rural life" (1.6) and "Farm type - spatial and temporal heterogeneity" (1.5). The "Marketing" was of "Legislation coupled with local and natural capital" (-0.2) that is because so far the legislation is very badly adjusted so they stakeholders have opinion that it is never well adjusted as all adjustments fail and cause other side-effects. As for **Adaptability**, the "Marketing" uencing is "Reasonably profitable" (-0.4) and that is because stable profitability stops adaptability – there are no incentives in this situation. In case of **Transformability**, the most positive effect would

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have "Functional diversity"(1.8), "Response diversity" (1.5) and "Infrastructure for innovation" (1.3). So it is important for transformability to be able to diversify and also to implement innovations. On the contrary there are quite a few attributes which would negatively affect transformability, such as: "Reasonably profitable" (-0.8), "Diverse policies" (-0.6), "Legislation coupled with local and natural capital" (-0.5). These are attributes which lower incentives for transformation of the system towards better resilience.

Discussion on attributes

The most important attributes for the resilience of the Polish family-farming system are:

1. "Reasonable profitable", 2. "Socially self-organized" and 3. "Spatial and temporal heterogeneity (farm types)", 4. "Supports rural life", 5. "Coupled with local and natural capital (production)".

However, the extent to which the attribute actually apply differ. The most applicable was: "Production coupled with local and natural capital" and the least applicable was: "Reasonably profitable". In division by groups of stakeholders, the best performing attributes were:

- For *Farmers*: "Coupled with local and natural capital (production)",
- For *Government* officials: "Spatial and temporal heterogeneity (farm types)",
- For *Others*: "Functional diversity".

The most positive contributions of attributes by resilience capacities were:

- For Robustness: "Coupled with local and natural capital (production)",
- For Adaptability: "Socially self-organized",
- For Transformability: "Response diversity".

7 Discussion

7.1 Essential functions of the farming system

The farming system is perceived primarily though the "Economic viability" and the "Food production" essential functions. It was clear that what is most understandable and important on the daily basis to the majority of present stakeholders were the issues of income and profitability. The farming activities are a constant struggle to generate income relevant for a decent level of life, and as in their perception the income levels of the urban citizens have a constantly growing trend, they expect the same.

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This was the reason the key indicators selected were the "Price relation of agricultural products to agricultural production costs (%)" and the "Dynamics and relations of nominal incomes per capita of rural and urban residents (%)", which are perceived as most important to describe the farming system, yet when their performance is concerned, the scores show that the stakeholders estimate them as between the "poorly performing" and "not good not bad" (the scores being 2.3 and 2.5 respectively). Still the overall feel is that their income is not sufficient, or at least not satisfactory according to their vision.

This is widely confirmed in the literature, as the perception of rural citizens in Poland still has a post-socialist trail, in which the rural resident are to some extent a lower class citizen (what's most important – from the perception of both rural and urban residents), with lesser average income, less possibilities, with a key urge to move to urban areas (Sączewska-Piotrowska, 2016; GUS 2012; Bieńkuńska & Góralczyk, 2018). In reality the differences are not as drastic anymore, the gap between the incomes of urban and rural inhabitants have been gradually decreasing in Poland, the infrastructure has been developing as well, and with the Common Agricultural Policy's support the conditions in rural areas, and especially for the farmers, have been improving (Wilkin & Nurzyńska, 2018).

7.2 Robustness, adaptability and transformability of the farming system

When it comes down to possible robustness, adaptability or transformability the approach is similar, yet the stakeholders have defined, among other, some key strategies: enduring, marketing and diversification.

The strategy of enduring appeared in the answers of stakeholders concerning both prices of black currant and sugar beet, and in practice has been understood as withstanding the negative exogenous conditions and waiting for more favourable market conditions. Stakeholders did not connect any possible actions with this strategy indicating they see it as just waiting.

Marketing, being a strategy of adaptability, has been perceived as actions to expand the markets, reach new consumers, both at the domestic and foreign markets. Key obstacle they see in implementation of such actions are the limited abilities of single farmers and connect the successful implementation of this strategy with a different one, namely the cooperation. In stakeholders' opinion, in the particular farming system the most efficient way to achieve success in marketing (including distribution, logistics) is creation of local producers groups. At the same time stakeholders have indicated (in particular in case of black currant and raspberry) that there is a very limited number of such producer groups in their area and the ones they have contacted didn't agree to cooperation due to small output volumes of the particular farmer.

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As the diversification represents transformability, the stakeholders have perceived it as an effective strategy, mostly (but not limited to) in case of sugar beet and raspberry producers. They have stated that they have been implementing diversification for many years, transforming from monoculture to diversified agriculture including not only fruits and vegetables, but also cereals and other crops (see Table A1 in Appendix A for detailed information on diversity of agriculture of farmers participating in the workshop).

7.3 Options to improve the resilience of the farming system

As the farming in Poland overall and in the particular farming system is greatly fragmented, one of the key directions to improve the resilience is the creation of producer groups, developing the agricultural infrastructure (in case of horticulture mainly concerning storage facilities with refrigeration), providing agricultural producers with advisory services to make the proper choices in the types of crops to grow.

While the stakeholders themselves see the need of constant financial and technical support from the government and various state institutions, in our opinion the key is the education and development of skills needed to implement the resilience strategies on the farm level. This can only be achieved by consequent educational and training activities organised for farmers, which would not only aid them in technological issues, but transform the perception of their role and abilities from the "recipient" of private and public goods to their "initiator" and "supplier".

7.4 Methodological challenges

The key workshop challenge was to present the methodological approach in as easy (understandable) way as possible in order to achieve the most accurate research results. In order to do this the presentation was thoroughly prepared throughout several weeks by the IRWiR PAN researches and made as clear as possible from the standpoint of a farmer (rural resident). The concepts and definitions were translated into Polish in such a way that the stakeholders could understand the meaning at the first glance. Due to this fact not a "scientific" language, but its adaptation was used during the presentation, which has made a great positive difference.

Another issue was the length of the workshop, which was a challenge itself for the farmers, who are not used to participating is such events. The IRWiR PAN researchers have tried to create a friendly and learning environment, which would ease the tension and help everyone understand this is a learning (researching) process for all who were present there, not only the stakeholders, but the researchers as well. Since it was everyone who was learning something from each other, and in fact, it was the stakeholders who had the practical knowledge and could share it. This approach has helped to create a levelled relation with the stakeholders, which was visible during

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and even after the workshop – the discussion was active and practically all stakeholders participated.

8 Conclusions

Overall, the horticulture farming system is poorly performing according to the key functions defined by the stakeholders. These functions outlined as having the highest importance are the "Economic viability" and "Food production". Yet the best performing functions, although still performing at the level of below 3 out of 5 (defined as "not good not bad") are the "Bio-based resources" and "biodiversity". Most opinions during the discussion proved these findings, as the participants were overall dissatisfied with economic situation and rather perceived the changes of environmental issues as positive.

In terms of resilience capacities the Robustness is perceived through the prism of cooperation, which is still underdeveloped in the farming system due to weak links between the producers (horizontal cooperation) and between the producers and processors (vertical cooperation). Marketing is strongly tied with cooperation in the perception of stakeholders, as they see the labelling, certification and finding new markets (all of these voiced out by the participants) as the prerogative of cooperatives (producer groups), and mainly not of single farms. Adaptability is viewed in a similar way, as basically the same strategies apply according to the participants, and again a strong exogenous (primarily government) influence is expected, or at least cooperation with other producers. As far as Transformability is concerned, it is divided between "State support", but also "Diversification", being rather ambiguous, as receiving totally opposite scores. Diversification of economic activities was often mentioned by the stakeholders during the discussion, as they do see it as was to lower risks, maintain or increase income, as well as try (experiment with) new crops/products. Most have stated they have good diversification of agricultural activities, combining fruits with vegetables, cereals and even livestock.

Resilience attributes were overall assessed by stakeholders as having moderate to low performance, with an average score of 1.96 out of 5. The attributes they perceive as best performing were the "Production coupled with local and natural capital" (3.0), then the second place shared by "Spatial and temporal heterogeneity (farm types)" and "Socially self-organised" (both scored 2.29), and the final top attribute being the "Functional diversity" (2.27).

One of the key ideas that was possible to capture from most stakeholders during the workshop is that the government (state) should help (support, aid, provide payments) to farmers to maintain their income levels and ensure the proper level of life in the rural areas. This was also

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proven by the high influence of "State support" and "Insurance" strategies, as with the latter the government role in compensation was perceived as high as well.

While the researchers have tried to probe and urge the stakeholders to voice out what could be the actions they could undertake to improve their situation (gently explaining the endogenous potential of rural residents/farmers, possibilities to face challenges by selecting proper strategies), majority of the answers were coming down to the ideas that "someone" should (has to) help them. This concerned most of the issues the farmers have voiced out.

Moreover, when some problematic issues were discussed that have created obstacles to receiving the expected income by the farmers (unfavourable weather conditions, price fluctuations), the key message was that the government should have create more favourable insurance conditions, introduce insurance reimbursements and so on. The conclusion on this observation is that the active participation in changes is still not perceived as the prerogative of the farmers or the rural residents (at least not by the farmers or rural residents themselves).

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Appendix A. Workshop memo

1) Describe the ambiance and conditions in which the workshop was held, e.g. comfort of the room (temperature, sound echo etc.), chairs, quality of the food, attitude of the participants.
2) Give details on the participants and the duration of the workshop

The workshop was carried out in the premises of Rural Chamber of Culture and Tourism in the village of Widniówka, having one main meeting room of ca. 60 m^2, large dining tables were placed in a horseshoe pattern, on the opening of which stood the small table with a computer and a projector. The wooden benches provided by the organisers were not too comfortable, but there was no other choice available. The catering included constants access to hot beverages and snacks near the entrance to the room, while during the lunch a full meal was served. The participants were open to cooperation and were rather very positive, ready to give feedback and listen to researchers' directions. The only exclusion were 2 people (male), who were rather opposed to giving much information and focused on random criticism of the research approach or the idea of the workshop itself. Yet this attitude was not supported by the majority. Overall the workshop was perceived by the stakeholders as a very difficult and complex (even though they were informed on the complexity at the time of invitation), but a very pleasant event, which was visible at the ending discussion and after the meeting, when most participants stayed to speak with IRWiR PAN researchers and exchange ideas and personal information.

Start time: 10:07

End time: 15:20

Total break time (estimation): 25 minutes (13:35-14:00).

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Table A1. Stakeholder overview

No	Function	Organisation	Stakeholder group
1	Deputy head of local authority	Local authority	Government
2	Farm owner (100 ha family farm managed together with his father and uncle: cereals, rape seed, corn, fruits)	Own farm	Farmer
3	Farm owner (20 ha farm: fruits, cereals)	Own farm	Farmer
4	Local state authority representative, also a farmer (17 ha farm: sugar beet and cereals)	State and local authority	Government
5	Farm owner (18 ha farm: soft fruits)	Own farm	Farmer
6	Farm owner	Own farm	Farmer
7	Farm owner	Own farm	Farmer
8	Farm owner (10 ha farm)	Own farm	Farmer
9	Researcher	Institute of Agricultural and Food Economics - NRI	Other
10	Farm owner (10 ha farm: raspberries, herbs, rape seed, cereals)	Own farm	Farmer
11	Member of the Council, also a farmer (fruits and vegetables farm)	Council of Regional State Extension Service	Government
12	Deputy head, also a farmer	Farmers' Union of Poland	Other
13	Member of the union, also a farmer (20 ha farm: hazel, cherries, vegetables)	Farmers' union	Other
14	Farm owner (21 ha farm: strawberries, hazel, carrots)	Own farm	Farmer
15	Veterinary inspector	Veterinary inspection	Other
16	Member	Farmers' union	Other
17	Farm owner (100 ha family farm managed together with brother and son: cereals, rape seed, corn, fruits)	Own farm	Farmer
18	Director	NGO "Sanctus Nemus" (environmental)	Other
19	Authority representative, also a farmer (80 ha farm, dairy cows, rape seed, corn)	Local authority	Government
20	Farm owner (20 ha farm: soft fruits)	Own farm	Farmer

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

Table A2. Mean and standard deviation of scores per function per stakeholder group and for all participants. 100 points needed to be divided to 8 function (n=19)

	Farmer		Government		Other		All	
Function	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Food production	13	8	23	13	31	20	20	14
Bio-based resources	7	8	11	13	7	8	8	9
Economic viability	35	15	20	0	15	21	26	17
Quality of life	19	11	14	8	3	4	14	11
Natural resources	6	7	9	5	17	7	10	8
Biodiversity & habitat	3	5	4	5	8	9	5	6
Attractiveness of the area	10	8	13	11	8	6	10	8
Animal health & welfare	8	9	6	5	11	10	8	9

Table A3.1. Capacity of indicators to represent the essential functions (n=18). Mean and standard deviation per stakeholder group and for all participants (original values). The names of some indicators have been abbreviated

Indicators	Original values							
	Farmer		Government		Other		Total	
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Purchase prices for apples (PLN/kg)	43	22	30	N/A	37	22	39	20
Purchase prices for onions (PLN/kg)	20	18	30	N/A	24	19	23	17
Area of ecological farmland with a certificate (ha)	37	22	40	N/A	39	30	38	25
Biomass production - straw (t/ha)	33	33	18	18	29	25	30	28
Average selling price of wood (PLN/m3)	24	24	10	7	12	13	19	20
Share of fruit cultivation (% of sown area)	42	27	73	25	59	26	51	27
Price relation of agricultural products to costs (%)	57	23	60	36	41	15	53	24
Price of NPK fertilizers (PLN/kg)	24	13	10	17	19	19	20	16
Labour costs (PLN/hour)	19	13	30	26	41	12	27	17
Population with access to sewerage network (%)	23	24	15	22	43	22	28	24
Unemployed registered in the countryside	14	14	7	6	22	18	15	14
Nominal incomes of rural and urban residents (%)	64	31	78	26	43	26	60	30
Changes in land use	31	12	36	9	43	15	37	13
Indicator of surface water availability per capita	35	14	29	1	31	9	33	11
Gross balance of nitrogen and phosphorus	33	17	34	8	26	9	31	13
Quantity of common birds	34	23	48	4	33	10	36	17
Protected areas as % of total area	22	14	38	21	41	21	31	19
Number of wild game - boars (thousands of pcs)	44	30	14	25	26	14	33	26
Balance of migration in rural areas (people)	28	12	32	11	14	20	24	16

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Agritourism farms (number of units)	27	11	35	7	23	6	27	9
Concentration of air pollution	45	12	33	18	63	24	49	21
The number of bee colonies (pcs)	55	17	33	16	58	41	52	28
Changes in livestock population per 100 ha of UAA	28	14	36	14	31	36	30	23
Antibiotic consumption per livestock unit	17	8	31	18	11	9	17	12

Table A3.2. Capacity of indicators to represent the essential functions *(n=18)*. Mean and standard deviation per stakeholder group and for all participants. Corrected values including the importance of the function and the number of indicators per functions, to allow for direct comparison between indicators across the functions. The names of some indicators have been abbreviated

Indicators	Corrected values							
	Farmer		Government		Other		Total	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Purchase prices for apples (PLN/kg)	16	8	20	N/A	35	21	27	18
Purchase prices for onions (PLN/kg)	8	7	20	N/A	22	18	17	15
Area of ecological farmland with a certificate (ha)	14	8	27	N/A	36	28	27	23
Biomass production - straw (t/ha)	7	7	6	6	6	5	7	6
Average selling price of wood (PLN/m3)	5	5	3	2	3	3	4	4
Share of fruit cultivation (% of sown area)	9	6	24	8	12	6	12	8
Price relation of agricultural products to costs (%)	59	24	36	22	18	7	43	27
Price of NPK fertilizers (PLN/kg)	25	14	6	10	8	8	17	14
Labour costs (PLN/hour)	19	13	18	16	18	6	19	11
Population with access to sewerage network (%)	13	14	6	9	4	2	9	11
Unemployed registered in the countryside	8	8	3	2	2	2	5	6
Nominal incomes of rural and urban residents (%)	37	18	32	11	4	2	26	20
Changes in land use	6	2	10	3	22	8	13	9
Indicator of surface water availability per capita	6	2	8	0	16	5	10	6
Gross balance of nitrogen and phosphorus	6	3	10	2	13	5	9	5
Quantity of common birds	3	2	4	3	8	2	5	3
Protected areas as % of total area	2	1	3	3	10	5	5	5
Number of wild game - boars (thousands of pcs)	4	3	1	3	6	3	4	3
Balance of migration in rural areas (people)	9	4	13	4	3	5	7	5
Agritourism farms (number of units)	8	3	14	3	5	1	8	4
Concentration of air pollution	13	4	13	7	15	6	14	5
The number of bee colonies (pcs)	12	4	6	3	19	14	14	9
Changes in livestock population per 100 ha of UAA	6	3	7	3	10	12	8	7
Antibiotic consumption per livestock unit	4	2	6	3	4	3	4	3

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Table A4. Mean and standard deviation of scoring on performance of indicators per stakeholder group and for all participants (n=19). Indicators were scored from 1-5 where 1 = very low, 2 = low, 3 = medium, 4 = good, and 5 = perfect.

	Corrected values							
	Farmer		Government		Other		Total	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Purchase prices for apples (PLN/kg)	1.8	1.0	1.8	0.5	3.2	1.5	2.2	1.2
Purchase prices for onions (PLN/kg)	1.3	0.7	2.3	1.3	2.4	1.7	1.8	1.2
Area of ecological farmland with a certificate (ha)	1.9	1.4	2.0	1.2	2.0	1.7	1.9	1.4
Biomass production - straw (t/ha)	2.3	1.1	2.3	1.5	1.8	1.1	2.1	1.1
Average selling price of wood (PLN/m3)	2.4	1.1	2.0	1.2	1.6	0.5	2.1	1.0
Share of fruit cultivation (% of sown area)	2.8	1.4	3.0	1.8	3.8	1.0	3.1	1.4
Price relation of agricultural products to agricultural production costs (%)	1.8	1.1	3.3	2.1	2.4	1.9	2.3	1.6
Price of NPK fertilizers (PLN/kg)	1.3	0.7	1.8	1.0	1.8	1.5	1.5	0.9
Labour costs (PLN/hour)	1.4	0.7	2.3	1.9	2.6	1.8	1.9	1.4
Percentage of population having access to sewerage network (%)	1.3	0.7	1.8	1.0	2.4	1.7	1.7	1.1
Unemployed registered in the countryside (thousands of people)	1.8	1.0	2.3	2.3	2.3	1.3	2.0	1.3
Dynamics and relations of nominal incomes per capita of rural and urban residents (%)	2.0	1.1	3.8	1.5	2.3	1.5	2.5	1.4
Changes in land use	1.9	0.8	2.0	0.8	2.8	1.6	2.2	1.1
Indicator of surface water availability per capita	2.2	1.2	1.8	1.0	2.7	0.8	2.3	1.0
Dynamics of the gross balance of nitrogen and phosphorus and gross value added of agricultural production	1.8	1.0	1.8	0.5	2.5	1.4	2.0	1.1
Quantity of common birds in the agricultural landscape and forest birds	2.7	1.5	2.3	1.0	2.8	1.5	2.6	1.3
Protected areas as% of total area	2.8	1.5	2.8	1.7	4.0	1.4	3.1	1.5
Number of wild game - boars (thousands of pcs)	2.2	1.5	2.0	1.4	3.4	1.8	2.5	1.6
Balance of migration in rural areas (people)	2.1	1.5	2.0	1.2	2.2	1.3	2.1	1.3
Agritourism farms (number of units)	2.4	0.9	2.0	1.2	3.3	1.0	2.6	1.1
Concentration of air pollution	2.7	1.4	2.8	1.7	3.5	1.8	2.9	1.5
The number of bee colonies (pcs)	2.3	1.6	3.3	1.7	3.3	1.6	2.8	1.6
Changes in livestock population per 100 ha of UAA	1.7	1.0	1.5	0.6	2.3	1.0	1.8	1.0

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Table A5. Mean and standard deviation of scoring on performance of essential functions per stakeholder group and for all participants (n=19). Derived from scoring of importance and performance of indicators.

	Corrected values							
	Farmer		Government		Other		Total	
Function	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Food production	1.8	1.8	2.0	2.0	2.3	2.3	2.0	2.0
Bio-based resources	2.9	2.9	2.6	2.6	2.8	2.8	2.8	2.8
Economic viability	1.6	1.6	2.7	2.7	1.8	1.8	1.9	1.9
Quality of life	1.7	1.7	3.5	3.5	2.1	2.1	2.2	2.2
Natural resources	2.0	2.0	1.8	1.8	2.7	2.7	2.2	2.2
Biodiversity & habitat	2.6	2.6	2.3	2.3	3.4	3.4	2.7	2.7
Attractiveness of the area	2.5	2.5	2.4	2.4	3.1	3.1	2.6	2.6
Animal health & welfare	2.0	2.0	2.4	2.4	2.7	2.7	2.3	2.3

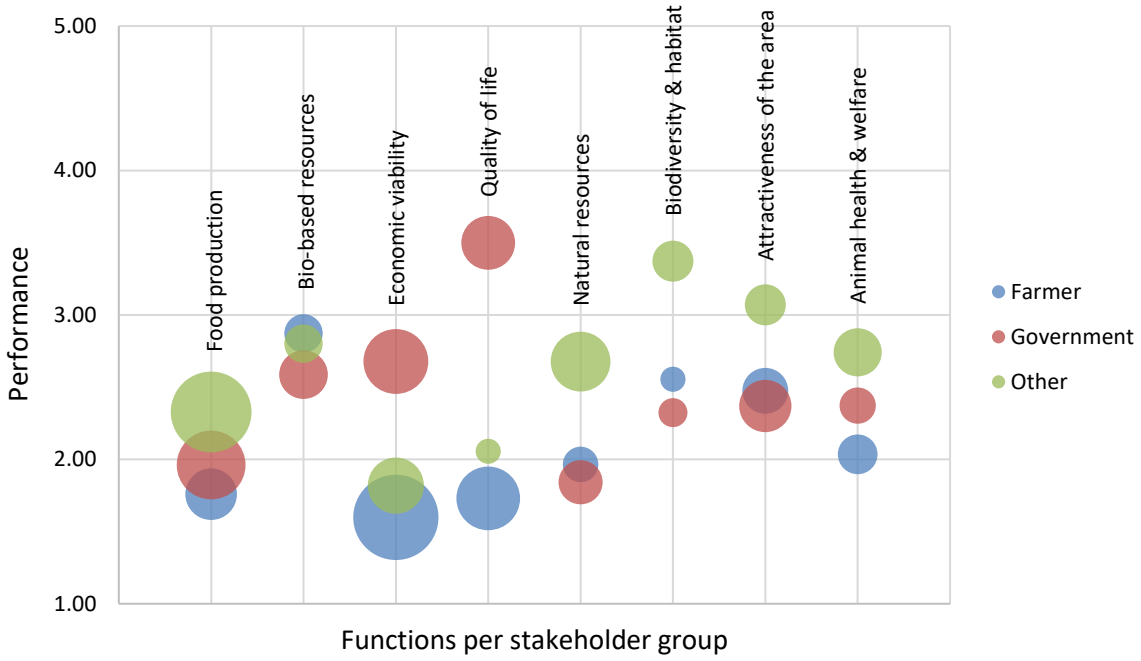

Figure A1. Bubble graph presenting averaged scores on performance of functions (from 1 to 5), aggregated by stakeholder group, while also indicating their importance (size of the bubbles), relative to each other (n=19)

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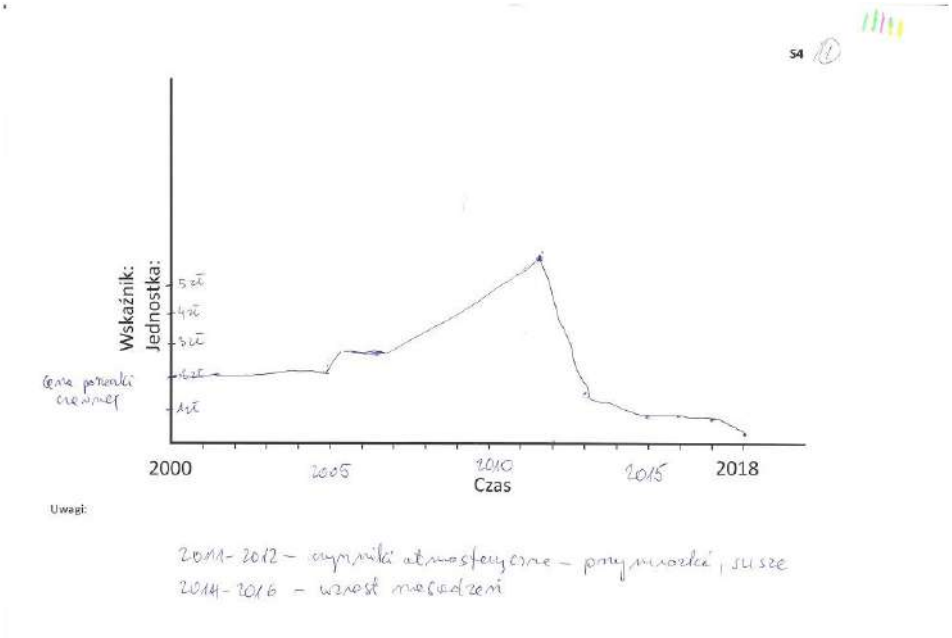
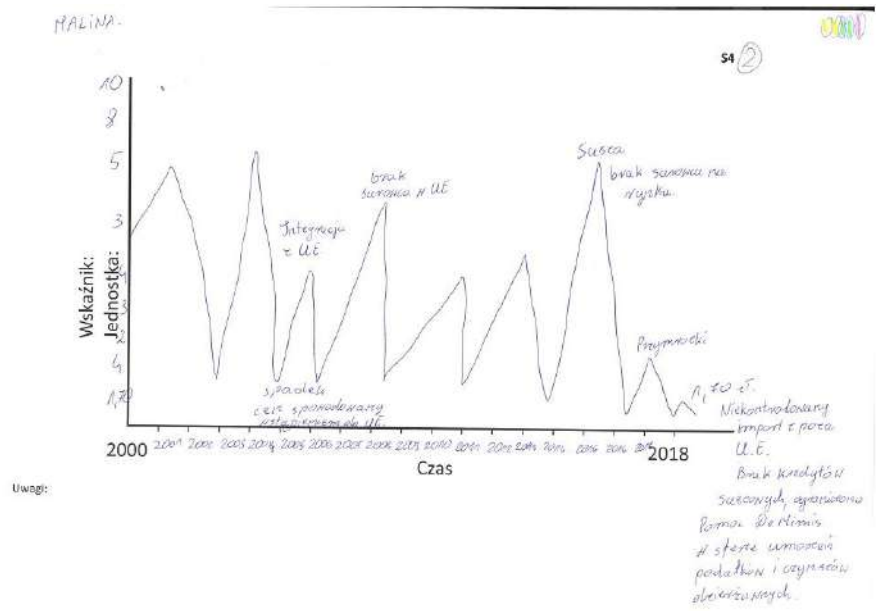
Appendix C. Dynamics of main indicators

Original drawings of each group's indicator are presented below.

Group 1. Price of black currant (4 people)



Group 2. Price of raspberry (6 people)



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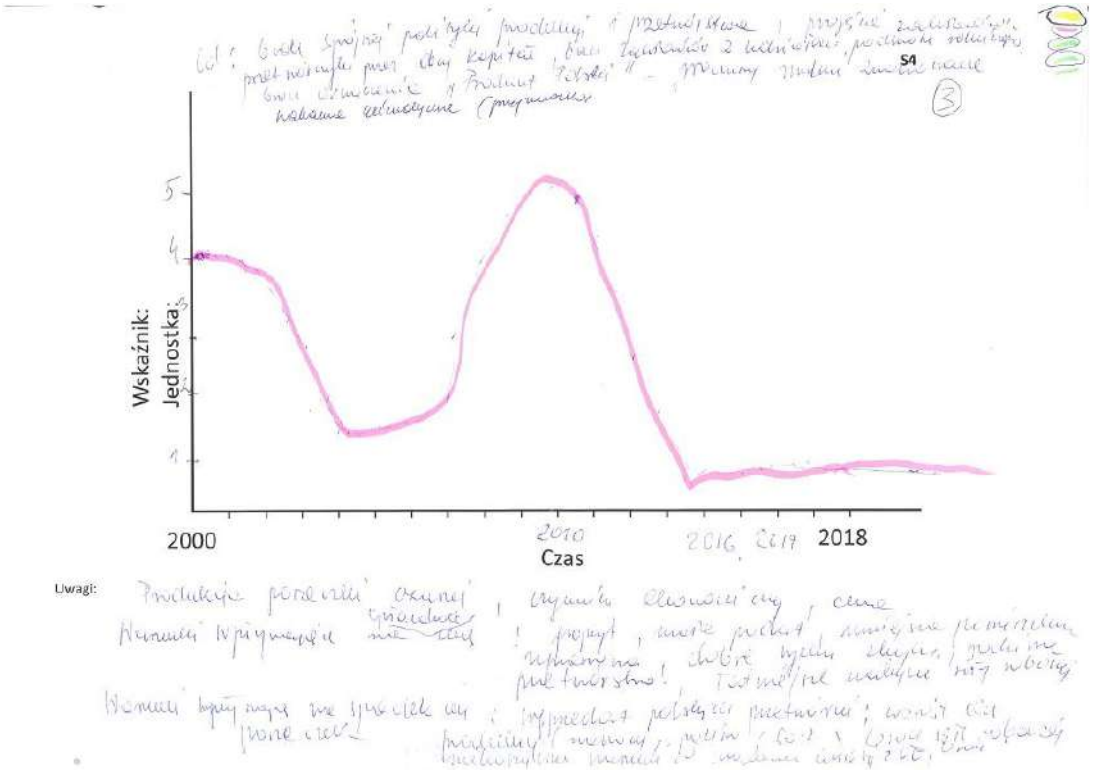
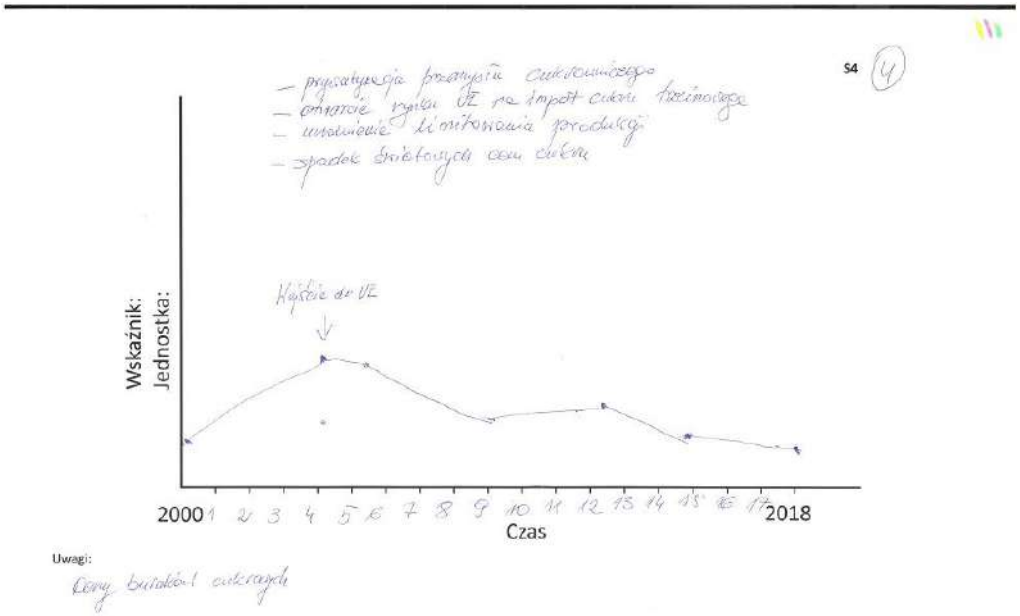
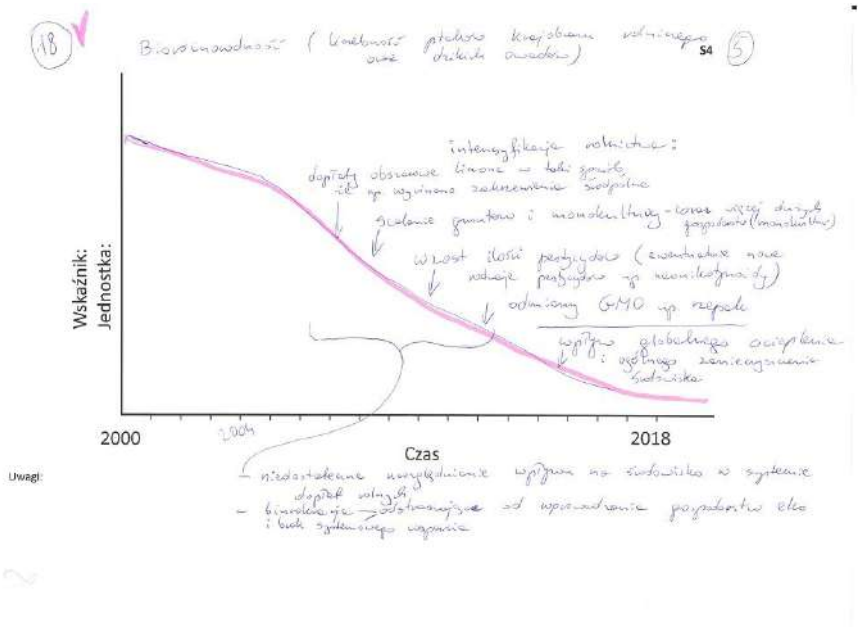
Group 3. Price of black currant (5 people)



Group 4. Price of sugar beet (3 people)



Group 5. Biodiversity (1 person)



Appendix D. Details on scoring strategies and resilience attributes

Table A6. Mean (and standard deviation) of implementation scores of strategies and their potential contribution to robustness, adaptability and transformability (n=14)

Selected indicator	Strategy	Implementation score		Potential contribution to resilience capacities: Robustness		Adaptability		Transformability	
		Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Price of black currant		1.6	1.2	1.4	2.3	2.2	1.3	-0.1	2.6
	Marketing	1.0	0.0	2.8	0.5	2.8	0.4	1.0	2.8
	Diversification	3.0	2.0	-2.7	0.6	-1.0	1.4	-3.0	0.0
	State support	1.1	0.2	2.3	0.6	2.3	0.6	2.2	1.1
	Enduring	2.0	1.7	0.4	2.3	2.5	0.7	-1.5	1.7
	Horizontal cooperation	1.0	0.0	3.0	0.0	2.7	0.6	1.0	3.5
	Insurance	2.0	0.0	3.0	0.0	2.5	0.7	1.0	1.4
	Vertical cooperation	1.0	N/A	3.0	N/A	2.0	N/A	-3.0	N/A
Price of sugar beet		3.7	1.2	2.3	0.6	0.7	1.2	1.0	1.7
	Diversification	5.0	N/A	2.0	N/A	2.0	N/A	3.0	N/A
	Enduring	3.0	0.0	2.5	0.7	0.0	0.0	0.0	0.0

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Biodiversity		3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Marketing	3.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A
	State support	3.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A
Price of raspberry		3.0	N/A	-3.0	N/A	-3.0	N/A	-3.0	N/A
	Marketing	3.0	N/A	-3.0	N/A	-3.0	N/A	-3.0	N/A
Grand Total		1.9	1.3	1.3	2.2	1.6	1.7	-0.1	2.4

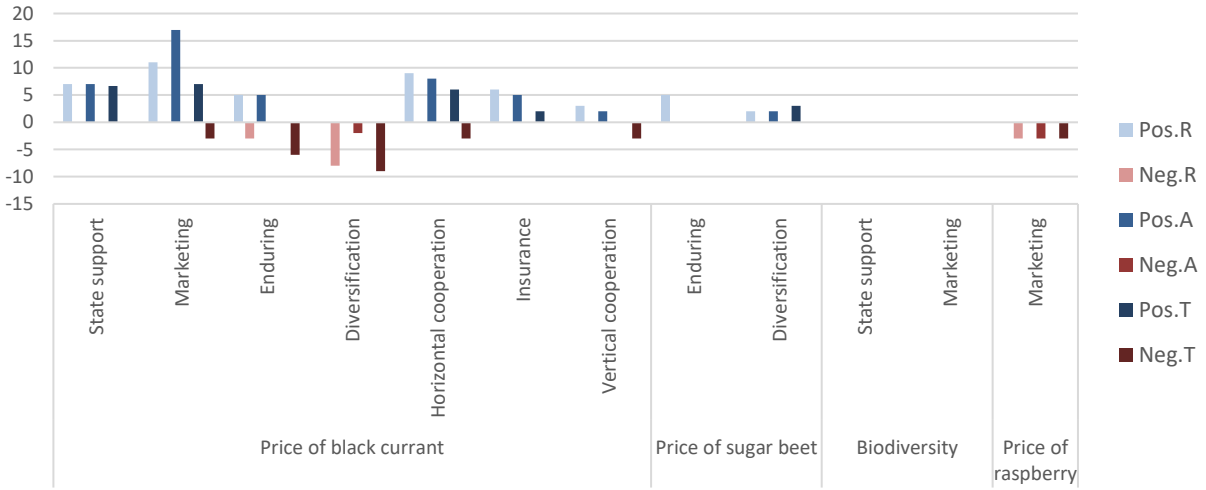

Figure A3. Bar graph presenting total positive and negative points allocated to a strategy's contribution to robustness, adaptability and transformability (n=14)

Table A7. Mean and standard deviation of performance scores of resilience attributes. Per stakeholder group and for all participants (n=16)

Extent into which attribute applies in the farming system								
	Farmer		Government		Other		Total	
Resilience attribute	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Reasonably profitable	1.4	0.5	1.7	0.7	1.8	0.6	1.5	0.6
Coupled with local and natural capital (production)	2.9	1.7	3.0	0.7	3.3	2.0	3.0	1.2
Functional diversity	1.6	1.5	2.0	0.7	3.8	1.0	2.3	1.3
Response diversity	2.1	1.4	1.7	1.2	2.0	1.2	2.0	1.2
Exposed to disturbance	1.4	1.0	1.0	0.7	1.8	0.0	1.4	0.7
Spatial and temporal heterogeneity (farm types)	1.7	1.9	3.7	1.0	2.3	2.3	2.3	1.6
Optimally redundant (farms)	1.4	1.3	1.0	0.5	2.3	0.0	1.6	0.9

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Supports rural life	2.1	1.0	1.7	0.9	2.3	1.2	2.1	0.9
Socially self-organized	2.7	1.9	1.3	1.7	2.3	0.6	2.3	1.6
Appropriately connected with actors outside the farming system	1.9	0.6	1.3	1.6	1.5	0.6	1.6	1.2
Infrastructure for innovation	2.0	0.5	1.7	0.6	2.3	1.2	2.0	0.7
Coupled with local and natural capital (legislation)	1.8	0.5	1.0	0.8	1.3	0.0	1.5	0.7
Diverse policies	2.0	1.7	1.0	1.7	2.8	0.0	2.0	1.5

Table A8.1. Mean and standard deviation of resilience attribute's contribution to robustness. adaptability and transformability (concerning the following groups: Farmers and Government) (n=16)

	Extent into which resilience attribute potentially can contribute to resilience capacities in the farming system											
	Farmer						Government					
	Robustness		Adaptability		Transformability		Robustness		Adaptability		Transformability	
Resilience attribute	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Reasonably profitable	1.9	-0.8	1.5	-1.6	1.7	-2.0	0.0	3.0	N/A	1.0	0.0	-3.0
Coupled with local and natural capital (production)	1.4	1.0	1.0	1.0	1.7	1.4	0.7	2.5	0.6	1.7	0.0	1.0
Functional diversity	2.2	0.2	1.2	1.3	2.6	1.0	3.5	-0.5	0.6	1.7	0.7	2.5
Response diversity	2.0	0.2	1.9	-0.6	1.6	1.8	2.6	1.0	0.7	1.5	2.8	1.0
Exposed to disturbance	1.9	-0.3	2.1	-0.3	2.1	-0.4	0.0	2.0	0.7	1.5	2.1	0.3
Spatial and temporal heterogeneity (farm types)	1.0	1.3	1.9	-0.3	1.7	-0.6	2.1	1.3	1.4	2.0	3.5	0.5
Optimally redundant (farms)	1.7	-0.3	2.5	0.3	1.7	1.4	0.7	1.5	1.5	0.7	2.1	0.5
Supports rural life	1.0	1.5	1.3	1.3	1.8	0.8	0.7	2.5	1.4	2.0	1.2	1.7
Socially self-organized	2.5	0.3	2.2	0.0	2.6	0.2	0.0	2.0	2.0	1.0	4.2	0.0
Appropriately connected with actors outside the farming system	1.7	-1.3	2.1	-0.8	1.8	-2.2	0.7	2.5	2.8	1.0	2.1	1.3
Infrastructure for innovation	2.8	1.0	2.9	0.3	2.6	0.8	0.7	1.5	1.2	0.3	2.1	0.5
Coupled with local and natural capital (legislation)	1.5	-1.3	2.4	0.0	2.5	-1.2	0.0	2.0	2.1	0.5	1.2	-0.3
Diverse policies	2.9	0.0	2.8	-1.0	1.4	-2.0	2.1	1.3	2.8	1.0	2.8	1.0

Table A8.2. Mean and standard deviation of resilience attribute's contribution to robustness. adaptability and transformability (concerning the following groups: Other and Total) (n=16)

	Extent into which resilience attribute potentially can contribute to resilience capacities in the farming system	
	Other	Total

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	Robustness		Adaptability		Transformability		Robustness		Adaptability		Transformability	
Resilience attribute	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Reasonably profitable	0.0	1.0	2.7	0.8	2.1	1.8	2.4	0.6	2.0	-0.4	2.6	-0.8
Coupled with local and natural capital (production)	0.0	2.8	1.3	1.5	0.6	1.0	1.4	2.0	0.7	1.4	1.1	1.2
Functional diversity	0.7	2.0	0.8	1.8	0.5	2.0	2.1	0.7	0.7	1.6	2.0	1.8
Response diversity	2.8	1.8	0.5	2.0	0.8	1.4	1.8	0.9	1.8	0.7	1.6	1.5
Exposed to disturbance	2.1	2.0	0.8	2.0	0.8	1.8	1.7	1.1	1.7	1.0	2.0	0.6
Spatial and temporal heterogeneity (farm types)	3.5	1.8	1.0	1.8	1.0	1.2	1.2	1.5	1.7	1.0	1.9	0.3
Optimally redundant (farms)	2.1	0.5	2.4	2.0	0.8	0.8	1.8	0.4	1.8	1.0	1.8	1.0
Supports rural life	1.2	1.3	0.5	1.5	0.6	1.0	0.8	1.6	1.0	1.5	1.6	1.1
Socially self-organized	4.2	2.0	1.2	2.5	1.0	1.2	1.8	1.3	1.9	1.2	2.6	0.6
Appropriately connected with actors outside the farming system	2.1	1.8	0.5	0.5	1.7	0.4	2.0	0.7	2.0	0.1	2.3	-0.4
Infrastructure for innovation	2.1	1.8	1.0	1.8	1.0	2.0	1.8	1.4	1.7	0.9	1.8	1.3
Coupled with local and natural capital (legislation)	1.2	-0.3	2.6	0.5	2.4	0.0	2.1	-0.2	2.1	0.3	2.3	-0.5
Diverse policies	2.8	-0.5	3.0	0.8	2.6	0.2	2.6	0.2	2.6	0.1	2.5	-0.6

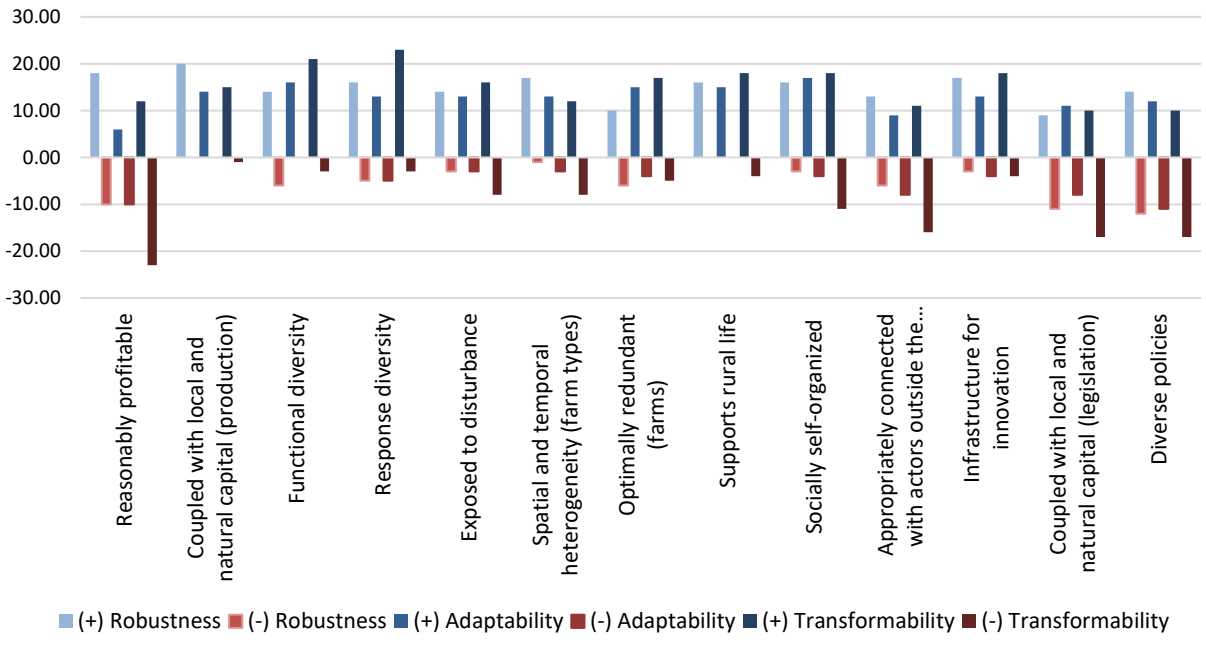

Figure A4. Bar graph presenting total positive and negative points allocated to a resilience attributes' contribution to robustness. adaptability and transformability (n=16)

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Appendix E. Workshop challenges and improvements

Complexity of the methodology, even though understandable by the researchers and definitely thought-through, was quite difficult to perceive by the stakeholders. It was visible at some points that particular issues were misunderstood or not understood to the full extent (e.g.: 1) resilience attributes, in particular the question in the questionnaire S6 regarding how would a high level of the resilience attribute contribute to resilience in their farming system, b) indicating actual/possible strategies during the group exercise and writing them down on a graph – most, despite numerous explanations, have limited their efforts to analysis of indicator changes over the time, not). It was at time the case even though the IRWiR PAN team had 5 people overseeing the workshop and helping the participants with any questions they had, actively working with each group and guiding them (sometimes even more, than thought necessary from the standpoint of methodology).

On one side, the workshop was too long and complicated, so it was a challenge to keep people present/focused and not have them leave before finishing all the questionnaires. Yet there is an understanding that splitting such workshop into two parts would be too difficult as well, as not the same people would participate, as well as the explaining (reminding) even the basic ideas of the methodology would be even more time consuming.

At the same time there is a risk to "wear off" the stakeholders positive attitude and willingness to participate in any future events, as they do not receive much in return. Presenting them with certificates of participation and ensuring a full meal is a good practice, but definitely not enough in case of such time consuming events.

Unfortunately, it was not possible to perform an *ex post* evaluation of the stakeholders' opinion, as most of the participants did not leave their e-mail contacts.

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